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Progress Narrative

Use this form to provide updates to your foundation program officer regarding progress made toward achieving your project's stated outputs and outcomes.

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

General Information

Investment Title	Harnessing Opportunities for Productivity Enhancement (HOPE) of Sorghum and Millets in sub-Saharan Africa-Phase 2		
Grantee/Vendor	International Crops Research Institute for the Semi-Arid Tropics		
Primary Contact	Ramadjita Tabo	**Investment Start Date**	November 12, 2015
Feedback Contact[1]	Ramadjita Tabo	**Investment End Date**	December 31, 2020
Feedback Email[1]	r.tabo@cgiar.org	**Reporting Period Start Date**	November 12, 2016
Program Officer	Jeffrey Ehlers	**Reporting Period End Date**	December 31, 2017
Program Coordinator	Emily Zuberi	**Reporting Due Date**	March 31, 2018
Investment Total	$15,000,000.00	**Opportunity/Contract ID**	OPP1129015
Scheduled Payment Amount (If applicable)	$2,925,045.00		

[1] Feedback Contact/Email: The full name and email of the contact whom foundation staff queries for various surveys.

Submission Information

By submitting this report, I declare that I am authorized to certify, on behalf of the grantee or vendor identified on page 1, that I have examined the following statements and related attachments, and that to the best of my knowledge, they are true, correct and complete. I hereby also confirm that the grantee or vendor identified on page 1 has complied with all of the terms and conditions of the Grant Agreement or Contract for Services, as applicable, including but not limited to the clauses contained therein regarding Use of Funds, Anti-Terrorism, Subgrants and Subcontracts, and Regulated Activities.

Date Submitted	March 31 2018	**Submitted by Contact Name**	Ramadjita Tabo
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Progress and Results

1. Progress Details

Provide information regarding the current period's progress toward achieving the investment outputs and outcomes as well as the work planned or anticipated for the next period. In addition, submit the Results Tracker with actual results as requested.

Executive Summary

Building on the first year of HOPE II's achievements, in 2017 the HOPE II project continued to support the core cereal improvement activities of the ICRISAT and NARS programs, that ranged from crossing, generation advancement and selection to meeting release specifications and supporting seed systems for sorghum and millets in the target countries. Influential in planning HOPE II support has been the critique and feedback from the BMGF-supported Breeding Program Assessment Tool (BPAT) reviews of ICRISAT programs in Africa. A similar work was extended to the national programs and preliminary assessment informed the program improvement plans that led to decisions to renovate seed storage facilities, upgrade irrigation facilities, procure computers and hand-held tablets for field data collection as well as train partners on the use of BMS. At least 70 scientists and technicians were trained in digital data capture, breeding platforms, data analysis, and other subjects related to the use of BMS. This was an improvement on the 38 trained during year 1 and above the target of 48 scientists and technicians per year. The breeding program in Ethiopia had additional financial and technical support through the MERCI project funded by BMGF and backstopped by the University of Queensland. This enabled them to gain additional skills in data collection and crop management and enhanced the quality of experimental protocols and quality of data. The Cereals Crop Improvement National Coordinator has requested additional support to adopt BMS, which was put on hold to sort out

the choice of the breeding management software within EIAR. This has been communicated to the relevant scientist in ICRISAT and will be implemented in the coming year. Registration is nearly complete for all the 4 PhD and 4 MSc students identified for the project. Most of them are interested in breeding. We are working with partners to ensure that the courses fulfill their needs. For example, most countries do not have millet breeders.

Irrigation facilities were upgraded in Ethiopia, Nigeria and Mali, while seed cold storage facilities were improved in Ethiopia, Uganda, Burkina Faso and Nigeria. The different components of BMS-related trainings conducted in year 1 were rolled out in all the six project countries for each crop during year 2 of the project, and all the 12 NARS breeding programs (2 crops x 6 countries) are at different levels of operationalization and institutionalization of BMS in daily breeding operations. The three breeding programs at ICRISAT (sorghum, finger millet and pearl millet) have also made significant progress in fully digitizing field operations from barcoding of field labels, digital data collection as well as managing breeding operations using BMS. Besides, ICRISAT has developed Product Concept Notes (http://crp-gldc.icrisat.org/) which are under discussion with NARS partners and will be finalized during the upcoming Annual Review and Planning Meeting for feedback and alignment with country priorities, not only for enhanced efficiency, but also for better demand-led crop improvement for greater technology adoption and adaptation.

Using the outcomes of stakeholder consultation workshops in Uganda, Ethiopia and Burkina Faso as well as National Review and Planning Meetings where implementing teams and partners were identified, work plans were developed, seed roadmaps were outlined, targets were set, and field activities were conducted on the specific objectives targeted for each country. At least 10 out of the 12 NARS crop breeding programs with phenotyping facilities at country levels, are engaged with ICRISAT's genomics unit and provided material for genome-wide association studies (GWAS) to identify associations between genetic regions such as QTLs, genes or other loci and traits such as *Striga* resistance, and disease resistance. QTLs for resistance to *Striga* were introgressed into 17 varieties of sorghum and millet with farmer-preferred traits. Again, the Ethiopian Sorghum Crop Improvement Program had an advantage over others because of the Integrated Striga Control (ISC) Project from Purdue University funded by BMGF that provided the necessary upstream breeding resources and has extended the zones in the regions beyond where the HOPE II project is working, with a new focus on hybrid varieties. This has increased awareness as well as brought the *Striga*-tolerant varieties to more farmers.

Across crops and countries, 584 advancedlines combining different input traits (*Striga*, midge, and smut resistance, and drought tolerance) were exchanged between ICRISAT and 11 NARS crop improvement programs for evaluation and trait validation in the field. Besides, preliminary identification of 744 new hybrid parents were derived from local germplasm with tolerance to drought and resistance to Striga and validation trials have been planned for 2018. In year 1, only 55 new hybrids were tested but these were only in Mali. The other countries did not report testing of hybrids. Also, 7 new finger millet breeding lines with blast, *Striga*, midge, covered smut resistance, and drought tolerance were submitted for National Performance Trials (NPT) and Tests of Distinctiveness, Uniformity and Stability (DUS) for possible release later in the year. During year 1, only 3 lines were submitted for DUS. Besides, a total of 9 varieties and hybrids were released across crops and countries, of which 4 were sorghum varieties with resistance to Striga. This has been a major milestone compared to year 1 when only 1 variety was recommended for release and none was actually released.

Variety adoption requires seed to be available in sufficient quantities and at the right place. To achieve this, proper seed production planning is a must, guided by target adoption roadmaps. Eight variety adoption roadmaps were developed for crop improvement programs and seed production planned. Four more programs are yet to complete their variety adoption and seed roadmaps. Across crops and countries, 90.8t of high quality and affordable early generation seed (breeder + foundation) of various recently released varieties were produced by the NARS partners and collaborators in each major agro-ecology for each crop and made available to the private sector and farmer cooperatives for further multiplication. A total of 5.6t of breeder seed of sorghum (2.2t), pearl millet (3.1t) and finger millet (0.3t) was produced and made available for foundation seed production. Additionally, 79.8t of foundation seed of sorghum (59.9t), pearl millet (10.7t) and finger millet (9.2t) was produced and made available for certified/QDS seed production. Besides this, 267 contract farmers were trained and accredited at various levels of the foundation seed supply chain, including farmer co-operatives, cooperative unions, and farmers' seed growers associations (SGAs) as well as individual farmer seed producers. This boosted the total supply of EGS. Besides, private sector involvement led to the production of 226.3t of certified seed of sorghum (173.6t), pearl millet (46.1t) and finger millet (7.0t) while 39.6t of quality declared seed (QDS) of market preferred cultivars of finger millet was produced by farmers' seed producers' associations. The seed was distributed to end users in 45,184 small seed packs (1 kg), implying that a similar number of new users of these varieties were reached. This was way above the 32,000 farmers targeted with small seed packs per year and significantly higher than the 12,112 small seed packs distributed in year 1.

Awareness of new varieties was enhanced through training and participation of stakeholders in field days on 1464 demonstration trials, a significant improvement from the 19 demo trials conducted in year 1. Besides, 7411 integrated *Striga* and soil fertility management (ISSFM) kits were distributed and demonstrated to farmers. This was beyond the 5000 targeted per year and far above the 1025 ISSFM kits distributed in year 1. These kits included improved *Striga*-resistant sorghum varieties, use of cowpea in intercropping or rotation and application of fertilizer microdosing. At least 5 reports were published that summarize farmer feedback on the seed mini packs and ISSFM minikits in each relevant country. Sixteen seed fairs were conducted to increase awareness of new sorghum and millet technologies across the target countries, a significant improvement from year 1 when only 3 fairs were conducted. Agreements were signed with 6 new partners committed to participating in scaling out the relevant technologies for target crops and agroecologies and 5188 new subject matter specialists and extension officers were trained as ToTs for sorghum and millet production, way beyond the 533 trained in year 1. Together, awareness creation and technology promotion reached 57,783 farmers.

Five studies were conducted documenting farmers' trait preferences, yield, profitability, and improved sorghum and millet varieties across countries and incentives for adoption of key improved crop technologies identified, with men paying attention to pre-harvest traits while women are keener on post-harvest and utilization traits. All programs use PVS for variety nomination to NPTs and to identify

traits relevant to women farmers and consumers of sorghum and millets. These results will be used to inform crop breeders and agronomists on key elements to target to improve adoption of technologies by smallholder farmers.

Taking a cue from the Tropical Legumes III project, HOPE II is putting in place a digital Monitoring & Evaluation (M&E) system that will capture in near real time indicators related to project outputs and outcomes to track progress over time. The system is linked to the seed catalogues of varieties released from field evaluations, giving a robust data of performance across environments that supplements variety description in terms of its relative advantages over the current dominant variety. The seed catalogue is then linked to a seed production plan that enables project partners to plan the production of breeder, foundation and certified seeds with a clear adoption roadmap of the target variety. The M&E and seed roadmap dashboards are available and in final stages of assigning accessibility credentials to appropriate project staff, where necessary. Their operationalization and full implementation will be discussed at the upcoming Annual Review and Planning Meeting in Uganda. Once fully adopted, reports will be built into this new system which will include established baselines for key scale and performance metrics for breeding programs, as well as for the seed system in order to track changes over time. For successful implementation, an MLE scientist was recruited to support both TL III and HOPE II projects in developing the necessary indicators to track the projects' progress and contribution in the target countries.

HOPE II project was brought together under the same global coordination as TL III and the former HOPE II coordinator has taken on additional roles in WCA that include support to TL III. A seed systems specialist has been recruited to work in West and Central Africa (WCA) and the role of the TL III seed systems scientist has been expanded to include HOPE II activities in Eastern and Southern Africa (ESA). The recently recruited TL III MLE officer has also been asked to take on additional roles in HOPE II while the administrative assistants on the projects in ESA and WCA have both been asked to take on additional roles. In addition to these project management adjustments, there were budgetary adjustments on all partner budgets, taking care of the current burning rates and rationalizing planned activities for the remaining project years.

INTRODUCTION

HOPE II is a visionary project that seeks to improve the lives of smallholder farmers in the semi-arid tropics of Africa through enhanced dryland cereals productivity and production. It operates under five objectives: (1) Produce new, well-adapted sorghum, pearl millet, and finger millet cultivars with high yield potential and the genetic capacity to withstand major biotic and abiotic stresses; (2) Strengthen seed production and delivery systems for improved varieties; (3) Expedite the scaling out of new dryland cereals technologies (4) Quantifying uptake and adoption, gender, and impacts; and (5) Project oversight and results-based management to ensure accountability, learning and scalability. To succinctly cover an overview of the project's progress on outputs without going into minor details of each activity, this report is organized into the following sections: (i) Developing Superior High Yielding Stress Tolerant Cultivars; (ii) Strengthening Seed Production and Delivery Systems for Improved Varieties; (iii) Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption; (iv) Gender Integration into Variety Development, Adoption and Impact; and (v) Strengthening Cereal Breeding Capacities of National Partners. These sections are described for each crop improvement program for each country with an introductory overview of ICRISAT's backstopping activities and an overall project management section.

1. Sorghum in Eastern and Southern Africa (ESA) Region

Sorghum research for development under HOPE II was conducted in all the 3 ESA project countries (Ethiopia, Tanzania and Uganda). ICRISAT partnered with NARS in the 3 countries alongside other project collaborators to carry out different activities under different project objectives. Outputs realized from each activity varied by country, activity and objective. This report systematically documents key outputs delivered under each activity by crop and by country for the last 2 years of project implementation. We start by highlighting the key backstopping activities carried out by ICRISAT to enable the NARS (primary implementers of project activities) to implement project activities.

