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Final Report

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Improving the livelihoods of smallholder farmers in drought-prone areas of sub-Saharan Africa and South Asia through enhanced grain legume production and productivity (TLII Phase II)

Submitted to
Bill & Melinda Gates Foundation, USA

ICRISAT
Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

This work was undertaken as part of the

CGIAR RESEARCH PROGRAM ON Grain Legumes

Final Narrative

Global Development

Use this form to provide your final update to your foundation program officer regarding the results achieved for the entire project. In addition, please provide your perspective on key lessons learned or takeaways and input on the foundation's support of your work to ensure that we can capture and share learning as appropriate both internally and externally.

The Final Narrative must be submitted in Word, as PDFs will not be accepted.

Progress and Results

1. Final Progress Details

Provide information regarding the entire investment's progress towards achieving the investment outputs and outcomes. In addition, submit the Results Tracker with actual results as requested. Progress towards Product Development outputs and outcomes should be captured in the IPDP; refer to the IPDP for PD outputs and outcomes.

Executive Summary

The Tropical Legumes II project supported by the Bill & Melinda Gates Foundation seeks to enhance productivity of six legume crops (groundnut, cowpea, common bean, chickpea, pigeonpea and soybean).

Legumes represent the most affordable source of protein and micronutrients available to the rural and urban poor and are especially important to hundreds of millions of women and children living in Africa and South Asia. Nutrition experts note that legumes are nutrient dense and provide an essential complement to the starches derived from cereals and root crops. The nutritional value of grain legumes is attributable to their high nutrient composition (e.g. quality protein, complex carbohydrates, essential minerals and fatty acids) as well as properties that promote nutrient absorption and reduce gut inflammation. For this reason, the Foundation has chosen to invest in the six tropical legumes with a 10 year vision to improve the livelihoods of smallholder farmers in drought prone areas of 13 Sub-Saharan Africa countries (Burkina Faso, Ghana, Mali, Niger, Nigeria, Senegal, Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Uganda, Zimbabwe) and two in South Asia (Bangladesh, India) through enhanced grain legume production and productivity. The project targets are to enhance the productivity of these six crops by at least 20% through increasing availability and adoption of improved varieties and associated crop management practices. Specifically, TL-II aims to achieve a 20% increase in production and productivity, replace 30% of the legumes area with improved varieties and benefit some 60 million poor farmers with annual aggregate value of >$300 million.

Significant achievements have been made:

- 163 New improved varieties with more than 20% yield superiority over existing ones have been released through the project in target countries during past 7 years.
- Seed enough to cover 5,074,547 ha of cropland has been produced and distributed to farmers in small seed packs (2 – 10kg packs). Improved legume varieties already occupy 23.8% of the area cropped to legumes in the target countries benefiting more than 50 million smallholder farmers. (a smallholder farmer in SSA owns approx. 0.2ha under legume)
- The project has generated about US$978 million based on adoption and expert opinion survey
- Other project based seed production estimates indicate that TL-II has generated ≥ US$513 million from project funding and nearly US$2 billion from leveraging partners' investment.
- Every dollar invested to TL-II ($48 million including interest to-date) has had $11 - $39 return based on adoption, project's own seed production and leveraging of partner investments
- Project own funding produced 127,000 tons improved seed while project and partner leverage produced 530,756 tons certified / quality assured seed.
- Country seed road map an effective tool to track variety specific dissemination has been availed. The country strategy and seed road map provides an up-to-date intelligence on seed production and dissemination for each variety released in a particular country. The country strategy reveals how each released variety will contribute to reaching the 30% area cover with improved varieties.

These achievements justified the Foundations' continued investment for another four years to consolidate sustained support for the development and release of farmer-preferred varieties in targeted focus crop x geography matrix identified by the Foundation, strengthening of the legume breeding capacity of partner CGIAR centers and national partners, and establishment of sustainable seed delivery systems that service the needs of small-holders, especially underserved women farmers in the African partner geographies.

Project achievements

Market opportunities, policies and partnerships

During the last 4 years, adoption and market studies conducted provided a range of useful insights guiding technology development and adaptation as well as scaling-up of promising options to the wider target domains beyond the pilot areas of the project. It has been shown that the major drivers of dissemination of research products and adoption by farmers are farmers' access to new information and awareness; expected benefits and local availability of the new technologies; market access and opportunities (performance of input and output value chains); and access to credit and policies to enable farmer investment in new technologies. While institutional and policy factors may hinder the uptake of otherwise profitable varieties and practices, addressing the needs and priorities of smallholder farmers especially women is the necessary condition for greater technology uptake and impacts. The use of farmer participatory variety selection in grain legume improvement

under the Tropical Legumes II project has increased the levels of awareness about the performances of new varieties among farmers.

A number of constraints have led to the diminished interest of the existing seed systems (e.g., commercial seed companies) to provide small-scale farmers with access to improved seed of grain legumes. First, public-sector seed production has not been able to meet the demand for seed of new varieties and for initial quantities of high-quality seed (breeder and foundation) because priority for foundation seed stocks is generally given to more profitable crops, such as hybrid maize. The private sector also has shown little interest in entering the legume seed industry due to low profitability (as farmers recycle varieties multiple times once they receive the initial germplasm). Many grain legumes also have a high seeding rate and low multiplication posing challenges in producing large quantities of seed and distributing it to producers who are widely scattered in the rural community.

The observed poor private sector participation in the legume seed systems may indicate a market failure and the need for stronger public support for legume seed production and distribution at least in the early stage until demand is high to attract private sector seed companies. It is also important to build on the strengths and resilience of the informal seed sector, and enhance it to increase both seed supply and quality through the participation of local seed producers, farmer groups, small seed companies and agrodealers with capacity building and monitoring to produce and market quality seed. The importance of quasi-formal or market based channels increases with the availability of new farmer-preferred varieties which creates incentives for the emergence of markets and trade in the supply of the new seeds.

Groundnut in SSA and SA

Groundnut productivity is limited by a number of abiotic and biotic stresses such as drought, foliar diseases, rosette, and aflatoxin contamination. The gap between potential and realized yield is large. Major activities focused on farmer participatory variety selection, breeding lines development and capacity building. In WCA, based on the PVS trials, the national program released 15 varieties; Niger (4), Nigeria (3) and Mali (8) between 2010 and 2013. In ESA, 28 varieties were released; Tanzania (5), Uganda (10), Malawi (7) and Mozambique (6) between 2010 and 2014. In SA, 3 varieties were released in India during the phase II period. These varieties showed a yield advantage of up to 42% over the local varieties grown by farmers with some of the varieties yielding over 3t/ha in some locations. Intensive hybridization program was initiated at all ICRISAT stations with various trait specific (productivity, aflatoxin tolerance, rosette, drought, early maturity, ELS, LLS) segregating populations developed over the years. One hundred thirty groundnuts varieties (88 in ESA, 38 in WCA and 4 in SA) were included in national level performance evaluations. Across the regions of SA and SSA, a total of 572 FPVS trials (70 in ESA, 358 in WCA and 144 in SA) involving 6265 farmers were conducted to identify location specific FPVs. In ESA, women constituted more than 50% of the farmers involved in FPVS trials, while in WCA the women represented 90% of the farmers. Over the years, ICRISAT supplied more than 2400 trait-specific advanced breeding lines (resistance to aflatoxin contamination, foliar diseases, rosette, early – and medium maturing, confectionery types and tolerant to drought) to the national programs of the project target countries. Eleven breeders (ESA-3, WCA-2, and SA-6) participated in Integrated Breeding Multi Year Course (IB-MYC) sponsored by Generation Challenge Program. Besides, four researchers and one technician from SA participated in training at ICRISAT on groundnut breeding. Eight breeders from WCA received training on Marker Assisted Selection (MAS) and electronic data capture. A breeder and a pathologist from the six project countries (Mali, Ghana, Burkina Faso, Nigeria, Niger and Senegal) benefited from one week training at ICRISAT-Mali conducted in October 2013 on groundnut breeding techniques and disease management. A similar training of technicians on data management, field techniques including population development was conducted in 2013 in Malawi involving 12 technicians from all TLII partner countries.

Cowpea in SSA

In phase II of the TL II project, cowpea productivity and production research activities were implemented in 7 countries, which include Burkina Faso, Ghana, Mali, Niger and Nigeria in West Africa and, Mozambique and

Tanzania in East and Southern Africa. During this time, nine varieties were released in 4 countries, breeding lines with enhanced drought tolerance and other desirable traits are being advanced for their evaluation in the field through Farmer Participatory Variety Selection (FPVS). Thousands of farmers were trained and participated effectively in FPVS. Seeds of farmers preferred varieties were multiplied annually to provide materials for the establishment of demonstrations plots. The quantity of seeds produced, the number of on-farm demonstrations conducted and the number of farmers trained were beyond the targets set at the beginning of the project. The research team participated actively in the training of graduate students, technicians and scientists from the National Institutes. Workshops on molecular breeding, data management and the use of electronic field books were organized. In addition each participating country received tools (computer, printer, tablets) to enhance the working condition of scientists. Delays in the validation of Tropical Legumes I generated markers have affected the outputs of the activity on the marker assisted backcross to introgress striga resistance into farmer preferred cowpea lines. The security issues in Northern Mali and Nigeria have also affected implementation of projects activities in some places. Important lessons learned will strengthen the ability of the project's stakeholders to consolidate the excellent results obtained.

Common bean in SSA

Under common beans, Phase II of the Tropical Legumes project II focused on the development and evaluation of nurseries for drought tolerance in combination with other key traits important for optimum performance of common bean under farmer's conditions. Nurseries consisted of segregating populations and fixed lines combining drought tolerance and other traits such as high mineral (iron and Zinc) grain content, low soil fertility tolerance, pest resistance specifically bruchids and bean stem maggot (BSM) tolerance and disease resistance mainly common bacterial blight (CBB). Small seeded Mesoamerican bush bean lines emerging from the breeding program in Colombia present as much as 80% higher iron and drought resistance equal to or superior to the tolerant check. Evaluations were conducted at different levels in the breeding pipe line PYT, AYT and NPT with active participation of farmers and other stakeholders through PVS in the five participating countries; Malawi, Zimbabwe, Uganda, Kenya and Tanzania. Within the four year period, (2011-2014), as many as 28 common bean varieties have been released while others are in the last stages of the development pipeline. Most of the released lines present a yield advantage of 10-40% over the commercial varieties in on-farm trials with additional traits of resistance to key pests and diseases and /or high grain Fe and Zn content. Effort was made to tap on wild *Phaseolus* species, *P. lunatus* (lima bean) and *P. accutifolius* (tepary bean*)* and interspecific lines with *P. coccineus* (runner bean), as sources of unique genes for drought, low soil fertility tolerance and a few interspecific lines have been advanced to AYT.

Even though, it has been a challenge to find consistent QTL for yield under drought, focusing on the trait of Pod Harvest Index (PHI) has been more promising, and some candidate QTL are being validated through additional phenotyping. Other factors were shown to limit the expression of drought tolerance on farm. In particular, soil factors and especially poor soil fertility do not permit adequate plant development for the crop to sustain additional physiological stress imposed by drought. The establishment of a SNP platform was the single most long term result of TL-1 that directly benefited TL2. Use of SNP's will probably be with us for the foreseeable future as the marker of choice for mainstream breeding programs of modest budget. SNP markers for major disease resistance genes (BCMNV, common bacterial blight, bruchids, angular leaf spot) were developed and markers of other classes (SCARS, SSRs) have been converted to SNPs ready use through the SNP platform. Degree and technician training was undertaken, with two Ph.D. degrees and two M.Sc. degrees granted. High priority was placed on technicians given their role in the daily execution of field trials. In addition, equipment including irrigation facilities was provided to improve the drought phenotyping capacity of the NARS.

Chickpea in SSA and SA

During Phase II, 10 chickpea varieties were released in ESA (5 in Ethiopia and 4 in Kenya) and SA (1 in India). Over 100 elite breeding lines (78 in India, 18 in Ethiopia, 5 in Kenya and 3 in Tanzania) were evaluated in National Performance Trials (NPTs) or equivalent trials for pre-release testing. Over 70 FPVS trials were

conducted in SA (India and Bangladesh) in which 4,345 farmers participated and 3 farmer-preferred varieties identified for India and 3 for Bangladesh. In ESA, 325 FPVS trials (Ethiopia: 183, Tanzania: 71, and Kenya: 71) were conducted in which 16,978 farmers participated. Four farmer-preferred varieties were identified for Ethiopia, 4 for Tanzania and 3 for Kenya. In addition, 2651 field demonstrations were organized in ESA (Ethiopia: 2437, Tanzania: 22, and Kenya: 192) to sensitize farmers on promising varieties and production technologies. Heat tolerant breeding lines were identified both in ESA and SA by screening the breeding lines under late sown (heat stress) conditions. Marker Assisted Backcross (MABC) and Multiparent Advanced Generation Intercross (MAGIC) lines developed under TL-I project were evaluated by TL-II project partners and promising drought and heat tolerant lines were identified. Breeding lines with high yield potential, market-preferred seed traits and high resistance to fusarium wilt were identified both in ESA and SA from evaluation of International Chickpea Screening Nurseries and other breeding lines. In screening trials for pod borer resistance, 145 progenies were selected in India and 11 genotypes in ESA. Breeding lines with moderate resistance to Botrytis grey mold (BGM) were identified in Bangladesh and with moderate to high level of resistance to Ascochyta blight (AB) in Ethiopia and Kenya. In India, breeding lines suitable for mechanical harvesting were identified through multilocation evaluation of breeding lines with tall and upright growth habit. Heat tolerant breeding lines were identified both in SA and ESA by screening of breeding lines under field conditions. Six degree students (2 PhD and 1 MSc in India and 2 MSc + 1 PhD in ESA) completed their research work and were awarded degrees while two PhD students are currently carrying out their research work in India. Training was provided to 8 NARS researchers (SA: 2 and ESA: 6) in integrated chickpea improvement. Six NARS researchers (3 each from SA and ESA) were trained on usage of Breeding Management System (BMS) at Wageningen, the Netherlands and Zaragoza, Spain through Generation Challenge Program (GCP).

Pigeonpea in SSA and SA

The pigeonpea activities were conducted in Andhra Pradesh, Odisha and Bihar states in SA, Tanzania, Uganda and Malawi in ESA. TL II project has given scope for the fast track release and breeding lines development in the target states in India and countries in SSA. From Andhra Pradesh RGT 1 white seeded variety with wilt resistance (First white seeded type for the state) was released during 2010 from Agricultural Research Station Tandur, Rangareddy (district). This will help the farmers (120,000 households) in nearly 80000 hectares of the state where there is peculiar preference for the white seeded types. Under the project in phase II ICPH 2740, first pigeonpea hybrid for the state was released. The hybrid is having yield potential of 3 tons/hectare under rainfed situation and provides rainfed smallholder farmers' additional net income of $1000 per hectare. In the state of Andhra Pradesh enhancement of productivity from 450 kg/ha in 2007 to 600 kg/ha in 2012 was achieved as a result of effective seed system and linkages with the partners which helped in large scale quality seed production. In ESA, the project was implemented in Babati (Manyara Region), Karatu (Arusha Region) and Kilosa (Morogoro Region) districts of Tanzania. In Malawi, on-farm research and promotion activities were carried out in 14 districts spanning from Southern (Balaka, Blantyre, Machinga, Mwanza, Zomba), Central (Kasungu, Mchinji, Ntcheu, Ntchisi, Salima), and Northern (Chitipa, Karonga, Mzimba, Rumphi) regions. In Uganda, project was implemented in Lira, Albetong, Pader and Kitgum districts of northern region. Six varieties were released in ESA (Kenya-1, Malawi-1 and Tanzania-4). 359 Farmers' Participatory Varietal Selection (FFPVS) trials were conducted in Tanzania, Malawi and Uganda that included 28 pre-released/released varieties along with a farmer's variety as a check. 6995 farmers took part in the FPVS trials and demonstrations from Tanzania, Malawi and Uganda. During the FPVS farmers came up with a number of preferred traits, which facilitated in short-listing of varieties for fast track varietal release. Training Program on 'Hybrid pigeonpea technology, seed production and integrated crop management' conducted with 18 participants (15 men + 3 women) from ESA. One MSc student completed research on pigeonpea. Two more MSc students are pursuing their research work.

Soybean in SSA

Twenty two improved soybean varieties have been released in Mozambique-9, Kenya-7 Nigeria-5, and Malawi-1 between 2009 and 2013. Prior to 2007, no soybean varieties were released in Kenya. One hundred and fifty

genotypes have been analyzed for protein and oil components. The protein content ranged from 32.6% (TGx 1988-22F) to 41.8% (TGx 1019-2EB) with the average of 37.6%. The oil ranged from 14.0% (TGM903) to 21.1% (Soy104) with an average of 17.5%. The high protein lines were identified and crossed with adapted varieties for further selection for high protein, Three hundred accessions were evaluated for nitrogen fixation characteristics in multiple countries. The lines with high nodulation and high yield were identified and crossed with high yield low nodulation genotypes. Learning with farmers has also been a core aspect of TL-II soybean work. This has been achieved through PVS, demonstration and field days. It is from these that preferences of soybean varieties has been determined, information that continues to inform the breeding work. Success in releasing of the varieties has been made possible through improved partnerships among CG centers, NARS, universities, seed companies and community organizations. Models of such partnerships exist in the four countries that can be replicated and adapted to other regions. Over 1,300 germplasm lines were evaluated in the field for their yield and performance and 30 lines with enhanced drought tolerance were identified and crossed to existing breeding lines with farmers and consumers preferred traits. Over 100 populations segregating for early maturity as drought tolerance, and resistance to rust were generated. The best among the advanced lines are now being evaluated across various agro-ecologies. DNA markers (SNPs) associated with nodulation traits have been identified. Five more lines (Two early (TGx1988-5F AND TGx-1990-67F) and three medium maturity (TGx1989-19F, TGx1987-14F and TGx1991-10F)) were submitted for release in Nigeria in 2014. Five graduate students were trained at MSc level in plant breeding.

Seed systems in SSA and SA

During Phases I & II of the TL II project, a total of 617,398 tons of different seed grades of all the six legumes (chickpea, common beans, cowpea, groundnuts, pigeonpea and soybeans) were produced by project partners in the target countries. This is composed of 7,380 tons breeder seed, 79,262 tons Foundation seed and 530,756 tons Certified/Quality Declared seed. During the four years of Phase II, the certified/QDS seed produced was 456,544 tons which is more than six fold the amount produced in Phase I (74,211 tons by Dec. 2010). Almost all countries surpassed their respective seed production targets for each year and crop. A total of 540 training and short courses on improved legume pre- and post-harvest management were provided to 34,976 farmers including seed producers and to 5,970 extension staff. More than 60,000 copies of assorted awareness materials (leaflets, flyers, manuals, factsheets); with information on legumes variety, improved agronomic practices, post-harvest, business management were provided to farmers, service providers and to traders. A total of 180,363 farmers and 3,438 extension staff participated in 384 fields days/seed fairs and demonstrations. Several awareness creation campaigns/tools helped to stimulate the seed demand for sustainable seed supply. These include 170 radio, 94 TV programmes and 161 articles in newspapers. Strategies that create variety awareness were implemented in several target countries (involving partnerships with agro-processors and traders). More than 2.1 million small seed packs were supplied/ marketed to farmers, 62% of them women. The approach is being adapted by private sector and mainstreamed across crops and countries at different levels. Innovation platforms were established/ strengthened in various countries to link bean value chain actors (seed producers, grain traders, researchers, extension staff and other input suppliers) in order to develop the legume seed sub-sector in the respective countries.

Through the implementation of the activities, several lessons have been learned, key among them are:

1. Engaging with a range of seed producers in each country is positively yielding good impact and laying foundation for sustaining the project outcomes. The training of seed producers and the increased availability of basic (foundation) seed through the project were critical to the increased seed production. The country seed road maps provided a good planning tool for country teams.
2. Small packs approach is being mainstreamed as avenue to increase seed access to millions of farmers particularly women. The small packs marketing approach has potential to reach hundreds of thousands of farmers, quickly and has expanded the use of certified seeds by providing farmers the opportunity to experiment new varieties - at minimum risk.
3. For sustained and equitable seed production and supply of new varieties, an integrated and pluralistic seed system which comprises of decentralized local business seed systems, seed companies,

use of client oriented marketing (small packs) and supportive variety information and demand creation tools are instrumental. The success of small-scale seed producers and inclusion of women in seed production show that it is possible to target seed production as well as fight poverty and food insecurity.

4. Despite commendable results (seed quantity and improved access to new varieties); the ever- increasing demand of legume seed is far from being met. Therefore there is a need to expand partnership and link seed systems to grain value chains through multi-stakeholders platforms, diversify and decentralized the production of basic seed and mainstream the use of small packs by the private sector.

The returns to TL2 investment since 2007 are high. Modern legume varieties (MVs) developed and disseminated under the TLII project implemented by ICRISAT, CIAT, and IITA with NARS partners have been adopted on at least 5,074,547 ha and have generated more than US$513 million from project funding and nearly US$2 billion from project and partners' investment. Even when using the adoption rates data from adoption and expert opinion surveys, the aggregate gross benefits from TLII related modern legume varieties is estimated at about US$978 million, which is still far above the total TLII investment grossly compounded at US$48 million[1] (phases 1 and 2). The returns on investment are high. In effect, for each TLII dollar invested, the project generates USD11 with direct project investment, USD39 with partnership's investment and USD20 when using adoption rate based estimation.

Key Achievements

Objective 1 target countries include Ethiopia, Kenya, Malawi, Tanzania, and Uganda in ESA; Burkina Faso, Ghana, Mali, Niger, Nigeria, and Senegal in WCA; and Bangladesh and India in South Asia.

Key Milestone: Study of adoption, and constraints to adoption of groundnut (Malawi and Niger), Pigeonpea (Tanzania), Chickpea (Ethiopia), common bean (Ethiopia, Tanzania and Uganda), soybean (Malawi and Nigeria) and cowpea and groundnut (Nigeria) and baseline studies for groundnut (Odisha and Ghana), for pigeonpea (Bihar), chickpea (Bihar and Bangladesh) (Yr 1) rescheduled for (Yr 2)

Several baseline and adoption studies were conducted in the relevant countries for targeted crops.

Groundnut in West and Central Africa

- In Niger, adoption of improved groundnut varieties promoted under TL2 and in the Dosso region it increased by 14% from 2008 to 2011as a result of TL2 intervention on variety promotion (through FPVS) and seed production schemes.
- A sample survey (of 275 households from 11 villages) revealed that 78% of respondents are aware of the new varieties and 71 % actually tested the varieties in their farms.
- Information on groundnut varieties spread through farmer-to-farmer diffusion (52 %), radios (28%), family and relatives (23%), and research institutes (13%). However, traditional extension services accounted for just 9%.
- Overall, 69% of respondents adopted modern varieties such as RRB, ICG 9346, Fleur 11, J 11 and TS 32-1 accounting to 34 % of total area cultivated with groundnut.
- Non-availability of seed was considered as the major constraint to adoption of the new varieties by (54%) of the respondents while 21% mentioned about lack of credit to purchase.
- In Nigeria, a nationwide household survey of 2,732 households was used to assess the determinants of adoption and impacts of modern groundnut varieties were disseminated under TL2.
- Results showed that adoption is largely explained by awareness of the modern varieties known, age and

[1] Uncompounded investment is US$ 42 million. Compound rate is about 5% as in many projects in SSA with annual investment roughly estimated to US$7 per year

education of household head, the total work force and household size. In addition, assess to seed was significant while access to markets was not.

