Advances in groundnut breeding for drought prone West and Central Africa

ABSTRACT - The West and Central Africa region accounts for more than 70% of the groundnut production in Africa. The crop is challenged by various biotic and abiotic production constraints with drought being the main abiotic constraint. ICRISAT has been working with national breeding programs to develop climate resilient improved groundnut varieties. The approach used included identifying sources of resistance, developing populations, evaluating in target environments and releasing improved farmer and market preferred varieties for production. The Tropical Legumes project initiated in 2007 has been instrumental in strengthening the breeding program in the region. Nine drought tolerant accessions were identified from evaluation of the mini core collections, and these accessions have been utilized breeding programs. Since 2007, ICRISAT distributed more than one thousand advanced breeding lines to national programs. Farmer participatory variety selection was found very useful for fast track release and adoption of improved varieties. Twenty two varieties have been released/registered across the region as a result of project efforts (4 in Ghana, 5 in Mali, 4 in Niger, 3 in Nigeria and 6 in Senegal). These varieties are high yielding (yield advantage of >20%) with resistance/tolerance to drought and major diseases. Currently, efforts are underway to improve the efficiency of breeding programs to enhance genetic gain. These include designing product pipelines based on traits of breeding interest; rapid generation advancement of breeding populations (2 to 3 generations per year); integrating modern genomic tools; digitizing data collection, analysis, management and sharing by using Breeding Management System (BMS); and enhancing the skills of breeders and technicians.

INTRODUCTION - Groundnut is an important food and cash crop throughout Sub-Saharan Africa grown on close to 13 M hectares in 2014 (about 43% of world total) (FAO, 2016). The West and Central Africa (WCA) region accounts for more than 70% of the groundnut production in Africa. Nigeria and Senegal are the largest producers in the region with production of 3.1 million tons and 891,000 tons in 2014, respectively (FAO, 2016). Other important groundnut producing countries include Ghana, Burkina Faso, Mali and Niger. Groundnut yield in WCA is low, around 1 ton/ha attributed to a combination of biotic, abiotic and socio-economic constraints. ICRISAT’s WCA groundnut breeding program, in partnership with national breeding programs, has been working in the region since the late 1980s to develop improved farmer, market and consumer preferred varieties to mitigate production constraints and improve productivity and production. Here we highlight advances made in developing improved groundnut varieties.

ADVANCES - Significant advances have been made in genetic resources characterization and utilization, creation of variability, performance evaluation, and release of varieties. 1) Genetic resources characterization and utilization: the gene bank established in Niamey, Niger assembled over 6,000 groundnut accessions between 1995 and 2003 (Ntare et al., 2003). Accessions were identified with resistance and/or tolerance to drought (Hamidou et al., 2012; Mayeux et al., 2003), aflatoxin (Walliyar et al., 2016), Rosette (Olorunju et al., 2001). 2) Population Development: crosses have been made to develop populations for various traits of interest (drought, foliar diseases, rosette, aflatoxin and quality traits). Some of the important parents are ICG 7878, ICG 7, ICG 6222, ICG 4440, ICMP 40 (IFRS) 4, ICGV 00350, ICGV 86124, ICGV 86024, ICGV 86015, ICGV 91114, ICGV 00864, ICGV 01276, ICGV 03179, 55-437, J11, JL 24, Fleur 11, 47-10 and ICIAR 19 BT. Currently there are more than 350 F1 to F6 populations. 3) Performance evaluation: involved preliminary and advanced variety trials and FPVS. The advanced trials included multi-environmental and regional variety trials in partnership with NARS. 4) Variety release: based on performance evaluations, a total of 22 improved groundnut varieties were released/recommended in the respective countries since 2007. The national program in Niger released four varieties (RRB, ICG 9346, J11 and Fleur 11). In Nigeria, three short-duration rosette resistant varieties were released: SAMNUT 24, SAMNUT 25 and SAMNUT 26. In Mali, five varieties (Nieta Tiga, Yiriwa Tiga, ICGV 86024, Nisonja, Bagui-tana) were registered. In Senegal, six varieties (H7S5-0, PC79-79, 78-936, 55-33, SRV1-19 and 73-9-11) were released while 4 varieties (Oboolo, Obooshi, Othuia, Nenyawoso) were released in Ghana. The released varieties as well as varieties proposed for release showed a yield advantage of up to 42% over the local varieties grown by farmers with some of the varieties yielding over 31/ha in some locations.

APPROACHES - The ICRISAT regional groundnut improvement program for WCA was established at the ICRISAT Sahelian Center (ISC) in Niger in 1988. The breeding approach included identifying sources of variability for traits of interest, developing populations for increasing genetic variability and selection, evaluating selections in target environments in partnership with national breeding programs and releasing improved farmer preferred varieties for production in the region. Northern Sahel, Southern Sahel, Sudanian and Guinean Savannah have been the target agro-ecologies. Since the establishment of the WCA breeding program, tripartite links between ICRISAT’s WCA, Asia and East and Southern Africa (ESA) programs have existed. Focus traits of the breeding program included short duration and resistance/tolerance to drought and diseases (leaf spots, rosette and aflatoxin). Farmer Participatory Variety Selection (FPVS) using the mother and baby trial approach (Ntare et al., 2007) has been used to assess farmers’ trait preferences for varieties and increase farmers’ exposure to new groundnut varieties. The Tropical Legumes project initiated in 2007 has been instrumental in strengthening the breeding program and speed up the variety release process in the region.

CHALLENGES, OPPORTUNITIES AND WAY FORWARD - The utilization of integrated breeding is limited. There is opportunity to exploit available resources including through regional and international collaborations and/or outsourcing services to utilize genomic tools for enhancing genetic gains of breeding programs. Partnership has its challenges partly attributed to limited financial and human resources. Opportunities to strengthen the partnerships should be exploited, with appreciations of local limitations and mutual understanding among partners, for larger impact and efficient use of limited resources by minimizing redundancy. The groundnut breeding program in WCA is working to enhance genetic gains for traits of interest in WCA through: utilizing the genetic diversity of groundnut; working on a breeding pipeline; identifying representative test environments; rapid generation advancement; collaborating with national, regional and international programs; institutionalizing the application of the Breeding Management System (BMS) to enhance efficiency of crossbreeding programs and trial protocol management, data collection, analysis & management; using modern tools like NIRS for accurate measurement of specific traits; and enhancing the skills of breeders and technicians in the region.