Breeding in Africa for Africa

AUG 2018

SASHA Sweetpotato Action for Security and Health in Africa

In 2017/2018, experimental results at CIP-Headquarters showed genetic gains for root yield of between 70% and 118% over the baseline breeding populations selected for wide adaptation, earliness, high iron content, and non-sweetness. In Uganda, based on the performance of 1,600 crosses for three seasons (2016-2017), 48 cross combinations were identified to generate progenies with sweetpotato virus disease (SPVD) field resistance. In Mozambique, two promising clones have good combinations of beta-carotene, iron and zinc, and with annual increments of 0.166 to 5.91 mg/100g (dwb) in the three traits.

Fig. 1 Children also appreciate root assessments in Inhambane Province, Mozambique (Credit B. Rakotoarisoa)

What is the problem?

Traditionally, sweetpotato breeding programs have taken a long time, 7 to 8 years, to produce a new variety. Moreover, as of 2005, most countries in Africa had no real breeding program and relied on testing materials developed elsewhere. Currently, there are 13 Sub-Saharan African (SSA) countries with active breeding programs and two more engaged in varietal selection. The challenge now is to have sustained support for these breeding programs and deal with increasing demands to meet very diverse needs of different user groups (Fig 1).

What do we want to achieve?

We want strong, active conventional sweetpotato breeding programs in SSA. We want to use better methods of gene pool separation as they become available and cheaper (particularly DNA markers) to improve our abilities to exploit heterosis. During the first phase of SASHA, we redesigned sweetpotato breeding protocols ("accelerated breeding") to produce varieties in fewer years (about 4). We will continue investing in sweetpotato types that will provide national programs with a wide range of "parents" having the preferred trait combinations, paying more attention to preferences of processors and consumers of all ages (Fig 2). We expect national programs to release at least 30 additional, locally adapted sweetpotato varieties between 2015 and 2019 with a cadre of sweetpotato breeders trained in the latest techniques, using common protocols, and raising funds to support their programs.

Where are we working?

CIP breeders, based at three Sweetpotato Support Platforms (SSPs) in Uganda, Mozambique and Ghana, provide technical backstopping at the sub-regional level for the 17 countries targeted under the Sweetpotato for Profit and Health Initiative.

How are we making it happen?

First, using "accelerated breeding", we conduct multilocational testing from the earlier stages of selection, in contrast to the conventional approach of using one site for two or more initial evaluations. Second, are developing appropriate approaches to exploit heterosis ("hybrid vigor") systematically in each sub-region, through the creation of populations that will enable systematic long-term boosts in yield. Third, we are using near infrared reflectance spectroscopy (NIRS) for the rapid and inexpensive evaluation of micronutrients and sugars. Finally, since 2014, our breeding efforts have been linked to a project developing genomic tools to increase the efficiency of sweetpotato breeding. Our breeding effort exploits the broad genetic diversity of African sweetpotato germplasm to produce new locally adapted sweetpotato varieties in Africa. These population improvement programs are linked to national variety development programs, led by National Agricultural Research Systems (NARS) breeding programs. We are breeding in Africa for Africa, with a focus on creating populations with major traits, namely: 1) Sweetpotato virus disease

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CGIAR RESEARCH PROGRAM ON Roots, Tubers and Bananas

Key Partners

Major partners are the national sweetpotato programs in the target countries. The Support Platform (SSP) for Eastern and Central Africa is based at the National Crops Resources Research Institute (NaCRRI) in Uganda and the Kenyan Plant Health Inspection Service (KEPHIS). For Southern Africa, the SSP is based at the Agrarian Research Institute of Mozambique (IIAM) in Maputo. The West Africa platform is located at the Council for Scientific and Industrial Research-Crops Research Institute (CSIR-CRI) in Kumasi, Ghana.

Fig. 2 Consumers at Kaneshie market (Ghana) evaluating sweetpotato fries made from different varieties (Credit E. Dery)

Fig. 3 Speedbreeders at annual breeders and genomics meeting in Nairobi, Kenya in June 2018 (Credit F. Njung'e)

(SPVD) resistance and high beta-carotene content (Eastern and Central Africa); 2) Drought tolerance and high beta-carotene and high-iron (Southern Africa), and 3) High dry matter and low sweetness (West Africa). During SASHA Phase 1, the Alliance for a Green Revolution in Africa (AGRA) supported 10 national sweetpotato programs with breeding grants, 4 with seed systems grants, and sponsored 10 sweetpotato breeders for PhD training and 4 for Masters. Sweetpotato "speedbreeders" meet annually to learn new techniques and share knowledge (Fig 3). Moreover, farmers and value chain actors are active partners in the process of selecting materials to meet their conditions and preferences.

What have we achieved so far?

a) We have demonstrated in Peru and in SSA that heterosis can be exploited in sweetpotato breeding to, dramatically improve storage root and biomass yield.
b) The Speedbreeders Community of Practice has expanded to 15 countries to include Madagascar, and Côte d'Ivoire (Ivory Coast) which have selection activities; the other 13 countries (Burkina Faso, Burundi, Ethiopia, Kenya, Ghana, Malawi, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Zambia, and Uganda) have active sweetpotato breeding programs with crossing blocks.
c) Seven countries have released improved sweetpotato varieties following the accelerated breeding scheme.
d) Since 2009, 16 SSA have released 124 varieties. Of these, 76 have been bred in SSA in 11 SSA countries, 51 of which are orange-fleshed and three are purple fleshed.
e) To date, during phase 2, the population development program in Uganda has provided 399,986 seeds to 8 NARIs; the one in Mozambique distributed 146,662 seeds to 18 NARIs based in SSA, South America, and Asia. In Ghana, we used a range of techniques to improve seed production - a perennial problem in West Africa - with successful production of over 41,000 seeds from paired crosses, and distribution of seed to 9 NARIs.
f) The SASHA-supported breeding programs at HQ and in SSA evaluated genetic gains in storage root yield of released varieties over the years and found relatively consistent gains of about 0.3 t/ha/year across programs in Ghana, Mozambique, Uganda and Peru.
g) During the 17th Sweetpotato SpeedBreeders and Genomics Community of Practice annual meeting in June 2018 held in Nairobi, Kenya, the breeders had hands-on training on how to use Sweetpotatobase and HIDAP software programs for managing, analyzing, storing and sharing data. They also had a session on using PhotoSynQ equipment measuring photosynthetic parameters, which will help breeders select genotypes with inherent abilities for photoprotection and drought tolerance.
h) SASHA-GT4SP projects have made very good progress in capacity development, phenotyping, sequencing, and data development.
i) At CIP-HQ, four potential testers (materials with positive, medium to high general combining ability to the complementary genepool) were identified that will be used to evaluate more parents for their value in population improvement.
j) One clone (MUSGI 5052-2) was identified in the Mozambique high-iron (Fe) breeding effort, with 4.4 mg/100 g, exceeded the minimum target level of 2.4 mg/100 g (25% of RDI for a child, 4-8 years old) set by the breeding program. A multiple-meal feeding trial led by ETH Zurich to assess iron bioavailability of this clone is underway.

What are the next steps?

Population development work in SASHA Phase 2 (2014-2019) continues, with trials designed to exploit heterosis under drought and high SPVD pressure in Mozambique, Uganda, and Ghana. In early 2019, Ghana will release improved, less-sweet varieties. Breeders will increasingly engage with a diverse range of end users in the varietal selection process. In collaboration with the genomic tools project, HIDAP, linked to Sweetpotato base, is being tailored for off- and on-line use. If results for the feeding trial are positive, breeding for high-iron will be integrated into the East and West African breeding platforms.

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