



## About the bulletin

The Bulletin of Tropical Legumes is a quarterly publication of the Tropical Legumes III (TL III) project. The project is funded by the Bill & Melinda Gates Foundation and jointly implemented by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Center for Tropical Agriculture (CIAT) and the International Institute of Tropical Agriculture (IITA) in close collaboration with the national agricultural research systems (NARS) of target countries in sub-Saharan Africa and South Asia. This quarter, we focus on the progress made under Objective 3 of the project: *To enhance cowpea productivity and production in drought-prone areas of sub-Saharan Africa and Objective 6: Sustainable and impact-oriented legume seed delivery systems for smallholders – Cowpea seed system during 2 years of the project.*

## Executive Summary

A major focus of the TL III project is the modernization of cowpea breeding programs at IITA and national partners' institutes across West Africa. To this end, in addition to incorporating recommendations from the Breeding Program Assessment Tool (BPAT), approaches to trait discovery and breeding pipelines are being radically restructured to facilitate increased efficiency of key operations. TL III has placed emphasis on the development of genomic resources, management of genotypic and phenotypic data and training of scientists and their technicians for cowpea.

Genomic resources from partners have significantly contributed to the Trait Discovery

Pipeline mainly through sharing information and supporting West African scientists with the implementation of molecular breeding. High-density genotyping assay developed by leveraging collaborations with a range of partners will benefit the project considerably. SNP data from five bi-parental RIL populations were used to produce one consensus genetic linkage map comprising of 37,372 SNP markers. This is a 34-fold increase in marker density over the best previous map.

The Breeding Management System (BMS) has been institutionalized and its adoption is likely to improve in coming seasons. Electronic field books are being adopted and different data sets (pedigree, phenotyping and genotyping) are being stored in the system now. TL III scientists, both from IITA and NARS, are benefiting from training programs and workshops on genomics tools, data collection, analysis and a suite of database tools. Project interventions have helped develop and successfully implement innovative seed delivery models that significantly boosted the cowpea seed system in many countries of West Africa.

## Introduction

Cowpea (*Vigna unguiculata* L. Walp.) plays an important role in human nutrition, food security, and income generation for farmers and food vendors in sub-Saharan Africa (SSA). Globally, an estimated 6.5 million metric tons (MT) of cowpea is produced annually on about 14.5 million hectares. Africa accounts for about 83% of the global production, of which over 80% is produced in West Africa. An estimated 40% of the global production and over 60% of Africa's production is from Nigeria, the world's largest producer and consumer of cowpea. In the Sahel and Savanna agroecologies, farmers generate most of their income by selling cowpea seeds and fodder. Women and young girls are able to fulfil their basic needs by selling snacks made from cowpea.

Cowpea is adapted to different types of soils and cropping systems. However, the crop is susceptible to several biotic (insects, diseases, parasitic weeds) and abiotic (drought, heat and low soil fertility) stresses. In addition, cowpea is grown mainly under traditional systems resulting in low grain yields in farmers' fields, especially in the West African sub-region (250-300 kg/ha). Considering the large difference between farmers' yields (300 kg/ha) and experimental station yields

(1500 -2500 kg/ha), there is great potential to increase on-farm yields in the region. The project is designed principally to promote technologies and seed systems that enhance the productivity and production of target legume crops (groundnut, cowpea, common bean and chickpea) in drought-prone areas of Africa and South Asia. Objective 3 of this project covers cowpea breeding activities while Objective 6 targets seed systems activities. The four countries and institutes participating in these activities are Burkina Faso (Institut de l'Environnement et de Recherches Agricoles – INERA), Ghana (Savanna Agricultural Research Institute – SARI), Mali (Institut d'Economie Rurale – IER) and Nigeria (Institute for Agricultural Research – IAR). This bulletin highlights the key activities related to these two objectives.

## Enhancing Cowpea Productivity and Production in Drought-Prone Areas of Sub-Saharan Africa

### Modernization of Cowpea Breeding Program in West Africa

A major focus of the TL III project is the modernization of cowpea breeding activities in a sustainable way at the International Institute of Tropical Agriculture (IITA) and national partners' institutions across West Africa. Approaches to trait discovery and breeding pipelines are being restructured significantly to facilitate increased efficiency of main operations.

#### Self-assessment of cowpea breeding programs

To have a better understanding of the status of the cowpea breeding programs, the Breeding Program Assessment Tool (BPAT) version 2.0 through a joint project supported by McKinsey and Company and the Context Network, was first administered to the IITA cowpea breeding program. The BMGF and IITA managements received the results and the recommendations from this exercise. BPAT was later made available to collaborating national research institutes for self assessment, which was carried out in February 2017 by the NARS breeding programs.

All the breeding programs have a long history of cowpea improvement activities under the leadership of well trained scientists. A common trend across the breeding programs in West Africa is the involvement of young scientists who are now fully involved with the breeding programs. The cowpea breeders in IER, Mali and SARI, Ghana recently obtained their PhD degrees in plant breeding. The support staff are mostly ageing in many of the institutions but efforts are on to replace them. However, INERA, Burkina Faso and IAR, Nigeria have better opportunities for support from allied disciplines

compared to Mali and Ghana. Most programs have no trained biometricians. Prior to the introduction of the BMS through TL III, none of the breeding programs had a well structured data handling system in place.

There are a few old screen houses and some level of irrigation systems in place at the various national breeding nurseries, but through TL III, some of these are being rehabilitated as required. There is minimum mechanization in most of the programs as most activities are carried out manually. The self evaluation revealed a key issue in most programs – the lack of a specific capital equipment replacement plan. The quality and quantity of infrastructure support were rated as inadequate, and these have contributed to the limited sizes of the breeding programs. However, Program Improvement Plans (PIPs) are in place to address some of these challenges with TL III investments.