1.0 Overview of ICRISAT Sorghum Backstopping Progress

- During 2016, ICRISAT cereal breeding programs in ESA developed breeding modernization plans that included training of its staff and those of NARS on adoption of Breeding Management Systems (BMS), electronic data capture and alignment with product concept notes (PCNs). In 2017, ICRISAT-ESA conducted a 2-week plant breeding training at Kiboko Research Station in Kenya where 8 sorghum and finger millet technicians (4 from Ethiopia and 4 from Uganda) participated. Implementation of the skills acquired through trainings conducted since 2016 (alignment with product concept notes, adoption of BMS, electronic data capture using KSU Field Book and creating and advancing nurseries) were rolled out in all the 3 ESA project countries.

- In the 2 years, progress in Genome-Wide Association Studies (GWAS) has been made to support crop improvement research in Ethiopia and Uganda. Leaf tissue of 647 accessions were received from Ethiopia but were insufficient for the quality and quantity of DNA required for genotyping. Logistics are underway to send additional samples. Uganda sent seed of 210 accessions in 2016 and an additional 226 in 2017 which are currently undergoing sequencing using the DArT sequencing platform under the Integrated Genotyping Service and Support (IGSS). Tanzania is yet to send samples for similar support.

- ICRISAT-Kenya generated a total of 132 F_1s, 235 F_2s, 207 F_3s and 339 F_4s for drought and *Striga* resistance and high yield for distribution to NARS partners for further generation advance and evaluation. This represented a significant increase from 2016 where 77 bi-parental crosses were reported, with 13F_1 drought-, 20F_1 *Striga*- and 8F_1 insect and disease-resistant populations.

- To develop drought-tolerant disease-resistant cultivars for Tanzania, 10 *Striga*-resistant, 10 drought-tolerant and 7 leaf blight- and anthracnose-resistant lines (Table 1) were sent to Tanzania for off-season crossing. Further, to develop hybrid parents derived from local germplasm with tolerance to drought and resistance to *Striga* in Tanzania, 10 A/B pairs were sent for crossing with 15 adapted varieties to determine fertility restoration (Wahi, Hakika, Teso, Pato, Gadam, Tegemeo, Naco1, S35-5, Wagita, R8602, E15, IESV91104DL, IESV23010, IESV91131DL and IESV93034).

- To backstop breeding for *Striga* and fungal disease resistance in Uganda, 10 sources of *Striga*, 5 of midge and 7 of leaf blight and anthracnose resistance (Table 1) were sent to Uganda for off-season crossing. To develop hybrid parents from local germplasm with tolerance to drought and resistance to *Striga*, 280 hybrid lines were developed using 30 A-lines and 50 elite/released varieties that were provided by NaSARRI during the main rains of 2017. The 280 hybrid lines were sent back to NaSARRI at Serere for testcross evaluation during the short rains of 2017. A fresh batch of seed of 18 A/B pairs was sent to Uganda for use in the hybrid development program.

- To support the development of sorghum hybrids with tolerance to drought and resistance to *Striga* from Ethiopian landraces, 245 new A/B parents were tested for stability. Early generation advances totaling 440 for drought tolerance were established and joint selection conducted during 2017.

- ICRISAT also made selections of 16 varieties (8 elite lines and 8 hybrids) during 2016 and these materials were sent to 40 sites in Central Tanzania for FPVS in 2017. ICRISAT supported Uganda in promoting 8 sorghum varieties to DUS and to release 4, of which 3 were from the ICRISAT-Nairobi program (IESV 92043 DL, ICSR 160 and IS 8193). To ensure that released varieties are nutritionally rich, nutrient profiles of 20 elite sorghum lines are currently being analyzed at ICRAF labs in Nairobi.

- ICRISAT supported the ESA NARS to ensure that seed reach more farmers for enhanced genetic gains by sending 50 kg of

sorghum breeder seed (20 kg each of ICSR 160 and IS 8193 and 10 kg of IS 8193) to produce foundation seed. The ICRISAT team, on supervisory exercise, also visited on-station and on-farm trial sites in Tanzania and Ethiopia.

- Further, to understand the adoption and impact pathways of the project in ESA, the national program in Tanzania conducted a survey in 2016, whose data was analyzed in 2017 resulting in a draft survey report that was reviewed by ICRISAT's socio-economists. The reviewed report (Draft Report) is currently being cleaned up and finalized.

1.1 Ethiopia Sorghum Crop Improvement Program

1.1.1 Developing Superior High Yielding Stress Tolerant Cultivars

- Through iMashila, The Program for Emerging Agricultural Research Leaders (PEARL) project of Jimma University, Integrated Striga Control (ISC) and The Feed the Future Innovation Lab for Collaborative Research in Sorghum and Millet (SMIL) projects, genomic data was generated for 3,500 sorghum genotypes in 2017 and availed for use in HOPE II pipeline development.

- Morphological data was used to identify 300 mini core collection representing Ethiopia's sorghum diversity. This is a useful resource for mining sources of various agronomic and consumer traits of sorghum for Ethiopia.

- Two sets of trials were conducted to screen sorghum genotypes for *Striga* and drought resistance; one with 100 genotypes (Table 2) advanced from the pedigree for grain size and quality and another with 507 sorghum inbred lines (Table 3) as preliminary yield trial for earliness from lines generated from the MERCI project and evaluated under HOPE II at Mieso and Kobo.

- The results showed variability in grain yield performance ranging from 962 to 4832 kg/ha, and 31 lines with higher grain yield than the standard check were selected (Table 4). Their grain quality is currently being analyzed using NIRS while the protein profile will be analyzed at BecA with the support of ICRISAT.

- In 2017, 647 sorghum genotypes (Table 5) were screened for *Striga* and drought resistance and their tissues sent to BeCA lab in Nairobi for genotyping and sequencing.

- The 36 F_1s derived from 20 early-maturing, medium-duration improved and elite sorghum genotypes (Table 6) and 2 stay green gene sources (ICSTG2372; B35) in 2016 were advanced to F_2 in the off-season of 2017 at Werer.

- The 36 F_2 populations (Table 7) were planted at Mieso and Kobo and 237 F_3 progenies were selected from the populations at Mieso.

- Twenty nine genotypes (Table 8) were selected based on yield performance and crossed with 3 farmer preferred landraces with better biomass and grain quality traits. In total, 87 F_1 crosses were made in the main season of 2017. The F_1 crosses were planted in the off-season of 2017 to produce F_2 seed for evaluation in the 2018 main season.

- A total of 110 test crosses (Table 9) were made using selected early-maturing best performing advanced genotypes crossed with 3 female parents (ATX623, ICSA21 and PU209A) in the off-season nursery of 2017. Evaluation of the heterotic performance of the hybrids was done at Mieso, Werer and Sheraro, 24 of which (Table 10) were superior to the checks. The 24 superior hybrids will be advanced in 2018 to elite hybrid evaluation to get stable hybrid varieties. Hybrids derived from ATX 623 gave the highest mean yield, indicating that it could be used as a tester line in inbred line development.

- Twenty one (21) sorghum genotypes (Table 11) selected based on their genetic distance and agronomic merits were crossed as male parents with Gambella 1107. The 21 F_1 resulting from these crosses were advanced to F_2 at Werer under irrigation. The F_2 seed will be planted in two sites in the main season of 2018.

1.1.2 Strengthening Seed Production and Delivery Systems for Improved Varieties

- In 2017, 51.5 kg of breeder seed of 4 sorghum varieties (Melkam = 14 kg; Dekeba = 22 kg; Argiti = 5.5 kg) and one hybrid variety (ESH1 = 10 kg) was produced in addition to 150 kg of the 3 varieties (Dekeba, Melkam and Meko) and hybrid (ESH1) produced in 2016. Three sorghum varieties (Melkam, Dekeba, Girana1) and one hybrid (ESH1) have been identified for scaling out.

- Different approaches were used to multiply foundation seed, including seed multiplication at collaborating research centers, community-based seed multiplication schemes and public and private seed companies.

- A total of 20.1 tons of foundation seed of 2 varieties (Dekeba = 12.8 tons and Meko = 7.3 tons) were produced and 34.9 tons of certified seeds of 4 varieties (Dekeba = 8.6 tons; ESH1 = 2.5 tons; Melkam = 20.8 tons; Girana1 = 3 tons) were multiplied in 2016. In 2017, a total of 28.5 tons of foundation seed of 4 sorghum varieties (Melkam = 8.2 tons; Dekeba = 12.4 tons; Girana1 = 7.3 tons and ESH1 = 0.65 tons) were multiplied, representing a 42% increase over 2016. By the end of 2017, foundation seed cleaning and treatment was still underway, implying that the total figure will increase.

- In addition, a total of 21 technicians (7 women and 14 men) were trained on hybrid seed production and seed management at Melkassa research center.

- The NARS supported lead farmers in multiplying seed by providing quality foundation seed and technical support while a total of 34.9 tons of certified seed was produced with the support of the project in 2017.

- Technical support was provided to one private seed grower and 10 community-based seed growers (2 women and 8 men). A total of **23.9** tons of certified sorghum seed (Melkam = 23.4 tons; ESH1 = 0.5 tons) were produced in addition to 34.9 tons produced in 2016. Therefore, the project has provided support in producing 108 tons of seed (Table 1).

1.1.3 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- A total of 3 early-maturing sorghum varieties (2005MI5065, IESV23007DL and 2005MI5064) were submitted for DUS verification in 2016 with 2005MI5064 being released under the name Argiti. Field days were organized to popularize target improved sorghum varieties in which 5,040 farmers participated (3,724 male and 1,316 female). Other field days were conducted in North Wello region (71 men and 12 women) and Eastern Hararghe region (42 men and 7 women).

- In 2017, regional level multi-stakeholder platforms led by regional research centers were established to promote project technologies.

  Apart from field days, the project also targets to distribute about 300,000 small seed packs between 2016 and 2020 as a way of creating technology awareness and accelerating uptake. In 2016, a total of 110 sorghum demonstrations of 4 varieties (Melkam, Dekeba and Meko and hybrid ESH1) were hosted. A total of 9.3 tons of seed (Melkam = 4.6 tons; Dekeba = 1.5 tons; Teshale = 1.15 tons; Grana-1 = 0.54 tons; Meko = 0.4 tons and ESH1 = 1.55 tons) was distributed to 1,560 farmers (295 men and 1265 women) with 2 tons in 1-2 kg small seed packs and 7.3 tons in 3 kg packs (Table 12). In 2017, the amount of seed distributed in small seed packs increased by almost 850% to a total of 18.9 tons of five sorghum varieties (Melkam, Dekeba, Meko, Grana1 and ESH1) to 13,899 farmers (2,461 women and 11,438 men) nearly a 10-fold increase over the year 1 figures of the number of farmers reached.

- In addition to distributing small seed packs, training on improved sorghum seed and grain production was given to 1,468 farmers, development agents and experts (1,105 men and 363 women) during 2016. A total of 605 farmers in Tigray (430 men and 175 women) and 63 farmers (56 male and 7 female) hosted on-farm variety demonstration trials.

- In 2017, a national field day involving policy makers, researchers, farmers and relevant stakeholders was conducted in Tigray region on the demonstration and scaling out plots using varieties Melkam, Dekeba, Argiti, ESH1, Jiru and Adele. In addition, 6 field days consisting of 6 varieties (Melkam, Dekeba, Argiti, ESH1, Jiru and Adele) were also conducted at regional and district levels. A total of 13,783 farmers participated (9,324 men and 4,459 women).

- Three recently released sorghum varieties (Argiti, Melkam and Dekeba) were selected during these field days and 40 demonstration trials were established in the 3 new project implementing regions (Oromia, Amhara and Tigray). Additional demonstration trials co-supported by ISC project involved two hybrids (ESH1 and ESH4) along with one check (Melkam) on 30 farmers' fields. An additional 13 demonstration trials were conducted in the highlands and wet lowlands of Ethiopia using 4 varieties (Jiru, Adele, Assosa1 and Adukara). The demonstrated varieties showed better performance in comparison to the check. In total, 83 demonstrations were conducted during 2017.

1.1.4. Gender Integration into Variety Development, Adoption and Impact

- In 2016, the deliverables under this activity included the successful organization and implementation of a gender integration workshop held in Nairobi to formulate gender research questions, identify target geographies, finances and timelines. It was also during this reporting year that one desk review was completed on the role of gender in sorghum production.

- In 2017, with support from another project (i.e. SMIL- USAID), a survey was conducted to identify farmers' preferred traits for consideration in technology development and delivery. The data was analyzed during 2017 and the results were used to inform ICRISAT's product profile development that HOPE II contributed to. Besides this analysis to understand farmers' preferred traits, an evaluation of farmers' experiences with new technologies was conducted during the first year of the project.