- The current adoption rate for modern groundnut varieties is estimated to 22.44% of the farmers accounting for 13% of the groundnut area planted.
- Using the treatment effect estimation framework, the potential adoption rate for groundnut is estimated to be 78.44% leading to an adoption gap of 55.99% implying that there are potential to increase adoption of modern groundnut varieties based on the awareness and promotion.
- Matching methods indicate that the effects of modern groundnut varieties on yield are estimated between 155.05 kg per ha and 202 kg/ha between adopters and matched non-adopters. The estimated impacts of adoption on the score of consumption and coping strategy index (proxy for food secure) were significantly different between adopters and matched non-adopters implying that policies and institutional innovations to promote seed projects are essential to improve the number of groundnut varieties in Nigeria and generate more impacts.
- A baseline study was carried out in Northern Ghana in 2011/2012 to characterize the farming community. Stratified randomly selected sample of 300 households from three groundnut producing districts of Northern Ghana were used.
- Results indicate that household heads were generally young (approx. 43 years) with more than 90% married.
- About 70% of households were illiterate and household sizes are relatively high (average 11 members).
- Agriculture is the main source of livelihood practiced for about 91% of surveyed households (approximately. 15 years' experience farming groundnut).
- Thirty percent of households engage in other income generating activities dominated by petty trade.
- Groundnut is cultivated on an average 4.95 acres i.e. about 28% of the total cultivated area. Farmers travel on average 11 km to get to the fields and there are high transaction costs for accessing fertilizers and extension information.
- The average groundnut production per household is estimated to be 23 bags of 100 kg of which 74% is sold.
- Access to formal credit is limited but there are several information supply sources of which traders and other farmers are the major resource.
- Own saved seed is the major seed supply source for 78% of surveyed farmers while only 11% purchase seed from the market. Radios, local markets, extension agents, and other agents are the major sources of information on groundnut market price.
- All the surveyed farmers were classified as poor by the UN standards from the revenues and expenditures perspectives. Groundnut contributed about 32% of their total income. Food security is a major problem in Northern Ghana especially during the dry season. Farmers reduce food consumption during the lean period in 4 out of 12 months in Northern region while it is estimated to 2 months in the Upper West region.
- The most dominant coping strategies include the sale of livestock (62% of households surveyed).

Common bean in Eastern and Southern Africa

- An adoption study to provide information on progress in terms of access and utilization of improved bean varieties was completed in Southern Tanzania and Ethiopia. These studies were conducted in 2011-2013, covering 750 households selected across 75 villages in Southern Tanzania and 600 households from 16 districts (Woredas) in Ethiopia. The data sets for both countries have been cleaned and can be made available.
- The household level questionnaire contained questions about the household composition, socioeconomic characteristics, land holdings, bean production and varieties cultivated, harvest and its use, sales and use of revenues, decision-making, current and past use of bean varieties, varietal preferences and demand for

seed, social capital and networking, access to services, and household consumption expenditure.

- **In Southern Highlands Tanzania**, results indicate that 23.4% of bean producers have adopted varieties released between 2002 and 2010. Among the adopters in Southern Tanzania, 15% replaced their traditional varieties with new ones while 8.4% have adopted partially (plant new varieties alongside other varieties that they were growing before the project.
- In terms of area, varieties released in Southern Highlands Tanzania since 2002 are grown on 18.3% of the bean area while bean varieties were released in the period 1970- 2000 dominate, thus occupying 46.58% of the area.
- In South Tanzania, better access to market was found to increase the probability that a farmer adopts improved varieties. For a one km increase in the distance from the market place, the probability of adopting improved bean varieties partially was observed to reduce by 0.2 percent and by 0.3 percent for full adoption.
- Household characteristics such as wealth indicators (livestock and farm equipment) and household size were also important factors that positively increase the adoption of improved bean varieties in South Tanzania.
- **In Ethiopia**, improved bean varieties (released 2002-2010) and supported under TL-II account for 43.3 % of bean area in the study regions at the time of the survey. On the other hand, bean varieties developed and released under the project (during 2008-2011) and disseminated under TL-II account for 4.4% of the bean area, equivalent to about 10,000 Ha of bean area.
- Out of 48 varieties released between 2003 and 2012 (PABRA database, 2014), 17 varieties have been take up by farmers and are diffusing among the bean producing communities. In addition, varieties that dominated bean area in 2008 have been replaced by new ones in some agro-ecological niches. For example, in the southern region of Ethiopia, Naser variety released in 2003 and supported under the TL-II project was planted on 89% of the bean dethroning Red Wolaita that accounts for 14.8% of the bean area in the same region in 2011.
- Econometric analysis reveals some important constraints and facilitators of the decision to adopt improved bean varieties in both countries. The probability of adopting new improved bean varieties is 19.1% higher in villages with organized agricultural market places than in villages without one, suggesting that the market access is a significant pull factor for fast diffusion of varieties in rural Ethiopia.
- Membership in cooperatives/farmer group was also found to increase the probability of choosing new varieties over very old varieties by 7.7% in Ethiopia.

Groundnut, pigeonpea and chickpea in Eastern and Southern Africa

- **In Tanzania**, an impact assessment of modern pigeonpea varieties was carried out using a sub-sample of the TL-II baseline sample as well as additional households within the districts Kondoa, Karatu, Babati and Arumeru.
- Results indicate that the positive attributes of the improved varieties went beyond yield increase to include soil fertility improvements and food security. These results were confirmed by nationwide estimates based on related projects.
- ICRISAT efforts in Tanzania which include several other projects were estimated to have an internal rate of return between 13.5 and 25.5% based on either optimistic or pessimistic assumptions.

Soybean and cowpea in West and Central Africa

- In Northern Nigeria, an adoption study was carried out in two states Borno and Kano which are the two main cowpea production zones. A multi-stage sampling technique was used to select a sample of 500 respondents for the study in Borno and Kano states in northern Nigeria.
- The results showed that 72% of the sample households in Borno state and 81% in Kano adopted improved cowpea varieties. Participation in on-farm trials and demonstrations, educational status, and the

availability of improved seed markets were significantly and positively related to the adoption of improved varieties of cowpea.

- For soybean, the adoption survey covered a sample of 400 farmers consisting of participants and non-participants in TLII soybean promotional activities such as field trials, seeds evaluation, seeds multiplication, related soybean training.
- Results showed that access to information was a key factor which affects positively the adoption of improved varieties of soybean. Major sources of information on soybean varieties are extension service (59%), fellow farmers (24%), and community members (11%). More than half (58%) of the respondents indicated that they had no contact with extension services which impedes the adoption of improved varieties.
- The proportion of farmers who adopted improved varieties for the first time increased gradually from 2% in 1986 to 13% in 2000 and then subsequently peaked to 79% in the period during which the TLII project was implemented. In spite of the high preference given to the improved varieties, farmers indicated that they were constrained by the high cost of improved seeds (34%) of the improved varieties. The lack of availability of improved and high quality seeds of soybean varieties stands out as the main barrier to adoption of these varieties.
- In Malawi, an adoption study was conducted in 2012 involving a survey of 600 households followed by a similar number of sample households in Mozambique.
- Soybean is emerging as a major cash crop in Malawi and Mozambique. In both of these countries, over 80 % of the sample households in the pilot areas produced and sold soybean to generate cash incomes.
- Adoption of improved cowpea varieties ranges from less than 5% in Malawi to over 15% in Mozambique. On the other hand, adoption of improved soybean varieties stands at about 25% both in Malawi and Mozambique. The known soybean varieties are Makwacha in Malawi (grown by all adopters of improved varieties) and Santa Rosa in Mozambique (grown by over half of the adopter of improved varieties).
- Lack of access to improved seed was found to be the major reason for non-adoption of improved varieties of cowpea and soybean. Over 85% of the non-adopters in both countries indicated lack of availability of improved seed as being the main reason for non-adoption of improved varieties. By contrast, lack of access to capital (i.e. cash, credit, etc.) was the main reason for non-adoption of improved varieties of maize. The results reinforce the fact that poor access to improved seeds, in terms of both information on availability of seeds and seed delivery, is one of the major constraints to smallholder grain legume productivity in Sub-Saharan Africa.

Chickpea, groundnut, and pigeon pea in SA

- **With regard to chickpea**, in Kurnool district of Andhra Pradesh, India, only 13% sample farmers still persisted with Annigeri, while the remaining (87%) have switched to the improved cultivars like JG 11 and JAKI 9218 in adopted villages between 2007 and 2010. In case of control villages, entire sample farmers adopted JG 11 variety. KAK 2, the ruling kabuli variety, occupied nearly 80% and 78% of chickpea area in both adopted and control villages respectively in Prakasam district. JG 11, an improved desi variety covered an area of 18% in adopted and 20% in case of control villages. The real-time tracking survey conducted in 2013 concluded that nearly 85-90% chickpea area are occupied by project introduced cultivars (JG 11 and JAKI 9218) in the two targeted sites.
- A comprehensive adoption and impact study was undertaken on 'short-duration chickpea improved cultivars in Andhra Pradesh' during 2012-13 with partial financial support from the Standing Panel on Impact Assessment (SPIA). Results showed that nearly 85% of cropped area in the state is occupied by JG 11. Yield advantage on an average of 30-40 % was observed on chickpea farm households. The translated unit cost reduction was estimated at US $ 144 per ton2.

[2] Bantilan et al. 'Short Duration Chickpea Technology: Enabling Legumes Revolution in Andhra Pradesh, India' (forthcoming)

- During the baseline surveys (2007-08), the area occupied by Annigeri was 91 and 94 % respectively for Dharwad and Gulbarga districts of Karnataka state. But considerable changes occurred in composition of chickpea varieties in early adoption studies conducted during 2009-10. New varieties like JG-11 (23%), BGD-103 (18%) and JAKI-9218 (12 %) have occupied nearly 59% of the total sample chickpea area in Dharwad district. The share of Annigeri dropped to 41 % between baseline and early adoption surveys. In Gulbarga district also, the share of Annigeri declined to 42 per cent in the pooled sample. Improved cultivars like JG-11(22%), BGD-103 (18%), MNK-1(10%) and KAK-2 (5%) have replaced nearly 52% of chickpea pea area under Annigeri variety for the study sample. The real-time tracking survey conducted in 2013 showed that nearly 65% chickpea area in the targeted districts are occupied by TL-II introduced cultivars (JG 11 and BGD 103).

Similarly, the baseline surveys were established during phase 2 of the project for Bihar in India and Barind region of Bangladesh.

- **With regard to groundnut**, TMV-2 remained to be a dominant variety in both baseline (2007) and early adoption (2010) surveys in Raichur district of Karnataka, India. New varieties (R2001-02 and ICGV-00350) introduced through FPVS dropped the figures (around 5%) in terms of groundnut area adoption by 2010. The strangle hold of TMV-2 was also evident in Chitradurga district of Karnataka state. The groundnut area covered with FPVS introduced varieties (ICGV-91114 and R2001-02) accounted to only 9.2 per cent in the study area by 2010 even though FPVS trials demonstrated the superiority of the new varieties.
- In case of Tamil Nadu state, India, the penetration of new groundnut varieties was rather low in Erode and Thiruvannamalai districts. More sustained efforts were needed for enhancing the seed multiplication and popularizing high yielding new varieties. The initial FPVS screening, pruning of the cultivars and paired trait comparisons took three seasons for identification of suitable varieties (ICGV00351 in Erode, TVG0004 for Thiruvannamalai, ICGV 87846 for Namakkal districts) in Tamil Nadu state. The official release of these varieties and subsequent delay in seed production were the reasons for low adoption rate of new varieties. The real-time tracking surveys conducted in 2013 found that the extent of their adoption have increased to 6% in the project target sites.
- The baseline survey was completed during phase 2 of the project in Odisha state of India. Local cultivars had the high dominance than the formal releases in the targeted site.
- With regard to pigeonpea, *Asha*, *Abhaya*, and *Maruthi* were the dominant pigeon pea varieties observed during the baseline surveys (in 2007) in Andhra Pradesh. However, the variety Asha (43%) retained top in the list in the early adoption surveys (in 2010) as well. It was followed by LRG-41 (20%) and PRG-158 (8%) improved cultivars in the study area. The local variety (Nalla kandi) still occupied around 16 % pigeon pea area of the sample.
- The varieties *Maruthi and Asha* were dominant cultivars noticed during the 2007 baseline surveys of Akola district in Maharashtra, India. The early adoption surveys conducted during 2009-10 observed that Maruthi still occupied nearly 50% pigeonpea area of the sample. The other major cultivars were *BSMR 736, BSMR 853, Asha,* and *PVK Tara*. More than 90% of pigeonpea cropped area was under improved cultivars in the targeted sites.

Key Milestone 1.2.: Track diffusion of technologies for groundnut in Niger (WCA) and Tami Nadu (South Asia), cowpea and soybean in Malawi and Mozambique and Ghana and chickpea in Karnataka and Andhra Pradesh

- **With regard to groundnut in Niger**, a study tracking the diffusion of groundnut varieties revealed that 71% of farmers adopted at least one improved variety introduced during the first phase of the project. The

adoption rate is also estimated to about 38% of the groundnut area. The popular variety is RRB occupying about 74% of area planted with modern varieties. Adoption was high in project villages with 51% of the groundnut area planted among surveyed households, and less than half (24% and 20%) in diffusion and control villages respectively.

- The major constraints to adoption included the lack of access and availability of seed (31%), followed by poor crop association (7%), insect pests (6%), lack of knowledge of crop management (4%) etc. In 2012, groundnut seed was mostly exchanged between family members accounting for about 60% of the seed transactions, followed by friends and neighbors (32%). During the preceding good years, it is anticipated that seed trade within the social networks may decrease as many family members would prefer to keep the seed. In 2011, for example, it is noted that 48% of the transactions were done between family members and 35% between friends and neighbors. In 2012, it is estimated that one farmer exchanged seed with an average of 1.67 farmers (i.e. about 2 farmers) and about 1.42 farmers (about 1 farmer) in 2011.
- In Malawi and Mozambique over 80% of sampled households in the pilot areas produced and sold soybean for cash incomes. Adoption of improved soybean varieties stands at about 25% in both countries. Popular soybean varieties are *Makwacha* in Malawi and *Santa Rosa* in Mozambique. In Ghana, adaptation to climate change is a real problem for women because they have very limited resources. The major constraints affecting the women population here are lack of information and opportunities to strengthen their knowledge on adaptation strategies to climate change. Overall, farmers use short duration cowpea varieties as an adaptation strategy to cope with climate change, but women have seed access constraints, in addition to the lack of information on availability of such varieties.
- In India, 87% of chickpea farmers have switched from the 40 year old Annigeri variety to new cultivars JG-11 and JAKI -9218 in Kurnool district of Andhra Pradesh, while 100% of farmers in Prakasam district have switched to two new varieties KAK-2 (8 0%) and JG-11 (20%). There is similar trend in Gulbarga and Dharwad districts of Karnataka where the area under Annigeri has been reduced by 52% and 59% respectively, in favor of the new improved varieties (JG-11, BGD-103, JAKI-9218, MNK-1 and KAK-2).
- The penetration of new groundnut varieties remains rather low even in India. More sustained efforts are needed in seed multiplication and for popularizing the high yielding new varieties. The official release of these varieties and subsequent delay in seed production were the reasons for low adoption rate of new varieties.
- **Key Milestone.:** International Food Policy Research Institute *(*IFPRI*)* **global futures for agriculture (IMPACT) model customized for groundnut (WCA, ESA and Asia), pigeonpea (Asia), chickpea (ESA and Asia) and soybean (WCA and ESA) to allow scenario analysis for assessment of future supply and demand for TL II legumes (Y2)**

Groundnut In WCA

IMPACT model projections for groundnut were completed. Initial results showed that even under the pessimistic scenario (high population growth and lower income), the total demand for groundnut will still increase compared to the status quo. The per capita kilocalories available will be decreasing significantly and the number of malnourished people increased significantly. Under the optimistic scenario (higher income and lower population growth), the total demand with increase compared to the base scenario, and the per capita kilocalories available increases significantly. However, groundnut supply as well as total number of malnourished people will be decreasing significantly. Under the scenario of increased yield as a result of research investments, IMPACT model results showed that the trend in per capita food demand will be increasing; groundnut trade will be increasing along with the total food supply. Under the climate change scenario, both producer and consumer prices will increase, per capita food demand as well as the groundnut yield will decrease. Similarly the per capita kilocalories available will be decreasing. This study was completed for Asia in 2013.

Groundnut In ESA

The model projections show that the total demand for groundnut would significantly increase in the baseline scenario. There would be an increase in supply as well. However the increase in supply would not be sufficient to match the rise in the demand. In contrast to baseline supply, which will start increasing by 2040 in the pessimistic scenario, the optimistic scenario supply increases are lower throughout. The demand for groundnut will be increasing significantly by 2050 in both optimistic and pessimistic scenario. Under the climate change scenario, yield of groundnut increases and per capita demand decreases. Both consumer prices and producer prices increase under the climate change scenario.

Chickpea in ESA

The model projections show that the demand for chickpea would be increasing. Consequently, the supply of chickpea would also increase. However the increase in the supply will not be sufficient to meet the increase in demand. Thus there would be a mismatch between demand and supply. The demand increases in 2030 and 2040 in the pessimistic scenario and the increases in the optimistic scenario is similar to that in the status quo relative to the baseline. The supply increases are higher by 2050 in the pessimistic scenario while they are lower in the optimistic scenario relative to the baseline**.** The food demand consistently increases in the pessimistic scenario. Under the climate change scenario both consumer and producer prices increase. Yield of chickpea, per capita demand, and total demand for chickpea increases under the climate change scenario.

Pigeonpea in ESA

The model projections show that the demand for pigeonpea would be increasing. Supply would be increasing in the baseline scenario. However, there will be a gap in demand and supply in Tanzania and Uganda. The total demand increases in the pessimistic scenario and decreases in the optimistic scenario relative to baseline. Under climate change scenario, total demand of pigeonpea increases in all the countries and per capita demand for pigeonpea also increases in most of the countries. The yield of pigeonpea increases in all the climate change scenarios. There are slight increases in producer and consumer prices in most of the countries

Groundnut Chickpea and Pigeonpea In SA

A global partial equilibrium multi-commodity trade model (IMPACT) was used to assess the future projection of supply, demand, prices and trade of the food legume producing and consuming countries around the world. The study revealed that production has not been able to meet the demand due to the secondary treatment of pulses in the Asian countries. The projected demand for groundnut, chickpea, and pigeonpea in Asia will grow much faster than production as direct consequence of growing population in the region. By 2050 the production of chickpea will be about 8% less than that of demand in Asia. Although yield increases compensate for much of the production forgone due to area contraction, it does not fully satisfy demand, leading to a deficit of chickpea production intensifying with time. The aggregate production and consumption of pigeonpea in Asia will be more than double in 2050 compared to the level in 2000 which was 3 million tons. It is anticipated that the projected demand for groundnut in Asia will increase from 7 million tons in 2010 to 8.9 million tons in 2050. To meet the increasing demand of food legumes in the region, there is need to improve the average yield and profitability of the legume crops by developing short duration, drought resistant, high yield varieties and ensuring competitive prices to increase the adoption of new technologies by farmers in the regions.

Key Milestone: Study of legume seed systems for common bean (Ethiopia), groundnut (Mali and Tanzania)

- In Ethiopia, a follow up study across six bean production zones found ten different seed channels that adopters used to access new bean varieties. These included: local seed merchants (17.7%), local grain traders (15.6%), farmer to farmer seed exchange (12%), farmer groups (10%), ministry of agriculture and extension (7.5%), demo plots (6.9), Bureau of Agriculture (6.5%), NGOs (5.7%), on farm trials (5.5%) and relatives (2.7%) etc. The cash-seed transaction dominates bean seed systems in Ethiopia where bean production is commercialized. Less than 30% of farmers use their own preserved seed for planting. Local markets dominate the seed market, accounting for 32.2% of purchases among the sampled households

because seed from this channel is readily available and relatively cheaper (about 8 Birr) compared to seed from agro-input dealers (about 11 birr). Small packs of 200g-1000g were also used to access the new varieties. The other studies were scheduled for next reporting season.

- In South Tanzania, about 30.5% of the farmers that accessed seed in 2009-2013, bought it from the grain market, while 28% of the farmers accessed it through farmer to farmer seed delivery channels. Public interventions through national research institutions and government local institution contributed 32.5% while formal channels (agro-seed dealers) contributed only 4.4% of seed access. It is therefore, evident that new varieties of common bean continue to diffuse mainly through the informal channels, which supports the strategy of strengthening the linkages between the formal and informal seed delivery channels.

- The study also shows that many farmers are currently using external sources for seed during plantation. Approximately 63% of the farmers in Southern Tanzania bought their seed from the grain markets or from fellow farmers in the 2012 cropping season. This could be because this part of Tanzania has one cropping season and keeping seed is more costly than purchasing from the market which implies a potential for private investment in seed businesses. In collaboration with Makerere University, two studies are being implemented as MSc research programs, under topics: "Community based common bean seed multiplication prospect and profitability, in Ethiopia" and another study seeks to evaluate the formal and other quality declared seed channels in terms of geographical and social reach and estimate farmers' willingness to pay for improved seed. Preliminary information from Ethiopia revealed household biases in community based seed production model where wealthier households (i.e. in terms of livestock, landholding and finances) are likely to participate. Final and detailed results will be documented in the students' thesis.
- In Mali using a dataset of 166 households in Kayes and Koulikoro regions, results showed that the major constraint to adoption of modern groundnut varieties was the non-availability of seed for 83% of the surveyed households. Most farmers source seed from own harvests (52%), followed by village markets (33%) and occasionally from on-farm trials and research institutions. The seed transactions are free (83%) followed by cash (16%).

Key Milestone: Market and value chain surveys conducted and reported for groundnut (Mali and Odisha), pigeonpea (Bihar), chickpea (Bihar and Bangladesh) and common bean (Tanzania) (Y2 for Asia)

- In India, information related to marketing and marketable surplus were collected along with the baseline studies. However, data entry and analysis are still in progress. In Mali, a participatory market chain analysis was conducted and the report is available. In Tanzania, a value chain analysis of pigeonpea was initiated and a second one was jointly designed with the Pan African Bean Research Alliance (PABRA) for common bean production in Eastern and Southern Africa. The common bean study also monitors cross border trade at six border points between Tanzania and Zambia, DRC, Kenya, Rwanda, Uganda, and Burundi. Preliminary results based on key informants confirm significant cross border trade through the informal systems that goes unrecorded. Estimation of the proportion of informal trade is on-going to ascertain the true value of the bean trade in the Southern Africa Region.

Common bean in Tanzania

- A value chain study for common bean was conducted in Southern Tanzania. A market level questionnaire was used to elicit information from traders and local vendors in district markets by trained enumerators. In addition, information on marketing was also elicited from farmers at the primary node of the chain during adoption surveys.
- The results indicated that, in most cases, bean businesses (about 77%) are not specialized but conducted alongside other crop businesses especially maize, soyabean, cowpea, and millet. Accordingly, the scale of

bean business per trader is small, with a stock turnover averaged at 12 ton per year. Both men and women are involved in the trade of bean, but women are more likely to participate as retailers (constituting 60%). Net consumers prefer visual characteristics such as size, color and uniformity of grain when purchasing bean for their home consumption. All these grain attributes weigh nearly the same but cleanliness is the most important preference.

- Most of the bean transactions from farmers are through middlemen or traders transacting directly with individual farmers (supplying 77.8% of the traders) while only 19.79% of the traders were supplied by farmer associations, which highlights on limited collective marketing and high transaction costs that characterize bean marketing in Tanzania. High transaction costs are translated to farmers in form of low farm gate prices, thereby discouraging adoption of high yielding but expensive inputs. Transaction costs were exacerbated by lack of contractual arrangement in business transaction as most traders reported moving from village to village gathering grain for sale. Mobile phone technology is increasingly being used in bean trade as majority of traders obtain information about grain price at the time of grain purchases from other traders (57.80%) or via short message services using mobile phones (47.71%). Bean grain marketing costs that include: bagging, market dues, transportation and inspection fees, and storage are mainly incurred during purchases of stock, vary across value chain nodes and are most important determinant of the gross margins. Overall, the total gross margin is about Tanzanian Shillings (Tshs) 492 per kg, with the biggest share (52.5%) transferred to the retailers, followed by wholesalers with 29.2% share and middlemen with the least share (24.2%).

Pigeonpea in Tanzania.