Breeding methodologies, cultivar development and release processes are appropriate in most national programs, yet there is room for improvement in several areas. Processes for cultivar development and commercial release are in place in most of the countries although the releases are not well implemented in some countries. Adoption of new technological tools and updating infrastructure by NARS institutions may lead to improvement in field operations.

#### Implementation of trait discovery pipeline

As with other TL III crops, the emphasis for cowpea is on the development of genomic resources, management of genotypic and phenotypic data and training of scientists and their technicians.

Given its leadership under phase I of the Tropical Legumes project (genomic resources), the University of California, Riverside (UCR) contributed to the Trait Discovery Pipeline mainly through sharing of information on genomic resources and supporting West African scientists in implementing molecular breeding. UCR has leveraged the Feed the Future Innovation Lab for Climate Resilient Cowpea (ILCRC) project through collaborations with INERA, ISRA – Senegal, SARI and IITA, using a new tool called “Illumina 60k iSelect Bead Assay” developed for cowpea genotyping. In conjunction with the LGC Genomics, KASP genotyping platforms for cowpea were developed from UCR-generated SNPs. These tools allow a range of genotyping capabilities for trait mapping and marker-assisted breeding. By using the Illumina iSelect “60k” SNP assay, more than 48,000 validated SNP markers were made available for conversion to marker platforms other than Illumina iSelect. The TL III project is making use of this new high-density genotyping assay for cowpea in deployment of traits. SNP data from five bi-parental Recombinant Inbred Lines (RIL) populations were used to produce

one consensus genetic linkage map comprising of 37,372 SNP markers. This is a 34-fold increase in marker density over the best previous map. Molecular breeding activities initiated under TL III will benefit from the information generated from this map, especially in the development of improved cowpea lines.

The technology will also enable the production of genetic fingerprints for any individual cowpea genotype so that similarities and differences between individuals can be readily ascertained. This tool clarifies pedigrees and purity of breeding lines, which are essential to the success of breeding programs. A set of populations including Multiparent Advanced Generation of Inter-Cross population (MAGIC) segregating for key traits like drought tolerance, *Striga* and bacterial blight resistance; Recombinant Inbred Lines segregating for aphid resistance; and Marker Assisted Recurrent Selection-derived lines for drought tolerance, *Striga* resistance and seed size are being phenotyped. The genotyping knowledge generated will be combined with phenotyping data to genetically map target traits and generate new marker information for molecular breeding.

Phenotyping and evaluation data are being collected using tablets and other handheld electronic devices. The Breeding Management System was introduced and being used in all cowpea breeding programs. Crossing block, nursery and evaluation trials are being developed using this platform. Electronic field books are being used and different data sets (pedigree, phenotyping and genotyping) are being stored in the system.

### **Implementation of breeding pipelines**

Activities are being conducted to develop drought tolerant, P-use efficient, aphid, *Striga* and bacterial blight resistant improved breeding lines. Progress is at different stages with respect to the traits being considered for incorporation into new breeding lines. Important outputs are expected to be available from the breeding pipelines from the third year.

**IAR** – Fifty seven cowpea genotypes comprising 14 released varieties and 33 accessions were screened to validate their status for aphid and cowpea bacterial blight (CoBB) resistances. The genotypes were heavily infested (>100 colony per stand) with adult aphid collected from farmers' fields. The genotypes have shown varying levels of susceptibility/resistance to these constraints. Cowpea advanced yield trials were conducted at four locations in Nigeria. These included: (i) 24 medium-duration entries, (ii) 18 short-duration entries, and (iii) 16 grain quality and fodder yield entries.

Furthermore, 18 elite lines of cowpea received from IITA plus two checks were evaluated at Zaria for resistance to

aphids, flower thrips, pod borer, and pod sucking bugs, with and without insecticide application, and laid in a Randomized Complete Block Design (RCBD).

The line IT08K-150-12 was preferred by farmers due to its early maturity, good grain size and color as well as high grain and fodder yields. The trials were harvested and data collation and analysis are in progress to prepare for its release in Nigeria. In addition, seed samples from five candidate varieties (IT08K-150-24, IT08K-150-12, IT07K-297-13, IT07K-274-2-9 and IAR-1050) were collected and submitted to the Product Development Research Programme of IAR and Multiuser laboratory, Ahmadu Bello University (ABU), Zaria for proximate analyses and determination of micronutrients' content. The results of the analyses are awaited.

A total of 1,965.5 kg of breeder seeds from five varieties, IT89KD-288, IT99K-573-1-1, IT99K-573-2-1, IT07K-318-33, IT07K-292-10 was produced in 2016.

**IER** – Breeder seeds of Acar 1, CZ06-1-05, CZ06-2-17 (Simbo), CZ06-4-16, CZ06-1-12, Cinzana Telimani, IT93K-876-12, and Sanoudaoulou were produced at Cinzana Research Station. Their seeds were further increased during the 2016/2017 off-season in Niono research station to produce foundation seed.

**IITA** – About 300 F8:10 MAGIC RILs population and their 8 parents were received from UCR and planted in the screen house for seed increase at IITA Kano. They were planted at Kano and Ibadan Stations to evaluate their agro-morphological and physiological performance under well-watered and post-flowering water stressed conditions. A second experiment is being conducted currently to determine the responses of the RILs to terminal drought. Data collection on agro-physiological performance is in progress.

A set of 50 cowpea accessions including mini core collections and breeding lines were evaluated in the laboratory and field for their phenotypic differences in rooting traits for adaptation to drought and low soil phosphorus using cigar paper roll-up and shovel omics techniques. There was significant genotypic variation for root morphology and system architecture among the tested lines at both seedling and flowering stages.

A set of 330 mini core collections in addition to 15 breeding lines were planted in the field to evaluate their genotypic variations in root system architecture and agro-physiological performance under well irrigated, post-flowering drought and low-P conditions.