- A review of literature was initiated by EAIR scientists on the 'Gender role in agriculture in Ethiopia: Sorghum and finger millet'. The report highlights that women in rural households do provide labour at all stages of crop production but they, especially in male headed households, don't attend trainings offered by extension services ((Ethiopia Rehima Literature review).

- In 2017, a study was implemented through USAID-SMIL to document 'sorghum varieties and traits preferences for men and women among farmers and consumers'. A paper was prepared to be presented at the sorghum conference in SA. Based on the findings, a consultation meeting is planned with the breeders working on HOPE2 to synthesize the implications of the findings for the sorghum breeding program.

- Plans are in place to initiate technology testing models that work for women farmers adopting new sorghum varieties in 2018

1.1.5. Strengthening Cereal Breeding Capacities of National Partners

- Based on the needs assessment results derived from BPAT that was deployed in 2016, 40 breeders and technicians were trained in BMS, electronic data capture and development of PCNs.

- In 2017, a follow-up on-the-job training was conducted for 10 participants (5 men and 5 women) to enhance the skills of trainees for implementation electronic data capture.

- Data collection and curation of historical data in BMS was done. Trial data (1983-2003) was converted to Excel, checked for consistency in genotype nomenclature, trait description, trial design and location name. By the end of 2017, data analysis was underway to study the genetic advances in the past 30 years.

- Other areas of support that were highlighted from the needs assessment using BPAT in 2016 included variety development, seed multiplication and storage. In response to this inventory assessment, substantial investments have been made from 2016 through 2017 to enhance the rate of genetic gains. These included purchasing a vehicle, fabrication/renovation of the storage facility, upgrading the irrigation facility, procuring computers and hand-held tablets for field data collection, partly supported by the MERCI project. Renovation of the seed store at Melkassa research station is expected to be completed during year 3 of the project. It is also important to note that in addition to infrastructure development, 21 technicians were trained in hybrid seed multiplication and seed management in collaboration with ISC-I.

1.2 Tanzania Sorghum Crop Improvement Program

1.2.1 Developing Superior High Yielding Stress Tolerant Cultivars

- In 2016, sets of 25 sorghum lines sourced from ICRISAT-Nairobi were evaluated each for midge, *Striga*, drought and adaptation sub-humid to sub-humid agroecologies. To validate the results of 2016, these evaluation trials were repeated in 2017.

- The F_1 populations for sorghum smut, midge and *Striga* resistance were generated on-station during this period.

- Fifty populations each for *Striga*, drought and midge resistance sourced from ICRISAT were established in crossing blocks in the screen house and a nursery involving 9 A lines crossed with 15 R lines.

- Further, 12 adapted A lines sourced from ICRISAT were crossed with 20 adapted varieties to identify new R lines and develop new A/B lines. A total of 105 crosses for various traits were made.

- FPVS trials sourced from ICRISAT were conducted in 6 locations and further multi-locational trials are planned for year 3.

1.2.2 Strengthening Seed Production and Delivery Systems for Improved Varieties

- In 2017, 90 kg of sorghum breeder seed (Hakika = 25 kg; Wahi = 20 kg; Tegemeo = 18 kg; Pato = 7 kg; Macia = 10 kg; NACO I = 10 kg) was produced based on a seed roadmap and decentralized production model put in place in 2016.

- To accelerate the production of foundation seed for the project, two seed producers (Agri-seed Tech and Dryland Seed Company) were identified in 2016 for training and accreditation as foundation seed suppliers. These companies are currently producing foundation seed and the quantities produced will be reported in year 3. Meanwhile, they have produced 3.4 tons of certified sorghum seeds.

- In 2016, manuals of production and marketing of QDS were translated into Kiswahili in order to train small-scale farmers, suppliers and other partners in agricultural extension. Printing and distribution of these manuals to stakeholders is underway.

- Thirty QDS producers were trained in production, marketing and group dynamics and 20 agro-dealers and seed retailers were trained on agronomy, benefits and end-user attributes of available seeds and linkages in 2016. In 2017, 2,772 QDS seed producers were trained (1,157 women and 615 men), a significant increase compared to 2016. As a result, 38.125 tons of sorghum QDS seed were produced (Hakika = 23.075 tons; NACO I = 2.4 tons and others = 12.65 tons).

1.2.3 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- Concerted efforts were made to increase technology (seed and fertilizer) awareness among target populations and geographies. This was through conducting rigorous FPVS, demonstrations, field days, seed and agri-fairs/shows, etc. to raise awareness on their availability.

- In 2016, 8 PVS trials were conducted in 10 locations for 7 OPV (ASARECA 24-4-1; CR 35.5; GADAM x IS 8193; IESV 92172 DL; IESV 92174 DL; KARI MTAMA 1; R8602; MACIA) and 7 new hybrid varieties with MACIA as a check (ATX 623 x IESV 91131DL; ATX 623 x MACIA; ICSA 90001 x ICSR 160; ICSA 90001 x ICSR 172; IESH 22009; IESH 22017; IESH 22023; MACIA).

Performance of sorghum varieties in PVS trials across sites in Central Tanzania 2016

Entry name	DAF	Leaf disease score (1-9)	Plant height (cm)	Agronomic score (1-5)	Grain yield(t/ha)
IESV 92172 DL	59	3.0	90.0	3.0	1.367
CR 5:5	61	3.0	129.8	2.5	1.433
GADAM x IS 8193	85	2.5	111.8	2.3	1.667
IESV 92174-DL	55	3.0	121.2	2.8	1.933

R 8602	65	3.5	112.5	2.8	1.350
ASARECA 24-4-1	64	2.5	110.8	2.8	1.983
KARI Mtama	66	2.5	132.0	2.3	2.133
Local variety	100	3.5	182.8	3.5	0.900
Grand Mean	**69**	**2.9**	**123.9**	**2.7**	**1.596**
$LSD_{0.05}$	13.4	0.7188	28.98	0.66	0.4832
SE±	13.37	0.7167	28.9	0.6581	0.4818
CV%	19.5	24.4	21.5	24.3	26.7

Performance of Sorghum hybrids in PHS trial across sites in Central Tanzania 2016

Entry No	Entry name	Plant stand after thinning	Days 50% flowering	Plant height (cm)	Agronomic score (1-5)	Plant stand at harvest	Grain yield (t/ha)
1	IESH 25008	75	69	140.5	3.0	71	1.650
2	IESH 22023	87	69	209.8	2.0	86	1.750
3	IESH 22009	88	68	174.2	2.0	83	2.750
4	IESH 25007	83	68	163.8	2.3	80	2.250
5	IESH 29010	91	66	150.2	1.8	89	2.683
6	ICSA 44X IESV 91104 DL	86	69	187.2	2.5	83	2.333
7	NACO SH 2	85	67	175.5	2.0	81	2.533
8	Local variety	72	116	253.0	3.5	69	1.400
	Grand means	**83**	**74**	**181.8**	**2.4**	**80**	**2.169**
	$LSD_{0.05}$	12.91	2.685	25.03	0.5706	11.85	0.64
	SE±	8.82	1.836	17.11	0.3901	8.1	0.437
	CV%	10.6	2.5	9.4	16.4	10.1	20.2

- Three demonstration trials and 1 field day were conducted in each of the project districts to promote soil fertility management. Also, an agricultural show was held in each project region.
- Three farmer seed producer groups and seed retailers from each district were trained in seed treatment, packaging and use of mini-packs. Building capacity of input suppliers continued throughout 2017 and selling small seed packs alongside small packs of fertilizer was promoted as a practice.
- One kg packs each of Hakika variety were distributed to 1,099 farmers and NACO Tama 1 to 1,008 farmers. In total, the project reached 2,107 farmers with sorghum technologies (improved seeds, soil and water management, microdosing and *Striga* management).
- In 2016, a seed fair was held in each district of the project i.e. a total of 14 seed fairs were conducted. In 2017, 38 sorghum demo trials were successfully conducted in 4 districts (Singida = 12; Iramba = 10; Mkalama = 6 and Ikungi = 10). Besides, an agricultural show was used in each project zone to showcase HOPE II technologies.
- The project reached 1,752 smallholder farmers (842 women and 910 men) with 1 kg seed packs and production information materials in addition to the 2,107 farmers reached in 2016.
- The total number of sorghum seed fairs conducted increased from 14 in 2016 to 17 in 2017. Of the 17 held in 2017, 5 were held during the annual agricultural shows i.e. one in each region (Central, Western, Lake, Southern highlands and Northern). A total of 19,678 farmers (9514 men, 10,164 women) attended the fairs.

1.2.4. Gender Integration into Variety Development, Adoption and Impact

- Two main studies covering farmers' experiences and preferred traits by gender were successfully conducted in Tanzania during 2016. The data collected in 2016 was analyzed during 2017 by national partners with backstopping from ICRISAT economists and a draft report was submitted in 2017 (Trait_preference_incentive_adoption_uptake).
- The study was conducted in six districts in three agro-ecological zones of Tanzania; (1) Central zone: (2) Northern zone: and (3)

Lake Zone. The sites were purposively selected based on production and utilization of sorghum and finger millet technologies with project interventions (HOPEII).

- The report shows that the majority of the household heads are aware of improved technologies such as improved sorghum/finger millet varieties, more efforts are needed to increase the availability and accessibility to smallholder farmers. Access to improved technologies is still limited due to the long distance to seed markets and limited extension services. Therefore, attention should be given to making the technology delivery system more efficient.
- As affordability and willingness to pay are important factors for technology adoption, agricultural development actors should consider creating competitions among input suppliers. Both men and women farmers were willing to pay for improved sorghum and millet seeds albeit at different prices from Tsh 600 to 2000 per kg.
-
- Preliminary results from the report show that men and women have different trait preferences, i.e., while men pay more attention to pre-harvest preferences, women are keener on post-harvest and utilization traits.

1.3 Uganda Sorghum Crop Improvement Program

1.3.1 <u>Developing Superior High Yielding Stress Sorghum Tolerant Cultivars for Uganda</u>

- A set of 226 genotypes of sorghum were sent for GWAS in Nairobi in addition to the 210 accessions sent in 2016.
- A trial with 49 entries from ICRISAT to identify midge-resistant sorghum genotypes was set in 2 midge hot spots and promising resistant genotypes were identified in 2016.
- In 2017, 49 males were crossed with 12 female lines to identify materials with good combining ability for midge and *Striga* resistance. Twenty-three successful crosses were identified and will be advanced in 2017.
- Further, sorghum accessions provided by ICRISAT were evaluated for *Striga* resistance and stay-green trait in eight locations. Two lines were identified from 16 entries provided by ICRISAT and planted in *Striga* hot spots to identify genotypes tolerant to *Striga*. These two successful lines will be evaluated in multilocation trials in 2018.
- Three good combiners were identified for good yield from 7 A lines crossed with 10 R lines for good combining ability for yield and *Striga* resistance.

1.3.2 <u>Strengthening Seed Production and Delivery Systems for Improved Varieties</u>

- While no activity was conducted in 2016, in 2017, the project in Uganda trained 30 trainers of trainers (ToTs) who in turn are training seed producers in the production of high quality foundation seed.
- A total of 1,450 kg of breeder seed was produced for 5 sorghum varieties (SESO1 = 300 kg; SESO3 = 250 kg; NAROSORGH1 = 150 kg; NAROSORGH2 = 400 kg; NAROSORGH3 = 150 kg; NAROSORGH4 = 200 kg).
- A total of 2.4 tons of foundation seed of two sorghum varieties (SESO1 = 1200 kg; SESO3 = 1200 kg) was produced in Uganda.

1.3.3 <u>Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption</u>

- Ten target geographies from the project were identified for testing and promoting promising technologies, and their geo-reference data collected during 2017.
- Twenty demo trials were conducted with 6 sorghum varieties (SESO1, SESO3, NAROSORGH1, NAROSORGH2, NAROSORGH3, and NAROSORGH 4). A total of 750 farmers attended field days on these demo trials (300 women and 450 men).
- Eight sorghum lines were evaluated in NPTs and 4 of them performed better than the local checks and were released as NAROSOGH1, NAROSORGH2, NAROSORGH3, and NAROSORGH4.

1.3.4 Gender integration in Sorghum cropping systems – Uganda

- HOPE2 didn't have objective 4 activities in Uganda, but through mapping of GLDC activities, a postdoctoral fellow was supported to compliment HOPE2 activities on Gender integration in Uganda. The study was conducted among 419 households (48% are women respondents) in North and East Uganda, regions where sorghums and millets are predominantly grown and the report is herewith hyperlinked (Women and Technology Adoption in Uganda).
- Preliminary results show that Sila hybrid variety is very popular among both men and women farmers in Uganda. Sourcing of sorghum seeds from agrovet shops/seed merchants was a popular practice among men and women farmers but higher for men farmers.