- In collaboration with an International Fund for Agricultural Development/ European Union (IFAD/EC) funded project, a pigeon pea value chain assessment survey was conducted in Tanzania. The main findings derived from this survey revealed that the pigeonpea sector in Tanzania has grown massively in the recent years and now constitutes the third biggest supplier in the World. However, the sector heavily depends on two dominant trading houses which handle the bulk of the exports to India, the major market for Tanzanian pigeonpea.
- Besides being an important cash crop for Tanzanian farmers it is also widely consumed and thus contributes to the local diet and food security. Additionally, the adoption of improved varieties and management practices was reported to almost quadruple the revenues from pigeonpea production.

Groundnut and Soybean in Malawi and WCA

- For groundnut in Malawi, although the volumes of groundnut exports remain lower than the 1980's levels, the review showed that Malawi maintains a comparative advantage in groundnut production and competitiveness in exports suggesting that there is scope for increasing groundnut exports with the adherence to required quality standards.
- Soybean producers in Malawi are beginning to respond to the growing market price incentives, with over 75% of the soybean produced being marketed.
- In West Africa, the competitiveness of groundnut in the domestic, regional and international markets has been limited by the low productivity, aflatoxin regulations, and stricter grades and standards.

Key Milestone: Reports: i) Institutional innovations and business practices to improve access to markets and reduce transaction costs for smallholder farmers; ii) Best business practices for linking producers to processors; iii) Agribusiness opportunities for legumes; iv) Opportunities for small-scale women processors to develop markets in WCA (Y3)

Value chains

- Results from Niger and Burkina on challenges faced by cowpea stakeholders reveal that farmers' access to inputs is hampered by several factors, including contact with extension service, physical distance from house to farm, area under cultivation, income generated from the previous season, and mostly the total distance traveled by farmer to purchase inputs.
- In Mali, a study was conducted on groundnut value chain targeting the supply of high quality groundnut i.e. with less aflatoxin. The direct value chain actors were surveyed including farmers', traders, policymakers, and service providers in terms of knowledge, attitude, perception and practices on Aflatoxin in groundnut.
- Focus group meetings with value chain actors revealed that the producers, rural and urban consumers, rural and urban assemblers, rural and urban wholesalers, small-, medium- and large processing units are the direct actors in the chain. The channels are made of lots of intermediaries that not only increase the cost of intermediation but also reduces the producer shares of social gains. Producers are poorly organized and uncoordinated to collectively sell their produce and thus decrease their bargaining power by collaborating with traders.
- Almost all value chain actors have little access to business services such as improved seed of modern varieties and/or tolerant or resistant to Aflatoxin contamination, financial services, market information, and fertilizers and pesticides.
- Value chain actors are not supported by policies and regulatory options that will help reduce the level of Aflatoxin in the local and international markets and will de facto reduce health hazards. There are no formal grades and standards set in the markets for assessing the groundnut quality. Government quality control measures do not necessarily target Aflatoxin issues and they are poorly enforced. However, traders have set informal norms and standards that do not specifically address Aflatoxin issues per se. These norms and standards are solely based on physical characteristics of the pods or seed whereas Aflatoxin could be invisible and requires chemical test kits for its detection. Value chain actors have spurious knowledge of the effects of Aflatoxin on animal and human health. Overall, information on the effects of aflatoxin is still very limited.
- Potentially critical points along the groundnut commodity value chain are found in the pre- and post-harvest stages of groundnut production, processing and marketing. These need to be tested formally by drawing samples along the chain and measuring the levels of aflatoxin contamination.

Opportunities for small-scale women processors to develop markets in WCA

In order to explore the various opportunities available for women processors to enhance the small-scale businesses, two studies were undertaken including (1) assessing women processors preference for groundnut oil and cake characteristics and (2) assessing the performance of women oil processing businesses.

- In Western Niger, in order to assess women preference for groundnut oil and cake characteristics, a set of 31 women panelists were selected to assess the six varieties already selected by women producers. Panelists-women were of average 38 years old, with 61% illiterate, 77% married from which 13% were divorced. Almost all women processors were poorly equipped and estimated to be about US$86. All women panelists were engaged in oil processing, 77% in making groundnut paste, 76% in groundnut cakes, and 43% in processing grilled nuts. All women regularly consumed: oil for 93% of panelists, 69% for cakes, and 41% for paste. Two processed products were targeted mainly oil and cakes with three levels each (good, medium, bad) and seven varieties including 55-437, Fleur 11, ICG 9346, J11, Local and TS 32-1 were the object of the sensory tests. Oil traits included color, taste, smell, and fluidity. Cake characteristics included color, hardiness at touch, stickiness at touch, taste, hardiness at consumption, and stickiness at consumption. Based on the median scoring, women preferred Fleur 11 followed by ICG 9346, RRB, etc. for processing oil and 55-437, RRB, TS 32-1 etc. for making cakes. Ordered probit models were used to identify traits likely to explain the ranking of varieties by women. For processing oil,

color and stickiness (fluidity) came out as the most critical factors driving their preferences. Likewise for making cakes, color and taste significantly explain women ranking. None of the socio-demographic profile was found significant. This was followed by a baseline survey on women small-scale business enterprises.

- A participatory value chain analysis showed that six major constraints were limiting groundnut value chain efficiency and among those, inconsistent supply of raw material, lack of processing equipment, linkage to product markets were very common. Baseline survey of 397 women groundnut oil and cake processors in the Dosso region in Niger showed that women processors are relatively young and have a considerably large experience processing groundnut (~39 years) but are poorly equipped. There is little product differentiation as they focused mainly on groundnut oil, cake and paste. These are small-scale enterprises employing less than two permanent employees and less than one temporary labor and using mainly hand tools estimated to about US74 on average. Processing activities are important during the cold and hot seasons where agricultural activities are limited. The major sources of raw material are traders in neighboring villages followed by the individual producers. The average quantity of raw material needs is estimated to 5,000 kg of shelled nuts. Processors care about quality criteria that include physical purity, humidity level, and seed size. The size of bag, seed color, and seed shape are also important. On average, women process 1,459 liters/year of groundnut oil, 121 bags of kuli-kuli3 (groundnut snacks) and 1,610 kg of groundnut paste. The return to investment in processing is estimated to US$1,251 and benefits to cost (BC) ratio estimated to be 1.97. The major constraints reported by women include access to products markets (55%), access to investment capital (35%), lack of processing equipment (33%), and poor access to working capital to purchase groundnut grains (26%).

Key Milestone: Alternate options (radio, mobile phones, internet, etc.) identified for delivering relevant and timely market information to farmers in sub-Saharan Africa (Y3)

- To raise awareness on aflatoxin contamination among groundnut farmers, ICRISAT's team went on Kenya's highly popular farming TV show, '*Shamba Shape Up'* to offer advice to farmers on groundnut production and suggest improvements that will not only result in higher yields, but also reduce aflatoxin exposure. With over seven million viewers across three countries in East Africa, '*Shamba Shape Up'* is an important channel to reach out to smallholder farmers. For farmers in Kenya, the TV show offers additional support by providing free-of-charge information flyers that can be requested by sending a text message. Farmers can also pose queries through text messages to which experts would respond within 48 hours. Aimed at East Africa's rapidly growing rural audience, the makeover style TV show intends to offer both farmer and audience the tools they need to improve productivity and income on their farms. The show's team visits a farm each week in different areas of the country and involves experts from partner organizations who specialize in the topics covered in the episode. A team from ICRISAT ESA worked with the ICRISAT Pathologist (Dr. Sam Njoroge) and the show's production company, *mediae.org*, on planning the episode's content and messaging. The program can also be viewed online at: *http://youtu.be/X8H9ETNeieA*. The data generated from this exercise is helping the ICRISAT team to further improve aflatoxin-related messaging. The program was sponsored by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) with supporting funding from Tropical Legumes II project and features parts of an animation produced by the Innovative Communication Media and Methods project, funded by the McKnight Foundation. This highlights synergetic effects of various projects to spread results as far as possible. Besides its initial release in Kenya, the program is also being aired in Tanzania and Uganda in both English and Swahili.

[3] Kuli-kuli is a Hausa food that is primarily made from peanuts. It is a popular snack in Nigeria.

- Tablet based household surveys have been piloted in Ethiopia in an effort to make data collection more efficient. After holding a brief introductory training on open data kit (ODK), which is the application used for the survey, for ICRISAT staff in Nairobi a small team converted the TL-II survey instrument to ODK and trained enumerators and partners in Debre Zeit research station in Ethiopia. While the questionnaire content had to remain due to the panel setting of the survey, the implementation on the tablet had to be carefully thought through in order to maximize benefits. Therefore, cross checks and automatic skips were implemented according to the initial set up. Furthermore, restrictions on variable ranges and limitations on skipping answers were set up to ensure highest possible data quality. Initial feedback during the training and field deployment were very positive. Prior concerns about the enumerators' ability to adjust to the electronic questionnaire and touch screen were wiped out after the enumerators' first hands on experience. The enumerators confidently handled the tablet and farmers were fascinated by the new technology. Tablet based data collection will not only improve data quality but also ensures quicker availability of data as data entry will no longer be necessary and the need for data cleaning will be reduced. Finally, the investment costs for the tablets are estimated to be recovered after approximately 1,000 interviews.

Key Milestone: Two graduate students in Niger and Uganda (MSc level) (Yr 2)

- A graduate student from the University of Abdou Moumouni in Niger is studying a Value chain analysis of groundnut for the Dosso region of Niger. Another student from Makerere University Uganda has been identified to study "Processing practices and their effects on the price of groundnuts and groundnut products in Kampala and Soroti Markets".
- One Ugandan student has been trained in Value chain analysis and submitted the MSc proposal to be finalized during early 2015

Key Milestone: On the job training for 8 NARS partners (Burkina, Senegal, Ghana, Nigeria, Uganda) in adoption studies, impact assessment, market value chain analysis and institutional analysis (Yr 2, Yr 3)

- A joint training workshop on "Impact assessment and value chain analyses" was organized from 8-13 August 2012 by ICRISAT and IITA in Niamey. Fifteen participants from Burkina Faso (2), Mali (1), Nigeria (3), Ghana (1), Niger (5) and ICRISAT (3) attended. Other training workshops organized include a training program on conducting baseline surveys (30-31 Aug and 1-3 Oct 2012) and real-time tracking of diffusion (4-5 Oct 2012).
- One NARS Uganda and one professor from Makerere University in Kampala were trained in Value chain analysis.
- In each country, data was collected by NARS scientists who were trained in a two-day workshop on the questionnaires, survey methods, data entry and analysis. Training of enumerators and supervisors was conducted by one CIAT economist, one economist from the NARS, (MARC) and the national coordinator _bean program. From Tanzania we trained 17 (14 females) and from Ethiopia we trained 22 (18 females).

Key milestone: Gross Economic Benefits from Tropical Legumes II (TL II-related) Modern Varieties in Project Countries

- The TL II project was designed to increase the productivity (yield per unit area) and production (total availability) of six major grain legumes – chickpea, common bean, cowpea, groundnut, pigeonpea, and soybean in rural areas of Sub-Saharan Africa (SSA) and South Asia (SA). The project worked in a total of fifteen countries: thirteen in SSA (Burkina Faso, Ghana, Mali, Niger, Nigeria, Senegal, Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Uganda and Zimbabwe) and two in SA (India and Bangladesh) during the second phase. Burkina Faso, Ghana, Senegal and Uganda were new countries in SSA whereas Bangladesh, Orissa, and Bihar were newly added in SA during phase 2.

- The project focused on developing improved legume varieties and ensuring access of smallholder farmers

to seed of these varieties, in the context of ongoing environmental constraints such as drought, pests and diseases. In particular, efforts were targeted on the informal and formal seed sector and the supply of quality seed, which is a major constraint in the adoption of legumes. The targeted expected increase in added value of productivity gains in the rural areas of these regions amounted to about USD1.3 billion over the ten year period 2007 to 2017. It was also expected that at least 50 new varieties, with yield advantages of at least 20% over the adapted checks, across the six crops would be released to farmers, with the seed sector (public and private) producing more than 96,000 metric tons (MT) of quality seed, enough to plant 1.6 million ha through the formal seed sector and considerably more when informal distribution systems are added.

- During the first two phases (2007 to 2014), 126 new varieties were released, yielding more than 20% over the local checks. More than 127,000 metric tons of seed of these legume varieties were produced directly with project funds and more than 446,731 metric tons with project and partners' investment. In addition, the total amount of seed produced during these covered more than 2,007,889 ha with the funds provided under TL II and 6,524,027 ha with project and partners' investment. The average adoption rate of modern legume varieties in TLII countries was estimated to 23.82% of area cropped with legumes. So far, the project has attained some of its major targets in just seven years of implementation. The total gross benefits from project intervention was computed using two approaches: (1) the total seed produced during the initial years of project implementation and (2) the data on adoption rate derived from adoption surveys and/or expert opinions conducted between 2010 and 2012.
- It is estimated that, since 2007, modern legume varieties (MVs) developed/disseminated under the TLII project implemented by ICRISAT, CIAT, and IITA with NARS partners have been adopted on at least 2,007,889 ha and have generated more than US$513 million from project funding and nearly US$2 billion from project and partners' investment. Even when using the adoption rates data from adoption and expert opinion surveys, the aggregate gross benefits from TLII related modern legume varieties is estimated to be about US$978 million, which is still far above the total TLII investment grossly compounded at US$48 million4 (phases 1 and 2). The returns on investment are high. In effect, for each TLII dollar invested, the project generates USD11 with direct project investment, USD39 with partnership's investment and USD20 when using adoption rate based estimation.

Objective 2 To enhance groundnut productivity and production in drought-prone areas of SSA and SA

Target countries include Tanzania, Uganda, Malawi and Mozambique in ESA, Nigeria, Niger, Mali, Burkina Faso, Ghana and Senegal in WCA, India and Bangladesh in SA.

Key Milestone: At least one FPV identified for each location across 130 locations in 10 countries.

ESA:

- The mother baby trial approach involving, more than 148 groundnut mother trials (researcher managed) and 440 baby trials (farmer managed) trials were set up in the first four years of the program in Malawi from where seven varieties were released in 2014 (ICGV-SM 01724, ICGV-SM 01731, ICGV-SM 08501, ICGV-SM 08503 ICGV-SM 01514, ICGV-SM 99551 and ICGV-SM 99556); 60 mother trials and 300 baby trials in Tanzania (underpinning the five varieties [ICGV-SM 99555, ICGV-SM 99557, ICGV-SM 01711, ICGV-SM 01721, ICGV-SM 83708 (ICGMS 42)] released in 2009 with expectations for new release in 2015) and 48 mother trials and 162 baby trials in Mozambique underpinning the six varieties (ICGV-SM 01513, ICGV-SM 01514, ICGV-SM 99541, ICGV-SM 99568, CG 7 and JL 24) released in

[4] Uncompounded investment is US$ 42 million. Compound rate is about 5% as in many projects in SSA with annual investment roughly estimated to US$7 per year

2011. The FPVS in Tanzania, which is the largest groundnut producer in ESA has been remarkable with 20,500 farmers involved in PVS in between 2012-2014.

- In Uganda (new country for Phase II), 140 genotypes were identified for evaluation and in 2013, in 18 locations spread across six regions of Uganda and 13 FPVS trials have been planned for subsequent seasons starting 2015. Through previous ICRISAT collaboration with Uganda NARS, six varieties were released between 1999 and 2011 (ICGV-SM 83708 (ICGMS 42), ICGV-SM 90704, ICG 12991, ICGV-SM 93535, ICGV-SM 99566, and SGV-S1R x S2) and these are the current focus for promotion.

WCA:

- Thirty elite groundnut lines were evaluated in FPVS trials using the mother- and- baby methodology in important groundnut producing locations of the target countries. Farmer preferred varieties were identified from the FPVS trials for release as follows: In WCA, based on the PVS trials, the national program released 19 varieties; Niger (RRB, ICG 9346, J11, Fleur 11), Nigeria (Samnut 24, Samnut 25 and Samnut 26), and Mali (ICGV 97188, ICGV 86024, ICGV 92093, ICGV 92088, Nieta Tiga, Yiriwa Tiga, Nisonja and Bagui-tana) and Ghana (Oboolo, Obooshi, Otuhia, Yenyawoso) between 2010 and 2013. Between 400 and 1500 farmers directly or indirectly participated in the trials in each participating country in a particular year. In Mali, for example, 1590 farmers participated in conducting 179 FPVS trials (46 mother & 133 baby trials) in 2013 while 1039 farmers were involved in 30 FPVS trials in 2012.

SA:

- Seven FPVs were identified in Bangladesh (2), Bihar (4) and Odisha (1) from the trials conducted during Phase II of the project. In Bangladesh, FPVS were conducted in Jamalpur, Mymensingh, Kishoregong, Lalmonirhat, Kurigram, Pabna, Panchagarh, Noakhali and Cox's Bazzar districts. Four early maturing groundnut varieties were evaluated in 131 trials, out of which two (BARI Chinnabadam 8 and BINA Chinnabadam 4), which produced 28 to 58% greater pod yield over local control, were found suitable for cultivation.
- In Bihar, FPVS trials involving eight Spanish bunch varieties were conducted in four villages each in Araria, Purnea, Jehanabad and Nawada districts A total of 80 FPVS trials in 2012 and 40 paired comparisons (PC) trials in 2013 were conducted. In Araria and Purnea, ICGV 02266 emerged as a preferred variety and recorded a 25 % pod yield increase over the local check. ICGV 93648 and ICGV 91114 were farmer-preferred varieties in Jehanabad and Nawada. Dh 86 is also preferred by farmers of Araria district for spring cultivation.
- In Odisha, three varieties (ICGV# 00308, 02266, and 07213) were evaluated together with a standard check (Smruti) in PVS trials in the target districts, and farmers identified ICGV 02266 as the best performing variety. In Karnataka, 625 paired comparison trials of the improved varieties (ICGV 91114 and Chintamani 2) with local variety (TMV 2) were conducted in the farmers' fields in four districts. ICGV 91114 on an average of across 429 demonstrations produced 25 % greater yield over TMV 2 (average pod yield, 1323 kg ha-1), while Chintamani 2, produced 29 % greater pod yield over TMV 2.
- A total of 100 frontline demonstrations (0.4 ha each), involving ICGV 91114, Chintamani 2, and TMV 2were conducted at farmers' fields in Chitradurga, Tumkur, Chikballapur, and Kolar districts. ICGV 91114 and Chintamani 2 on an average produced greater pod yield of 23% and 19%, respectively over TMV2. The FPV trial in 2011 rainy season was conducted on 96 farmers' field in Badami, Bagalkot, and Bilagi in Bagalkot district. ICGV 00350 on an average produced 13% greater pod yield over TMV 2 (pod yield, 1145 kg ha-1). In 2012 rainy season, the PC trial was conducted on 20 farmers' fields in Bagalkot district. ICGV 00350 on average produced 19% greater pod yield over TMV 2. In 2013 rainy season, PC trial was conducted on seven farmers' fields in Bagalkot district. ICGV 00350

on average produced 10% greater pod yield over TMV 2. In Tamil Nadu, a Virginia bunch variety ICGV 87846, which was evaluated in FPVS /PC trials in 985 trials during 2008 to 2013 rainy seasons in Namakkal district, on average produced 41% greater pod yield over local control (1066 kg ha^{-1}). A Spanish bunch variety ICGV 00351 was evaluated in 731 FPVS /PC trials in Erode during 2008/2013 rainy seasons and in 720 PVS/PC trials in Thiruvannamalai during 2009 to 2013 rainy seasons. In Erode district, ICGV 00351 on average produced 30% greater pod yield over TMV Gn 13 (pod yield, 1340 kg ha-1), while in Thiruvannamalai district, it produced 20% greater pod yield over TMV Gn 13 (pod yield, 1587 kg ha-1). Both the varieties have been released as CO 6 (ICGV 87846) and CO 7 (ICGV 00351) for cultivation in these districts in Tamil Nadu.

Key Milestone: At least four (4) elite lines per country entered into national performance trials (NPTs):

ESA:

- Elite lines were entered in national performance trials as follows: Malawi (88), Uganda (35), Mozambique (18), and Tanzania (15). ICRISAT supplied 2,500 new breeding lines to NARS in anchor countries like Tanzania, Malawi and Mozambique and Uganda as well as spill over countries(like Sudan, DR Congo, South Africa and Zambia) for evaluation of adaptability in different agro-ecologies during the second phase of the project.

WCA:

- A total of 38 elite lines were entered in national performance trials in Burkina Faso (4), Ghana (4), Mali (8), Niger (16) and Nigeria (8). ICRISAT supplied more than 1,100 trait specific advanced breeding lines in the form of variety trials, observation nurseries, and demonstrations to NARS partners from 2008 to 2014.

SA:

- In India eight entries, 4 each from Tamil Nadu and Karnataka are under NPTs conducted by All India Coordinated Research Project on Groundnut (AICRP-G). TNAU-Coimbatore has identified four high oil lines (ICGV# 03128, 06146, 07018, 07222) and recommended to NPTs during 2013 and 2014. Two varieties (CTMG-9 and CTMG-10) from UAS-Bangalore and two (RSG 1 and RSG 7) from UAS-Raichur were included in NPTs of AICRP-G. ICGV 02266, a FPV identified in Odisha has completed two years of NPTs under AICRP-G in India during 2012 and 2013. The trial data derived from four seasons of testing showed that ICGV 02266 is the best test entry in Zone V of India.

Key milestone 2.3: At least twelve new varieties released in six countries:

ESA:

- The program in ESA has been able to test and release 24 groundnut varieties under TL-II. In Malawi, seven varieties were released in 2014. In Mozambique six varieties were released in 2011, five in Tanzania in 2009 and six in Uganda in 2011 (see complete list in Key milestone above).

WCA:

- The national programs in WCA released 19 groundnut varieties under TL-II. These included four new varieties released in 2010, three in Nigeria in between 2011 to 2013, four in Ghana in 2012 and eight in Mali between 2008 and 2013 (see complete list in Key milestone above)

SA:

- GPBD 5 (from UAS-Dharwad, Karnataka), CTMG-6 (from UAS-B), and ICGV 00351 (from TNAU) were released in India, while Dh 222 (from UAS-D Karnataka) and ICGV 96246 (in Bangladesh) were proposed for release.

Key milestone 2.4: Two graduate students complete MSc from Mali and Niger (Yr 2):

- In WCA, Ms. Idi Garba from the University of Niamey, Niger and Mr. Mamary Traore from Mali completed their MSc-Breeding programs. Mr. Coulibaly Adama (Niger) completed his PhD from the University of Ghana in April 2014. Mr. Ousamane Sanogo (Mali) and Mr. Adama Zongo (Burkina Faso) started their PhD in 2013 and are in process of conducting their experiments at ICRISAT-Mali research station.
- In SA: One MSc female student, Ms. Ashna Akthar from BAU, Bihar completed her MSc research work on the topic 'heat tolerance in groundnut'

Key Milestone: i) Annual meeting of breeders in each region (ESA, SA, WCA); ii) Annual groundnut breeding and production course for technicians in each region (ESA, SA, WCA); iii) At least one farmer awareness activity (field days, etc.) every year in each region: ESA (Malawi, Mozambique, Tanzania, Uganda); Bangladesh, India (Karnataka- eight districts, Tamil Nadu- five districts, Bihar, Orissa); WCA (Burkina Faso, Mali, Niger, Nigeria, Ghana) (Yr 1, Yr 2, Yr 3); iv) Training course in marker assisted selection and electronic data capture for breeders in Yr 2 for each region (ESA, India, WCA) (Yr 2) "

- **In Uganda;** a regional review and planning meeting was held in Kampala (May 19th – 25th, 2013).
- Twenty two technicians and partners drawn from the National Groundnut Improvement team, Zonal Agricultural Research and Development Institutes (ZARDIs), Trial Verification Centers (TVCs), national extension services (NAADS), Uganda Seed traders Association (USTA) and seed companies were trained on various aspects of groundnut crop production breeding and seed production.
  More than 10 field days were organized with 20 to 200 participants per day. Selected groundnut genotypes were showcased to about 5000 participants in the National Agricultural Show for two years in a row during 2013-2014.
- **In Tanzania**. Over 250 farmers engaged in seed production of Quality Declared class in Tanzania.
- Field days (19 per season), open days and seed fairs (two per site per season), farmer field schools (80 in Tanzania) have become tools for regular monitoring of project activities. In Tanzania, for example over 100 extension officers and policy makers (40 women and 60 men) have been exposed to improved groundnut varieties through these awareness activities and brought about 2000 farmers per fair.
- **In Malawi**, starting from 2007, 20-50 farmers' field days were conducted annually by NARS and ICRISAT in collaboration with their respective partner countries, with the aim to upgrade the skills of farmers and stakeholders on improved varieties and integrated crop management (ICM), while soliciting feedback to improve focus of the breeding program. There are over 400 active farmer field schools in the project sites in Malawi.