Marker-Assisted Backcross (MABC) is being carried out for the introgression of *Striga* resistance gene into two released varieties, IT93K-452-1 and IT89KD-288. The BC<sub>3</sub>F<sub>2</sub> seeds from resistant BC<sub>3</sub>F<sub>1</sub> plants were planted

in *Striga*-infested plots in Kano and Minjibir. Out of the 124 families with recurrent parent IT93K-452-1 that were screened for *Striga* resistance at the Kano location, 52 did not show any *Striga* emergence. Thirty of these families displayed similar morphological attributes as the recurrent parent. For the 32 families with the second recurrent parent IT89KD-288, 17 families did not show *Striga* emergence. Twelve of these showed similar morphological traits as the recurrent parent.

At Minjibir, about 318 families from BC<sub>3</sub>F<sub>2</sub> with recurrent parent IT89KD-288 were screened for *Striga* resistance. No *Striga* emergence was observed in 203 families. Thirty nine of these families showed similar characteristics as the recurrent parent. Lines from families showing resistance and phenotypes as recurrent parents will be further evaluated in 2017 for possible nomination for release since the recurrent parents have already been officially released.

The IITA cowpea breeding program maintains line development pipelines. Segregating populations being advanced and homozygous lines F<sub>5</sub>-F<sub>7</sub> are being tested in a series of Initial Evaluation Trials (IETs) grouped according to their maturity. Best performing lines selected from IETs are advanced to Preliminary Yield Trials (PYT). After evaluating these across multiple locations (3-4), the best lines are selected to constitute Advanced Yield Trials (AYTs), from which the best lines are then advanced to Cowpea International Trials or nominated to the All Nigeria Coordinated Trials [Short duration (SD) and medium duration (MD)] for potential release in Nigeria. Breeding lines with high and stable grain yields across locations for two years were grouped into two sets of trials, SD (14 lines) and MD (12 lines), in 2016. The National Performance Trials (NPT) were conducted in five locations using these breeding lines. Among the SD lines, IT07K-301-1 gave highest grain yield of 1473 kg/ha while IT08K-10 had the lowest at 1100 kg/ha. Across locations, grain yield at Samaru was highest at 1911 kg/ha. Line LDP10-OBRI gave the highest grain yield of 1551 kg/ha among the medium-maturing lines, which was closely followed by IT07K-297-13 with 1506 kg/ha. Line IAR-06-1006 gave the lowest yield at 1188 kg/ha. On-farm data are being recorded for the best lines tested across locations for the last two years.

A total of 4.021 t seeds of 16 breeding lines were produced at six locations. The 16 breeding lines whose seeds were multiplied are: IT04K-333-2, IT08K-150-12, IT08K-150-24, IT97K-568-11, IT07K-274-2-9, IT04K-303-1, IT07K-292-10, IT98K-491-4, IT04K-227-4, IT07K-321-2, IT07K-318-33, IT08K-297-13, IT07K-321-2, IT89DK-610, IT99K-573-2-1 and IT99K-573-1-1.

**INERA** – Three crosses were made involving KN-1, Donsin (local), and Moussa (local) as resistant parents

and Tiligre as susceptible to Brown blotch disease. F<sub>1</sub> and F<sub>2</sub>s were grown in a screen house for genetic studies on drought and aphid resistance and marker discovery. A student visiting University of Virginia, USA is to screen the F<sub>1</sub>s and F<sub>2</sub>s for marker discovery.

Two sets of four lines in the pipeline for release were evaluated in Saria, Pobe, Kamboinse, Fada, Sapouy, and Farako-ba (Bobo) in larger plots (20m x 15m) for yield estimation. Two sets of 25 entries were also evaluated in the same zones for *Striga* Race Kp. Twelve lines from MARS-C2 population have also been evaluated using the platform area (Pobe, Gourcy, Pouni) and also at Kamboinse and Saria. Data from all these tests are being analyzed for decision making. Ten lines from MARS-C2 are in the platform for evaluation, and five lines from each of the two sets of the 25 entries have also been retained for on-farm evaluation.

Contact has been made with the University of Ouagadougou's biochemistry lab to do the nutritional profiling of the eight lines in the pipeline for release. Of these lines, two are dual purpose (grain and fodder type). Nutritional profiling and digestibility tests will be conducted in 2017 at Kamboinsé. About 5 t of breeder seed was harvested from seven varieties (Komcallé, Tiligré, Nafi, Yisyande, KVx745-11P, Niizwe, and KVx61-1).

**SARI** - Crosses were made to incorporate preferred traits in improved breeding lines. Advanced generations of these crosses were evaluated at Nyankpala during the 2016 cropping season. These advanced lines included: (a) 20 drought tolerant + early maturing + thrips resistant lines; (b) 40 extra-early + grain quality (seed size and seed color) + thrips resistant lines; and (c) 54 early + grain quality (size and color) + thrips resistant lines. Promising lines identified and selected from these will constitute the multilocation trials during the 2017 cropping season.

The advanced breeding line SARC 1-57-2 identified as resistant to cowpea aphid (*Aphis craccivora*) by Kusi et al. (2010) formed the basis for the ongoing aphid resistance breeding program. SARC 1-57-2 was crossed with most preferred cultivars (Songotra, Padi-tuya and IT99K-1122) to produce enough F<sub>1</sub> seeds. SSR marker CP 171/172 was found to be linked to aphid resistance in SARC 1-57-2. MABC is being used to improve the field resistance of three cowpea genotypes. On the other hand, Songotra was also used as a source of *Striga* (*Striga gesnerioides*) resistance donor parent and crossed with the following recurrent parents: Padi-tuya, SARC 1-57-2 and IT99K-1122. The SSR marker linked to *Striga* resistance in Songotra will be identified and used in MABC to improve the field resistance of the three cowpea genotypes. Crosses were made to introduce consumer-preferred seed coat color into IT99K-1122, a new high-yielding breeding line.