*There were farmers who indicated that they never changed their sorghum seed for many years (never introduced new material) but a few reported replacing their sorghum seed every 2 seasons. Further analysis will be focused on production gaps between men and women and key factors that drive the difference.***1.3.5. <u>Strengthening Cereal Breeding Capacities of National Partners</u>**

- From the preliminary information gathered through the BPAT tool in 2016, seed storage facilities and drying floors were identified

for repair and expansion to serve both sorghum and finger millet and work is underway on these facilities.

- Besides building capacity in infrastructure, the project has also targeted activities in improving the soft skills of NARS. To this end, trainings on BMS were successfully conducted in 2016. In 2017, two students (1 PhD and 1 MSc) were identified and enrolled for crop breeding.

- Two short courses were offered to technicians in Uganda. The one on data management using BMS was offered to 3 technicians in Nairobi. The one on sorghum and finger millet field breeding techniques, including making crosses, hybrids and hybrid parents development, trial layout and designs, barcoding in nurseries and trials, data management and design of trials was offered to 4 technicians at Kiboko-Kenya for two weeks.

2. Finger millet in Eastern and Southern Africa

2.0 Overview of ICRISAT Finger Millet Backstopping Progress

- By the end of 2016, all ICRISAT cereal breeding programs in sub-Saharan Africa had developed a modernization plan and were in the process of implementation, including adoption of BMS, electronic data capture and alignment with PCNs. A 5-day training on BMS and digital data collection was conducted for 6 technicians from the sorghum and millets breeding programs of, Ethiopia, Tanzania, and Uganda.

- During 2017, refresher training was conducted on electronic data capture, using KSU FieldBook and creating and advancing nurseries for 8 NARS technicians (Ethiopia = 4;; Uganda = 4).

- ICRISAT Kenya is leading GWAS to map genomic regions responsible for desirable agronomic traits.

- Finger millet samples were received from Uganda (200) and Ethiopia (208) for genotyping on the DArT sequencing platform under IGSS and the analysis is underway.

- ICRISAT also took the lead in assessing materials with superior mineral content with selected varieties being planted at ICRISAT-Kiboko station and fresh grain samples from these trials were submitted for analysis at Kenya Analytic labs using XRF technic during 2016. Varieties high in Ca, Fe and Zn were selected and established in different agroecologies in Tanzania and Uganda to evaluate nutrient stability in 2017.

- ICRISAT shared with the NARS programs of Ethiopia, Tanzania and Uganda experimental nurseries for evaluation (Table 13). During 2017, ICRISAT also produced seed for materials to be shared with Tanzania for the second season, Uganda the first season 2018 and Ethiopia for the year 2018.

- More than 500 crosses were made and F_1 populations were developed using several parents (Table 14). These F_1s were re-planted to identify true F_1s and for advancement to F_2 during year 3 of the project.

- At Kiboko and Alupe stations, ICRISAT continues to advance populations for traits of interest (blast, *Striga*, nutrient content, snapping trait and general yield). More than 1200 F_2 lines, 3616 F_3 lines, 2224 F_4, 398 lines at PYT, 250 lines at advanced and uniform yield trials were evaluated and advanced during 2017 in ESA (Table 15).

- Eighty one entries for PYT blast trials, 25 entries for advanced blast trials and 25 advanced yield trials were shared with NaSARRI by ICRISAT for further evaluation in Uganda.

- ICRISAT produced more than 100 kg of breeder seed and 5 tons of foundation seed in 2016. In 2017, it increased its breeder seed production of finger millet by more than four-folds to 410.4 kg for a number of varieties that were released, to be submitted to NPT and at advanced stages of evaluation (Table 16). The production of breeder seed was conducted at Kiboko and Alupe research stations for Tanzania and Uganda NARS.

2.1 Ethiopia Finger Millet Crop Improvement Program Outputs

2.1.1 Developing Superior High Yielding Stress Tolerant Cultivars

- In addition to 200 accessions sent to BecA for genotyping in 2016, 208 Ethiopian finger millet genotypes (Table 17) representing dry lowland areas of Ethiopia were sent in 2017.

- The same genotypes were planted using irrigation in the off-season nursery of 2017 at Werer Research Center for phenotyping response to terminal drought stress and the trial is underway.

- The tissues of finger millet genotypes representing dry lowland areas were collected from Ethiopian Biodiversity Institute and sent to BecA for genotyping by sequencing, which is also underway.

- Thirty eight (38) F_4 (Table 18) and 136 F_5 progeny were selected based on their reaction to blast and agronomic desirability at Bako and Adet research stations, respectively. The progenies were purified, and seed increased for preliminary variety evaluation in 2017

- During 2016, 40 progenies at F_6 stage (Table 19) from ICRISAT were purified and evaluated at Arsi Negele and Bako research stations.

- In 2017, 30 promising lines (Table 20) were selected from the 40 evaluated in 2016 based on their agronomic desirability for further evaluation along with the check and other varieties (Table 21) selected from the regions.
- Seven released finger millet varieties (Tadesse, Tesema, Axum, Meba, Gute, Necho and Mereb1) were selected for nutritional and grain quality analyses. These 7 varieties are to be tested for quality of different end user trait preferences during year 3 of the project (2018).
- In 2016, variety trials were conducted to evaluate grain yield and reaction to blast in 28 finger millet genotypes (Table 22) introduced from ICRISAT (Meba and Addis1 as checks) at Arsi Negele and Bako. A second set containing 101 finger millet genotypes (Table 23) introduced from ICRISAT were evaluated at Arsi Negele. Two regional (Oromia) trials at Bako identified accession numbers BKFM0063, BKFM0005, BKFM0007 (red), BKFM0020, BKFM0006, and BKFM0010 (black) as promising varieties. Two sets of finger millet variety trials (brown & black type) were conducted in 2016 in three different locations by Bako Research Center.
- Three promising varieties (accession numbers BKFM0063, BKFM0007, and BKFM0005) that performed better than the checks were selected and proposed for variety verification (VVT) in 2017. The second set of regional variety trials (RVT) consisted of accessions obtained from different sources and they were grown at Bako and Gute.
- The black seeded finger millet variety trial consisted of 12 genotypes along with Degu as standard check. Three promising genotypes (BKFM0020, BKFM0006, and BKFM0010) were selected and advanced for VVT to be evaluated.
- In 2017, a total of 55 finger millet genotypes (Table 24) were selected from ICRISAT breeding lines and landraces and then evaluated at Bako and Arsi Negele. The genotypes performed better than the standard check. This trial will be repeated for one season in six locations during year 3 of the project (selected lines from different trials in 2016 will be included).

2.1.2 Strengthening Seed Production and Delivery Systems for Improved Varieties

- To address the supply/demand gap, a total of 0.191 tons of finger millet breeder seed of 3 varieties (Tesema, Axum, and Meba) was produced in 2017 (Table 25) in addition to 0.525 tons of 8 varieties (Boneya, Wama, Gute, Gudatu, Bereda, Addis1, Urji, and Diga-1) produced in 2016 (Table 26).
- A total of 9 tons of foundation seed of 7 finger millet varieties were produced in year 2 (Table 27) in addition to 1.55 tons of 5 finger millet varieties (Mereb-1, Tesema, Tadesse, Meba, and Axum) produced in 2016 (Table 28).
- In 2017, technical support was provided to private and community-based seed growers. A total of 7 tons of finger millet certified seed of two varieties (Gute = 4 tons and Gudatu = 3 tons) was produced and this will be considered for scaling up in year 3.
- Beside growers, a total of 21 technicians were trained on hybrid seed multiplication and seed management.
- Through a stakeholders consultative meeting, the amount of seed required to increase adoption of improved finger millet varieties by 15% in the next three years was estimated (Table 29).

2.1.3 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- In 2016, Bako research station released one high-yielding and blast-tolerant finger millet variety (accession number 214995 (Bako-09). During 2017, a total of three finger millet varieties (accession numbers BKFM0020, BKFM0006, and BKFM0010 with Diga-1 as a check) were evaluated in three variety verification trials (Bako, Gute, and Diga Research sub-stations) and 6 on-farm plots, 2 under each station. These varieties will be released in 2018.
- Field days for released varieties were organized in 2016 with 5,040 farmers attending (3,724 men and 1,316 women), among whom were 46 development agents, 125 decision makers, district experts and members of cooperatives in the Tigray region. The varieties included in these field days were Dekeba and Melkam. Other field days were held in North Wello (71 men and 12 women) and Eastern Hararghe (42 men and 7 women). In addition, a total of 99 district experts and development agents from Amhara region were trained in finger millet production, management and uses.
- In 2017, a national field day involving policy makers, researchers, farmers and relevant stakeholders was conducted in Oromia region, where a total of 305 participants attended (Table 30).
- In West Wellega of the Oromia region, two finger millet varieties (Gudatu and Addis1) were identified in a PVS involving 33 male farmers and 10 female farmers in 2016 for scaling up in 2017. Gudatu has proved to be a favorite in 2017.
- Farmers in 4 districts of the Amhara region identified Necho and Tesema for scaling out in 2017. To reach more farmers with improved finger millet technologies, a total of 3 tons of finger millet seed of three varieties (Bareda = 1.25 ton; Mecha = 0.75 tones; and Nech = 1.0 ton) were distributed to 383 men and 17 women farmers in small packs in 8 districts in Amhara region.
- Three innovation platforms were established at the regional level to create awareness and promote new improved finger millet varieties.
- Targeted areas for scaling up finger millet activities were identified and the amount of seed required to reach 4800 target was estimated. .
- About 1.7 tons of finger millet seed was distributed to 722 farmers in Oromia and Tigray regions, which is 15% of the target for the crop season. In year 3, the plan will consider the number of farmers not reached in 2017 (Table 31).
- Training was also given to 1,105 men and 363 women farmers, development agents, experts from the bureau of agriculture on

improved finger millet production, the concept of hybrid production and extension approach (Table 32).

2.1.5. Strengthening Cereal Breeding Capacities of National Partners

- Based on the needs assessment results derived from BPAT, 40 researchers (4 women breeders, 32 men breeders and 4 men technicians) were trained in electronic data capturing, improved statistical designs and analysis methods, use of NIR for grain quality, crop modelling, trial design, and managing breeding trial data using Excel and spatial data analysis.
- In 2017, on-the-job training was conducted following the implementation of electronic data capturing that had been conducted in 2016. A total of two trainees participated (a male researcher and a female technician).
- Further, the BPAT assessment conducted in 2016 identified the soft skills areas as well as NARS infrastructure that needed development. Capacities of collaborating research centers were assessed in 2016 to prioritize investments to support variety development, seed multiplication and storage.
- The BPAT assessment of 2016 identified the following available equipment: 4 electronic weighing scales, 8 tablets for data collection, 4 barcode readers, 3 cold rooms, and 1 *Striga* field screening facility. Areas of support identified from the BPAT included support for variety development, seed multiplication and storage. Program improvement activities included the purchase of a vehicle, fabrication/renovation of the seed storage facility, upgrading the irrigation facility, and procurement of computers and hand-held tablets for field data collection.
- Renovation of the seed preparation and storage room at Melkassa and the cold room at Assosa are underway.

2.2 Tanzania Finger Millet Crop Improvement Program Outputs

- **2.2.1 Developing Superior High Yielding Stress Tolerant Cultivars**
- In 2017, 6 kits of regional trials shared by ICRISAT were evaluated at different sites. Short duration kit for low altitude low rainfall of 25 entries was evaluated at Miwaleni, Mpambaa and Hombolo.
- All the entries out yielded and had shorter maturity period than the local check. This was a repeat of 2016 trial to confirm results and promising entries advanced to the regional trial.
- Thirty (30) drought tolerant lines of 30 entries were evaluated at Miwaleni, Mpambaa and Hombolo. Five (5) varieties (IE 2323, IE 712, IE 563, IE 48 and IE 633) were selected for advancement to onfarm during the 2018 season
- Twenty five medium duration lines were evaluated at Ukiruguru, Miwaleni and Mpambaa for the second season, and 6 lines (Emorumoru, GBK 000597A, GBK 027189, IE 2872, Etio-Brown and IE 4121) selected for advancement to PVS
- Blast screening trial was conducted at Ukiruguru for the first time and this will be repeated in 2018 to confirm the results
- Twenty-five (25) lines were evaluated in advanced yield trials at Miwaleni and Mpambaa and selected lines will be advanced to regional trial
- Thirty (30) lines were evaluated for high nutrient content stability in three sites and 5 high yielding and stable genotypes (IE 510, IE 3738, IE 6993, IE 4350 and IE 4491) were selected for advancement to on-farm trials in 2018.

