AUG 2017

Breeding in Africa for Africa

By July 2016, efforts at CIP-Headquarters in Peru to systematically exploit heterosis were well advanced with testing of hybrid progenies underway following a full cycle of reciprocal recurrent selection (RRS). In Uganda, results on the potential to exploit heterosis confirm selecting strongly for virus resistance using RRS. Genetic gains of 0.3 t/ha/year in storage root yield of released varieties over the years were found across programs in Ghana, Mozambique and Peru. Two improved data collection, storage and analysis tools were introduced to the breeding community of practice: Highly Interactive Data Analysis and Productivity Tools for Breeding (HIDAP) and Sweetpotatobase.

Fig 1. Speedbreeders at the annual meeting for breeding and genomics held in Kigali, Rwanda (May 2017) (credit C. Bukania)

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 countries with active breeding programs in sub-Saharan Africa (SSA) 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.

What do we want to achieve?

We will continue to strengthen conventional sweetpotato breeding in Africa. 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. Attention is paid to preferences of processors, women producers and consumers of all ages. We expect national programs to release at least 30 additional locally adapted sweetpotato varieties between 2015 and 2019. We want to see an expanding 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, we are working to develop appropriate approaches to exploit heterosis ("hybrid vigor") 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 important quality attributes, including 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

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 Seed collection in the crossing block at Umbeluzi Research Station (credit J. Ricardo)

Fig. 3 Grafting of poor-flowering clones to prolifically flowering rootstocks is used to increase flowering for seed production (credit T. Carey)

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 in storage roots, namely: 1) Sweetpotato virus disease (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 1). 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 14 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.
b) Seven countries have released improved sweetpotato varieties following the accelerated breeding scheme. Mozambique released seven more drought tolerant varieties in February 2016, their second round of accelerated breeding.
c) Since 2009, 10 SSA countries have released 57 new sweetpotato varieties, 40 of which are orange-fleshed and two are purple-fleshed. The 2014 Catalogue of Orange-fleshed Sweetpotato for Africa describes 60 varieties.
d) To date, during phase 2, the population development program in Uganda has provided 361,366 seeds to 8 NARIs; the one in Mozambique distributed 128,570 seeds to 12 NARIs (Fig. 2). In Ghana, we used a range of techniques to improve seed production – a perennial problem in West Africa - with successful production of over 25,000 seeds from paired crosses (Fig. 3).
e) 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 and Peru. Ugandan trials are yet to be completed.
f) The SASHA sweetpotato breeding and genomics (GT4SP) projects collaborated in introducing training on and use of molecular markers at the Speedbreeders annual meeting at BecA, Nairobi, in June 2016 and in Kigali in May 2017.
g) To continue to improve breeding management tools, the CloneSelector tool was upgraded to HIDAP (detailed brief available), and linked to Sweetpotatobase for maintenance and analysis of data.
h) 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.
i) One clone (MUSG15052-2) was identified in the Mozambique high-iron (Fe) breeding effort that, at 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. An Australian lab confirmed there was no sample contamination.

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 and Uganda, respectively. By the end of 2017, 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 Sweetpotatobase, is being tailored for off- and on-line use. We will collaborate with ETH Zurich in the coming year to assess the bio-availability of the high-iron OFSP clone bred in Mozambique.

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