Six sets of advanced cowpea yield trials made up of 16 drought tolerant, 12 early maturing, 16 medium maturing, 14 dual purpose, a baby trial and 22 thrips resistant + extra early maturing advanced breeding lines with checks were performed at six locations (Nyankpala, Yendi, Manga, Damongo, Bihinayili and Savelugu). The trials have been harvested and yield data is being analyzed.

About 15 hectares were planted with Padi-tuya, Songotra, Apagbaala and Zaayura for the production of 1,510 kg of breeder seed.

### **Training in modern tools and approaches**

**Implementation of molecular breeding** – TL III scientists both from IITA and NARS (IAR-Nigeria, IER-Mali, INERA-Burkina Faso and SARI-Ghana) are benefiting from different training workshops organized by UCR under the FtF Climate Resilient Cowpea and Legume Innovation lab projects. Examples of topics covered in the training activities include the application of genotype information to identify rogues (outcrosses, labeling errors, etc.) for elimination from further work as against progeny carrying desired segments of donor genomes. Some of the key tools for data analysis discussed during the workshop included GenomeStudio, Excel and Flapjack softwares. Additional tools included BreedIT SNP Selector (breedit.org), OptiMAS, ICI Mapping, and a suite of data-basing tools from field layout through QTL analysis available in the Integrated Breeding Platform's (IBP) Breeding Management System. Training of TL III scientists is on-going through continued dialogue by email, phone or Skype, and at international meetings.

**Cowpea scientists and technicians receive training in Breeding Management System** – A five-day workshop on BMS was held at Ouagadougou for cowpea scientists from Burkina Faso, Ghana and Mali along with some of their technicians (Figure 1). Mr. Some based at CERAAS Senegal was the resource person. The workshop went through the various stages of BMS, from making spreadsheets for nurseries, germplasm management, trial design, data collection and analyses, data capture using electronic handheld tablets, data transfer from tablet to desktop computers. However, more training is needed on BMS tools such as breeding view, MBDT, OptiMAS, and ISMU to enable their application in MABC and MARS. A similar workshop was held at IITA, Kano station for cowpea scientists and select technicians from IAR and IITA between 30 May and 3 June, 2016. The two IAR cowpea breeders who attended, in turn trained 12 other IAR technical staff on the use of BMS tools from 27 June to 1 July, 2016. Three tablets were procured for IAR technical staff to start electronic data capture. An electronic fieldbook was generated for all the trials (on-station and multilocation) conducted at Zaria, Bakura and Minjibir and transferred into tablets.



Figure 1. Breeders and technicians from INERA, SARI and IER undergo BMS training in Ouagadougou, Burkina Faso.

Electronic data capture commenced in Zaria and Minjibir during the 2016 rainy season and is continuing in other locations in 2017.

**Cowpea research technicians adopt electronic fieldbooks (tablets) for data capture** – Since the commencement of TL III, cowpea scientists and their technicians have been encouraged to use handheld electronic data capture devices such as tablets. These are among some of the tools being used in the different cowpea breeding programs. Graduate students (Figure 2) are trained in the use of tablets to capture data from their experimental plots. The use of the devices followed the training of users on the breeding management system as well. The use of tablets reduces chances of errors that occur during data transfer from paper-based field notebooks. Moreover, different handwritings become difficult to decipher when data is fed from paper-based field books into computers for analysis. Errors that creep in in this manner will be reflected in the quality of data obtained following analysis. More accurate results are expected with the adoption of handheld electronic data capture devices. Additionally, time is saved as data transfer from the tablet is carried out either through direct connection to a computer or by Bluetooth.



Figure 2. A female graduate student recording Striga counts on a tablet at Minjibir experimental station, Kano, Nigeria.

## Farmer participatory varietal selection (FPVS) to boost adoption of improved cowpea lines in sub-Saharan Africa

Cowpea yields in farmers' fields are very low; so regularly injecting newly improved lines should help increase productivity. IITA and NARS cowpea breeding programs conduct Farmer Participatory Varietal Selection (FPVS) to promote new improved cowpea lines which will ensure better adoption by farmers.

### Some features of FPVS in Northern Nigeria

IITA conducted FPVS trials in 32 local government areas (LGAs) in three states (Kano, Jigawa and Katsina) of Northern Nigeria during 2011, 2013, 2015 and 2016. Of the 32 LGAs, 34% of farmers, including 29% males and 4% females with an average age of 39 participated. Among the participants, 14% had no formal education, while 19% had primary, secondary and tertiary education.

Over four years of FPVS trials, a total of 19 best improved cowpea breeding lines were selected by the farmers (<5 lines each year). Farmers used the following selection criteria in the field: (a) High grain yield for food and income; (b) high fodder yield for animal feed; (c) market value; (d) manure production; (e) early maturity to be able to plant twice in a season; (f) source of income; (g) escapes early and midseason drought; (h) growth habit (erect and prostrate type) for easy harvest; (i) pods don't decay or turn black when it rains; (j) superior to farmers' own varieties; (k) large and medium seed size for market preference; (l) swelling ability, easy to process; testa color (white and brown) for market preference, good taste, most popular in Northern Nigeria; and (m) testa texture (rough and smooth) for faster cooking time, acceptable in the local market (Figure 3).

Farmers grow cowpea because it is a good cash crop, source of food for the families following processing into *kosai*, (deep fried cowpea paste), *moin-moin* (steamed cowpea paste) etc.. Majority of the farmers in the target communities agreed that IITA is a good source of cowpea seeds compared to other sources (Figure 4).

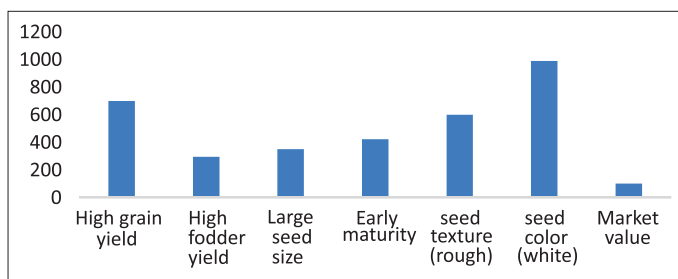


Figure 3. Farmer criteria used to select best performing cowpea lines.