2.2.2 Strengthening Seed Production and Delivery Systems for Improved Varieties

- In 2017, 174 kgs of breeder seed of released and promising varieties were produced at Miwaleni. These included KNE 814 (25 kg), U15 (60 kg), P224 (30 kg), ACC 32 (18 kg), KNE 688 (11 kg), UFM 149 (5 kg), KNE 628 (25 kg).
- A total of 9.98 tons of QDS seed was produced by farmer groups, who are mainly women for sale in the project areas in 2018. Foundation seed was mainly sourced at ICRISAT-Nairobi, where 0.6 tons of U15 and P224 was availed; this was distributed in 1 kg packs for promotion. In 2016, manuals of production and marketing of quality declared seed (QDS) were translated into Kiswahili in order to train small-scale farmers, suppliers and other partners in agricultural extension.

2.2.3 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- Ten (10) varieties were evaluated at PVS in 45 sites in the northern and central Tanzania. Four (4) varieties (Acc 32, KNE 628, KNE 628 and UFM 149) were selected for submission to NPT in 2018. Apart from high yield and farmer preferred traits KNE has high Fe content.
- Management options, (micro-dosing and use of tie ridges) were demonstrated at 30 sites and improved the yield by an average of 17.8% and 14.8% respectively.
- Released varieties U15 and P224 were promoted on farmer schools and demonstration plots in areas not previously reached by

the project

2.2.4. Gender Integration into Variety Development, Adoption and Impact

- Two main studies covering farmers' experience and preferred traits by disaggregated by sex were successfully conducted in Tanzania in 2016 for both finger millet and sorghum. The data collected in 2016 was analyzed during 2017 by national partners with backstopping from ICRISAT economists and the report is currently being finalized.
- Preliminary results from the report show that men and women have different trait preferences i.e. while men pay more attention to pre-harvest preferences, women on the other hand are keener on post-harvest and utilization traits.
- As few districts were done for finger millet it was agreed that another survey be done in 2018 to cover more finger millet growing areas

2.2.5. Strengthening Cereal Breeding Capacities of National Partners

- Two technicians attended a course on data management using BMS at ICRISAT-Kiboko; Training was conducted on finger millet field breeding techniques, trial layout and designs, barcoding in nurseries and trials, data management and design of trials
-

2.3 Uganda Finger Millet Crop Improvement Program Outputs

- This report highlights the activities done in 2017, where emphasis was on capacity building and release of improved varieties that were at an advanced stage in the finger millet breeding pipeline. The Uganda team implements Objective 1, 2 and 5 because it was not a tier 1 country.

2.3.1 Developing Superior High Yielding Stress Tolerant Cultivars

- In collaboration with the PEARL project, molecular characterization of diverse isolates of blast pathogen was done at BecA on 75 finger millet samples in 2016. The results will enhance accuracy in screening the isolates for pathogenicity and finger millet genotypes for blast resistance.
- In 2017, a total of 200 finger millet samples were received from Uganda for genotyping. Sequencing of the samples is underway at BecA-ILRI on DART-seq platform.
- Field screening of finger millet for blast resistance was conducted using elite and advanced lines during 2016. The best 10 lines (FMS-376, Entry 53, Entry 52, Entry 2, Entry 41, Entry 37, Entry 23, IE2440, Entry 64, and Entry 71) from this selection were recommended for advanced yield trials as well as used as parents for blast resistance in 2017.
- A total of 25 finger millet genotypes with *Striga* resistance and tolerance backgrounds were evaluated on-farm in Striga hot spots. The results showed that 10 genotypes (FMS-376, Entries 53, 52, 2, 41, 37, 23, 64 and 71 and IE2440) out of the 25, were superior to the local check.
- In 2017, 10 variety testing sites for adaptation to different agroecologies were identified and their geo-reference data using GPS was collected.

2.3.2 Strengthening Seed Production and Delivery Systems for Improved Varieties

- In 2017, a total of 119 kg of breeder seed of newly released finger millet varieties were produced (PESE1 = 11.25 kg; SEREMI1 = 15 kg; SEREMI2 = 20 kg; SEREMI3 = 12 kg; NAROMIL1 = 11 kg; NAROMIL2 = 12 kg; NAROMIL3 = 10 kg; NAROMIL4 = 15 kg; and NAROMIL5 = 13 kg).
- Similarly, a total of 173 kg of foundation seed was produced (PESE1 = 20 kg; SEREMI1 = 11.5 kg; SEREMI2 = 31.50 kg; SEREMI3 = 90 kg; and NAROMIL2 = 20 kg).

2.3.3 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- Twenty demo trials were conducted in which 9 finger millet varieties (SEREMI1, SEREMI2, SEREMI3, PESE1, NAROMIL1, NAROMIL2, NAROMIL3, NAROMIL4, and NAROMIL5) were involved. There were 750 stakeholders attending the field days on the demos (300 women and 450 men).
- Besides the demos, 7 finger millet lines were evaluated in 10 NPT trial sites (4 *Striga* hot spot sites and 6 for drought adaptability), 5 of which were released as new varieties (NAROMIL1, NAROMIL2, NAROMIL3, NAROMIL4, and NAROMIL5).

2.3.5. Strengthening Cereal Breeding Capacities of National Partners

- Capacity strengthening efforts reported for sorghum apply here too.

3.0 Sorghum in West and Central Africa (WCA)

3.0 Overview of ICRISAT Sorghum Backstopping Progress in WCA

- ICRISAT Mali assembled BCNAM-Lata populations developed from 2009 to 2012 and evaluated them in two contrasting environments (high and low P) for grain yield, plant height, heading, panicle and grain traits. Genotyping by sequencing (GBS) was done. With the combined phenotypic and genotypic data for 1083 BC_1F_4, BCNAM-Lata populations of 13 different donors were made available.
- ICRISAT Nairobi received 1,622 accessions, out of which DNA was extracted from 1427 and sent to BecA for genotyping. A summary of all sorghum accessions received from WCA for genotyping is summarized in Table 33. A duplicate of all accessions was kept at ICRISAT Mali and Nigeria for seed multiplication and phenotyping. The genotypic data will be combined with genotypic results for GWAS analysis.
- Three hundred and twenty duplicate sorghum accessions received by ICRISAT Mali from NARES breeding program (217 Mali and 103 Burkina Faso) were evaluated for anthracnose, *Striga*, and grain quality characterization (heading and grain yield). The preliminary results indicated that out of the 320 accessions, 38 were resistant to *Striga* and this screening will be repeated in year 3 to confirm resistance.
- Four hundred and ten Nigerian sorghum landraces from 2014 and 2015 germplasm collections were evaluated for agronomic data. Yield data, reactions to smut diseases and stem borer, and grain quality characteristics (colour and size) were collected (Table 34).
- Twelve Elite lines and 14 donor parents were planted during the 2016 off-season for the development of drought, *Striga*, and midge resistant populations. Seventeen F_1 *Striga*-, 7 F_1 midge-resistant, and 9 F_1 drought-tolerant populations were generated. These populations were advanced to F_2 in 2017 and will be shared with NARS as training populations for QTL identification.
- One hundred and eighty promising lines with P use efficiency from progenies BCNAM-Lata Advanced Trial were crossed with two P donors (Sc566 and DouaG) to generate 180 promising lines with P use efficiency. These will be shared with NARES for testing by partners.
- One hundred and ten progenies from BCNAM-Lata Advanced Trial were crossed with one midge donor (IS15401) to generate 110 fixed lines with midge resistance. These are available for testing by NARES.
- Nine donors for P use efficiency were backcrossed to the recurrent parent CMS63E to generate 9 BC_1F_1. The F_1s generated were advanced to BC_1F_2 at Cinzana resulting in 1112 BC_1F_2 BCNAM-CSM63E drought-tolerant populations.
- Thirty females were crossed with 15 male parents from BCNAM-Lata to produce 158 hybrids which were tested for combining ability. Data was collected on grain yield, plant height, and grain quality. Data analysis is underway.
- Forty seven new hybrids were evaluated for grain yield, plant height, and grain quality in a regional trial at seven locations (IER (2 locations), ICRISAT/Samanko (3) Nigeria (1), and INERA (1). Preliminary results showed that grain yield varied from 1423 kg/ha to 2907 kg/ha across the locations.
- Forty five promising lines were characterized for fodder and grain quality traits (grain yield, fodder yield and quality, grain quality) to identify dual-purpose sorghum varieties.
- The logistics of transferring popular varieties identified in 2016 (SAMSORG 14, SAMSORG 40, SAMSORG 44, and CF35:5) to ICRISAT Mali for the development of NAM and training populations in 2017 is underway.
- Multilocation evaluation for 36 dual-purpose sorghum lines (Table 35) was conducted at Samaru, Dadinkowa, Sokoto and BUK experimental farms based on high brix content, high grain yield and quality fodder. Preliminary analysis of the data showed significant environmental variability among the genotypes.
- As part of the implementation of the modernization plan developed in 2016, a meeting was convened in 2017 at Bamako between ICRISAT WCA scientists from Mali, Niger and Nigeria and Dr. Yilma Kebede, BPAT consultant, to review the progress made and also provide the support required to develop product concept notes. Four product concepts - Sorghum Nigeria were developed (Table 36). Further, Dr. Kebede assessed all cereals programs in Mali and Burkina Faso using questionnaires (Mali_sorghum; Mali_millet; BF_sorghum; BF_millet). Although his final report is underway, he has already put together a trip report (Kebede_trip_report).
- In addition to the trainings held in 2016, ICRISAT organized three trainings to equip the NARES with the skills to collect and evaluate trial data using modern tools of the IBP platform.
- A training on the use of modern tools (BMS, ODK, and tablet) of the IBP-Breeding Management System was attended by 11 scientists and technicians (10 from IER and 1 from INERA).
- A training on electronic data capturing and germplasm migration to BMS was conducted by Dr. Abhishek Rathore, attended by two IAR technicians.
- A training was conducted to operationalize and institutionalize BMS. A technician and ICRISAT Nigeria country representative attended.
- ICRISAT offered a two-week training to a newly hired young breeder, Dr Nofou Ouedraogo, from INERA on crossing and hybrid breeding techniques.

3.1 Nigeria Sorghum Crop Improvement Program Outputs

3.1.1 Developing Superior High Yielding Stress Tolerant Market-Preferred Sorghum Cultivars

- In 2017, IAR sent 160 sorghum accessions (Table 37) in addition to 250 accessions (Table 34) sent in 2016 to Nairobi for GWAS analysis.
- In 2016, IAR evaluated 100 *Striga*-resistant/tolerant lines (Table 38) received from ICRISAT India (4), ICRISAT Nairobi (4), Sudan

(50), Ethiopia (3), IAR/ABU (39) at the IAR *Striga* sick plot and a hot spot of *Striga* infestation at BirininKudu. 6 BC_3F_5 progenies of crosses with N13 were observed to be tolerant to *Striga* infestation. The 6 BC_3F_5 lines that had been identified in 2016 to be resistant together with two additional sources (FRAMIDA and HAKIKA) received from Nairobi were crossed with 7 farmer preferred cultivars to generate 102 F_1s (Table 39). These F_1s were planted during the 2017 rainy season to generate 111 F_2s. The F_2s generated will be advanced to F_3 during the 2017/2018 off season.

- A re-evaluation of the 100 *Striga*-resistant lines with addition of 15 lines (Table 40) from IAR/ABU was done at the IAR *Striga* sick plot and a hot spot of *Striga* infestation at BirininKudu (Jigawa State). Data analysis is underway.
- In 2016, 32 sorghum lines (Table 41) from ICRISAT-Nairobi and 8 local selections were evaluated at the IAR, Zaria experimental farm and BUK Kano for bold grain trait and color as farmer preferred traits and 20 lines were selected for further evaluation. The 20 lines were re-evaluated at three locations: Zaria, BUK and Dadinkowa experimental stations. 5 lines (KL2, IS15127, IESV 92147DL, IESV 99088, and IESV 91012 DL) were selected for inclusion in MLTs in year 3.