Overall in all partner countries, training on groundnuts hybridization techniques, design of experiments and statistical data analysis, disease screening, and use of the infector row technique have benefited seven research technicians; Malawi (3), Tanzania (2), and Mozambique (2). Three scientists one each from Tanzania, Mozambique, and Uganda attended the statistical data analysis training conducted at ICRISAT Malawi.

- In WCA: A regional review and planning meeting was held in Accra Ghana (March 18th -20th, 2013).
- More than 10 field days were organized across the participating countries with attendance ranging from 30 to 250 participants.
- ICRISAT coordinated training of 3,265 farmers in Mali and over 1,100 in Niger (85% women) including 44 extension agents in ICM and integrated aflatoxin management.

- In SA: Annual groundnut breeders' meeting was held in India during 15th -17th April 2013. In addition to this, state level review and planning meetings were held in Karnataka, Odisha, and Tamil Nadu.
- One technician from Tamil Nadu Agricultural University (TNAU), Coimbatore and four researchers (3 from BARI, Bangladesh and one from BAU, Sabour) participated in two-week hands-on training on groundnut improvement and seed production technologies at ICRISAT during September 2012
- A total of 1,080 farmers (25% women) participated in 15 field days (Bangladesh-2, Bihar-2, Odisha-1, Tamil Nadu -5, and Karnataka-5), organized by the partner countries. Besides this, 4,391 (30% women) farmers and extension personnel across India were trained on ICM practices of groundnut production and seed production and storage aspects as well.

- Across countries; Eleven breeders (Uganda-1, Tanzania 2, Senegal-1, Ghana -1, India-4, [Tamil Nadu-2 Karnataka-1, and Bihar-1] and Bangladesh-2) participated in Integrated Breeding- Multi Year Course (IB-MYC) sponsored by the Generation Challenge Program.
- A breeder and a pathologist from the six project countries (Mali, Ghana, Burkina Faso, Nigeria, Niger, and Senegal) benefited from one week training at ICRISAT-Mali conducted in October 2013 on groundnut breeding techniques and disease management.

Key **Milestone: i) Information bulletins on hybridization and screening for foliar diseases (Yr 1); ii) Screening for drought tolerance (Yr 3); iii) Manual on groundnut breeding (Yr 2) (single publications for all regions in both English and French)**

ESA, WCA, and SA:

- A groundnut breeding training manual has been revised and editing is in progress and soon it will be translated into French. Computer based version in CD and PDF soft copies format are available.
- Groundnut production manual for Uganda is available.

Key Milestone: At least 5,000 leaflets/flyers on FPVs distributed to farmers and extension workers each year; and, farmer-friendly literature on groundnut production distributed to farmers and extension personnel each year (Yr 1, Yr 2, Yr 3)

- In ESA: Flyers for production, aflatoxin management, and seed production have been developed and translated into vernacular in Tanzania, Malawi and Uganda, and Mozambique (at least 6000 flyers are distributed annually during field days). Additionally in Tanzania, more than 3, 000 booklets describing good agronomic practices and methods for good quality seed production were produced and disseminated.

- In WCA: Flyers on integrated aflatoxin management and post-harvest technologies have been published (500 copies of each in French, and 2,000 each in Bambara) at ICRISAT- Mali. More than 50% of the hard copies have been distributed in Mali. Additionally, soft copies (PDF) of the French version have

been distributed to Francophone countries for wider distribution.

- In Nigeria 500 copies of variety description brochure '*Knowing your new varieties* ': Samnut 21, Samnut 22, Samnut 23 and Samnut 24 varieties by Kano Agricultural and Rural Development Authority (KNARDA) and 1,000 copies of brochure comprising of all four varieties description by Jigawa Agricultural Rural Development Authority (JARDA) have been produced in both English and Hausa languages and distributed to the farmers and extension personnel.
- In SA: In India about 15,000 leaflets on FPVs of groundnut and ICM practices of groundnut cultivation were distributed to farmers and extension personnel in vernacular language (5,000 in Tamil Nadu, 4, 500 in Karnataka, 4, 000 in Bihar).

Objective 3: Enhancing cowpea productivity and production in drought-prone areas in sub-Saharan Africa

Target countries include Tanzania and Mozambique in ESA, and Nigeria, Niger, Mali, Burkina Faso, and Ghana in WCA.

Key milestone: At least one (1) elite line selected for registration/release in six countries: Burkina-1, Mali-1; Mozambique- 1; Niger- 1; Nigeria-1; Tanzania- 1, (Y2, Y3)

- *Nigeria:*-Two lines adapted in Sudan Savanna and Sahel, IT99K-573-1-1 and IT99K-573-2-1 were released officially in December 2011 and named Sampea-13 and Sampea-14 respectively. In 2014, two promising lines (IT07K-318-33 and IT 07K-292-10) identified from national trials in 2013 were tested in on-farm trials conducted in four states: Jigawa, Kano, Kebbi, and Katsina in 2014. Data from both on-station and on-farm trials are being compiled as part of the dossier to support the nomination of these two lines for release in June, 2015.
- *Mozambique*: - Over 250 new farmers involved in FPVS confirmed the selection of lines IT00K-1263, IT97K-1069-6, and IT82E-16 as previously chosen and preferred lines in some other communities. These lines were officially released in 2011.
- *Tanzania*: - Two breeding lines IT99K-7-21-2-2-1 (named Vuli ARI) and IT99K-573-1-1 (named Vuli AR2) were registered and released officially in 2013. Vuli AR1 is tolerant to drought and resistant to Alectra, while Vuli AR2 is also Alectra resistant.
- *Burkina Faso*: - Two drought tolerant lines IT99K-573-2-1 (named Yiis yande) and IT98K-205-8 (named Niizwe) also resistant to Striga were released in 2013.
- Among the six countries expected to contribute to this objective, two (Mali and Niger) have not yet registered/released any breeding line as planned. The main reasons are the inadequate information to support the nominations of improved breeding lines to the national varietal release committees.

Key milestone: At least 14 elite lines with drought tolerance (two per country) selected by FPVS involving at least 1,000 farmers each year (Y1, Y2, Y3)

- Activities associated with this objective were performed annually in each target country. At IITA in Nigeria, about 150 advanced lines were selected from the segregating populations subjected to drought stress. The segregating populations were derived from more than 200 crosses. Seeds of these selected lines were multiplied to produce enough quantities for evaluation in the field across different locations. Several farmers in drought prone areas of three states (Jigawa, Kano, and Katsina) were involved annually

in FPVS. In addition to the above lines, 361 advanced lines, selected from the segregating populations derived from crosses involving drought tolerant lines were evaluated in four environments (Minjibir, August 2012; Ibadan, November 2012; Minjibir, February 2013 and Minjibir September 2014). The analysis of the agronomic data across these environments and other key traits (tolerance to drought, resistance to Striga and farmer preferred seed traits) were used to identify a set of 50 advanced lines, which were evaluated through FVPS during the last (i.e. 2014) rainy season. A group of 95 farmers (64 males and 31 females) were involved in the on-station FPVS. The best selected lines included: 13-245A-3; 13-309 and13-126. The important traits used for selecting these lines included high grain yield, seed size, and white seed coat color.

- In Mali, more than 153 lines derived from nine single crosses and nine backcrosses were evaluated in field for 2 to 3 years. Five new lines [CZ06-2-17, CZ06-2-21, CZ06-1-30, CZ06-1-35, and CZ06-1-05] were planted to produce breeder seeds and subsequent foundation seeds for additional testing prior to their release. In addition, 21 lines derived from BC1F3 were evaluated. Eight early maturing and 10 medium maturing lines were identified. In Mali and Niger, selected lines were used in FPVS during the cropping season as it was done in Nigeria.
- In Ghana, sixteen elite cowpea lines were evaluated both on-station and on-farm for drought tolerance with farmer participation at five locations in northern Guinea (Savannah zone) using the "mother and baby trial" concept in 2012 and 2013 cropping seasons. Selection of promising lines in both mother and baby trials was done using the participatory approach. About twenty-five farmers each from five communities (Bugbomo, Bihinaayilli, Wulugu, Wungu and Yendi) were brought to the "mother and baby trial" to observe the benefits of the treatments and select their preferred lines as part of a learning and technology dissemination process. The following lines are the ones preferred by farmers and they would readily adopt these varieties: IT98K-412-13, IT98K-491-4, IT89KD-288, IT98K-628, IT86D-610, and Baawutawuta (SARI's variety). These lines have bold or large grain size and white seed coat. Among the criteria used by the farmers in selecting their preferred lines were yield, quantity of biomass produced, color of the seed coat, and size of the seed.
- In Burkina Faso, during the 2014-cropping season, 28 lines obtained from different double crosses were compared to two released varieties (Nizwe and Tilgré) in FPVS. Twenty-five s and 32 farmers participated at Pobé and Saria research stations, respectively. Lines CD9P4 (949 kg/ha), CD9P5 (1004 kg/ha), CD12P2 (1236 kg/ha), CD5P3 (887 kg/ha), NIZWE (check) (984 kg/ha) and TILGRE (check) (1179 kg/ha) were among the best-selected lines. The criteria used for section were earliness, biomass, grain yield (pods), and seed quality (size, color white).

In Mozambique, more than 250 new farmers involved in FPVS confirmed their preferred lines as: IT00K-1263, IT97K-1069-6 and IT82E-16, which were previously selected by the farmers in some other communities. These lines were officially released in 2011.

Key milestone: At least 14 elite lines (150 kg of each line) distributed to farmers in 7 countries: Burkina Faso-2; Ghana-2; Mali-2; Mozambique-2; Niger-2; Nigeria-2; Tanzania-2 (Yr 1, Yr 2, Yr 3)

From September 2011 to December 2014, seeds of the breeding lines selected by farmers during the previous years' FPVS were multiplied and distributed to them for establishing demonstration plots. Although Burkina Faso and Ghana were new countries in phase II of the project, lines with good performance and farmer-preferred traits identified in the other countries of the sub-region were sent for evaluation in some communities of both the countries.

- In Mali, four varieties (Jiguiya, CZ1-94-23-1, CZ1-94-23-2 and Fakson) were planted during the off-season for foundation seed production. These seeds were used for the 50 demonstrations that were

planned for the cropping season activities starting July 2015.

- In Tanzania, seeds from five farmer-preferred varieties were multiplied during the cropping season. The harvested seeds were distributed to farmers in 10 identified communities, including Kingwarang'anga, Mkula, Mfyome, Kihwele and Nyabula (Iringa), Chigongwe, Mchemwa and Ipala (Dodoma), Mtanana and Virundilo (Kongwa District).
- In Mozambique, more than 200 kg of good quality cowpea seeds were produced from the following lines: IT18, IT00K-1263, IT97K-1069-6, IT16 and IT98K-390-2. These selected lines preferred by farmers were distributed to the government agencies, community-based organizations, and farmers' associations to establish demonstration plots and community seed multiplication fields.
- In Nigeria, 2,650kg seeds of 22 selected lines were multiplied by IITA at the Minjibir farm to support demonstrations during 2013In 2014, IAR (Nigeria) produced 651 kg breeder seeds of 10 selected cowpea varieties on-station at Samaru. In addition, 0.75MT and 1.53MT of foundation seed were produced at the research station in 2013 and 2014, respectively. The quantity of certified seed produced at the farmers' fields under supervision was 3.85MT and 4.8MT in 2013 and 2014, respectively. Total breeder seed multiplication to support breeder and demonstration plots in Nigeria for the past 4 years was 13,138kg.
- In Burkina Faso, breeder seeds of KVx 442-3-25 (125 kg), KVx775-33-2 (200 kg), IT98K-205-8 (150 kg) Nafi (50 kg) and IT99K-573-2-1-1 (90 kg) were produced in 2012, In addition, 465kg of KVx 442-3-25, KVx775-33-2 , IT98K-205-8, Nafi, IT99K-573-2-1 was produced in2013 and 8,050 of Tilgré, Nizwe, Komcalle, Gorom local, KVx 61-1, KVx 745-11P, Yisyandé, Telma, Gourgou produced in 2014.
- In Ghana, 350 kg of breeder seed of nine selected lines (IT86D-610, IT97K-390-2, IT98K-128-3, IT9K-311-8-2, IT98K-491-4, IT98K-628, IT99K-216-24-2, IT99K-529-2, IT99K-1122) under demonstrations was produced and available to the farmers for use in 2012, and 311kg of eight selected lines (Songotra, Padi-tuya, Apagbaala, Baawutawuta, SARVx-09-001, SARVx-09-002, SARVx-09-003, SARVx-09-004) was available in 2013.
- In Mali**,** 8424 kg breeder seed of fourteen varieties (KPR1-96-54, KPR1-96-73, CZ06-3-1, CZ06-1-05, CZ06-2-17, CZ06-4-16, CZ06-1-12, CZ1-94-23-1, CZ1-94-23-2, IT93K-876-1-2, IT93k-876-30, IT90K-372-1-2, Sanoudaoulen, and M'Barawa) was made available for foundation seed production between 2011 - 2013**.** In addition, 1,909 kg of foundation seed of the varieties Jiguiya, Korobalen, Sangaraka and Cinzana Telimani have been produced in the Segou region in 2014 for multiplication during the 2015 off-season in Niono research station to produce foundation seed.
- In Mozambique, 3400kg breeder seed of the following varieties; IT18, IT00K-1263, IT97K-1069-6, IT16, IT98K-390-2, IT98K131-2, IT98K-128-3 was availed for foundation production in 2011 and 2012. An additional 2,750 kg seeds of IT-16, IT-18, IT-1263, IT-1069, IT-96D-610, Sudan-1, IT99K-529-1, IT-98K-131-2, IT97K-390-2 and IT99K-573-1-1 were produced for distribution to partners in the plants during the 2014 cowpea growing period. Total breeder seed multiplication to support breeder and demonstration plots in Mozambique for the past four years was 6,150kg.
- In Tanzania, selected lines during FPVS were multiplied for demonstration purposes. 2,327 kg of IT00K-1263 IT99K-1122 was produced during 2011, 795kg of IT00K -1263, IT99K-1122, IT99K-7-21-2-2, IT99K-573-1-1 during 2012, 2,955kg of IT00K-1263; IT99K-1122, Fahari, Tumaini, Vuli I, Vuli 2, Vuli I AR, Vuli II AR during 2013 and 6,860kg of Fahari, Tumaini, Vuli I, V uli 2, Vuli I AR, Vuli II AR, IT00K-1263; IT99K-1122 during 2014. Total breeder seed multiplication to support breeder and demonstration plots in Tanzania for the past four years was 12,937kg.

Key milestone: At least one farmer-preferred variety improved for Striga resistance using Marker-

Assisted Breeding (Yr 3)

Marker-Assisted Backcrossing (MABC) strategy that uses foreground and background selections started during phase II of the TL II. F_1 and BC_1F_1 were generated from crosses between improved the adapted but Striga susceptible lines and Striga resistant lines. The main objective of this activity is to introgress, using MABC, Striga resistance gene into IT89KD288 and IT93K-452-1, two released varieties with farmer preferred characteristics but susceptible to the prevalent Striga strains in Nigeria.

- Two Striga resistance gene donors IT99K- 573-2-1 and IT97K-499-35 were used in these crosses. F_1s were generated in 2012 and BC_1F_1 were obtained early in 2013. Two backcross populations of 100 plants each (IT93K-452-1/IT97K-499-35//IT93K-452-1 and IT89KD-288/IT97K-499-35//IT89KD-288) were planted in screen house on Ibadan campus in March 2013. Fresh leaf samples were collected and sent to LGC Genomics for genotyping. The results of genotyping were obtained in early October 2014 and analysis of the genomic data allowed the identification of BC_1F_1 plants with Striga resistance allele to be used to generate BC_2F_1. The two striga resistant sister lines of IT93K-452-1 and IT89KD-288 will eventually be nominated for release in Nigeria because of their enhanced levels of productivity even in Striga infested fields.

Key milestone: i) Two stakeholder workshops per year (one each for ESA, WCA); ii) 140 community workshops per year (two per community, 10 communities, seven countries); iii) 14 workshops (two per country) each year for farmers on PVS (Yr 1, Yr 2, Yr 3); iv) One workshop/training on Introduction to Molecular breeding in each Region (Yr 1); v) One workshop/training on the use of electronic books (Yr 1); vi) Two graduate students (MSc) trained (Yr 3)

- The annual regional meetings for WA were held in Niamey, Niger (March 12-15, 2012) and in Accra, Ghana (March 18-20, 2013) while the regional meetings for ESA were held in Nampula, Mozambique (April 12-15, 2012) and in Kampala, Uganda (May 19-27, 2013). A combined annual meeting was organized in Nairobi, Kenya between March 17 and 21, 2014 for both WA and ESA. All cowpea breeders involved in TLII in the seven countries attended these meetings regularly. The results of the different activities conducted in previous years were presented and discussed at the meetings. These stakeholder meetings also provided opportunities to discuss the activities to be conducted in the next cropping season. The country strategies for each participating country were discussed intensively with all the stakeholders.
- In addition, the regional meetings provided opportunities to organize some training workshops. For example, all the objective three members participated in the data management workshop and QA/QC workshop organized jointly with GCP. The importance and opportunity to perform QA/QC were introduced during the workshop. The use of International Vigna Information System (IVIS) in managing cowpea pedigree information was also demonstrated. Discussions about generating and using electronic field books were carried out. In WCA, a brief introduction to molecular breeding was also done. Major breeding methods (MABC, MARS…) and the availability of support tools through IBP were presented. The use of tablets in generating electronic field books and capturing data in the field was also demonstrated. Each of the objective's breeders received a Samsung tablet 10.1.

Community workshops were organized in order to discuss with the farmers the implementation of the demonstration plots and to get feedback on the performance of the tested lines.

- In Nigeria, IITA organized in 2012 two community workshops for 274 farmers responsible for the demonstration plots.
- In Mozambique, two community workshops were organized and about 230 farmers from Rapale, Meconta, Monapo and Angoche participated. In partnerships with IKURU, IIAM and farmers

associations, workshops were organized in each community to intimate farmers about FPVS and on-farm demonstrations on variety selection and better crop management practices. A total of 425 farmers across the communities attended the training workshops in 2012.

- In Burkina Faso, prior to planting, workshops were organized in mid-July for two groups at Saria and Réo for 50 farmers from 10 communities.
- In Tanzania 50 farmers were trained in the evaluation of drought tolerant lines early January 2013.
- In Mali, inter-village visits among farmers were conducted at Cinzana, Mopti and Sikasso over the growing season. Field days were also organized at Cinzana and Koporo Research Stations on September 8 and 9, 2012, respectively. One workshop was organized with NGOs (Faso kaba, Eucords, Plan Mali and Sahel 21) and the other was conducted with farmers from the commune of Cinzana.

The following country workshops were implemented.

- In Nigeria, IITA held 2 workshops for 47 communities organized into eight and 47 sessions for the pre-planting and post-planting workshops, respectively in 2013. In 2014, IAR in collaboration with its partners organized in each community two workshops made up also of pre-planting and post-planting trainings. The post-planting workshops were in the form of interactive visits. A total of 602 males and 115 females were trained in 10 Local Government Areas (LGAs) of three States. In addition, IITA trained 664 males and 72 females in Kano, Katsina and Jigawa across 18 LGAs and 12 communities.
- In Burkina Faso**,** prior to planting, one meeting was organized at Poa near Saria on July 18, 2013. Twenty five farmers participated in the training where the activities that will be carried in the succeeding cropping season were discussed and a training session on cowpea production techniques including seed production and conservation was organized. A similar training session was realized at Saria on July 19, 2013 and Réo on July 23, 2013. A total of 35 farmers participated to the training at the two sites. In 2014, two workshops were organized prior to establishing demonstration plots per community (one workshop in beginning of July 2014 just before planting and the second one in September 2014, before harvest), making a total of 20 workshops for the nine communities identified in the seven divisions.
- In Ghana, CSIR-SARI organized two workshops at pre-planting and post-planting for five communities out of the ten proposed target communities.
- In Mozambique, three hundred (300) cowpea demonstration plots were established on the fields of 300 farmers [118 females; 182 males] during the period under review. The demonstrations were established in collaboration with farmers' associations and the Angoche, Meconta, and Rapale Districts Department of Agriculture.
- A training workshop was organized for 38 members (22 males and 16 females) of farmers' association from Muriaze in Rapale district on 22 January 2013 at Muriaze.
- Also in Mozambique, twenty nine extension agents (23 males and 6 females) from the Department of Agriculture in Cabo Delgado province were trained in the field at Muriaze on 25 Feb 2013. The training focused on cowpea variety characteristics, variety selection and crop management.
- In collaboration with Farmers' Associations and partners, including CLUSA, Africare and Save the Children, 198 farmers [35 females; 163 males] from several districts in Nampula province were trained on several aspects of crop production including crop management, disease diagnoses, variety selection, and post-harvest storage on 15 and 22 April 2013 in Nampula.
- In Tanzania, 2 workshops were organized for 15 communities; these were conducted during pre-planting and after planting in 2013. During the 2014 cropping season, the two workshops were conducted in five

districts comprising 15 villages where 73 males and 83 females attended.

- Farmer participatory varietal selection was conducted in Minjibir, Kano State, Nigeria. A total of 95 farmers were involved in this activity. Sixty seven per cent of participants were males and 33% were females. Forty percent of these farmers did not attend formal education while 27%, 23% and 10% attended primary, secondary and tertiary institutions respectively. The FPVS was organized at an early maturity stage of the evaluated lines. A total of 56 communities were identified from four states of Katsina, Kebbi, Sokoto and Zamfara in 2014. These communities were mainly used for seed production and multiplication in both 2013 and 2014, and demonstration plots and on-farm trials in 2013 and 2014, respectively.
- In Ghana, participatory varietal selection was conducted on the mother trial in Nyankpala and the baby trial at Bihinaayili and Bugbomo in the Tolon and Savelugu districts of the northern region of Ghana. Fifty farmers participated in the activity. Thirty-three percent of participating farmers were males and 67% were females and were mostly illiterates.
- In Burkina Faso, a workshop was held at Saria for farmers participating in PVS on July 4, 2014 for farmers from 10 communities. A total of 20 farmers (2 per community) participated at the workshop**.**
- In Mali, farmers' visits were undertaken to see the activities of breeder seed production at Cinzana Research Station over the growing season. These visits provided the opportunity to promote new varieties. Meetings with farmers were organized to discuss the activities planned for the coming season and to sensitize them on the performance of new varieties proposed to be released. This was one of the best ways to let farmers become aware about the new varieties in the breeding programme.
- In Mozambique, several farmers across 41 communities in nine districts of Nampula province were trained to participate in the PVS during the 2013 cowpea growing season. Due to the geographical spread of the communities, at least 12 trainings involving 500 farmers (336 males and 164 females) were conducted at the district and community levels. Varieties were evaluated at mid-season and after harvest.

Graduate students

- Under IITA activities, the project supported three MSc students' research activities in IITA headquarters in Ibadan:
- Jonathan Joseph Iduh Otene from University of Ibadan worked on growth responses of selected cowpea varieties under water stress condition
- K. Olomide Oluwatosin also from University of Ibadan studied nitrogen use efficiency of selected cowpea varieties under low phosphorus soils of Nigeria
- Grace Adusei from University of Bonn worked on response of Cowpea genotypes to low soil phosphorus conditions
- Samuel Oladejo of Obafemi Awolowo University Ile Ife, Nigeria continued with his PhD research work on the genetics of resistance to flower bud thrips
- In Burkina Faso, Lalsaga Joel is carrying out his Doctorate field work on application Marker-Assisted Recurrent Selection to cowpea improvement.
- In Ghana also, Haruna Mohammed, who is registered at Tshwane University of Technology in South Africa, is working on the "Symbiotic performance, nutrients use efficiency of drought tolerant cowpea genotypes under low soil phosphorus conditions in northern Ghana" for his PhD.