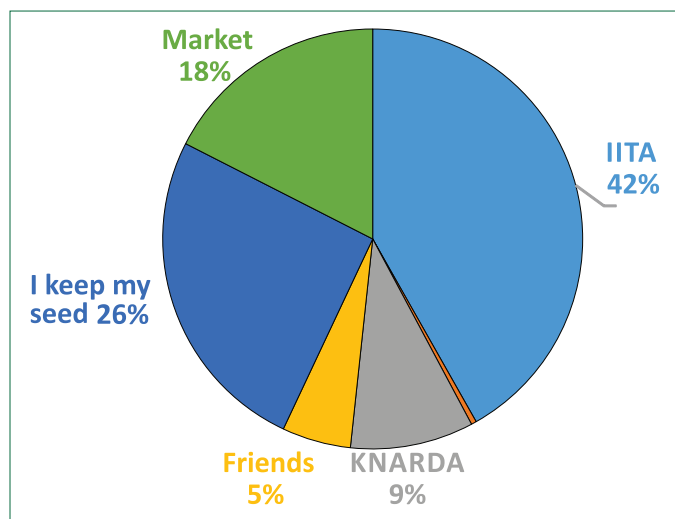


Figure 4. Sources of seed of improved cowpea for farmers' cultivation.

## Success stories

### TL III cowpea contributed to 'Seeds of Renaissance' IITA donation to Nigeria to address humanitarian crisis

The Northeast of Nigeria has been facing numerous attacks by militants through raids and bombings over the last 8 years. Insurgency has left thousands dead and generated one of the largest humanitarian crises in the world with tens of thousands in famine-like conditions. Millions of people in the region are in need of humanitarian assistance. To respond to this crisis, IITA which has its headquarters in Nigeria, donated about 35,930 kg of seeds to the Borno state government in 22 May 2017. Donated seeds include improved varieties of cowpea, soybean, maize, millet, sorghum, and rice that are adapted to the climate of the region. Details of the quantity and variety of cowpea seeds offered by the project are given in Table 1.

Farmers in this part of the country grow cowpea intensively as a food and cash crop. Our intention is to encourage them to use these seeds to produce certified seeds that can be widely distributed to farmers in the affected areas. During the donation ceremony (Figure 5), Dr. Dashiell, who represented IITA Management, said: "The donation is being given because IITA is concerned about the plight of the people of the Northeast who, by many accounts, are very food insecure, malnourished, and need assistance to get back to normal life. We are committed to working with the Federal Government and the State governments in northeastern Nigeria to transform agriculture. We also plan to partner with WFP and the Food and Agriculture Organization (FAO) of the United Nations during this 2017 growing season. It is also an opportunity for IITA as an international agricultural research-for-development institution to implement its mission to transform agriculture in Nigeria and Africa at large." (IITA Bulletin)

**Table 1. List of cowpea varieties (from TL III) donated to the Borno State Government.**

Variety name	Seed color	Maturity	Adaptation zone	No. of 5-kg bags	Total weight (kg)
IT99K573-1-1	White	Medium	Northern Guinea Savannah	300	1500
IT99K573-2-1	White	Medium	Northern Guinea Savannah	300	1500
IT97K499-35	White	Medium	Northern guinea savanna	160	800
IT89KD-288	White	Late	Guinea Savanna ecology	20	100
IT07K-292-10	White	Medium	Sudan Savannah and Sahelian agro-ecologies	160	800
IT07K-318-33	Brown	Medium	Sudan Savannah and Sahelian agro-ecologies	100	500
Total					5,200



Figure 5. The Governor of Borno State, Alhaji Kashim Shettima; Deputy Director General, Partnerships for Delivery at IITA, Dr Kenton Dashiell; and IITA Ambassador and Former President of Nigeria Chief Olusegun Obasanjo during the donation of seeds and 2640 kg rice to Borno State government, 22 May 2017, Maiduguri. (Source: IITA Bulletin Issue No.2382, 22-25 May 2017).

### Malian cowpea farmers respond positively to promotion of new varieties

There are a number of ongoing projects in Mali with activities on cowpea. The projects include the USAID-supported 'Taking cowpea to scale', also known as the Cowpea Outscaling Project (COSP) (Figure 6). There is synergy among these projects activities which generally focus on technology transfer in the rural communities. Five radio programs promoting newly developed cowpea varieties were done in Ségou région (Dioro) which cover three communes of Dioro, Yolo, and Boussin where cowpea production is popular with farmers. Apart from the radio program, TL III and COSP in Mali have collaborated in the promotion of recently released cowpea varieties among farmers through their organizations in Koutiala. One of the farmer groups made up of 6 women and 17 men visited the IER experimental station at Cinzana a number of times during the cropping season to observed seed production in the field and post-harvest handling (Figure 7).

Mali's Minister of Agriculture Mr Kassoum Denon and two deputies from the Mali National Assembly visited



Figure 6. A farmer's field day co-organized by TL III and COSP projects on 27 September 2016, where farmers visited cowpea foundation and breeder seed production fields at Cinzana Research Station.



Figure 7. Farmers visit cowpea foundation and breeder seed production fields at IER Cinzana Research Station, Mali.

the Cinzana Station on 7 August 2016 where they were shown round cowpea breeding and seed production plots (Figure 8). The Honorable Minister and his team expressed satisfaction with the level of activities going on at the station.