3.1.2 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- Six field days were conducted in three localities where 178 farmers attended desegregated into 113 men and 65 women. None was conducted in 2016.
- In 2016, three MLTs were conducted for three sorghum maturity pools in the 2016 rainy season: 10 early-maturity lines, 20 medium-maturity lines and 10 late-maturity lines (Appendix 1). Close to the end of the season, 1 FPVS was conducted where farmers selected five early-maturing lines: Gadam, Lata//Ribdahu//BC1-3-1-1-V, Lata//Ribdahu//BC1-1-17-1-V, Macia and NR71151. In 2017, 4 MLTs were conducted; 2 were a repeat of the entries with an increase in the number of multi-locational sites (from 2 to 4 sites for early maturity and 3 to 6 sites for medium maturity).
    - Early - 10 entries at Kano, Minjibir, Kadawa, Ikara and Sokoto (Table 42)
    - Medium - 20 entries at Saria, Kano, Danja, Tsafe, Dadin Kowa and Kadawa (Table 43)
    - Hybrid -16 lines at Minjibir, Samaru, and Dadinkowa (Table 44)
    - Short and dwarf 15 lines at Minjibir, Samaru, and Sokoto.
- From the evaluation, 4 early-maturing (CF35-5, NR71151, Macia and KL-1) and 4 medium-maturing (ZaunaInuwa, Kaura Borno, Fara Bauchi and Dalwanda) lines were selected and advanced to on-farm trials which were conducted in 10 locations each. From on-farm trials' results, 2 medium-maturing (ZaunaInuwa and Kaura Borno) and 1 early-maturing (CF35-5) lines were proposed for release.
- In year 1, 3500 mini seed packs of two sorghum varieties (CF35-5 and SAMSORG 40) were distributed to farmers across the 4 states (875 small seed packs per state). In year 2, 299 kg of SAMSORG 40 were distributed to farmers in 1 kg mini seed packs in 9 locations of 3 states.
- In 2016, 1,000 sorghum Integrated Soil Fertility Management (ISSFM) trial kits were distributed across the four states (Kano, Jigawa, Sokoto, and Kebbi). Sorghum variety CF35-5 gave higher grain yield at all the locations and lower *Striga* populations in ISSFM compared to farmer-managed plots. In 2017, 500 ISSFM kits of SAMSORG 40 and CF35-5 (300 of SAMSORG 40, 200 of CF35-5) were distributed to farmers in three states for demonstration to serve as incentives for adoption of the technology.

3.1.3 Strengthening Seed Production and Delivery Systems for Improved Varieties

- In year 2, 10 tons of certified seed of two sorghum varieties [SAMSORG 45 (5 tons) and SAMSORG 46 (5 tons)] released in 2016 for production in the Sudan and Sahel ecologies were produced. The new varieties have bold and white grains preferred by farmers and markets.

3.1.4 Gender Integration into Variety Development, Adoption and Impact

- The decision to use varieties CF35-5 and SAMSORG 40 for demonstration trials was informed by the focused group discussions (FDGs) in the 4 states (Kano, Jigawa, Kebbi, and Sokoto) where 80% of the farmers preferred them due to earliness in maturity and bold grains.

3.1.5 Strengthening Cereal Breeding Capacities of National Partners

- Preliminary BPAT assessment identified the following biggest needs of the sorghum improvement program of Nigeria: (i) a vehicle to support the development work as well as project coordination; (ii) a water pump, irrigation pipes and related accessories to facilitate off-season seed production; (iii) and farms for seed production. The purchase of all the items was facilitated in 2017.
- IAR is now able to undertake off-season generation advancement as a result of the water pump, irrigation pipes and related accessories that were installed.
- Two technicians from the sorghum team were trained in 2016 and 3 in 2017. Now digital data capture and the use of BMS for field planning and data management have been institutionalized.

3.2 Mali Sorghum Crop Improvement Program Outputs

3.2.1 Developing Superior High Yielding Stress Tolerant Market-Preferred Cultivars

- A set of 320 accessions of sorghum were sent to ICRISAT-Nairobi for genotyping in addition to the 217 accessions sent in 2016 and a duplicate to ICRISAT Mali for phenotyping. DNA has been extracted from 260 accessions and genotyping is underway at BecA.
- The 320 accessions sent in 2017 were evaluated for *Striga* and anthracnose. Preliminary results showed that 248 were resistant to leaf anthracnose. A validation trial is planned for 2018.
- Ten high-yielding sorghum ecotypes were selected from 2016 evaluation of 355 ecotypes on the basis of grain yields, days to 50% flowering and plant height; the 10 will be used in new crossing schemes.

- In 2016, 5 best varieties (Seguifa, Tiandougou-coura, Grinkan, Djakumbe, and CSM-388) preferred by farmers were crossed with four donors: Kenikeni Diema (anthracnose resistant), M-84-7 (head bug resistant), Latta (phosphorus efficient) and Ethiopie 55 (*Striga* tolerant) to generate 11 F_1s which were advanced to F_2 in the off-season. In 2017, two evaluation trials were conducted using these F_2 populations.
- Five F_2 anthracnose populations (Grinkan/Kenikeni, Kenikeni/Grinkan, Axtell4/Kenikeni, Tiandougoucoura/Kenikeni and Kenikeni/Tiandougoucoura) with 2 checks, SURENO (resistant) and IRAT204 (susceptible) were planted at Sotuba and evaluated for yield, anthracnose and dual-purpose criteria. Among 1,427 dual-purpose plants, 290 plants were resistant to anthracnose. The F_2 plants harvested F_3 (all panicles) were sown in the off-season to produce F_4 seeds that will be evaluated in the rainy season of 2018.
- Three F_2 head bug populations: M84-7/AXTELL-4, F2-78/M84-7, and M84-7/Tiandougoucoura along with 2 checks [Malisor 84-7 (resistant) and F34 (susceptible)] were planted at Sotuba in August for proper timing of high pressure head bugs. Among the 441 individuals, 347 plants were resistant to the head bug. The F_2 plants harvested (all panicles) were sown in the off-season to produce F_4 seeds that will be evaluated in the rainy season of 2018.
- In 2016, a total of 421 new F_1 hybrids obtained from HOPE I were evaluated for fertility reaction. A total of 389 lines showed good restorer reaction (R lines) whereas 2 lines were B (sterility maintainer). The 2 sterility maintainer lines identified were sterilized using A/B pairs. The trial was repeated in 2017 with 275 new hybrids. One hundred and seventy five lines showed good restorer reaction (R lines) but 2 lines were B lines and are being sterilized by A/B pair backcrossing.

3.2.2 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- In 2016, 102 BC_1F_6 progenies were compared to 3 recurrent parents (Grinkan, Seguifa, and Tiandougou-coura) in an agronomic evaluation at Sotuba and 20 best progenies (with 8-51% better yield; 20 and 31% digestibility index over the recurrent parents) were selected. The trial was repeated in 2017 with a set of 22 progenies BC_1F_6 with high digestibility (over 18%) which were compared with 2 recurrent parents (Grinkan and Tiandougou-coura) at two sites (Kolombada and Sotuba). The best lines (016-BE-BC1-F5-CT-1043; 393 g/m^2 and 016-TST-KAFARA-108 CT; 382 g/m^2) will be evaluated on-farm in the rainy season of 2018/2019.

Two evaluations were conducted for (i) grain yield and (ii) amino acids and minerals content.

  - Forty seven new hybrids (Table 5) were compared with one best variety and 6 hybrids for phenotypic and agronomic evaluation at 3 sites (Sotuba, Kolombada, and Farako). Hybrid trials showed significant difference between hybrids and checks for grain yield at Kolombada and N'Tarla. At Sotuba, the best yielding hybrids were ICSX 1765593:H (443 g/m^2), ICSX 1765598:H (346 g/m^2), and ICSX 1765038:H (348 g/m^2). At Kolombada, the best yielding hybrids were ICSX 1765685:H (436 g/m^2) and ICSX 17651236:H (430 g/m^2). Two hybrids (ICSX 1765593:H (22%) and ICSX 1765685:H (13%) showed grain yields superior to the check in all locations.
  - Thirty BC_1F_6 lines were compared with 5 improved released varieties (Seguifa, Tiandougou-coura, Grinkan, Darrelken and Djakumbe) at PROSLABS for their amino acid and minerals content. There was a significant difference between varieties for lysine. Two lines, BC_1F_6-1105 (6.82) and BC_1F_6-1090 (6.16), recorded the highest levels of lysine compared to the best check Darrelken (3.98). The average threonine content is 2.25 mg. Line BC_1F_6-1090 obtained the highest level of 7.06 mg. The iron content varied from 1.99 to 5.53 mg. The highest iron content was observed with line BC_1F_6-1068 (5.53 mg). The highest Zn content was observed with line BC_1F_6-1022 (3.721 mg).

3.2.3 Strengthening Seed Production and Delivery Systems for Improved Varieties

- In 2017, the program produced a total of 188 kg of breeder seeds (Table 45) from 10 varieties in addition to the 70 kg produced from seven varieties in 2016.
- Seven sub-contracts were signed with AOPP, EUCORD, USCPMD, COOPROSEM, SOPROSA, AMASSA, and NIETA. These led to an increase in the production and distribution of certified seed from 9.5 tons to 57 tons of 4 varieties, and the number of field days increased from 1 to 10.
- In 2017, 23 seed producers, 8 extension agents and 3 NGO agents (EUCORD) were trained on hybrid and OPV seed production in addition to the training of 42 seed producers and extension agents in 2016, which together equipped the partners and resulted in increased seed production.

3.2.4 Integration into Variety Development, Adoption and Impact

- An impact survey was undertaken using a gender-based questionnaire developed in the Gender Integration workshop held in Nairobi in 2016. Six hundred respondents (416 farmers from 31 project area villages and 200 farmers in 24 villages in the control area) were interviewed. Data analysis is underway.

3.2.5 Strengthening Cereal Breeding Capacities of National Partners

- Nine technicians were trained in BMS in addition to the 4 trained in 2016 by ICRISAT. This has enabled operationalization and institutionalization of digital data capture in the field and use of BMS.
- Five tablets were purchased and given to the technicians for data collection. This has enabled digital data collection at three sites on 8 yield trials' analysis using BMS.
- In response to a rapid appraisal done by the ECOFIL program of IER where irrigation was the most urgent need, a solar pump 'PS1800 by Sonikakara Solar Electro' was obtained and as a result off-season planting has been made possible.

3.3 Burkina Faso Sorghum Crop Improvement Program Outputs

3.3.1 Developing Superior High Yielding Stress Tolerant Market-Preferred Cultivars

- In 2017, 103 accessions out of the 104 assembled in 2016 were successfully sent to ICRISAT-Kenya for genomic analysis.

Duplicate accessions were sent to ICRISAT-Mali for phenotyping.

- Two anthracnose donors from ICRISAT were introduced to develop NAM populations.
- Six *Striga* donors were also introduced from ICRISAT and CIRAD for crossing with *Striga*-resistant common parent. The introgression will be conducted in 2018.
- Thirty crosses involving new parents have been planted to develop new hybrids.
- 49 BCNAM lines identified from 99 BCNAM lines evaluated for cytoplasmic reaction in 2016 were evaluated again in 2017 and 4 lines selected to be used for the development of new hybrids.
- In 2016, the program undertook two MLT evaluations using 47 lines.
    - The 1st trial was conducted with 32 lines at Kera, Lekuy and on-station at Saria. Grain yields varied between 1,083 kg/ha and 2870 kg/ha. Nineteen lines produced between 3% and 63% more grain than the local check (1,760 kg). The same trial was assessed by 15 farmers (7 men and 8 women) at Kera and two farmer-preferred lines were selected (BM_Ta17-1, BM_Ta17, BM_Sar32, BM_Sar7-1 and BM_Ta18).
    - The 2nd trial was conducted with 15 lines at Zikiémé and Guinsa, Ademtenda and on-station at Saria. Grain yields were very low at Ademtenga (315-1430 kg/ha) but on-station and at Zikiémé, grain yields varied between 1536 kg/ha and 2780 kg/ha.
- In 2017, the project increased the number of evaluations from two that were done in 2016 to five.
    - Two on-station trials were conducted using 20 early-maturing lines and 13 medium-maturing lines. In the first trial, yield ranged from 1780 kg/ha to 3900 kg/ha and in the second trial it ranged from 975 kg/ha to 3425 kg/ha. A total of 15 lines with yields greater than 2.8 t/ha will be proposed for catalogue listing in 2018.
    - Thirteen advanced lines were evaluated to confirm agronomic performance and grain acceptability and 7 lines were selected for their adaptability, grain yield and forage value.
    - Eighteen lines were screened for *Striga* resistance in a hot spot and selected lines proposed for NPT and DUS.
    - Six intermediate cycle lines from North Central region were evaluated for adaptability in two villages and like North Center region, these lines showed a long cycle with average yield levels.