Key milestone: At least 350 demonstration plots established each year to compare breeder selected and farmers' lines (five per community, 10 communities per country, 7 countries) (Yr 1, Yr 2, Yr 3)

In WCA, these activities were carried out annually during the cropping season (July-October) while in ESA they were conducted in December-May. Seeds for the different lines selected by farmers during the previous year FPVS were multiplied to be able to have enough seeds to cover the number of planned demonstration plots per community and per country. Demonstration plots were used as complementary efforts to the FPVS activities. Each farmer was provided seeds of one or two improved lines to compare with his own cultivar. Each farmer had also received about 0.5 l of insecticide to control insect pests in the field. In each country, at least 10 communities were identified and demonstration plots conducted annually. It should be noted that in Mozambique and Nigeria, the project had succeeded to leverage from existing IITA projects to cover more communities than the planned number of communities.

In Nigeria, forty demonstration plots were established during the 2012 cropping season at the level of the whole community in four states of Katsina, Sokoto, Kebbi and Zamfara. In 2013, IITA identified 47 communities in 13 local government areas in 3 states (Kano, Katsina and Jigawa) where 400 demonstrations were established. In 2014, 18 on-farm trials were established in 18 communities in Katsina, Kebbi and Jigawa states. In addition, IITA established 464 demonstrations in 44 communities where two promising improved drought tolerant, *Striga/Alectra* resistant cowpea varieties (IT07K-318-33 and IT07K-292-10) identified in multi-locational variety trials in 2011 - 2013 were compared with the farmers' variety. These demos were conducted in partnership with the Institute of Agricultural Research (IAR) and the Agricultural Development Programs (ADP) of the different states. The recently released variety IT99K-573-1-1 was distributed to all the 47 communities in addition to one other improved line. The farmers were requested to plant their best local variety to be compared to the two improved lines. Out of 400 farmers who received the line IT99K573-1-1, 73% have selected this line as their preferred line while 36%, 29% and 21% of farmers who received IT89KD-391 (63 farmers), IT99K-216-24-2 (194 farmers) and IT98K-491-4 (57 farmers) respectively have selected these lines as their first choice.

- In Ghana, to create awareness of improved lines, demonstration plots were established alongside with already known varieties. Treatments for the demonstrations were; two cowpea varieties (Songotra and Padi-tuya) and three management practices. These were to demonstrate the importance and effect of different management practices (mostly on rates of fertilizer applied, levels and method of weed control, and spray regime) on the performance of these varieties. In each farming community, 40 farmers comprising 15 males and 25 female farmers participated. One acre (4000 m^2) of land was acquired, ploughed and harrowed at all locations for the demonstrations. In 2013, on-farm demonstrations were conducted in three communities, which included Nyankpala, Bugbomo and Bihinaayili.
- In Mali, on-farm tests were conducted at two locations: Koporo (Mopti) and the Millennium Village Project, (Segou). A total of 16 farmers (10 men and 6 women) in Koporo (Mopti) and 12 farmers (10 males and 2 females) (Segou) participated in the trials. At Cinzana (Segou), 200 farmers (150 males and 50 females) attended a field day organized during the 2013 cropping season while in Koporo (Mopti), the number of farmers was 100 (75 males and 25 females).
- In Burkina Faso, 10 communities (3 in the Department of Reo near Koudougou (Sanguié Province) and 7 around Saria and Poa) were identified for the demonstration plots. In each of these communities, five farmers were chosen to conduct these demonstrations. In addition to the seeds of improved varieties, fertilizers were also distributed to the farmers. IT99K-573-2-1 gave the best yield (1.2T/ha) followed by the local check (925 kg/ha). In 2014, 10 communities were identified in seven divisions. Three improved varieties (Komcallé, Tilgré and Nizwe) were compared with the local variety of each farmer. Each of the 50 farmers compared one improved variety with the one s/he presently grows, which was in most cases one of the old released varieties called KVx 396-4-5-2D. In all instances, the improved varieties were higher yielding by a magnitude of 25 – 30% but also preferred because of their early maturity (65days) and large seeds.

- In partnership with the Platform Mozambique five hundred (500) cowpea demonstration plots were established on the fields of 500 farmers [336 females; 164 males] during the period under review. The demonstrations were established in collaboration with farmers' associations and the Angoche, Meconta, and Rapale Districts Department of Agriculture. Demonstrations were established in nine districts including Meconta, Rapale, Mogovolas, Angoche, Ribaue, Muecate, Monapo, Murrupula and Nacaroa. Three cowpea varieties from among IT00K-1263, IT97K-390-2, IT-18 and IT-16 were planted on each farmer's field to allow them to compare performance with the local variety Namurua. The preferred cowpea varieties differed among women and men farmers. Most men preferred high yielding varieties more than any other trait. Although, high-yield is also important to women, seed size, color and taste are more important in most cases than high yield. Yields of the improved varieties were consistently higher than the yields of the local test lines.

Key milestone: At least 30% of farmers in each of the communities where project activities are being implemented (Burkina, Niger and Nigeria) store their cowpea seed using the hermetic storage technique (60 communities) (Yr 1, Yr 2, Yr 3)

The planned community workshops were exploited to demonstrate the use of the Purdue Improved Cowpea Storage (PICS) technology in the target countries. These target countries are the countries where PICS technology was already being demonstrated. These include Burkina Faso, Ghana, Mali, Nigeria and Niger. In ESA, some level of demonstrations was also conducted with the availability of triple bags. The concurrence of several institutions to disseminate PICS technology and the availability of the triple-bags in the sub-region have enhanced the introduction of this technology.

- In Nigeria, the PICS technology was demonstrated and promoted in five communities each in three states (Katsina, Sokoto and Kebbi) with a total of 430 farmers benefiting. In 2014, demonstrations were conducted in five new communities in Jigawa, three in Katsina and two in Kebbi state. A total of 320 farmers participated in the demonstrations.
- In Burkina Faso, a training of trainers was organized (13 November 2014) at Saria Research station for 20 farmers (10 communities, 2 per community) to promote hermetic seed storage bags. After training, each farmer received five PICS bags in order to train their relatives and friends as soon as they returned home.

Objective 4: Enhancing common bean productivity and production in drought-prone areas in sub-Saharan Africa

Target countries include Ethiopia, Kenya, Uganda, Tanzania and Zimbabwe.

Key Milestone: Nursery of drought resistant tepary and lima beans (25, 75 lines, respectively) increased in Colombia and distributed to two sites in Africa (Kasinthula, Kiboko) (Yr 2).

- These nurseries were planted in Kasinthula (followed by seed increase in Chitedze) in Malawi. In Kenya, Katumani replaced Kiboko as introduction site.

Key Milestone: At least one accession of tepary or lunatus enter PYT's. (Yr 3).

- Seed was increased in anticipation of PYT in the long rains, March, 2014.
- Tepary and Lima bean has been evaluated in Kenya, Malawi, and Zimbabwe for drought tolerance. In Kenya, out of 50 tepary bean lines 30 were selected for evaluation under the preliminary yield trials during the long rainy season of 2014. The trials were established at Kambi ya Mawe, Katumani, and Kiboko Research.

Key Milestone: At least one fast-tracked variety released in 5 countries: Ethiopia- 1; Kenya- 1; Malawi- 1; Tanzania- 1; Zimbabwe- 1 (Yr 2).

- Twenty-eight varieties have been released from four countries (Ethiopia-14, Kenya-2, Malawi-6 and Zimbabwe-6): Yield advantage of these lines ranged between 10-50% over the locally grown varieties in the specific markets classes. They include;
  - Ethiopia: KAT B1 (yellow medium seed size) and KAT B9 (red round medium sized seed), Navy-87 (small white), SER1125 (small red), and SER 119 (small red) were released during this period.
  - Kenya: KAT-SR-01 (small red), and a large red mottled drought tolerant line KAT-RM-01 was officially released on 15th January 2014 and gazetted on 7th February 2014.
  - Malawi: VTTT 924/4-4, SER 124 (small red), VTTT 925/9-1-2, SER 83 (small red), and BF 13607-9
  - Zimbabwe: CIM 9314-17, SUG 131, Gloria (PC652-SS3), NUA 45, MG 38 and VTTT 925/9/1/2
- In addition, a number of lines are at pre-release stage:
  - Zimbabwe: three promising drought tolerant and high yielding, red speckled, large seeded sugar bean varieties were submitted for DUS in November 2013 by the crop Breeding Institute in Zimbabwe; They include; DAB 51, DAB 52 and DAB 411.
  - Ethiopia: eight varieties are in the pipeline for release after being submitted to the release committee. They include; five small white varieties (Ecabunci cross 4, Ecabunci cross 8, Ecabunci cross 11, Ecabunci cross 12, and Ecabunci cross 13) that out-yielded the standard check Awash-1 with a yield advantage of 10-15 % and three small red *varieties* (SER 125, SER 128 and SER 194) that out-yielded the standard check (Dinknesh) with a yield advantage of 6-8% and three varieties;
  - Four varieties are at pre-release stage in N. Tanzania.

Key Milestone: Additional elite germplasm distributed to 5 partner countries (Yr 2).

- Additional lines have maintained a complete pipeline as follows- Ethiopia: 175 lines for National Varieties Trial (NVT) at Melkassa, 85 lines of Advanced Yield Trials (AYT) at Awassa and 96 for AYT Melkassa. Kenya: 46 lines for AYT; Malawi: 20 lines for NVT; Tanzania: 21 lines for AYT at Arusha and 12 lines for

AYT at Uyole. Uganda: 39 lines for AYT; Zimbabwe: 25 lines for NVT.

- A number of new nurseries were distributed to the five participating countries. They included: lines segregating for drought tolerance and fixed lines combining drought tolerance with other traits such as high mineral (iron and zinc) content, low soil fertility tolerance, pest resistance (bruchids and bean stem maggot; BSM), and disease resistance (Common bacterial blight; CBB).

Key Milestone: Nursery of 30 elite F7 lines with unique trait combinations established in African test sites (Yr 3).

- Nurseries were distributed to the TL-2 participating countries; Malawi, Zimbabwe, Uganda, Kenya, and Tanzania. These nurseries consisted of materials segregating for drought tolerance and fixed lines combining drought tolerance with other traits such as high mineral (iron and Zinc) content, low soil fertility tolerance, pest resistance (bruchids and bean stem maggot; BSM) and disease resistance (Common bacterial blight; CBB). Selections were made and materials are at different stages in the breeding pipeline. Furthermore, these nurseries for specific traits served to evaluate lines for their potential use as parents in additional crosses, and especially for the application of molecular markers to recover resistance with greater confidence.

***Key Milestone: A nursery of >50 entries of elite common bean drought lines and interspecific progenies is evaluated for heat tolerance in 2 sites (Kasinthula, Kiboko*). (Yr 3).**

- Evaluation of improved drought-tolerant materials organized in different nurseries (a total of >500 lines) was conducted in Uganda, Zimbabwe, Kenya and Malawi. Materials evaluated include Andean drought populations, drought Andean lines, lines with bc3 gene, wild *Phaseolus* lines, *P. lunatus* (lima bean) and *P. accutifolius* (tepary bean*)* and interspecific lines with *P. coccineus* (runner bean), lima bean tepary bean.

- In Kenya, the nurseries were evaluated at two sites; Katumani, Kiboko and Kambi ya Mawe under rain-fed conditions showed high significant differences in both moisture stress treatments.
  - Yield averages of 2,463 kg/ha and 1,123 kg/ha at Katumani and Kambi ya Mawe respectively were obtained among the lines with *bc*3 gene most of which were of the small red market class (the third most preferred seed types in Kenya).
  - A yield average of 1,616 kg/ha across the two test sites was recorded among the interspecific lines. One *P. coccineus* interspecific line, ALB 4 was among the six genotypes selected for AYT in S. Tanzania. In Kenya, ten lines showed exceptional performances with regards to disease resistance and yield potential.
  - Out of 50 tepary bean lines, 30 were selected for evaluation under preliminary yield trials during the 2014 long rain season in S. Tanzania,
  - Among the drought Andean beans 191 most adapted lines were selected and further evaluated for adaptability Katumani and Thika. Thirty-six out of the 191 lines were further evaluated at the farmer's fields at Nyeri, Kirinyaga and Machakos.

- During an off-season nursery in Kasinthula, Malawi, 51 lines produced 30 % more grain than the average of four checks, although almost none beat the best check by this margin. It was noted that the lines selected in the Malawian programme have performed well in other environments, and local materials might have a degree of tolerance already. While the fast track entries were recovered and cycled through the evaluation scheme, lines selected previously under a parallel project were advanced and are at the point of release. Across four sites including two on-farm sites in the north of Malawi (CHS and BOK), small red-seeded lines out-yielded the local check CAL 143 by as much as 50 %). Although not the most preferred type in Malawi, small red beans do appear in local mixtures. The national programme is

considering the release of SER 83 and SER 45. In Malawi, an experiment that evaluated 20 bean genotypes for multiple stress tolerance at Chitedze was conducted and ten lines selected. Seed increase was done for these 10 lines in preparation for multi-location evaluation in the 2013/2014 season.

- In Zimbabwe, among 166 drought Andean bean lines evaluated at the Gwebi Variety Testing Center, Harare Research Station and Save Valley Experiment Station, 79 lines were selected and advanced to PYT stage. In addition, 89 lines were selected from five other nurseries (drought physiology lines, drought Andean red and white nursery, BSM nursery, advanced backcross drought nursery and Andean drought red mottled nursery) comprising of 221 lines in total in evaluations done at the Gwebi Variety Testing Center and Kadoma Research Station. These have also been advanced to PYT.

- Among 121 lines from four separate nurseries evaluated at the Ismani research station, Tanzania, 29 lines including ALB4 were selected and advanced to PYT. Other nurseries comprising of 409 lines in six different nurseries (F4 climbers, drought Andean, low soil fertility, High Fe and Zinc climbers, F3 climbers, SARBYT climbers, and SABREN climbers) were also evaluated. The yields ranged between 1031-3547 and 669-1496 kg/ha with and without moisture stress respectively were obtained in the climbing bean nurseries when evaluated for drought tolerance and 20 promising genotypes were selected for further evaluation. Among the low soil fertility bush lines, yield ranged between 935kg/ha (BFS 75) to 2225 kg/ha for BFS 4.

- In Uganda, materials that had been selected from previous drought screenings trial conducted in 2012 at NaCRRI-Namulonge were further evaluated in different drought prone areas of Uganda. Using on-station trials, 12 drought-tolerant lines namely DOR 364, SCN 1, SCN 11 SCN 8, SCR 26, SCR 35, SEN 46, SEN 56, SEN 70, SEN 80, SEN 95 and SEN 98 and four Uganda market class varieties including K132, NABE 4, NABE 15 and NABE 16 (used as checks) were evaluated in six drought-prone areas of Uganda. The trials were set in these areas and subjected to the normal seasonal conditions of the different localities.

Key Milestone: At least 15 crosses made locally each in Ethiopia, Kenya and Malawi employing locally selected elite lines and drought sources (Yr 3).

- An extensive review of parental materials was carried out with partners to identify nurseries to be evaluated and the lines from which the parental lines would be selected.

- More than 150 crosses were conducted among the participating countries targeting different traits. In Zimbabwe for example, 85 single cross combinations involving 43 parents to develop new breeding lines combining bruchid and CBB resistance with BCMV resistance and good performance under drought were conducted. The sources of resistance were selected from the MAZ lines Trial, DAB trials, BRB lines and CBB trial. 53 F1 populations were advanced to F2 in the greenhouse during December, 2012. A total of 53 F2 populations were established at the Save Valley Experiment Station during winter. These lines resulted from bi-parental crosses which were initiated in 2012 with the aim of improving tolerance to low N, low P, acid pH, BCMV in commercial cultivated large seeded beans. No selections were made since heritability of the quantitative traits in the common bean is usually low. Hence, the selection is delayed to the F4/F5 stage. From the F5.6 nursery consisting of 47 progenies, a total of 15 families were selected based on the tolerance to CBB, ALS and Rust.

- In Uganda, NaCRRI-crosses were conducted on introgress bruchid and bean stem maggot (BSM) resistance genes into farmer preferred varieties. Six exotic bruchid resistant/tolerant genotypes sourced from Malawi, MALUWA/KK25/443, KK25/MALUWA/112-mw, KK25/MALUWA/19-mw, KK25/NAGAGA/184-mw,

KK25/NAGAGA/184-mw, MALUWA/KK25/9-mw and one local (Tapara) were crossed with four susceptible local varieties (i.e. NABE 4, NABE 15, NABE 17 and NABE 23). In addition, 16 different crosses were made to introgress BSM resistant genes into susceptible Ugandan market class varieties (NABE 4, NABE 15, NABE 16, and NABE 17) with known BSM resistant genotypes from CIAT. A field screening trial has been set up to identify other bean genotypes resistant to BSM. Still in Uganda, crosses were made with three local bean lines (K132, NABE 4, and NABE 15) and five drought elite lines (SCR 48, SCR 6, SCR 9 SEN 98 and SEN99) and 183 segregating populations obtained, these are currently undergoing screening.

- In Kenya, KARI-Thika conducted targeted introgression of crosses and observed BSM tolerance from eight lines into popular bean varieties grown in central Kenya i.e., GLP 2, GLP 585, GLP 1127, GLP 24 and KAT B1. Successful crosses included those of Ikisinoni x GLP 24, GLP 24 x CCC888, GLP 585 x Mkombozi, GLP 24 x Ikinimba, GLP 2 X CCC 888, GLP 2 x macho, EX 290 x GLP 1127, CIM 9314 x GLP 2, GLP 1127 x Mrama 127, Mrama 127 x GLP 2, and Mrama 127 x GLP 2. The F1 seeds were planted in the screen house in May, 2013. The crosses targeted drought tolerance and seed market class. In Ethiopia, seven new single crosses were also made and successful pods harvested in this pattern with genetic variability of several sources. Similarly, new segregating populations were developed in Malawi.

Key Milestone: Two PhD candidates have received degrees (Yr 2) and two additional MSc candidates are 75 % into their graduation (Yr 3).

- Godwill Makunde (Zimbabwe) and Berhanu Fenta (Ethiopia) graduated with PhD degrees.
- Ms. Mabel Nabateregga (Uganda) is in her second year of MSc slated to complete in 2015.

Key Milestone: Training courses on: field management of drought trials for two new partner programs (Yr 2); use of electronic field books and uniform evaluation scales (Yr 2); and data review accumulated with the perspective of identifying parents for crossing (Yr 2); evaluation of the industrial canning quality (Yr 3).

- Training in drought phenotyping, focusing on bush beans (of both Mesoamerican and Andean gene pools), was conducted at CIAT-Colombia in September, 2013. A climbing bean workshop was held in August, 2013.
- A training course introducing the single nucleotide polymorphism (SNP) genotyping for bean breeders was conducted at CIAT-Uganda in May, 2012 in collaboration with the TLI project. Use of tablets and data management was the result of a joint collaboration with GCP including recent courses at CIAT Uganda.
- Eight bean breeders from Ethiopia, Kenya, Uganda, and Zimbabwe completed the Breeding Management System (BMS) multi-year training course of the GCP.
- Under the Bio-innovate project, representatives of industrial processors, extension agents, NGO staff, and farmers were trained on improved bean production.
- Semi-formal training sessions were organized in Ethiopia and Kenya where extension agents were trained on improved bean production of canning beans. Farmers, NGO staff, extension agents, cooperatives staff, and industrial processors staff were trained on improved canning bean production, quality assurance, aggregation, and marketing. An additional 49 men and 31 women were trained by Trufoods Ltd on canning bean production.

Objective 5: Enhancing Chickpea productivity and production in drought-prone areas in sub-Saharan Africa and South Asia

Target countries include Ethiopia, Kenya, Tanzania in ESA, and India and Bangladesh in South Asia.

Key Milestone: At least 44 elite lines enter NPTs in 4 countries: Bangladesh- 4, Ethiopia- 8; India- 16; Kenya- 8; Tanzania- 8 (Yr 1, Yr 2, Yr 3)

- *SA:* A total of 78 chickpea entries were evaluated in various trials under the All India Coordinated Research Project (AICRP) on chickpeas. A total of 61 chickpea entries were evaluated in IVTs (Initial Varietal Trials) and 16 in AVTs (Advance Varietal Trials).

- ESA: A total of 26 chickpea entries were evaluated in various trials in Ethiopia (18), Tanzania (3) and Kenya (5) under National Performance/Varietal Trials.

Key Milestone: At least 6 varieties released in 45 countries: Bangladesh-1, Ethiopia- 1; India- 2; Kenya- 1; Tanzania- 1 (Y2, Y3)

- *SA:* From Regional Agricultural Research Station, Nandyal, Andhra Pradesh, India one desi chickpea variety Nandyala senaga 1(NBeG 3) was released during 2012-13 for Andhra Pradesh, and another variety NBeG-47 is in the pipe line for release. GBM 2, an erect and tall variety suitable for mechanical harvesting, has been proposed for release by the Agricultural Research Station, Gulbarga, India.

- ESA: Nine chickpea varieties were released in Ethiopia (5) and Kenya (4). In Ethiopia, two Kabuli (Akuri, Kasech) and three desi (Kobo, Teketay, Dalota) varieties were released. In Kenya, three desi (Chania desi 1, Chania desi 2, Chania desi 3) and one Kabuli (Saina K1) were released. Chania desi 1 and Saina K1, though identified in Phase 1, were officially released in 2012.

Key Milestone: At least 90 elite lines/year for PVS trials (6 lines/site, 3 sites/country, 5 countries) (Yr 1, Yr 2, Yr 3)

- *SA:* Seventy three FPVS trials were conducted on chickpea varieties in India and Bangladesh in which 4,345 farmers (3,263 men + 1,082 women) participated in it. In India 3,146 (2,160 men + 986 women) farmers and in Bangladesh 680 (571 men + 109 women) farmers participated in these varietal selections. Farmers preferred ICCV 92944, JAKI 9218 and Vihar in India and ICCV 92944, BARI Chola 9, and BARI Chola 3 in Bangladesh.

- ESA: A total of 325 FPVS trials were conducted in Ethiopia (183), Tanzania (71) and Kenya (71); and 16,978 farmers (Ethiopia 8670, Tanzania 3936 and Kenya 4372) participated in it. Farmers preferred Minjar, Kutaye, Teji, Yelibe in Ethiopia; ICCVs 97114, 07112, 97128, and 97318 in Tanzania and ICCVs 92944, 97306 and 92318 in Kenya in addition to the varieties preferred in Phase 1. In addition, 2651 field demonstrations (Ethiopia-2437, Tanzania-22 and Kenya-192) were organized to disseminate information about promising varieties and production technologies.

Key Milestone: At least 300 lines were developed annually for drought and heat tolerance, fusarium wilt resistance (20 lines/site, 3 sites/country, 5 countries); at least 60 lines were developed for resistance to ascochyta blight, with market-preferred traits in Ethiopia and Kenya (10 lines/site, 3 sites, 2 countries); at least 10 lines were developed for resistance to botrytis grey mold in Bangladesh; at least 60 lines with resistance to pod-borer developed each year (5 lines/site, 3 sites/country, 4 countries) (Yr 1, Yr 2, Yr 3)

- SA: A "QTL-hotspot" containing QTLs for several root and drought tolerance traits was transferred from the drought-tolerant line ICC 4958 to two chickpea cultivars JG 11 and ICCV 10 through marker-assisted

backcrossing (MABC). Forty two BC3F5 lines of JG 11 and 22 BC3F5 lines of ICCV 10 were evaluated at four locations in India. Several lines with significantly higher yield and seed size than recurrent parents were identified under rain-fed and irrigated conditions.