### More farmers adopt the Purdue Improved Cowpea Storage (PICS) technology

When cowpea seeds are harvested, dried and stored, they are most often adversely affected by the storage weevil (*Callosobruchus maculatus*), also known as bruchid. Bruchids lay eggs on the seed coat right in the field. The larvae hatch, bore through the seed coat and feed inside the cowpea seeds thus causing up to 30%



Figure 8. Mali's Minister of Agriculture Mr Kassoum Denon and dignitaries visit Cinzana Station in Mali.

or more weight loss and 70% of seeds are rendered unfit for planting or consumption within six months of storage. Farmers usually sell their cowpea seeds cheaply immediately after harvest to prevent losses caused by bruchids. The most common storage method currently used involves the application of chemicals by those who can afford them. The disadvantage of chemicals is that they are often mishandled or the wrong chemicals are used which endanger consumers' health. Lack of appropriate storage technologies is, therefore, a major challenge among cowpea growers and consumers. The Purdue improved cowpea storage (PICs) technology which uses triple layers of plastic bags is a simple and cheap method for storing cowpea seeds without the need for any chemical. The PICS 'triple bagging' technology consists of an outer layer of woven polypropylene or nylon bag and two liners of 80 micron high density polyethylene bags. The simple technological idea behind PICS is "No air, no life". Insect pests need air (oxygen) to survive. Thus, if these pests are denied oxygen as done by PICS, they will eventually die. PICS bag was basically produced for cowpea storage though it has been found to be effective in storing other grains as well.

With this method, farmers are able to make more money from their cowpea harvests. In addition, price fluctuations in the grain markets have reduced as grains are released into the market gradually thus making it available almost throughout the year. Farmers and grain retailers in several communities in Mali, Burkina Faso, Ghana and Nigeria are now using PICS bags for cowpea seed storage. A private company based in Kano, Nigeria manufactures these bags which are being promoted by traders across the West Africa sub-region. PICS bags can now be found even in very remote villages where cowpea is grown across West Africa.

IITA, Purdue University, USA and local partners started the large-scale dissemination of PICS technology in West Africa. Promotion and dissemination of PICS technology in Nigeria and Ghana are carried out through market

and village demonstrations. IITA demonstrated the effectiveness of PICS technology in 21 States of Nigeria during the 2014/2015 season, covering 1,500 villages with 79,817 participants. Similarly, in Ghana, IITA and local partners did the same with 65,646 participants in 1000 villages (Figures 9, 10 and 11).

Media outreach plays a crucial role in the publicity for PICS technology. With more vendors of the PICS bags in different parts of Nigeria, radio jingles have been found to be one of the major strategies for linking end-users with vendors. The jingles are broadcast in the local



Figure 9. Farmers with their opened bags of grains at Dormaa west, Ghana, 2016.



Figure 10. Market demonstration by IITA team at Food Stuff market in Abakaliki, Ebonyi State, Nigeria 2017.



Figure 11. Women preparing cowpea seeds for storage in PICS bags at IER Cinzana Research Station.



languages and Pidgin English. Other dissemination strategies used by IITA include audience participatory radio phone-in programs and village video shows.

A common question many farmers ask each time PICS technology is first introduced to them, is: “is it possible to store cowpeas without the use of chemicals?” Open the Bags Ceremony (OBC) conducted in villages, which is part of the PICS village demonstration, has given such farmers opportunities to confirm that it is possible. During village demonstrations, volunteer farmers offer to store their cowpeas in PICS bags for a period of six months without applying any chemical. At the end of the period, the cowpea stored in PICS bags are publicly opened in the village.

PICS bags make the use of chemicals unnecessary and allow farmers to store cowpea until the right moment for consumption or sale. Otherwise, nonavailability of appropriate storage technologies often leads to situations where smallholders sell their cowpea soon after harvest, only to buy it back at an expensive price a few months later.

To date, about 5 million PICS bags have been produced and sold in Nigeria and Ghana alone. They are also being sold in Niger, Mali, Cameroon, Burkina Faso, and Togo. Dissemination efforts have since moved to east and southern Africa with the PICS3 project.

## Additional Activities

### Seed Fair in Tamale, Ghana

A well-attended seed fair was jointly organized in Tamale in northern Ghana by the USAID-supported Cowpea Outscaling project, TL III and Farm Radio International (FRI). About 750 participants (350 male and 400 female) were in attendance. May 13, 2016 was Cowpea Day and seeds of several released cowpea varieties including Apagbaala, Padi-tuya, Zaayura and Songotra, among others were showcased at the seed fair. In addition, women exhibited a number of cowpea recipes which

are commonly consumed in Ghana as well as other parts of West Africa, such as koose, tubaani, gable, waakye, and rice beans (Figure 12). A total of 400 copies of cowpea production guides and 300 copies of post-harvest handling guides (leaflets) were distributed to participants during the Cowpea Day.

Former TL III project coordinator Dr Emmanuel Monyo visited West African NARS, ICRISAT and IITA cowpea and groundnut fields in Nigeria, Burkina Faso and Ghana from 10- 20 October 2016. In Nigeria, he visited IAR’s experimental fields at Samaru where he saw fields planted with seeds of released cowpea and groundnut varieties that were being multiplied for use in the coming cropping season. He also seized the opportunity to see the work of the groundnut breeders at IAR and interacted with graduate students and technicians. While in Kano, he visited the Centre for Dryland Agriculture (CDA), Bayero University, where he held discussions with cowpea and groundnut scientists and the Director of the institute and was taken around cowpea and groundnut experimental plots. They later visited cowpea and groundnut farmers’ seed multiplication plots, especially those located close to the highway. Farmers walking or driving past the location usually appreciate the performance of the varieties, whose seeds are being multiplied near the roadside.

In **Burkina Faso**, he visited the Sapouy and Manega experimental fields where cowpea breeders’ and foundation seeds were being produced on 10 hectares (Figure 13). While taking Dr Monyo around his fields, Dr Joseph Batiemo, Cowpea breeder, INERA- Burkina Faso said that he expected to harvest at least 400 kg of clean seed per ha. That means that 4000 kg of breeder seed would be harvested in 2016 with some additional seed from INERA Saria station, thus adding to five tons. Some plots with earlier planted cowpea varieties had been harvested and seeds were being processed during the visit. Varieties whose seeds were being multiplied are Komcalle, Tiligre, Nafi, Yisyande, KVx745-11P, Niizwe, and KVx61-1.