3.3.2 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- Twenty-seven lines in preliminary and advanced trials were put in on-farm trials covering 5 villages in BM and involving 10 farmers (5 men and 5 women).
- Eighteen varieties identified from PVS in 2016 were multiplied and submitted for DUS analysis during 2017 in Burkina Faso.
- In 2017, the number of sorghum demos conducted increased tremendously to 226 from just 19 in 2016. These demos involved 16 sorghum varieties (Sariaso 11, Sariaso 14, Sariaso 15, Sariaso 16, Sariaso 18, Sariaso 20, Sariaso 21, Sariaso 22, Kourbouli, Rouko, Bèma, Pisnou, Kapèlga, CSM63-E, ICSV 1049, and Flagnon). However, only 13 female farmers (representing a mere 6%) hosted these demos.
- Generally, all the varieties in the tests were well appreciated for their productivity advantage. Sariaso 16, almost as early as Sariaso 15, particularly attracted the attention of visitors in guided tours, for its productivity and tolerance to drought.
- Four seed fairs were organized at Kaya, Boussouma, Ouahigouya and INERA/Ouaga where a total of 5341 participants turned up (3225 men and 2116 women).
- About 880.5 kg of 7 sorghum varieties (CSM63-E, Sariaso 15, Sariaso 22, Sariaso 21, Sariaso 20, Kapelga, and Flagnon) were distributed in 2017 in small seed packs to 1,761 smallholder farmers (436 women and 1325 men).
- A total of 977 mini kits of ISSFMs were distributed to 977 farmers (762 men and 215 women).
- Thirty field days were organized in 6 districts (Andemtenga, Korsimoro, Boussouma, Pissila, Guibare La and Dora) with 1468 farmer participants (982 men and 486 women).
- An aggressive technology awareness and dissemination campaign was conducted by facilitating 6 radio broadcasts.
- A total of 361 trainees (226 men and 135 women) were trained in sorghum seed production in 13 different sites.

3.3.3 Strengthening Seed Production and Delivery Systems for Improved Varieties

- A total of 450 kg of breeder seed of 12 elite sorghum varieties (Sariaso 11, Sariaso 14, ICSV 1049, Grinkan, Sariaso 15, Sariaso 16, CSM 63-E, Sariaso 18, Sariaso 20, Kapèlga, Flagnon, and Gnossiconi) were produced at Saria in addition to 46 kg produced in 2016, nearly a 10-fold increase mainly attributed to the implementation of the seed roadmap developed the previous year.
- In 2016, 18 tons of foundation seed were produced from 7 sorghum varieties (Sariaso 11, Sariaso 14, ICSV 1049, Sariaso 15, Sariaso 16, Sariaso 20, and Kapèlga). In 2017, production of foundation seed increased by about 61% to a total of 29.035 tons of 9 elite varieties. The amount of foundation seed produced from two other elite varieties was not yet ready for reporting by the end of 2017.
- A total of 79.3 tons of certified sorghum seed for 7 varieties were produced.

3.3.4 Gender Integration into Variety Development, Adoption and Impact

- With a clear understanding of the role of gender in sorghum production and using a gender research questionnaire developed in 2016, a survey and FGDs on gender decision-making process in sorghum production, farmers' experience in improved production technologies and adoption of sorghum varieties was undertaken in 2017.

3.3.5 Strengthening Cereal Breeding Capacities of National Partners

- A hands-on training on BMS was offered to one sorghum breeder in 2017 that enabled operationalization and institutionalization of the use of BMS for trial planning and digital data collection as envisaged in the training conducted in 2016.
- In response to a need assessment done in 2016 that identified renovation of screen house and seed storage facilities as priorities, the renovations were done in 2017.

4. Pearl millet in WCA

4.0 Overview of ICRISAT Pearl millet Backstopping Progress in WCA

- ICRISAT-Nairobi received a total of 755 pearl millet accessions, out of which DNA has been extracted from 296 and sent to BecA for genotyping. A summary of all pearl millet accessions received from WCA for genotyping is summarized in Table 46.
- The duplicate set of 519 accessions [IER Mali (27), Burkina Faso (199) and Nigeria (68 inbreed lines and 225 accessions)] sent to ICRISAT-Nairobi by partners for GWAS was sent to ICRISAT-Niamey for *Striga* resistance phenotyping. Seed increase and phenotyping will be done in 2018.
- A set of 30 (Annex 1) advanced OPVs (12 *Striga*-resistant varieties, 16 improved for other traits and 2 checks) developed at ICRISAT-Niamey were shared with Nigeria, Mali and Burkina Faso to evaluate for *Striga* resistance. Results from the ICRISAT-Sadore sick plot and IER Cinzana *Striga* screening have shown that genotypes ICMV 147141, ICMV 14142, ICMV 14143, and ICMV 14144 were resistant. Some entries, ICMV 167007, ICMV 167008, ICMV 167009, ICMV 167010, and ICMV 167011, were tolerant to *Striga* in Cinzana. The most popular and adapted variety Sosat-C88 was found to be highly susceptible to *Striga*. Lines PE00077, PE08043, and PE00025 were highly susceptible to *Striga*, but resistant to millet head miner under artificial and field screening. Twenty kg seed each of the resistant entries ICMV 147141, ICMV 147142, and ICMV 147144 were produced for further validation trials.
- Two crosses were made between 29Aw (wild pearl millet accession) which is completely resistant to *Striga* (identified under HOPE I) and Sosat-C88-P10, which is susceptible, to develop F_1s (Sosat-C88_P10 x 29Aw) and (29Aw x Sosat-C88_P10) the generated F_1s (14 plants) were confirmed through SSR markers and the true F_1 selfed to generate 450 F_2 plants, which are currently being phenotyped.
- Multi-location on-station and on-farm yield trials were conducted with 25 full sibs selected for downy mildew resistance in 2016 from 1000 full-sib crosses between ICRI-Tabi and SOSAT- C88, along with their parents and popular checks (ICMV IS 94206 and ICMV IS 89305). Eight best entries were identified: ICMP 167014, ICMP 167069, ICMP 167086, ICMP 167092, ICMP 167063, ICMP 167411, and ICMP 167403.
- Forty pearl millet genotypes (Annex 2) consisting of OPVs, populations, improved varieties and germplasm lines were screened for resistance to the head miner and 20 genotypes (Annex 3) were selected with a damage score ranging from 2.22 to 4.33. These genotypes will be employed in developing populations to be shared with NARS.
- The ICRISAT millet breeder worked with the NARS to develop seed road maps for Burkina Faso (MISARI 1, IKMP 5, IKMV 8201, SOSAT-C88, IKMV 8201, ICMV IS 89305); Nigeria (Jirani, SOSAT-C88 and Supper SOSAT); and Mali (CzSyn 00 02, CzSyn 00 06, CzSyn 03 03, CzSyn 03 11, Toroniou HTC Ariste (hybrid), CzMil Aristé, CzSyn00 06, Maiwa HTC (hybrid), Maiwa) for selected varieties.
- Breeder seed of three *Striga*-resistant OPVs -- ICMV 147141, ICMV 147142, and ICMV 147144 -- were increased and 20 kg of each supplied to the IER pearl millet breeding program in the rainy season of 2017.
- ICRISAT WCA scientists from Mali, Niger and Nigeria convened a meeting at Bamako from 28-29th Sept 2017 with Dr Yilma to assess and reviewed the progress made and to develop PCNs. A follow-up assessment based on BPAT has been completed. Three product concepts (Pearl millet -WCA) were developed.

4.1 Nigeria Pearl Millet Crop Improvement Program Progress

4.1.1 Developing Superior High Yielding Stress Tolerant Market-Preferred Cultivars

- Pearl millet accessions collected in 2015 were evaluated to remove duplicates. The non-redundant duplicate (219) accessions plus 6 commercial varieties (totaling 225) were then sent to ICRISAT-Nairobi for genotyping in addition to the 66 inbred maiwa genotypes sent in 2016.
- The 225 landraces were screened across 3 locations for *Striga* resistance in 2016 and repeated in 2017. 10 genotypes identified (CAPARLGPMG20150110, CAPARLKPMG20150013, SOSAT-C88, CAPARLGPMG20150016-1, CAPARLGPMG20150134, CAPARLGPMG20150102, SUPER SOSAT, CAPARLGPMG20150145, CAPARLGPMG20150060, and CAPARLGPMG20150073)
- Another set of *Striga* and yield evaluation was done at Dabagi using 30 resistant lines (Table 47) received from ICRISAT- Niger and 10 genotypes were identified (SOSAT-C88, Sadore local, ICMV 167002, ICMV 147143, ICMV 167006, ICMV 147144, ICMV 177004, PE8077, ICMV 167010, and Gamoji).
- The 225 pearl millet landraces were screened for resistance to downy mildew in 2016 and repeated in 2017. Ten landraces were identified as parental lines for crosses during December 2017/April 2018 (Table 48).
- In 2017, set of 30 lines(Table 49) that had been received from ICRISAT-Niger and evaluated for *Striga* were also evaluated for Fe and Zn in three locations and the best 10 lines were identified (ICMV 167014, ICMV IS 85327, SOSAT - C88, GAMOJI, SOUNA 3, ICMV 167005, KAANATI, AKAD – KOM, FARINGUERO, and SOKOTO LOCAL).

- 221 S_1 inbred lines reported in 2016 were advanced to S_2 in 2017.
- A total of 35 advanced pearl millet lines (22 identified from *Striga* and downy mildew trials and an additional 13 accessions with potential for high Fe and Zn sent by ICRISAT-Niger) were planted to develop composite populations through full sib mating for *Striga* tolerance, downy mildew tolerance, high Fe & Zn content or a combination of these traits. Results are expected by April/May 2018.
- The 66 genotypes, 62 inbred lines of Maiwa type (late) of pearl millet and 4 improved gero types (totaling 66) submitted for genotyping in 2016 were evaluated for *Striga* resistance at BiriniKudu. No *Striga* emergence was observed on the Maiwa type of pearl millet.
- During the next season (off-season), 62 inbred lines of Maiwa type out of the total 66 genotypes were planted and randomly mated within six blocks to produce full-sibs for recurrent selection and 121 progenies were obtained from 72 plant-to-plant combinations. The 121 progenies were grown in a *Striga* hot spot nursery at BiriniKudu and 27 progenies selected for recombination during the Nov 2017 to March 2018 off-season under irrigation for cycle 2 recurrent selection.
- From the 66 Nigerian collections, 59 Maiwa land races were planted and advanced to 59 S_1 of which 57 have currently been advanced to S_2 and will be recombined during 2018.

4.1.2 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- Three MLT were conducted during the year and results are being analyzed:
    - 30 high-yielding and high-Fe OPVs received from ICRISAT-Niamey were evaluated at BiriniKudu.
    - 30 Regional Pearl Millet Striga Resistance Varieties received from ICRISAT-Niamey were evaluated at BiriniKudu.
    - 30 pearl millet hybrids received from ICRISAT-Niamey were evaluated at Minjibir Kano during the 2017 cropping season.
- Production of best-practice information material has been going on since 2016 and attached to seed packs at sales outlets.
- A total of 1800 ISSFM mini kits were distributed in four States in addition to the 775 mini kits distributed in 2016, representing a 232% increase. Farmers have responded positively to the technology and are adopting it rapidly.
- Four brown field days were conducted in four States (1 per state). A total of 328 farmers attended (227 men and 101 women).

4.1.3 Strengthening Seed Production and Delivery Systems for Improved Varieties

- In 2017, seed production was needed for only Jirani as there was sufficient foundation seed required by the seed companies for SOSAT-C88 and SUPERSOSAT for multiplication of certified seed in subsequent years. Fifty kg of foundation seed was produced of pearl millet variety SUPERSOSAT and a total of 2100 kg of certified seed SUPERSOSAT (800 kg), SOSAT-C88 (800 kg) and Jirani (500 kg) was produced in 2016. Therefore 100 kg foundation seed of Jirani variety was multiplied.
- A total of 4180 small seed packs of 3 varieties (Jirani – 180, SOSAT-C88 2400 and SUPERSOSAT -1600) were distributed in four States. This is an increase from 3,345 small seed packs that were distributed in 2016.
- A protocol for production of breeders' seed and maintenance, and determination of quantities required for each NARES was developed for use in the coming year.
- The need to revise the already existing monitoring plan for seed producers to incorporate in new initiatives was identified in 2017. The process is underway and will be concluded during the 1st and 2nd quarter of 2018.

4.1.4 Gender Integration into Variety Development, Adoption and Impact

- Assessment of impacts of HOPE I pearl millet intervention across four States in Nigeria was conducted; of the population sampled, 22.92% benefitted from ISSFM, 74.85% from small seed packs and 2.23% were processors.

4.1.5 Strengthening Cereal Breeding Capacities of National Partners

- A technical staff was trained in the use and application of BMS as a follow up to the training conducted in 2016 and this has enhanced the program's ability to use BMS.
- The program also sent one male technician to ICRISAT-Kano for pearl millet germplasm collection training, who then assisted in collecting 73 landraces for evaluation.
- The screenhouse, solar powered irrigation facilities, and seed storage facilities were identified as priority needs. The irrigation facility was installed and seed storage renovation will be completed in the 2nd quarter of 2018.