- A set of 30 germplasm/breeding lines, including both desi and kabuli types, were evaluated at four locations under normal-sown and late-sown conditions during 2011-12 and 2012-13. A high genotype x environment interaction was observed in these trials. Based on the results of two years under heat stress conditions, several promising heat tolerant genotypes (ICCV 07117, JG 11, JG 16, JG 130, JGK 2, JG 14, NBeG 3, ICC 8474, ICCV 07109, ICCV 06302, ICC 4958, ICCV 07102, and ICCV 07105) were identified. F4 bulks of 8-way crosses made for development of MAGIC population were shared with seven NARS partners in India for evaluation and selection. Over 500 heat tolerant plants were selected from this bulk at Patancheru. 576 MAGIC lines were evaluated for heat tolerance under late sown conditions at ICRISAT, Patancheru. The seed yield of these lines varied from 1 to 81 g/plot under heat stress. 13 MAGIC lines (ICCML10228, 10633, 11136, 11042, 10011, 10602, 10186, 10696, 11113, 10350, 10534, 10302 and 10645) were found promising under heat stress. These lines showed significantly higher seed yield than the highest yielding check variety ICCV 97105.

- Two International Chickpea Screening Nurseries (ICSN-Desi and ICSN-Kabuli) were evaluated at four project locations in India. The breeding lines (54 desi + 54 kabuli) in the nurseries were selected based on the yield performance and resistance to fusarium wilt at ICRISAT-Patancheru. At Gulbarga, 6 kabuli lines (ICCVs 13305, 13306, 13308, 13310 and 13317) produced significantly higher yield than the local check. Similarly, 7 (ICCV 13102, 13105, 13109, 13112, 13113, 13114 and 13115) and 5 (ICCV 13111, 13113, 13114, 13115 and 13117) desi lines produced higher yields than the local checks at Dharwad and Gulbarga locations, respectively.

- Under the pod borer resistance breeding, a total of 473 single plants were harvested based on seed yield, and tall and erect plant type from F4 populations derived from 21 different crosses. About 270 F5 progenies were evaluated based on the pod damage score and more than 125 progenies were selected for generation advancement. The seed of 145 F6, and 45 F7 populations was provided to entomology researchers as part of the collaborative experiment. Further, four inter specific progenies (ICCX-070009-F2-P78-P1-P1-BP-BP, ICCX-070009-F2-P118-BP-P1-BP-BP, ICCX-070011-F2-P107-BP-P1-BP-BP and ICCX-070011-F2-P131-BP-P1-BP-BP) were selected based on visual *Helicoverpa* damage score and final seed yield from 20 F7 progenies evaluated under rain-fed conditions.

- Over 1000 advanced breeding lines were screened for fusarium wilt resistance at ICRISAT-Patancheru. F4 populations from 20 crosses were screened for Ascochyta blight (AB) resistance at Punjab Agricultural University, Ludhiana and resistant plants were individually harvested. In Bangladesh, 30 breeding lines were evaluated for botrytis grey mould (BGM) resistance under field conditions.

- A trial was conducted with 22 advanced breeding lines at 3 locations for identifying varieties suitable for mechanical harvesting. The promising lines identified included ICCV 03104, ICCV 07312 and ICCV 01103 at Patancheru; ICCV 03112, ICCV 03106, ICCV 04111 and ICCV 03104 at Dharwad; ICCV 03108, ICCV 03106 and NBeG 47 at Nandyal.

- ESA: The evaluation of MABC lines at two locations (Nairobi and Nakuru) in Kenya during the last two years resulted in the identification of high yielding, drought-tolerant, adaptable and large-seeded genotypes, namely MABCs 2, 8,22, 17, 21, 19, 4, 10, 14,9, 1, 16 and 15 for their use in Kenya and sharing regionally.

- Evaluated heat tolerant lines (61 desi and 62 kabuli) at Nairobi and EU-Kenya (35 desi and 35 kabuli) and identified best lines of desi (ICCVs 07101, 07112, 07104, 07110, 07103, 07113, 07114, 07304) and kabuli background (ICCVs 01303, 03404, 05315, 07313, 07304, 07308, 05312, 07306, and 05315).

- Evaluation of large-seeded genotypes (84 desi and 60 kabuli genotypes) in ESA resulted in the identification of promising 15 desi (D018, D047, D018, D064, D040, D065, D028, D021, D051, D058, D046, D056, D052, D050, D049) and 15 kabuli genotypes (K001, K014, K026, K022, K036, K004, K041, K010, K027, K016, K012, K013, K009, K020, K029) that were high-yielding as well as large-seeded in nature.

- Forty-two AB tolerant lines along with checks were evaluated in Kenya and tolerant genotypes were identified, namely ICCVs 10516, 10514, 10510, 10505, 10512, 11505, 11520, 11503, 11507, 11506, 11519, and 11515.

- Eighty-one desi and 62 kabuli best genotypes, selected from ongoing nurseries, were screened for pod borer tolerance and 6 desi (ICCV 07104, D064, D049, D036, D021, and ICCV 08107) and 5 kabuli genotypes (ICCV 08307, K031, K038, K007, and K034) were found to be tolerant.

- Evaluation of ICSN-desi (with 20 genotypes) and kabuli (20) nurseries in Kenya over two years resulted in the identification of superior genotypes in desi (ICCVs 93954, 11103, 11114, 11112, 11107, and 11104) and kabuli backgrounds (ICCVs 92311, 11312, 11308, 11317, and 11313).

- Evaluation of 225 breading lines in Ethiopia over the years resulted in the identification of 41 high-yielding and 12 large-seeded, fusarium wilt resistant lines. The most promising lines identified are ICCVs 08111, 07104, 09118, 09108, 10107, 10108, 10109, 10103, 10102, 08105 and 08104. Similarly, evaluation of 97 desi and 117 kabuli lines in Tanzania over the last four years resulted in the selection of six promising desi (ICCVs 97406, 07304, 97126, 97031, 97128, and 97125) and 7 promising kabuli genotypes (ICCVs 07112, 07110, 07114, 97306, 00302, 97406, and 92311).

Key Milestone: Four graduate students (2 PhD, 2 MSc) (Yr 3)

- SA: Two PhD students, Tosh Garg (M) and SB Patil (M), completed their research work on chickpea crop at ICRISAT-Patancheru during 2012-13. One MSc student, Prity Sundaram (F), completed her research work and was awarded the degree in 2014. Currently, two PhD students, Pronob Paul (M) and BP Mallikarjuna (M), are conducting their research work in the chickpea breeding unit at ICRISAT.

- ESA: Two MSc students (Niguise Girma-Ethiopia, Tesfamichael Mallu-Kenya) and one PhD student (Musa Jarso-from Ethiopia) completed their thesis work.

Key Milestone: i) At least two NARS scientists from ESA trained in chickpea breeding; ii) At least 30 NARS and NGO extension workers trained in chickpea production; and, iii) At least 2,500 farmers (ESA- 1,000, SA-1,500) trained in improved chickpea production technologies. (Yr 1, Yr 2, Yr 3)

- SA: (i) One NARS Scientist from Bihar Agricultural University, India and one Research Technician from DZARC, Ethiopia received one-week training on improved chickpea production at ICRISAT-Patancheru; (ii) A total of 37 training programs were conducted on chickpea production technologies to extension personnel/NGOs from India and Bangladesh. In these trainings, 1,457 personnel (1,201 men + 256

women) participated (iii) 5,391 farmers (4,757 men + 634 women) were trained on chickpea production technologies in India and Bangladesh.

- ESA: A training course for two-weeks on "Pre-breeding and legumes improvement" was organized at ICRISAT-Patancheru in 2013 in which five researchers from ESA (Ethiopia 1; Kenya 2; Tanzania 2) participated. A training programme on chickpea agronomic management and germplasm maintenance was organized during September 10-12, 2013 in Nairobi with 23 participants from seven ESA countries.

- Training was provided to 7165 farmers (Ethiopia-3151, Tanznia-2040, and Kenya-1974) and 515 extension staff (Ethiopia-157, Tanznia-160, and Kenya-158) on various aspects of improved agronomic practices for crop and seed production, FPVS, large scale demonstrations, seed storage and utilization technologies. In total, 124 field days were conducted in target locations of Kenya (47), Tanzania (27) and Ethiopia (47).

Key Milestone: Electronic field books and pedigree and data management systems used by four NARS and ICRISAT

- SA: ICRISAT-Patancheru initiated the use of databases to store the trial data of chickpea breeding. In 2011 Agrobase Gen-II was implemented and two scientists from ICRISAT received training on the usability of this database. Three scientists from NARS, India were trained by GCP for two weeks on the usage of the BMS at Wageningen, The Netherlands in 2012 and at Zaragoza, Spain in 2013 and 2014. During these training programs, the participants received hands-on training on pedigree and trial data management, preparation of electronic field books, single and multi-site analyses, data recording tools (tablet), and genotypic data management.

- ESA: Three staff members from ESA were trained on electronic field books and data management at Wageningen through the GCP. Two training programs on field designs and statistical analysis were organized in 2011 and 2012 and chickpea researchers from the region participated.

Objective 6 To enhance pigeonpea productivity and production in drought-prone areas of SSA and SA

Target countries include Tanzania, Uganda and Malawi in ESA, and India in SA.

Key Milestone: At least 8 varieties evaluated in 4 countries: India- 8; Malawi- 8; Tanzania- 8; Uganda- 8; and 6 hybrids evaluated in one country: India- 6

- SA: During Phase II (2011-12 to 2013-14), 45 varieties and 16 hybrids were evaluated in the preliminary yield trials across different locations of India in super early, early and medium duration agro ecologies. Out of these entries, six hybrids and 12 varieties received entries into the All India Coordinated Research Project on Pigeonpea Multilocation trials. In AP, Bihar and Odisha, 30 FPVS trials were conducted and farmer preferred varieties were identified for large-scale seed production.
- ESA: Around 359 Farmers' Participatory Varietal Selection (FPVS) trials were conducted in Tanzania (160), Malawi (52), and Uganda (147) that included 28 pre-released/released varieties (12-Tanzania, 11-Malawi, and 5-Uganda) along with a farmer's variety as a check. In addition, 778 demonstrations were conducted (Tanzania-296, Malawi-82, Uganda-400) involving best-bet farmer preferred varieties along with good agronomic package for quicker dissemination and adoption. A total of 6995 farmers took part in the FPVS trials and demonstrations from Tanzania (2021), Malawi (1766) and Uganda (3208). During the FPVS farmers came up with a number of preferred traits, which facilitated in short-listing of varieties

for fast-track varietal release.

Key Milestone: At least one (1) variety released in 4 countries and one (1) hybrid in India: India- 2; Malawi- 1; Tanzania- 1; Uganda- 1

- SA: During Phase II (2011-12 to 2013-14), one variety (RGT 1) and one hybrid (ICPH 2740) was released from the state of Andhra Pradesh. RGT 1 is the first white-seeded variety and ICPH 2740 is the first hybrid from Andhra Pradesh. In Odisha, proposals were submitted for the release of hybrid ICPH 3762 (this is the first variety/hybrid in pigeonpea, which is going to be released for Odisha) to the State Varietal Release Committee (SVRC).

- ESA: During Phase II, one variety each was released in Malawi (ICEAP 01485/3-Chitedze pigeonpea 2) and Kenya (ICEAP 00902- Egerton Mbaazi M1). In Tanzania, two medium (ICEAP 00554, and ICEAP 00557) and two long duration varieties (ICEAP 00053 and ICEAP 00932) were submitted to TOSCI for release. Four varieties, namely ICEAPs 00850, 00557, 00554 and 00540 are being tested in the National Performance Trials in Uganda.

Key Milestone: At least 200 breeding lines and 50 inter-specific progenies screened each year for resistance to wilt and sterility mosaic disease and resulting elite lines supplied to NARS partners

- SA: About 466 genotypes were screened for wilt and SMD resistance and 238 were found resistant for both the diseases. These were shared with NARS partners to strengthen their breeding programme. Among 190 RIL lines evaluated for wilt and SMD, 46 were found to be resistant and 24 moderately resistant to wilt, 84 resistant and 12 moderately resistant to SMD. A total of three mapping populations, each consisting of 188 F7 lines, were phenotyped for FW and SMD resistance. PRIL_A population (ICPB 2049 × ICPL 99050) was phenotyped for FW resistance at two locations, namely ICRISAT, Patancheru and UAS, Gulbarga. PRIL_B (ICPL 20096 x ICPL 332) was phenotyped for FW resistance at ICRISAT, Patancheru and UAS, Gulbarga and for SMD resistance at ICRISAT, Patancheru and ANGRAU, Tandur. Similarly, another mapping population namely PRIL_C (ICPL 20097 × ICPL 8863) was phenotyped for SMD resistance at ICRISAT, Patancheru and ANGRAU- Tandur.
- To map the targeted genomic regions for FW and SMD resistance, PRIL_B (ICPL 20096 x ICPL 332) population segregating for FW and SMD resistance were targeted. Based on the phenotyping data of 188 lines, 16 PRILs from each category were selected for development of resistant (R-Bulk) and susceptible bulks (S-Bulk). Re-sequencing of these two bulks along with the resistant parent (ICPL 20096) generated ~19GB of 250 bp pair-end data with ~15X genome coverage. The entire genome sequencing data generated from R- Bulks and S- Bulks were aligned with de-novo assembly of resistant parent developed using pigeonpea genome assembly. Further analysis of datasets is in progress to identify the candidate genomic regions for FW and SMD resistance.
- A mapping population segregating the cleistogamous flowering structure and obcordate leaf shape (ICPL 99010 x ICP 5529) is constituted. ICPL 99010 has a normal leaf shape with cleistogamous flower structure, whereas ICP 5529 has obcordate leaf shape with normal flower structure. A total of 220 F3 segregating lines were grown in single four meter lines and single plants were harvested for generation advancement.
    - ESA: ICRISAT-Nairobi evaluated 254 new genotypes (short-36, medium-36, and long-130) at the three test locations mentioned earlier. Simultaneously, the best lines in each maturity group based on agro-ecologies in target countries supplied and evaluated. In Tanzania, Selian and Ilonga, respectively representing Northern Zone (more emphasis on long duration) and Eastern Zone (more emphasis on medium duration) evaluated 42 medium and 60 long duration genotypes. Similarly, in

Malawi, 35 medium and 60 long duration genotypes were evaluated at central (more focus on medium) and southern regions. In Uganda, the focus was only on medium duration varieties and 73 medium duration genotypes were tested in Ngetta and Kitgum locations and the best varieties were identified. Through multi-locational and multi-year evaluations, high-yielding genotypes possessing drought tolerance in medium (ICEAPs 01479, 01506, 01523, 01527) and long duration types (ICEAPs 01170, 01179, 01147, 01143/8, 01487/16, 01499/7, 01532, 01485/9) were identified. About 35 medium duration genotypes under natural infestation of pod borers, pod fly and pod suckers identified tolerant genotypes ICEAPs 00850, 00777, 00911, 01525, 01527, 01549 and 01529. Efforts are being made to incorporate purple and constricted pod traits into high-yielding and adapted genetic background duly keeping farmer preferred grain color (cream) as most of the purple podded varieties have dark colored grains.

Key Milestone: New cytoplasmic nuclear male-sterility sources stabilized through back-crossing and selection and hybrid breeding program initiated in ESA

- SA: During Phase II (2011-12 to 2013-14), a total of 20 CMS lines derived from *Cajanus cajanifolius* were maintained in different back cross generations. Similarly, efforts were made to develop CMS lines from *Cajanus lineatus* and *Cajanus reticulatus* wild species. About 134 progenies were studied (54 derived from *Cajanus platycarpus*, 43 derived from *Cajanus acutifolius* and 37 progenies belong to sib lines) and 97 single plants were selected for further evaluation. In sib lines, 32 sterile lines and 5 fertile lines were selected for further evaluation.
- To meet the demands of the African hybrid breeding programme, the pigeonpea breeding at the Patancheru headquarters has developed 20 hybrid combinations using white-seeded ICPA 2199 CMS line. Of these, 10 male-lines were germplasm collections from the African region. Of these, two cross combinations of ICPA 2199 x ICP 8501 (Karnataka) and ICPA 2199 x ICP 9158(Kenya) exhibited sterile reactions and were further back crossed. The remaining hybrids were fertile. One of the male-parent ICP 13092 exhibited wilt and sterility mosaic resistance and hence, the hybrids from this combination will be more focused on.
- Of the 119 elite germplasm lines from the gene bank, three lines (ICP 14759, ICP 15045 and ICP 16317) were resistant to both i.e. wilt and SMD. In addition, 23 lines were resistant to the wilt disease and 24 to SMD. These lines will be used in the hybrid breeding programme.
- Of the 64 elite lines collected from various locations, three (BSMR 2, BSMR 736 and SK line) were resistant to wilt and SMD. Besides, seven lines were resistant to wilt disease and 18 lines were resistant to SMD. These lines will be used in the crossing programme to develop high-yielding hybrids.
- Seven CMS lines with obcordate leaf markers and their corresponding B-lines were developed by backcrossing two established male sterile lines, ICPA 2047 and ICPA 2048, with obcordate leaf donor ICP 5529. These A-lines designated as ICPA 2200, ICPA 2201, ICPA 2202, ICPA 2203, ICPA 2204, ICPA 2206 and ICPA 2208 were crossed with four known male fertility restorers (ICPL 20116, ICPL 87119, ICPL 20108 and ICPL 20093) in a line x tester mating design.
- **ESA:** 8 The CMS lines ICPA 2042, ICPA 2098, ICPA 2101-3, ICPA 2166, ICPA 2188, ICPA 2198, ICPA 2199-1 and ICPA 2193 were crossed with their counterpart B lines to maintain male sterility in ESA. About 52 test crosses were attempted involving eight CMS lines and six elite lines of African origin namely ICEAPs 00540, 00554, 00557, 00902, 00040 and 00020 to test their ability as maintainers or fertility restorers and found all of them to be fertile. In addition to this A, B and R lines of the best hybrids in India were evaluated in ESA for their stability study and found to be stable. However, the yield performance of the hybrids was found to be low compared to the ESA elite medium varieties.

Key Milestone: Pigeonpea mini-core collection screened for response to different rhizobia isolates in collaboration with N2Africa project (Yr 2)

Will be implemented as a component of the product line in CRP 3.5 in 2013.

Key Milestone: Germplasm screened for: i) Drought escape (ESA, India); ii) Water-logging tolerance (India); and, iii) Photoperiod sensitivity

- SA: At seed level screening, it was observed that the dark-seeded genotypes, long duration lines and hybrids exhibited greater tolerance to eight days of continuous water logging as compared to short duration and white or brown-seeded lines. ICP 5028, ICPH 2431, ICPL 87119, ICPH 2740, ICPL 149, ICPL 20241, and MAL 15 were found to be tolerant to water logging stress at all the three stages of the screening. Morpho-physiological adaptations like parenchyma cells, lenticels and adventitious roots have been visible in some tolerant genotypes of pigeonpea.
- A programme was initiated to develop photo insensitive super early maturing pigeonpea lines to fit into the narrow window of major cereals and cash crops. The pedigree breeding programme, with eleven parental lines in full diallel mating design yielded a total of 110 stabilized lines (31 DT and 79 NDT). The material was evaluated at multi-year, multi-locations and were found to be photo and thermo insensitive based on the performance at higher latitudes (300 N at Ludhiana) and higher altitudes (1250 MSL).
- ESA: About 54 elite lines screened at Kiboko, Bvumbwe and Ilonga identified eight promising wilt resistant lines ICEAPs 01203, 01408, 01197, 01532, 00673, 01392, 01499/7 with high yield and photoperiod insensitivity. This paved the way for the spread of pigeonpea into non-traditional areas like central and northern regions of Malawi, lakezone of Tanzania, Kerio valley of Kenya and potential areas in southern Mozambique.

Key Milestone: Three (3) graduate students (1 PhD, 2 MSc) (Yr 3)

- SA: During Phase II (2011-12 to 2013-14), three MSc (2 male and 1 female) and two PhD students (both females) were registered out of which two students were from Bihar and one each from Andhra Pradesh and Maharashtra.

- ESA: One MSc student (Samuel Kamau-Kenya) completed his research on pigeonpea. Two more students (Moses Bayo-Uganda, Meshack Mekenge-Tanzania) are presently pursuing their research work.

Key Milestone: At least 3 training programmes in breeding and crop production, including integrated pest management (IPM) conducted in ESA and SA (Yr 1, Yr 2, Yr 3)

- SA: During Phase II (2011-12 to 2013-14), a two-week training programme on ‘pigeonpea improvement, including hybrid breeding and production technology’ was conducted for five researchers from ESA between Nov 26 – Dec 7, 2012 at Patancheru. About 6800 farmers (1750 females), 156 scientists (32fFemales), and 356 (74 females) extension personnel were trained on various aspects of improved crop and seed production and seed storage.

- ESA: Five researchers from TL-II NARS participated in a one-week training programme (Oct 15-19, 2012) on ‘Experimental designs and data analysis’ in Nairobi. A training programme on ‘Hybrid pigeonpea technology, seed production and integrated crop management’ was conducted from Dec 9-12, 2013 at Nairobi. About 18 participants (15 men and 3 women) from NARS of Uganda, Malawi, Ethiopia, Tanzania and Kenya, ICRISAT-ESA research technicians, and two representatives from private seed industry attended the programme.

- 17204 farmers (Tanzania-12562, Malawi-1142, and Uganda-3500) were exposed to various pigeonpea technologies including quality seed production and processing through field days and farmer/seed fairs.

- 743 extension staff (Tanzania-257, Malawi-404, and Uganda-82) was trained on pigeonpea production technology including FPVS methodology, quality seed production, and safe seed storage.

Key Milestone: Information bulletin on hybrid seed production technology published in local languages for ESA and SA

- SA: During Phase II (2011-12 to 2013-14) in India, 22,450 information leaflets on crop management practices and hybrid seed production aspects were distributed. Mass communication channels like local news articles (170), TV programmes (29), and radio programmes (19) were used to disseminate information about the best-bet varieties and production package.

- ESA: A total of 73 mass communication events (local newspaper-43, TV programmes-12 and radio talks-18) pertaining to local awareness was published and broadcasted on various topics. A manual for pigeonpea production in Malawi was published in English and Chichewa. About 8300 flyers/manuals (4000-Tanzania, 4300-Malawi) describing the pigeonpea technology in Chichewa and Swahili were distributed to farmers and all other stakeholders in the project sites. A documentary video titled 'the pigeonpea revolution in Malawi: new opportunities along the pigeonpea value chain' prepared both in English and Chichewa, was broadcast through radio and MBC TV during Dec, 2012.

Objective 7: Enhancing soybean productivity and production in drought-prone areas of sub-Saharan Africa

Target countries include Kenya, Malawi and Mozambique in ESA, and Nigeria in WCA.

Key Milestone: Soybean varieties/lines tolerant to drought with enhanced BNF

- Prior to 2007, no soybean varieties were released in Kenya. However, with the project, 11 varieties have officially been released in Kenya (DPSB19, DPSB8, Sc Squire, Sc Saga, Sc Salama, Nyala, Hill, Gazelle, Blackhawk, EAI3600, 931/5/34). The progress in Kenya has been possible through fast tracking testing and release of advanced materials developed in other countries.
- In a trial consisting of 20 genotypes in Malawi, two advanced genotypes TGx 1989-60F and TGx 1987-62F outperformed the controls. TGx 1989-60F yielded 1940kg ha^{-1} and 1921kg ha^{-} for TGx 1987-62F against the control Makwacha 1426 kg ha^{-1} (more than 35% superiority). The Kasinthula Research Station has been identified as an appropriate location for drought screening because it is a drought stress location with access to irrigation facilities. One variety Tikolore (TGx1740-2F) was released in Malawi in 2011.
- In Mozambique, as a result of the combined effort of IITA and IIAM under TL-II, the first varieties were released and farmers have more options to choose from. The released varieties are the following: Wàmini (TGx 1740-2F), Sana (TGx 1485-1D), Zamboane (TGx 1904-6F), Wima (TGx 1908-8F), Olima (TGx 1937-1F), Ocepara-4, H7, H17 and 427/5/7. In addition, 35 soybean genotypes were evaluated across four agro-ecologies for which 15 genotypes were selected for good agronomic performance including high and stable yields, drought tolerance, disease tolerance (including rust), promiscuous nodulation and adaptability. The genotypes with rust tolerance (TGx 1987 series eg TGx 1987-38F, TGx 1987-57F and TGx 1987-62) performed better than most of the other genotypes across the sites.
- Out of the six improved varieties tolerant to soybean rust, five varieties of bacterial and cercospora leaf spot in Nigeria (TGx1835-10E, TGx 1740-2F, TGx 1904-6F, TGx 1987-10F, TGx 1987-62F) were released through extensive support from IITA and partners. Also, in Nigeria two TGx1945-1F and TGx1951-3F were

approved for registration and released in December, 2014.