Figure 12. Scenes from the Cowpea Day at the seed fair in Tamale Ghana together with a display of cowpea recipes.



Figure 13. Dr. Monyo inspecting cowpea seed multiplication field at Sapouy, Burkina Faso.

Drs Ousmana Boukar, Cowpea breeder, IITA, Monyo and Dr Christian Fatokun, Legume geneticist/ breeder, IITA visited our activities in October 2016. They were able to visit the breeder and foundation seed production field at Sapouy.

In **Ghana**, the team visited SARI station in Tamale where they were shown screen house facilities where crosses are generated and initial seed multiplication for early segregating generations are made before going to the field. As in the other countries, there were visits to farmers' fields in different communities.

### Objective 6: Sustainable and impact-oriented legume seed delivery systems for smallholders – Cowpea seed system

Due to limited commercialization of cowpea varieties by the private seed sector, the cowpea seed system has remained rather underdeveloped and weak in many countries of West and Central Africa, resulting in a large seed supply gap. The Tropical Legumes II project developed and successfully implemented innovative seed delivery models that significantly impacted cowpea seed systems in many countries of West Africa. The integrated seed system developed strengthened linkages amongst various cowpea seed value chain actors. The participation of several community seed producers and a few private seed companies increased production of foundation, certified or quality declared seeds that ensured farmers have access to improved seeds in remote areas. There was also a rapid adoption and use of newly released varieties by farmers as a result of increased awareness on improved varieties through multi-media and user-friendly communication strategies and tools. In addition, there was an increase in the number of channels and outlets that provided seed to farmers, combined with affordable small packs.

The project introduced a new approach to catalyze sustainable production and supply of quality seed of improved cowpea varieties to smallholder farmers in

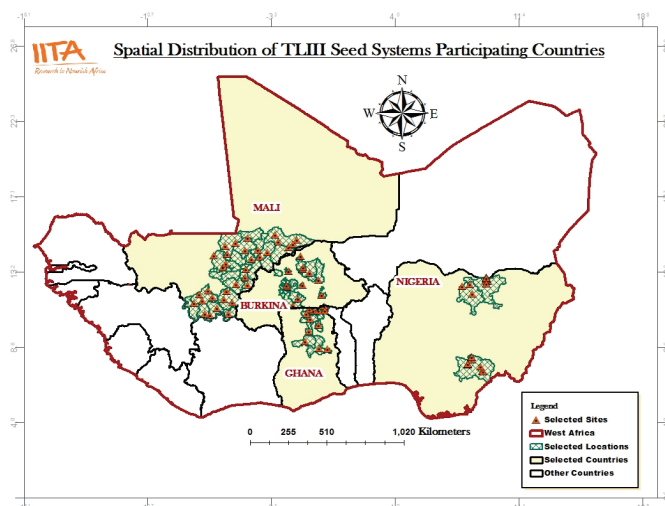


Figure 14. Map of West Africa showing countries where seed systems activities are being implemented.

West Africa. TL III was designed to build on the modest successes recorded during phase II of the project. Objectives 3 and 6 are complementary to increase productivity and production of cowpea by developing improved production technologies (Objective 3), and promoting and improving access to improved production technologies, particularly seeds (Objective 6). Four countries - Burkina Faso, Ghana, Mali and Nigeria are targeted for cowpea seed system from West Africa (Figure 14).

### Cowpea Seed Systems

Objective 6 aims to establish and strengthen sustainable and impact-oriented legume seed delivery systems for smallholders. This objective is led by CIAT with one seed system specialist appointed at ICRISAT ESA for that region and another one at IITA for West Africa to backstop NARS partners. It has five main complementary activities: (a) Establish multi-stakeholder platforms; (b) popularize new varieties; (c) sustainable production and delivery of various seed classes; (d) innovative and targeted seed marketing; and (e) strengthen multi-legume impact-oriented seed systems. TL III project works in partnership with other projects in target countries to strengthen the cowpea seed system. In West Africa for example, the project closely works with the USAID-supported Cowpea Outscaling project in Ghana, Mali and Nigeria to create awareness of improved technologies, enhance availability of seed and build capacity of value chain actors and stakeholders. Brief highlights of progress made in cowpea seed systems from 2015 to 2016 follow:

**Multi-stakeholders' platforms** – Activities conducted towards establishment of innovation platforms for cowpea are summarized in Table 2. A total of 16 platforms were established or strengthened to link actors in the cowpea value chain, providing avenues for training and skills enhancement as well as improving

**Table 2. Activities conducted towards establishment of innovation platforms for cowpea in 2015 and 2016.**

Country	Number of platforms established	Number of training programs organized		Number of platform members trained <sup>1</sup>	Number of platform members trained	Total
	2015-16	2015	2016	2015	2016	2015 and 2016
Burkina Faso	3	17	4	264 (M = 200; F = 64)	558 (M =357; F = 201)	822 (M =557; F = 265)
Ghana	5	21	4	3045 (M =2040; F = 1005)	1796 (M =913; F = 883)	4841(M =2953; F = 1888)
Mali	2	13	4	208 (M =187; F = 21)	431(M =328; F = 103)	639 (M =515; F = 124)
Nigeria	6	20	9	5727 (M =4278; F = 1449)	2211(M =1701; F = 510)	7938 (M =5979; F = 1959)
Total	16	71	19	9244 (M =6705; F = 2539)	4996 (M =3299; F = 1697)	14240 (M =10004; F = 4236)

<sup>1</sup> M= males; F=females.

efficiency and effectiveness in technology development and use. Establishment of multi-stakeholders' platforms has been achieved except for Burkina Faso and Mali where we will be able to reach this milestone in year 2. Platform members were trained in seed production and business management in each participating country. A total of 90 training and short courses were held in various areas including quality seed production, group dynamics and management, good agronomic practices, post-harvest handling, and pest management benefiting 14,240 (10,004 male and 4,236 female) platform members (farmers, seed producers, seed companies, grain traders, researchers, extension staff, scientists, technicians, CBOs, and agro input dealers) to develop the cowpea sub-sector in the respective countries. In each country, stakeholders' meetings were held to assess progress towards achieving the work plans developed during the previous implementation period and to refine the role of each stakeholder in order to have a greater impact in scaling-out the project goals. Nigeria and Ghana have surpassed the target (number of platform members trained). The remaining two years will be devoted to catching up in Burkina Faso and Mali (Table 2).

Sustainable production and delivery of various seed classes - A total 326.4 tons of basic (foundation) seed and 3,573.9 tons of certified seed were produced and entrenched into the cowpea seed system in the target countries in the last two years (Table 3). The seed production volume significantly increased in 2016

compared to 2015. However, there is still a large deficit, except for Nigeria that has achieved 33% and other countries achieving less than 30% (Figures 15 and 16).



Figure 15. A woman seed producer in Burkina Faso.



Figure 16. Foundation seed production in Nigeria.

**Table 3. Seeds produced and marketed from 2015 to 2017, including proportions sold in small packs.**

Country	Quantity of basic seed produced (t)			No. of varieties	Quantity of certified/QDS seed produced (t)			Quantity (t) of seed marketed in small packs (20 tons target)
	2015	2016	Total		2015	2016	Total	
Burkina Faso	31	58.9	89.9	8	239.6	301.7	541.3	16 (80%)
Ghana	19.2	7	26.2	4	171.9	570	741.9	78 (390%)
Mali	8.2	24.5	32.7	9	184	509.8	693.8	19 (95%)
Nigeria	46.1	131.5	177.6	11	751	845.9	1,596.9	48 (240%)
Total	104.5	221.9	326.4	32	1,346.5	2,227.4	3,573.9	

In 2017, we hope to make up for the deficit in the set target recorded in 2015 and 2016.

**Innovative and targeted seed marketing** – A small packs approach was used extensively to enhance affordable access to seed of improved cowpea varieties. All the certified/QDS seed produced was sold, of which over 25% was sold in small packs (1, 2, and 5 kgs), exceeding the target (Table 3).

A total of 468 (56 in 2015 and 412 in 2016) organizations (seed companies, farmer organizations, NGOs, public seed enterprises) and individual entrepreneurs were engaged in seed production/marketing of cowpea in the target countries (Table 4). There was a 600% increase in the number of organizations and individual entrepreneurs that were engaged in 2016 compared to 2015. These increases could have resulted in the large volume of cowpea seeds that were produced and sold across participating countries in 2016 compared to the previous year.

**Popularizing new varieties** – Various complementary awareness creation approaches were employed to popularize new improved varieties (Table 5). These included technology demonstrations, farmer field days, distributing technology promotional materials (production guides, flyers, leaflets, and manuals), radio/TV programs and agri/seed fairs. A total of 567 demonstrations were conducted in 2015 and 2016, while 48 field days were organized in the same period. More than 30,600 technology promotional materials were produced and distributed during the last two

years. A total of 52 radio/TV programs on improved technologies were broadcast or aired. Twelve agri/seed fairs were organized across the target countries attracting more than 11,940 (6,361 male and 5,579 female) participants.

Two labour-saving technologies/mechanization (planter and thresher) tools were identified and models for enhancing their access were tested for possible adoption by smallholder farmers. To enhance women's access to these and other agricultural inputs and technologies, 66 partnerships were established. Technical information was disseminated to target audiences, such as articles in the ICRISAT Happenings newsletter (4). To improve the efficiency of data and information gathering and dissemination and technical reporting, the project launched an MLE framework with standard indicators and data collection tools which are now being used for effective data capturing (ona.collect and ODK platform) and monitoring.

### In the NEWS



We would like to share the annotated genome of Cowpea IT97K-499-35, work done by Dr Timothy J. Close and team, which is now publicly accessible on Phytozome website ([www.phytozome.net](http://www.phytozome.net)) under the "Early Release Genomes" tab. This work was supported mainly by the NSF BREAD project, "Advancing the

**Table 4. Number and type of organizations involved in seed production and marketing of cowpea.**

Organizations	Burkina Faso		Ghana		Mali		Nigeria		Grand Total	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Seed companies	1	7	3	3	1	2	1	7	6	19
Public enterprises	5	13	2	-	1	-	2	2	10	15
Individual entrepreneurs	5	100	10	1	0	1	0	129	15	231
Farmer organizations/NGOs	7	73	1	20	1	8	16	46	25	147
Total of individual years	18	193	16	24	3	11	19	184	56	412
Total of both years	211		40		14		203		468	

**Table 5. Summary of awareness creation activities in 2015- 2016.**

Country	No. of demonstrations		No. of field days		No. of technology guides/leaflets distributed		No. of radio/TV programs/print media		No. of agri/seed fairs	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Burkina Faso	75	133	7	100	3000	1	14	-	4	
Ghana	40	80	10	-	700	1	5	-	1	
Mali	-	87	9	3100	300	1	17	-	2	
Nigeria	10	142	3	20000	3400	1	12	1	4	
Total of individual years	125	442	19	29	23,200	7400	4	48	1	11
Total of both years	567		48		30,600		52		12	

Cowpea Genome for Food Security” and partially by the “Feed the Future Innovation Lab for Climate Resilient Cowpea”. Please note this work is not part of TL III.

We believe that many of us from the TL III community could benefit from this reference genome work. A manuscript is in the works to provide more details; in the meantime, the genome information may be used

as per the standard pre-publication agreement that is on the Phytozome website. The assembly has also been deposited at National Center for Biotechnology Information (NCBI), but release from NCBI will await publication. For more information on this: Please contact Dr Timothy J. Close, University of California, Riverside, California at [timothy.close@ucr.edu](mailto:timothy.close@ucr.edu)

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