- Three IITA lines developed through TL-II support (TGx-1740-2F, TGx-1937-1F and TGx-1904-6F were submitted to Variety Release Committee in Zambia in 2013

Key Milestone: Annual exchange of at least 20 lines between TLII and N2Africa projects in five overlapping countries, including information about BNF and other important traits:

- Three hundred accessions were evaluated for nitrogen fixation characteristics in multiple countries. The lines with high nodulation and high yield were identified and crossed with high yield low nodulation genotypes and the resulting segregating populations advanced.
- Nine TL-II soybean varieties (TGx1740-2F; Namsoy 4m; Maksoy 1n; Sc Squire; Sc Sequel; Sc Samba Sc Saga and EAI 3600) were shared with N2 Africa for setting up joint BNF and Agronomy trials in Kenya.
- Five soybean varieties recently released in Mozambique were shared with the N2 Africa project to evaluate their nitrogen fixation potential.
- Three varieties were shared with the N2 Africa for BNF trials in Malawi and 15 shared with Sustainable Intensification of Maize/Legumes Systems (SIMLESA) project for trials in Zambia.

Key Milestone: At least five farmer-preferred lines in NPTs in 4 countries: Kenya; Malawi; Mozambique; Nigeria.

- Five varieties TGx 1987-62F, Namsoy, Maksoy 1a, 835/5/30 and SBH 6/1/1 were submitted in NPT and are going a second year test and 2 varieties ScS-1 and 915/5/12 are in DUS test in Kenya.
- National Performance Trials were established using five genotypes selected for rust tolerance in Mozambique. The TGx 1835-10E, TGx 1987-20F, TGx 1987-38F, TGx 1987-57F and TGx 1987-62F were evaluated for adaptability and yield stability across four important soybean agro-ecologies in Mozambique.
- Five varieties (TGx-1830-20E, TGx-1835-10E, TGx-1987-11F, TGx-1987-62F, TGx 1989-60F) and three checks (Makwacha, Nasoko, Tikolore) were tested with farmers for participatory variety trial in four districts of Malawi.

Key Milestone: At least one farmer-preferred variety released in three countries: Kenya- 1; Malawi- 1; Mozambique-1; and Nigeria- 1.

- Agronomic and botanical information on the five high-yielding and rust tolerance genotypes (TGx 1835-10E, TGx 1987-20F, TGx 1987-38F, TGx 1987-57F and 1987-62F) are being compiled to identify at least 2 farmer-preferred genotypes for submission to the National Variety Release Committee in Mozambique in 2014.

Key Milestone: At least 20 elite lines distributed to partners in five countries, each year

- Seventeen elite lines (TGx1987 series) from CIAT-TSBF continue to be evaluated at KARI Njoro in Kenya. On the other hand, CIAT-TSBF received 20 elite lines from IITA. The lines are being evaluated at the station for adaptability to Kenyan conditions.
- Nine promising genotypes (five rust tolerant genotypes-TGx 1835-10E, TGx 1987-20F, TGx 1987-38F, TGx 1987-57F and TGx 1987-62F and TGx 1932-1F, TGx 1951-3F, TGx 1963-3F and TGx 1972-1F were distributed to partners for testing in Mozambique.
- Fifteen elite lines including the TGX1987 series were shared with the national partners in Malawi for advanced national trials and rust screening
- Over 1,300 germplasm lines were evaluated in the field for their yield and performance and 30 lines with enhanced drought tolerance were identified and crossed to existing breeding lines with farmers and consumers preferred traits. Over 100 populations segregating for early maturity as drought tolerance, and resistance to rust were generated. The best among the advanced lines are now being evaluated across various agro-ecologies.

***Key Milestone: At least two Soybean Resource Centers (SRCs) functional in Kenya (Yr 2); at least 30 farmer associations using the services of the SRCs such that household incomes increase by at least US$200 pa by the end of Yr 3*:**

- Three new Soybean Resource Centers (SRC) were established in Teso, Busia and Bungoma. These are in addition to the existing five SRCs, namely Mumias District Federation of Soybean Farmers (MUDIFESOF), Butere Soybean Co-operative Society (BUSCO), Uriri Farmers' Co-operative Society (UFC), Kleenhomes and gardens and Kenya Soybean Farmers (KESOFA) that were formed under Phase I of TL II. The operations of the new resource centers commenced in December, 2012.
- 250 extension staff have been trained in soybean production using improved method of planting and identification of common diseases associated with soybean.

Key Milestone: Five MSc students (Yr 3)

- In Nigeria, one staff of NCRI is undergoing an MSc course in crop breeding at the Ahmadu Bello University, Zaria.

Objective 8: Sustainable seed systems

Targeting all countries for one commodity or the other.

Eastern and Southern Africa

Key milestone: Certified seed production- Common bean: Yr 1 (Ethiopia- 2,000 MT, Kenya- 500 MT, Uganda- 80 MT, Tanzania- 60MT); Y2 (Ethiopia- 3,000 MT, Kenya- 1,000 MT, Uganda- 160 MT, Tanzania- 120 MT); Yr 3 (Ethiopia- 5,000 MT, Kenya- 1,500 MT, Uganda- 360 MT, Tanzania- 180 MT); Chickpea: Yr 1 (Ethiopia- 1,000 MT, Kenya- 15 MT, Tanzania- 100 MT), Yr 2 (Ethiopia- 1,500 MT, Kenya- 30 MT, Tanzania- 100 MT), Yr 3 (Ethiopia- 2,500 MT, Kenya- 55 MT, Tanzania- 100 MT); Groundnut: Yr 1 (Malawi- 1,000 MT, Mozambique- 50 MT, Tanzania- 100 MT, Uganda- 50 MT); Yr 2 (Malawi- 2,000 MT, Mozambique- 60 MT, Tanzania- 200 MT, Uganda- 100 MT), Yr 3 (Malawi- 3,000 MT, Mozambique- 90 MT, Tanzania- 300 MT, Uganda- 150 MT); Soybean: Mozambique- 85 MT, Kenya- 85 MT (Yr 1, Yr 2, Yr 3); Pigeonpea: Y1 (Malawi- 100 MT, Tanzania- 100 MT); Yr 2 (Malawi- 150 MT, Tanzania- 150 MT); Yr 3 (Malawi- 150 MT, Tanzania- 250 MT); Cowpea (in Mozambique): at least 30 MT per year (Yr 1, Yr 2, Yr 3)

- High quality seeds of Common bean– total 30,896 MT: Yr 1 (Ethiopia- 2,820.3 MT, Kenya- 574 MT, Uganda- 1,067 MT, Tanzania- 538.9 MT, Malawi- 1,044.5 MT, Zimbabwe- 350 MT); Yr 2 (Ethiopia- 5,133.2 MT, Kenya- 710 MT, Uganda- 3,559 MT, Tanzania- 678.9 MT, Malawi- 863.7 MT, Zimbabwe- 353 MT); Yr 3 (Ethiopia- 5,591.7 MT, Kenya- 2,074 MT, Uganda- 4,229 MT, Tanzania- 748.9 MT, Malawi- 1,168 MT, Zimbabwe- 458.9 MT), Chickpea– total 122,268.8 MT: Yr 1 (Ethiopia- 34,678.46 MT, Tanzania- 131 MT, Kenya- 87.32 MT); Yr 2 (Ethiopia- 38,968.94 MT, Tanzania- 243.62 MT, Kenya- 123 MT); Yr 3 (Ethiopia- 47,546.4 MT, Tanzania- 252.38 MT, Kenya- 255.68 MT), Soybean– total 3,410.5 MT: Yr 1 (Mozambique- 896.3 MT, Kenya- 182.38 MT); Yr 2 (Mozambique- 1,350.8 MT, Kenya- 110.62 MT); Yr 3 (Mozambique- 757.4 MT, Kenya- 113 MT), Cowpea– total 785.35 MT: Mozambique (Yr 1: 181.25 MT, Yr 2: 280.5 MT, Y3: 323.6 MT), Groundnut total 31,008.87 MT: Yr 1 (Malawi- 3,981.09 MT, Tanzania- 3,478.5 MT, Uganda- 56 MT, Mozambique- 4.27 MT); Yr 2 (Malawi- 4,652.68 MT, Tanzania- 6,240.2 MT, Uganda- 67.55 MT, Mozambique- 19.73 MT) and Pigeonpea– total 2,410.5 MT: Yr 1 (Malawi- 220.4 MT, Tanzania- 131.57 MT); Yr 2 (Malawi- 800 MT, Tanzania- 262.4); Yr 3 (Malawi-

508.8 MT, Tanzania- 487.33 MT) were produced. Total seed production in ESA during Phase II of the TL II project was 191,846.52 MT.

Key milestone: Seed packets distribution- Common bean: Ethiopia (20,000); Kenya (20,000); Uganda (20,000) (Yr 1, Yr 2, Yr 3); Soybean: Kenya (5,000 in 5,10, 25 kg packs); Mozambique (5,000); Nigeria (10,000) (Yr 1, Yr 2, Yr 3) Chickpea: Ethiopia (20,000); Tanzania (20,000) (Yr 1, Yr 2, Yr 3); Groundnut seed packets: Malawi (10,000); Mozambique (8,500); Tanzania (10,000); Uganda (7,500) (Yr 1, Yr 2, Yr 3); Pigeonpea seed packets: Malawi (10,000); Tanzania (10,000); Uganda (7,500) (Yr 1, Yr 2, Yr 3)

- Small seed packs were extensively used in seed delivery. A total of 453 MT of common bean seeds were distributed in 192,766 small packs (sizes 0.1kg, 0.2kg, 0.4kg, 0.5kg, 1kg, and 2kg). Kenya received 81,375 while Ethiopia and Tanzania got 106,115 and 5,276 seeds packs, respectively. The 0.5 and 1.0 kg pack sizes were mostly preferred by the male farmers while the 2.0 kg was preferred by the female farmers (76% of buyers). About 2,742.3 MT of soybean seeds were packed in 25,000 small packs (sizes 1kg, 2kg, 5kg, 10kg, 25kg, 50kg, and 90 kg). In Kenya, 87.6 MT of soybeans seed were packed in 35,566 small packs while in Mozambique 2,654.7 MT of seeds were packed in 457,099 small packs and distributed to farmers. In Malawi, 840,000 small packs (size 2kg) of groundnut seeds were distributed. In Mozambique, 78.4 MT of cowpea seeds were distributed in 9,345 small packs (size 5kg). A total of 40.1 MT (18.5 MT in Ethiopia; 21.2 MT in Kenya; 0.4 MT in Tanzania) of chickpea seeds were distributed in 2,963 small packs (sizes 1kg, 2kg, 3kg, 5kg, 10kg, 30kg, 35kg and 40kg). In Tanzania, 3.66 MT of pigeonpea were distributed in 3,536 small packs (size 1kg).

Key milestone: Trainings- Common bean- At least 40 seed production specialists trained (10 in each of Ethiopia, Kenya, Uganda) (Yr 3); Chickpea, groundnut, pigeonpea: At least 4 trainings (Ethiopia- 1, Malawi- 1, Tanzania- 1, Uganda-1) on seed production (Yr 1, Yr 2) for at least 1,000 seed producers and extension workers (Ethiopia- 300, Malawi- 300, Tanzania- 300, Uganda- 100).

- A total of 135 trainings were conducted for 12,528 farmers/legume seed producers and 939 extension officers (6,012 in Tanzania, 1,898 in Kenya, 2,162 in Mozambique, 1,190 in Uganda, 1,852 in Ethiopia and 353 in Malawi)
- Short courses on seed production and delivery were conducted in Mozambique, Ethiopia and Kenya. Training modules, manuals, leaflets/flyers and information bulletins were produced. For instance, training manuals for cowpea and soybean production have been developed and used for training in Mozambique. In Kenya, a training manual for chickpea production in Kiswahili language was developed and used for training farmers

Key milestone: Farmers' awareness events (field days, etc.) at on-farm trial sites in Ethiopia, Malawi, Tanzania and Uganda (Y3); Cowpea: 250 farmers and 80 extension workers trained in cowpea production (Mozambique); Farmer-friendly publicity materials on seed quality and availability, communicated by radio and TV each year (Yr 1, Yr 2, Yr 3)

- Improved variety awareness programmes were implemented in Ethiopia, Uganda, Tanzania, Malawi and Mozambique. For instance, 9,000 leaflets with information on groundnut seed production (6,500 in Uganda, 2,500 in Malawi) were distributed. Additional 15,000 flyers with information on groundnut were printed in Chichewa and distributed to farmers in Malawi. About 2,507 bean seed production/business manuals in four languages (Amharic, Oromifa, Swahili and Luganda) were produced and shared with partners in Ethiopia, Kenya, Tanzania and Uganda. Similarly 5,850 copies of leaflets with information on common bean were distributed in Kenya and Ethiopia. In Mozambique, 1,350 and 950 copies of factsheets on production of cowpea and soybean respectively were distributed, and one cowpea production guide was produced and shared with the stakeholders.
- Mass communication was also used to disseminate knowledge about new varieties and their seed source

through several radio programmes (18 in Ethiopia, 30 in Tanzania, 10 in Malawi, 5 in Mozambique); TV programmes (12 in Ethiopia, 10 in Tanzania, 4 in Malawi, 3 in Uganda, 2 in Mozambique); five articles in local newspapers on chickpea varieties in Ethiopia.

- Over 23,600 farmers/legume seed producers (12,090 in Tanzania, 5,735 in Uganda, 2,500 in Ethiopia, 1,581 in Kenya, 877 in Malawi in and 857 in Mozambique) participated in a total of 171 farmer field days and 52 farmers' fairs held at on-farm and on-station trial sites.

Key milestone: At least four innovation platforms for seed production and delivery established (one per country) (Yr 2)

- In Ethiopia and Kenya, platforms were established/ strengthened to link bean value chain actors (seed producers, grain traders, researchers, extension staff and other input suppliers) in order to develop the bean sub-sector in the respective countries. In Ethiopia, the business opportunity is mainly around the white pea bean and is catalyzed by the Ethiopian National Bean Research Programme. In Kenya, the market demand is mainly red mottle/red, pinto and yellow beans and is catalyzed by the private bean traders.
- Strategies that create awareness about the varieties were implemented in Malawi (involving partnerships with agro-processors and traders), Tanzania (involving Dodoma transport and Kilimo markets), Ethiopia (involving farmer cooperatives), and Uganda (in partnership with the seed companies) and in Kenya through farmer field days and soybean resource centers (SRCs).

Key milestone: Report on Seed quality benchmarks for entrepreneurs (Kenya) (Yr 2)

- A quality assessment of the bean seed from trained farmers carried out in Kenya and Ethiopia confirmed the good quality of farmers' seed with average germination of 92 and 95%, respectively.

West and Central Africa

Key milestone: Certified seed- Groundnut: Yr 1 (Mali- 100 MT, Niger- 40 MT, and Nigeria- 130 MT); Yr 2 (Mali- 60 MT, Niger- 60 MT, Nigeria- 130 MT); Yr 3 (Mali- 80 MT, Niger- 100 MT, Nigeria- 140 MT). Cowpea: Yr 1 (Mali- 40 MT, Niger- 40MT, Nigeria- 100 MT); Yr 2 (Mali- 60 MT, Niger 60 MT, Nigeria- 200 MT); Yr 3 (Mali- 100 MT, Niger- 100 MT, Nigeria- 300 MT). Cowpea foundation seed (Nigeria- 10 MT, Niger- 5MT, Mali- 5MT) (Yr 1,Yr 2,Yr 3)

- A total of 4,779.7 MT groundnut seeds: Yr 1 (Mali- 272 MT, Niger- 152.55 MT, Nigeria- 111.63 MT, Burkina Faso- 75 MT, Ghana- 11 MT, Senegal- 0.64 MT), Yr 2 (Mali- 313 MT, Niger- 367.55 MT, Nigeria- 945.9 MT, Burkina Faso- 77 MT, Ghana- 12.7 MT, Senegal- 0.83 MT), Yr 3 (Mali- 651 MT, Niger- 540 MT, Nigeria- 1,061.8 MT, Burkina Faso- 175 MT, Ghana- 10.3 MT, Senegal- 1.0 MT), Soybean in Nigeria– total 5,596.38 MT (Yr 1: 897.78 MT; Yr 2: 1,452.53 MT; Yr 3: 3,246.07 MT) and Cowpea– total 4,562.53 MT: Yr 1 (Mali- 78.9 MT, Niger- 1,270.9 MT, Nigeria- 578.71 MT); Yr 2 (Mali- 93.71 MT, Niger- 905.5 MT, Nigeria- 172.18); Yr 3 (Mali- 106.33 MT, Niger- 1,197.28 MT, Nigeria- 159.02 MT) certified seed were produced. Total certified seed production in WCA was 14,938.61 MT. Additionally, a total of 337.3 MT of cowpea foundation seed were produced- Yr 1 (Nigeria- 78.32 MT, Niger- 10.02 MT, and Mali- 12.31 MT), Yr 2 (Nigeria- 91.78 MT, Niger- 8.03 MT, and Mali- 12.87 MT), Yr 3 (Nigeria- 103.6 MT, Niger- 11 MT, and Mali- 9.37 MT). A total of 3,358.64 MT of soybean foundation seeds were produced in Nigeria (Yr 1- 643.63 MT, Yr 2- 880.5 MT, Yr 3- 1,834.51 MT). A total of 204.89 MT of groundnut foundation seeds were produced: Yr 1 (Niger- 13.28 MT, Mali- 20.65 MT, Burkina Faso- 7.5 MT, Senegal- 0.4 MT), Yr 2 (Nigeria 4.5 MT, Niger 20.84 MT, and Mali 28.15 MT, Burkina Faso- 8 MT, Senegal- 0.2 MT), Yr 3 (Nigeria 27.3 MT, Niger 23 MT, and Mali 67.17 MT, Burkina Faso- 22 MT, Senegal- 0.22 MT). Total foundation seed production in WCA was 3,900.83 MT

Key milestone: seed packets- Groundnut Mali (5,000 -30,000 in 0.5, 1, 2, 5, 10 kg packs); Niger (5,000-

30,000 in 0.5, 1, 2, 5, 10 kg packs); Nigeria (30,000 in 1,2,5, 10 kg packs) (Yr 1, Yr 2, Yr 3)

- In Niger and Mali, more than 80 MT of cowpea seed were distributed in 81,699 small packs (sizes 1kg, 2kg, 5kg, and 10kg). In Nigeria, over 75,885 small cowpea seed packs (sizes 2.5 kg, 5 kg, 10 kg, 25 kg) and over 308,000 small soybean seed packs (sizes 1kg, 2kg, 10kg, 25kg) were distributed. In Mali and Nigeria, over 16 MT of groundnut seed were distributed in 8,790 small packs (sizes 0.05kg, 0.5kg, 1kg, 2kg, and 5kg). In Mali, 100 mini-kit seed samples (50 g / mini-kit for 3 groundnut varieties) were distributed to farmers.

Key milestone: Training of local seed producers (10) in small-scale business and marketing strategies in each of Mali, Niger, Nigeria (Yr 3); training of at least 300 farmers and extension workers in groundnut seed production each year in three countries (Yr 1, Yr 2, Yr 3). At least 1,000 farmers (250 in each of Mali, Niger and Nigeria) trained in seed production, 80 extension workers trained in cowpea production, including FVS (20 in each of Mali, Niger and Nigeria); At least 200 farmers (Nigeria) trained in soybean seed production and at least 400 farmers and small-scale seed producers trained in seed enterprises (Nigeria) (Yr 1, Yr 2, Yr 3).

- A total of 163 trainings were conducted for 8,230 farmers and 648 extension agents were trained in legumes seed agronomics, production and post-harvest management techniques (6,917 in Nigeria, 1,951 in Mali, 90 in Niger). Additional 104 public extension personnel were trained in cowpea production and management techniques in the three participating States in Nigeria. In Mali, 12 extension agents were trained in various aspects of seed production techniques. In Niger, 784 farmers were trained in cowpea production techniques and hermetic storage.

Key milestone: At least 10 demonstration plots established in pilot villages in 3 countries (Yr 1, Yr 2, Yr 3); Market information made available through radio and TV in 5 countries (Yr 1, Yr 2, Yr 3); Small-scale business management and seed production manuals and other promotional materials made available in local languages (Yr 2, Yr 3); At least 2 fact sheets or bulletins produced and 1 radio/TV documentary programs per country (5) each year (Yr 1, Yr 2, Yr 3)

- A total of 70 radio and six TV programmes/ documentaries (42 in Nigeria, 14 each in Mali and Niger) were used to create awareness on improved cowpea, soybean and groundnut varieties. In Mali, 3 Malian radio stations broadcasted programmes which delivered extension information from pilot sites. Over 1000 production guides for 3 groundnut varieties were made available to producers in Mali. Formal contracts have been established between rural radios and market information systems in Mali and Niger.
- Forty two mini, 5 mega field days and 10 farmers' fairs were conducted for 5,034 cowpea and soybean farmers in Nigeria. Eight large demonstrations were established in pilot villages in Samanko, Mali. Similarly, 8 and 6 field days were held in Mali and Niger respectively. A total of 2,890 farmers and policy makers participated.
- Strong platforms for seed production and delivery system have been successfully set up in Nigeria (Cowpea and Soybean), Niger (Cowpea) and Mali (Cowpea). The platforms consist of seed producers, farmers associations, extension agents, and seed certifying agencies, seed traders, soybean processor and agro-dealers. Planning workshops were organized across each of the three countries to discuss and plan activities for the various sectors of the soybean industry e.g., where and when to access seeds for the next season, agro chemicals required, seed production and delivery models available to members, credit facilities, seed loans and training on seed production. The platforms facilitate linkages and leverage among members.

South Asia

Key milestone: Certified seed production – groundnut India: 6,005 MT (Yr 1), 14,000 MT (Yr 2), 20,000 MT (Yr 3); chickpea India: 3,000 MT (Yr 1), 6,000 MT (Yr 2), 12,000 MT (Yr 3); pigeonpea India: 100

MT (Yr 1), 150 MT (Yr 2), 250 MT (Yr 3)

- High quality seed of chickpea- total 162,849.5 MT: Yr 1 (India- 22,793.5 MT), Yr 2 (India- 3,234 MT, Bangladesh- 65 MT), Yr 3 (India- 136,685 MT, Bangladesh- 72 MT); groundnut- total 11,988.51 MT Yr 1 (India- 4,237.5 MT, Bangladesh- 1.62 MT), Yr 2 (India- 3,613.5 MT, Bangladesh- 6 MT), Yr 3 (4,040.8 MT, Bangladesh- 88.4 MT) and pigeonpea in India- total 2,296.1 MT Yr 1 (161.52 MT), Yr 2 (1,014.15 MT), Yr 3 (1,120.43 MT) were produced. Total seed production in SA was 177,134.11 MT.

Key milestone: At least 4,000 seed packets (1-5 kg) of chickpea, groundnut and pigeonpea, distributed annually to farmers for evaluation and further seed production to ensure seed sufficiency at the individual farmer level (Yr 1, Yr 2, Yr 3)

- 88.7 MT of groundnut seed; 17.5 MT of pigeonpea seed and 660.9 MT of chickpea seed were distributed in small packets. Small seed samples (sizes 0.5kg, 5kg, 10kg) were distributed to 5,148 pigeonpea farmers; 3,346 chickpea farmers; 8,665 groundnut farmers in India as well as 936 groundnut farmers and 110 chickpea farmers in Bangladesh. A total of 20,707 small packs (sizes 0.5kg, 2kg, 3kg, 4kg, 5kg, 10k, 20kg, and 25kg) were distributed in India and Bangladesh.

Key milestone: At least 500 farmers trained per year at various project locations in India in chickpea (125), groundnut (125) and pigeonpea (250) seed production, processing, storage and marketing; ii) At least 10 potential seed entrepreneurs from Andhra Pradesh, Karnataka, Tamil Nadu, Bihar and Odisha trained at ICRISAT (Yr 1, Yr 2, Yr 3)

- In India, 207 trainings were conducted for 12,604 farmers and 4,137 extension personnel on pigeonpea, chickpea, and groundnut production technologies in the states of Bihar, Odisha, Andhra Pradesh, Karnataka and Tamil Nadu. In Bangladesh, 35 training sessions were conducted for 830 farmers and 130 extension personnel on chickpea and groundnut production technologies. Seed entrepreneurs (150 in Andhra Pradesh and 170 in Tamil Nadu) were trained on chickpea seed production.
- A total of 79 field days (51 in India and 28 in Bangladesh) and three farmers' fairs were conducted. A total of 8,309 legume farmers and 3,438 extension personnel participated (10,401 in India, 1,346 in Bangladesh). Over 135,000 farmers participated in farm fairs organized by the UAS-Dharwad and UAS-Raichur. In addition, 5,531 farmers were reached through state and regional farmers' fairs.

Key milestone: At least 5,000 pamphlets on chickpea, groundnut and pigeonpea seed production and storage released annually (Yr 1, Yr 2, Yr 3); One farmer awareness event annually at each project location, or cluster of project locations, during the cropping seasons for chickpea, groundnut and pigeonpea (Yr 1, Yr 2, Yr 3); One publication or talk on PVS and integrated crop management in local print and electronic media before the start of the cropping season each year for chickpea, groundnut and pigeonpea (Yr 1, Yr 2, Yr 3)

- Mass communication was used to create awareness on improved pigeonpea, chickpea and groundnut varieties (156 news articles in local newspapers with information on pigeonpea, groundnut and chickpea production technologies; 57 TV programmes documenting opportunities and challenges in pulse production, 34 radio programmes creating awareness on newly released pigeonpea, chickpea and groundnut varieties as well as seed production technologies, 3 radio programmes on ICM of groundnut; leaflets/brochures; and CD prepared with information on chickpea production technology, eight research bulletins and in-house newsletter articles). In Tamil Nadu, over 7500 copies of technical manual and 18,000 pamphlets with information on chickpea, pigeonpea and groundnut in the local languages were distributed to the farmers.

Project management, prioritization, monitoring and evaluation, data management and communication

Alignment of project objectives and activities to Bill and Melinda Gates Foundation new strategy

- Country strategies for all participating countries and seed road maps were developed and reviewed soon after the 2012/13 Annual Planning and Review meetings of TL2. This is now part of the TL-II accomplishments "Grain Legumes Strategies and Seed Roadmaps for Select Countries in Sub-Saharan Africa and South Asia" Monyo Emmanuel and Laxmipathi Gowda (eds). 2014. ICRISAT. ISBN 978-92-9066-559-5, Order code: BOE 062.292pp.
- Objective leaders and investigators met in January 2013 and reviewed their respective milestones to align them with the foundation's strategy refresh. It was generally agreed to devote more efforts and resources towards the anchor countries, while activities slowly taper down in the non-anchor countries.

Effective data curation and dissemination as Global Public Goods (GPGs)

- The aWhere consultancy has been engaged with the ICRISAT's Knowledge Sharing and Innovation Programme to develop a data management platform to make sure that technologies from the project continue to be available as GPGs.

Effective communication of project progress, achievements and impacts

- ICRISAT website has a dedicated webpage link for Tropical Legumes II.
- The web is constantly updated with TL-II news, information, happenings and technical publications of the project
- Hard copies of important reports/publications such as country strategies/seed roadmaps, baseline/early adoption survey reports have been produced and shared with partners.

Efficient project management and reporting

- Global/regional meetings: Successfully completed all three regional meetings for WCA, ESA and South Asia each year of the project. The ESA meeting for the second year was jointly hosted by TL-I and TL-II and developed joint work plan activities to ensure that TL-II breeders employ genomic tools developed through TL-I.
- Research and financial reports: Prepared annually from 2011 – 2013. End of Phase finance report will cover the entire grant period.
- Coordination with related projects operating in target countries and with foundation communications: Projects with similar goals and objectives were invited to share their experiences with TL-II during our regional meetings. Each year we invited and shared experiences with AGRA PASS, AGRA Soil Health, N2-Africa, the NGO CRS and FAO Seed Systems Project for Southern Africa. Private sector seed companies operating in ESA and WCA were also invited to contribute their experiences

Key milestone deviation, course correction, risks, sustainability, scalability.

Key Milestone Deviation:

The major deviation from the planned key milestones was the change in the number of countries where six more countries were added for Phase II (Uganda, Senegal, Burkina Faso and Ghana). Ghana, Uganda and Burkina Faso are the Foundation anchor countries in addition to Nigeria, Mali, Tanzania and Ethiopia

Course Correction:

All objectives are on track. Some challenges with activities related to the use of molecular markers have been anticipated because different objectives use technology according to their abilities.

Risks:

There were no major risks or concerns that had not previously been identified. Security concerns in Northern Mali and Northern Nigeria have affected the number of on-farm demonstrations and farmers trained in FPVS in these countries. Political instability and climate change in some of the implementing countries can stall the achievements made so far. Encouraging developments following improved governmental policies on agriculture is expected to create a favorable economic climate for both farmers and seed producers and eventually consumers.

Sustainability:

Close collaboration with colleagues in the NARS is contributing to increasing their ability to conduct research in a productive manner. Equipment such as computers, tablets and some of the renovation of infrastructure (seed storage, and irrigation facilities) has provided the opportunity of a better environment for high quality research. Capacity building is a principal contribution of the project for the development of the research system in the participating countries. Training of farmers to conduct PVS helped research institutions to involve farmers in their breeding efforts and to facilitate the release of their improved varieties. In all countries, project activities are being conducted in close collaboration with community development projects that has interest in maximizing the beneficial effects of the project. Stakeholders were identified and linked to promote the newly-introduced varieties. Current support for private seed growers by AGRA will help develop a strong legume seed industry to sustain the demand for improved seed, and hence research in legume breeding. With strong institutional linkages that were forged along the legume value chain under this project and other governmental and non-governmental policy initiatives towards the modernization of agriculture, a vibrant and self-sustaining legume industry is anticipated. Training of both farmers and scientists has helped facilitate the attainment of the new goals that were set. Logistics such as equipment and vehicles should be provided to all implementing countries so that all targeted locations can be accessed. The project activities will be continued under the CGIAR Research Programme on Grain Legumes and phase III of TL.

Scalability:

Conducting demonstrations in different communities within a country offered the possibility for farmers to learn not only about PVS but also the key production practices needed to achieve high yield. Some additional funds were used to increase the number of demonstration plots in some of the countries. It is observed in several communities that farmers who pass by demonstration plots also learn from what they see and even ‘voluntarily’ pick pods from good performing lines to plant in their own farms. The NARS members are also trying their best to involve more farmers in PVS. Participatory approaches will continually be used to identify varieties preferred by farmers and food processors. Available varieties will be grown in stations and on-farm for evaluation and selection by farmers. For variety promotion, many activities were carried out with high level of participation from farmers, the media, NGOs in agricultural development, agricultural extension agents and agro-processors. Radio programmes on the achievements of the project were aired on the FM radio stations in various local languages for the benefit of the farmers. Workshops and field-base training will further be organized as and when necessary throughout the course of the project and beyond to provide a learning platform for farmers and to communicate various findings to them and the general public. The activities will be continued under the CGIAR Research Programme on Grain Legumes and phase III of TL.

Gaps in achieving intended outcomes

A major gap in achieving the intended outcomes is the slow pace of implementing the marker-assisted backcross for introgression of some desirable traits in farmers’ preferred varieties. The time lag between leaf sampling in

the home country, shipment to KBio in the UK and genotyping as well as genotype data being warehoused at the UCR takes some time, which causes delays in conducting the project activities.

2. Location of Work

Provide the final list of countries and regions/states where this work has been performed and associated dollar amounts. If location of work includes the United States, indicate city and state. Add more locations as needed.

Location	Foundation Funding (U.S.$)
Niger (Dosso region)	$ 1,070,411
Mali	$ 1,040,654
Ghana (Tamale)	$ 153,746
Burkina Faso	$ 146,611
Nigeria (Kano, Kaduna, Katsina, Jigawa, Yobe, Borno, states)	$ 1,947,424
Senegal	$ 29,000
Uganda	$ 1,892,938
Tanzania	$ 1,535,435
Malawi	$ 1,779,973
Ethiopia	$ 644,492
Kenya	$ 5,142,516
Mozambique	$ 622,103
Zimbabwe	$ 35,000
Zambia	$ 404,821
Colombia	$ 538,274
Bangladesh	$ 149,375
India	$ 3,851,304
Total	$ 20,984,077

3. Geographic Areas to be Served

Provide the final list of countries and regions/states that has benefitted from this work and associated dollar amounts. If areas to be served include the United States, indicate city and state. Add more locations as needed.

Location	Foundation Funding (U.S.$)
Niger (Dosso region)	$ 1,070,411
Mali	$ 1,040,654
Ghana (Tamale)	$ 153,746
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Zimbabwe	$ 35,000
Zambia	$ 404,821
Colombia	$ 538,274
Bangladesh	$ 149,375
India	$ 3,851,304
Total	$ 20,984,077

4. Lessons Learned

Describe the top one to three takeaways or lessons learned from this project.

Lessons from market opportunities and partnerships

1. While the baseline surveys conducted at the beginning of phase 1 of the TLII project showed continued dominance of old improved varieties introduced several years ago, early adoption studies conducted in phase 2 showed increased adoption of new varieties disseminated through the project following farmer-participatory variety selection (FPPVS)
2. Lack of access to improved seed was found to be the major reason for non-adoption of improved legume varieties whereas lack of access to capital (i.e. cash, credit, etc.) was the main reason for non-adoption of improved varieties of maize due to greater private sector participation in the maize seed industry;
3. Demand for certified legume seed is driven largely by the subsidy programmes and donor-funded projects, indicating the lack of sufficient sustainable demand for seed, which is needed for creating the conditions for sustainable seed supply through private sector participation; and
4. In view of the growing private sector investments in the ICT sector, baseline and early adoption studies found high levels of mobile phone penetration and ownership in all project countries and this holds potential for enhancing farmer access to price information and improved technology for increased commercialization of legume production.
5. The observed low private sector participation in the seed systems may indicate a market failure and the need for stronger public support for legume seed production and distribution at least in the early stages until the demand is high to attract private sector seed companies. On the other hand, it is important to build on the strengths and adaptability of the informal approaches and enhance the opportunity to increase both seed supply and quality through the participation of local seed producers, farmer groups, and agrodealers with capacity building and monitoring to produce and market quality seed. The importance of quasi-formal or market-based channels increases with the availability of new farmer-preferred varieties which creates incentives for the emergence of markets and trade in the supply of the new seeds.

Lessons from enhancing groundnut productivity and production

1. Feedback from the farmers helped researchers identify preferred traits in varieties.
2. Participation of the farmers in FPVS provided a sense of belonging and ownership of the varieties preferred by the farmers facilitating fast spread of new varieties.
3. Capacity building and providing support to improve infra-structure development and critical aspects of uptake of new technology by the project partners.
4. Improving R&D efficiency. Scientist-farmer partnership in agricultural research and development is crucial in bringing about the desired changes in agricultural research and production scenario in the

country. There is a need for faster varietal testing and release systems to enhance the spectrum of varieties available to farmers.
5. Targeting and adoption. Farmers' advocacy of new varieties and technology is essential to bring about changes in the existing policies and large-scale adoption.
6. Impact orientation. Sustained seed support is essential for large area coverage by FPVs and resultant enhanced productivity in groundnut.
7. High performing genotypes could be targeted for regional release. Many such genotypes are generally good performers across the region. There is need to develop a mechanism, if possible, for regional release to overcome or at least minimize "slowdown" due to national institutional challenges.
8. Strengthening capacity via mentorship. Each of the countries is unique in their own right in terms of capacity and throughput. Exploring opportunities for mentorship amongst regional scientists over and beyond planning meetings is worth considering especially in the case of supporting development of leadership skills, which are needed to push things through government systems.

Lessons from enhancing cowpea productivity and production

1. Close collaboration with colleagues in the NARS is contributing to increase their ability to conduct research in a productive manner.
2. Supplies of equipment such as computers, tablets and upgrading of infrastructure (seed storage and irrigation facilities) provide an enabling environment that will ensure high quality research.
3. Training farmers to conduct PVS helps research institutions' variety development and their rapid adoption.
4. Opportunities to continue support for higher degree training are important in all the countries for the sustainability of the research activities beyond the present project. Human capacity building for research is enhanced by these training opportunities.
5. The conduct of demonstration plots in different communities offers the possibility of farmers in other communities to know of new varieties and technologies which they can adopt.
6. It is a common practice for farmers passing by demonstration plots mostly located by road sides to 'voluntarily' pick seeds of good performing lines for planting in their fields.
7. NARS colleagues need to be sensitized about the importance of sustainability of the activities beyond the current project.
8. Monitoring and evaluation tours have revealed very important contributions made by some NARS colleagues to the project activities but these are usually not incorporated in their reports.
9. Coordination of different legume projects of each country needs to be implemented to create complementarity between them.
10. Additional funds from other projects are used to increase the number of demonstration plots in some of the countries. Some NARS partners are more committed than others. These performing ones need to be identified and rewarded to sustain the project efforts.
11. In Ghana, it was observed that the land owners demanded some compensation before giving out their land for on-farm evaluations and trials to be conducted. The demonstration plots suffered managerial problems because the farmers paid little or no attention to following the agreed cultural practices. It is therefore important that research staff undertake regular visits to closely monitor and supervise activities carried out on these farmers' fields. This will, however, have a major impact on the budget.
12. Coordination of different legume projects at the level of country, regions and districts with linkages to NGOs and CBOs should be emphasized to create a spirit of teamwork.

Lessons from enhancing common bean productivity and production

1. Factors affecting remobilization of photosynthate to grain are key in determining drought resistance and probably yield potential in common bean. The Pod Harvest Index (seed weight/total pod weight including seed) was shown to be a viable selection criterion for drought resistance, and with positive effects on non-drought yield as well. While conventionally selection for stress tolerance or resistance has been thought to limit yield potential, this study suggests that drought resistance traits can contribute to yield in favorable environments. Thus, drought resistance does not have a yield penalty.
2. Even highly vulnerable farmers cultivate keeping the market in mind. While one might expect that farmers living "on the edge" might be concerned primarily with food security, the baseline study showed that they are equally concerned with markets for income and will maintain a "drought inferior" variety with hopes of selling some beans. This implies a challenge for breeders to obtain drought resistance in market types of the best grain size and color. Farmers are aware of genetic differences in drought resistance and rank these high among the traits for a preferred variety.
3. Market opportunities have dramatic influence on the input use and yields. The case of Ethiopia is striking, where having an assured market, combined with effective extension and seed systems, led farmers to improve crop management and to double national yields in eight years.
4. On the down side, the benefits of degree training have been limited by staff instability. None of the scientists who received higher degrees are currently working in their respective programmes. All but one studied in the African universities, which is not a cure at all for this long-standing problem. We need to intensify the efforts of training technicians who typically are more stable in their posts.

Lessons from enhancing chickpea productivity and production

1. The new SA locations included in phase 2 (Bangladesh, Bihar, and Odisha states of India) offer huge opportunities for expansion of chickpea area in rice-fallows. However, suitable agronomic practices need to be developed for improving crop establishment in rice-fallows.
2. Dry root rot has emerged as a major disease of chickpea in southern India.
3. Chickpea farmers in India are looking for more mechanized chickpea cultivation for increasing net profit. They are demanding varieties tolerant to herbicides and suited to mechanical harvesting.
4. Establishment of optimum plant stand is a major challenge in ESA and the farmers need proper machines for completing chickpea sowing in a short window of soil moisture availability.
5. Relay cropping of chickpea on residual moisture in non-traditional chickpea growing areas was identified as a potential approach for expanding chickpea area in Ethiopia, Tanzania and Kenya.
6. Sensitization of the policy makers is essential for quick dissemination of the best bet varieties and other technologies.
7. Ascochyta blight is emerging as a major challenge in ESA especially in Ethiopia and Kenya.
8. Technology demands for irrigation, double cropping, fertilization, and relay cropping are emerging to increase productivity further in Ethiopia.
9. Concerted efforts are needed to enhance adoption of IPM for pod borer control.

Lessons from enhancing pigeonpea productivity and production

1. Crop phenology-based breeding is critical due to narrow planting window in India.
2. Farmers' awareness on improved varieties and seed availability of improved varieties are the key factors in the spread of improved pigeonpea varieties;
3. Area and production fast increasing in ESA due to export demand, availability of promising varieties and technologies.
4. Favourable policy interventions such as Presidential Initiative on Poverty and Hunger Reduction in Malawi and Kilimo Kwanza (Agriculture First) in Tanzania etc. supported increasing interest in pigeonpea that resulted in area and production increase.
5. Development of climate resilient medium duration varieties that resulted in the spread of pigeonpea to new niche markets like central and northern Malawi, Lake zone and Kilimanjaro region of Tanzania,

Kerio valley in Kenya

6. The demand for pigeonpea in ESA continues to rise both for domestic consumption and as well as for the export market. The seasonal pigeonpea price variations in India offer a window of hope for African countries to export pigeonpea to India when prices are high around November-December, the time at which pigeonpea in Malawi, Tanzania and Uganda is harvested.

Lessons from enhancing soybean productivity and production

1. There is greater potential of coming up with many soybean varieties with desirable attributes like high yield, disease resistant, drought tolerance and early maturing among others. This calls for a huge investment in promotion of soybean production. However, the agro ecologies where soybean is produced by smallholder farmers are highly varied. This provides a major challenge to the breeders in developing varieties that are adaptable but still high yielding. These heterogeneous agro ecologies are the main cause of the observed yield gap. Direct moving of elite varieties from one region to another has not achieved the desired yield increases. This means that there is need to invest in targeted breeding to meet these unique site specific differences in the region. Addressing the yield gap in soybean production will require investment in developing adaptable technologies but also linking this to integrated crop management practices.
2. Production of soybean in the countries under TL-II continues to be constrained by low soil fertility, drought, pests and diseases. Soybean rust caused by *Phakopsora pachyrhizi* is a major constraint to soybean production in project countries (Malawi, Mozambique, Kenya and Nigeria) and requires special attention as most lines were found to be susceptible to the disease. A multidisciplinary and multi-institutional rust research programme should be initiated to monitor pathogen populations, identify and utilize new sources for resistance, develop molecular markers for various resistance genes to enable stacking resistance genes in new lines to strengthen the breeding process for developing a series of rust-resistant lines that are adapted to various regions. Breeding for early maturing bigger seed size soybeans is essential for southern African countries like Malawi and Mozambique as the season is not long enough for medium to late maturing promiscuous soybean varieties with high biomass. Multipurpose promiscuous varieties of West Africa were found to take more days to flower and mature under southern Africa condition. Use of modern breeding techniques will significantly contribute to improved breeding to address the challenges above.
3. PVS studied have provided important lessons that inform the breeding efforts. Studies in target countries have shown gender differences in preferences of the soybean varieties among men and women - with women choosing the early maturing, large-sized grain and with moderate yields while men opting for the medium-sized varieties. Understanding such preferences is important when promoting varieties for adoption.

Lessons from Seed Systems

1. Access to and availability of seed of modern varieties and product markets still pose as major constraints to adoption.
2. A nexus between informal and formal seed systems is critical to increase access to improved varieties and thus adoption.
3. Variety identification remains an issue in assessing adoption. Finger-printing methods could be explored.
4. Engaging with a range of seed producers in each country is positively yielding good impact and laying the foundation for sustaining the project outcomes. The training of seed producers and the increased availability of basic (foundation) seed through the project were critical to the increased seed production. The country seed road maps provided a good planning tool for country teams.
5. Small packs approach is being mainstreamed as an avenue to increase seed access to millions of

farmers, particularly women.

6. Informal seed systems, community based as well as individual farmer-based are instrumental to meet seed requirements and spread of new varieties. Power relations in resource allocation, sharing of proceeds and efficiencies of such seed systems need further study to draw lessons that could be used to scale up best practices.

5. Feedback for the Foundation

Provide one to three ways the foundation successfully enabled your work during this project. Provide one to three ways the foundation can improve.

Ways foundation successfully enabled work during this project: The foundation's hand-holding was extremely important in the integration of up-stream research of TL I, and down-stream product development and delivery of TL II. Strong gender perspective advocated by the foundation was useful to relook the activities and reframe them. As a result, a large number of women groups were involved in marker-oriented groundnut seed production activities as well as capacity building.

Ways foundation can improve: The foundation may identify target regions for interventions well in advance. It may be desirable to continue the work that is in progress at the target regions to sustain the gains made and achieve the impacts rather than change the target regions as and when the foundation's strategy is revised. Continuing the work will create successful examples that can be adopted in other regions and may bring more donors to the cause.

6. Sub-grants

If your grant agreement (not applicable to contracts) is subject to expenditure responsibility and permits you to make sub-grants to organizations that are not U.S. public charities or government agencies/instrumentalities, please complete the Sub-grantee Checklist and attach a copy with this progress narrative for each such sub-grantee.

Financial Update

7. Updated Budget Template

Unless otherwise directed by foundation staff, please use the Actual Costs & Expected Funding tab on the budget template to report total expenditures against the most recent foundation-approved budget. Provide the requested information regarding payments received, interest earned on grant funds, expenditure of interest earned, and unexpended balance. Also, provide updated information on the Geography & FX Estimates tab in the Reporting & Re-forecasting section of the budget template for Location of Work, Geography Served, and Currencies. Please follow the instructions in the budget template carefully and let your program officer know if you have any questions.

Note: If you received your grant prior to July 2010 or used our old budget template to create your grant budget, please use the Total Budget page of the final budget spreadsheet provided in your proposal to specify actual expenditures for the period for each line item. Please insert a column for actual expenditures, variance, and percentage. For variances that exceed 10 percent in either direction in the Total Cost category (i.e. Total Personnel, Total Supplies, Total Equipment), please describe these in Section Seven of the narrative report. Also, please update the geographic information for your work using the Grantee Geography Reporting Request.

8. General Budget Progress

Describe the general progress of meeting budget expectations, including where the project progressed as forecast (or re-forecast) and where it did not.

In general budget was spent on the planned activities. However because of some unexpected delays in recruiting scientist / staff etc., rate of expenditure, though projects goals were obtained, was low. As a result on the request of the project team the Foundation, gave an extension of 5 months till 28 February 2015. And unspent balance available at the official end (September 30, 2014) was spent during the extension period.

9. Budget Variances

To the extent that this information is not yet reported, for variances that exceeded 10 percent in either direction in the Total Cost category (i.e., Direct FTE, Direct Travel, etc.) or if there are unexpended funds, please describe the variance, the reasons for the variance, and what corrective actions have been taken to address the variance.

Budget line item realigned as per the Foundation approval vide email dated 10 February 2015. Overall utilization is 100% and there are no variances that exceed 10% in either direction. As per the attached financial statement unspent funds available is US$ 56,558, these funds will be utilized towards activities of digital seed road map in collaboration with aWhere, Inc.

10. Budget or Financial Challenges

Discuss how you addressed both anticipated and unanticipated financial challenges in the course of the project. Was there anything in the past that the foundation could have done to assist you with addressing those challenges?

As mentioned earlier, there was a need of re-alignment of unspent budget in extension phase. Based on request from the project team, the Foundation approval re-alignment. We appreciate flexibility of the Foundation to meet the project goals.

For Foundation Staff to Complete

Analysis (required if PO assessment differs from grantee/vendor assessment)

Progress Analysis

Include analysis of significant project variances and key learnings that may inform portfolio discussions for progress against the strategic goals.

Budget & Financial Analysis

Include analysis of over expenditures or unexpended grant funds. Refer to the Unexpended Grant Funds Policy for options available when recommending how to handle unexpended grant funds or reach out to your Grants and Contracts Management primary contact.