4.2 Mali Pearl Millet Crop Improvement Program Progress

4.2.1 Developing Superior High Yielding Stress Tolerant Market-Preferred Cultivars

- Thirty pearl millet genotypes (Table 50) received from ICRISAT-Niger together with a standard a local check were evaluated at Koporo and Sanogola for *Striga* resistance and yield and in both localities ICMV 147143 had better yield and moderate *Striga* resistance.
- For hybrid seed production, the A/BRs parents of the Toroniou hybrids identified in 2016 were synchronized with B and Toroniou R lines, Toroniou R line was synchronized with A & B lines, and B line was synchronized with A & Toroniou R lines. The number of A, B and R involved in the creation of subpopulations was high but the quantity of seed obtained (3.8 kg) was low. The seeds are being multiplied during the off-season to have relatively larger quantities of A/B seeds.
- Crosses were made with 2 early-maturing downy mildew resistant (CzMB01 and CzMB02) lines to improve 5 ecotypes (Sanio, Sogué, Sounan, Boii Sounan, and SOSAT-C88) that had been identified in 2016 as high yielding, farmer preferred but susceptible to downy mildew. Eight (8) F_1s (Cz MB 01xSogué Sounan, Cz MB 01/BOii Sounan, Cz MB 02/Boii Sounan, Cz MB 02/Boii Sounan,

Sanio/Cz MB 01, Sosat-C88/Cz MB 01, Boii Sounan/Cz MB 02, Sogué Sounan/Cz MB 02) were generated. The hybrids generated were phenotyped in the off-season and found to be early maturing, more tolerant to downy mildew and had yields equal to or higher than that of the productivity check. Comp-16-04, for instance, had a yield of 3600 kg/ha which is 197% higher than the best Banamba ecotype.

- One hundred and sixteen landraces were evaluated at Cinzana, Koporo, andN'Tarla in Randomized block design with three replications. Many of the entries had downy mildew ranging from 5 to 68%. However, 5 ecotypes (niou-bobo_gorobourou_omar, chôchô_kolonto_dramane, niou-bobo_téré_belco, boboni_n'tokorola_moudou and india_tara (sogosin) boureîma) with yield range between 2.5 t/ha to 3.1 t/ha and low rate of mildew infestation (between 5 and 15 %) were identified. S_1 of those landraces were produced during the off-season for their evaluation during the coming rainy season.
- An advanced yield trial was conducted using 12 early-maturing pearl millet populations (Cz-Population-16-04, Cz-Population -16-02, Cz-Population -16-01, Cz-Population -16-05, Boii/Sounan-16-07, Cz-Population -16-03, Toroniou C_1, Cz-Tiotioni/Sagnon-16-09, Boboni (TL), Sagnon, Bouadjan, and Sounan). Among 12 populations, 7 (Cz-Population-16-01, Cz-Population-16-02, Cz-Population-16-03, Cz-Population-16-04, Cz-Population-16-05, Cz Population-16-06, and Cz Population-16-07) were selected for their yield potential and disease tolerance. The average yield of selected populations was 2.9 t/ha. The identified populations are best suited to the Sahelian agroecology of Mali.
- Thirty entry pearl millet OPV trials received from ICRISAT-Niamey (Annex 4) were conducted in Mali in a randomized block design with three replications. Results indicate that grain yield range from 0.29 t/ha (AFRIBEH-NAARA) to 1.07 t/ha (ICMV 167005). A total of three varieties were selected (ICMV 167005, ICMP 177002, and Dhanashakti). These OPVs will be promoted among farmers.

4.2.2 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- In 2017, the program undertook two trials at Diema, Kayes and Nioro in partnership with 36 producers.
    - The first trial had three *Striga*-tolerant ines (ICMV 147141, ICMV 147143, and ICMV 147144) and the best OPVs were ICMV 147141 and ICMV 147143.
    - The second trial had 3 lines rich in Fe and Zinc (Chakti, ICMV 177001, and GB 8735) and GB 8735 was found to be the best fit cultivar.
- In 2016, 35 demonstration plots and 6 Farmer Field Schools were conducted. Also, four farmers' seed cooperatives (AOPP, NIETA, COPROSEM, USCPMD); two NGOs (EUCORD, AMASSA); and one private seed company (SOPROSA) were identified and sub-contracts signed to help in the implementation of this activity. In 2017, the partners already identified as implementers in 2016, distributed 5974 mini packs of 200 g of pearl millet seeds. Also, 2024 ISSMF kits were distributed by partners in 2017.
- Table 51 shows the number of different mini packs of sorghum distributed and the quantity of certified seeds produced in 2017.
- In 2016, the number of demonstration plots was 350 compared to 697 (282+415) in 2017.
- In 2016, 0.9 tons of certified seeds were produced by partners compared to 103 t (97039+6555) in 2017.

4.2.3 Strengthening Seed Production and Delivery Systems for Improved Varieties

- In 2017, a total of 1047 kg of breeder seeds was produced from six varieties (Toroniou C1 - 185 kg; CzSyn 00-06 - 185 kg; NKO/TC1 - 107 kg; Early maturing Cz Mil bristled – 180 kg; Intermediate Cz Mil bristled - 180 kg; and Synthétique 03 11- 210 kg) in addition to the 1337 kg produced in 2016.
- In 2017, a total of 456 kg of foundation seed was produced from nine varieties (Bristled millet - 35 kg; NKO/TC1 - 50 kg; Toroniou C1 - 46 kg; CzSyn 03-03 - 87 kg; Maïwa tardif - 10 kg; CzSyn 00-06 – 98 kg; Maïwa - 45 kg; Early maturing Cz Mil bristled – 50 kg; and Intermediate Cz Mil bristled - 35 kg). This is a decrease from the 1317 kg produced in 2016.

4.3 Burkina Faso Pearl Millet Crop Improvement Program Progress

4.3.1 Developing Superior High Yielding Stress Tolerant Market-Preferred Cultivars

- The program assembled and sent 221 accessions to ICRISAT for GWAS in addition to the 199 accessions sent in 2016. The same accessions were planted for screening for reaction to low and high P conditions (67 S_1 families) and 154 S_3 for downy mildew reaction screening (see results).
- In 2016, good specific combination trials were conducted using 2 male steriles, MS-SOSAT and Civarex-A. Thirteen topcross hybrids and their parents and 2 checks and six (Table 52) topcross hybrids were selected. In the next season, plant-by-plant crosses were initiated between the first four that gave > 15% yield advantage over the standard OPV (SOSAT- C88) to identify R lines, develop R version and develop Restorer populations.
- In 2017, 92 test crosses were conducted to develop restorative populations of male fertility using the best two hybrids (54/(MS-SOSAT X/ PE03012) and (42/(MS-Civarex/IKPM 5) that had been identified in 2016. Twenty eight (28) Test Crosses (17 MS-SOSAT/PE03012 and 11 MS-Civarex/ IKPM 5) were found fertile. Varieties IKMP5 and PE03012 gave 26% and 31.5% male fertility restoration rates, respectively.
- During 2017, crosses were initiated with 6 parents (Toma, Diguifa, Local Djibasso, Bomborokuy 1, Bomborokuy 2, and Bomborokuy 3) using ½ diallel method to develop 75 bold grain millet lines. But due to early onset of drought, only 10 crosses were successful.
- MS- KBH, MS-Civarex NA, MS-Civarex NNA BC1 male sterile populations that were advanced to BC_2 in 2016 were advanced to

BC_3 and BC_4 in 2017. MS-KBH BC_3 was advanced to BC_4 by undertaking 22 plant-by-plant TC crosses between MS-¾ KBH BC3 and ¾ KBH. The seed bulk of the 22 TCs is seed ¾ KBH/A while the bulk seed of pollinating S_1 is the seed ¾ KBH/B. The 22 TCs are individually preserved to refine the selection of S_1 sterility maintainers.

- Nine plant-to-plant crosses were made between SOSAT/A and SOSAT/B. The seed bulk of the 9 TCs constitutes the SOSAT/ A seed while the bulk of the S_1 pollinator seed constitutes the SOSAT/B seed. The 9 TCs are kept individually to refine the selection of S_1 sterility maintainers.
- 30 TCs were done by crossing the three restorers (Indiana05-R_C1, MISARI2-R_C1, GROUP 1-R_C1) identified in 2016 with MS-SOSAT-A and 30S1 (10 from each restorer) produced and kept. This is to assess the improvement of the R population after one cycle of recombination.
- In 2016, 13 FS-F2 families were recombined in isolated plots at Nahartenga and Didri and 13 yellow-grain composite varieties (Table 53) were thus created. In 2017, the same 13 yellow-grain composite varieties recombined with 6 S_1 (IKMP1, Indiana05, IKMV8201, Bomborokouy 1, Bomborokouy 2, and Bomborokouy 3) families and a total of 21 new composite varieties were developed.
- A total of 634 S_1 from six varieties (174 S_1 of IKMP5, 38 S_1 of PE03012, 123 S_1 of Group7, 118 S_1 of MISARI1, 64 S_1 of ICMVIS92222, and 117 S_1 of Indiana 05) produced in 2016, were planted during the raining season of 2017 to produce S_2 progenies but due to early onset of drought only 345 S_2 progenies were produced (96 S_2 of IKMP5, 38 S_2 of PE03012, 62 S_2 of GROUP7, 53 S_2 of MISARI1, 29 S_2 of ICMVIS92222, and 66 S_2 of Indiana 05). These 345 S_2 progenies are currently being advanced to S_3 (off-season 2018).
- In 2016, a total of 40 new pearl millet accessions were screened for tolerance to *Striga* at Gampela and Koupela. Late planting resulted in low *Striga* pressure. In 2017, the trial was repeated using 30 *Striga* lines received from ICRISAT-Niger and data is still being collected.

4.3.2 Promoting Best-Fit Cultivars and Allied Technologies to Enhance Awareness and Adoption

- A test trial to test performance of hybrids was conducted using 13 hybrids (Table 54) and 3 (¾ KBH-A/PE03012, ¾ KBH-A/Group 7 and ¾ KVH-A/ICMV IS 92222) were selected based on yield, male fertility, and uniformity.
- In 2016, one performance trial was conducted using 13 yellow varieties (Table 55) and a local check at Gampela, Fada and Dori and three OPVs with yellow grains were selected. In 2017, two similar trials were conducted using 53 yellow grain varieties (Table 56).
    - The first trial had 28 lines (12 yellow populations tested in 2016, plus 12 new yellow populations from the recombination of 13 FS-F2 yellow grain families done in 2016 and 4 checks (MISARI 1, SOSAT-C88, ICMVIS92222, and Local check). Twelve lines with grain yields of over 25% were selected; CMP-IS13092M (BFYPopC2M), MISARI1, ICMP-IS13092EM (BFYPopC2EM), G7-2j, ICMV-IS13091, ICMV-IS16091L, ICMP-IS16094Mb, G4-1j, G4-2j, G6-2j, ICMV-IS16092EM, and G5-2j.
    - The second trial had 25 yellow grain lines received from ICRISAT. Seven (7) composites showing gains in grain yield of more than 10% above the local check were selected: Mil Poiled FS, Late Maturing BF Yellow Pop FS, TCD62, ICMV-IS 13092EM Burkina Yellow, PopC2M, Mawa Badau (Nigeria Pop) and BF Yellow Pop C2.
- As promised in 2016, a repeat study to test the hybrids and new OPV varieties for fertilization, seeding density and adaption to different types of production systems (extensive, semi-intensive and intensive) in three replicates was done using 12 hybrids (Table 57) in addition to the 10 hybrids (Table 58) tested earlier.
- To obtain sufficient data for the DUS and registration in the national catalogue, 20 newly developed varieties (Annex 5) were evaluated in a RCBD with three replications at Gampela, Fada and Dori. The same trial was repeated in 2017. The late starting of the rains and the early onset of drought did not allow reliable data collection, hence the test will be repeated in 2018. For the registration of new varieties, at least two-year quality data is needed.
- In 2017, 10 varieties were evaluated in 16 preliminary on-farm trials. Four (4) varieties were identified by the partners from the participatory selection days. However, these trials faced some problems, hence will be repeated in year 3 of the project.
- 5 elite lines (Group1, Group 4, HIP1 : MS-SOSAT X P53/73, PE00397 X PE00515 -R3, PE00437 X PE00515 -R4) were put in advanced trials in 15 villages with 3 farmers per village (total 45 farmers involved). With the exception of PE00397 X PE00515 -R3, the other 4 varieties were selected by the partners from the PVS.
- On-farm demo trials were conducted with 233 men and 48 women, besides the 150 demo trials conducted in 2016.
- An aggressive campaign to disseminate information and create technology awareness was done through 6 radio broadcasts by AMSP (3), FEPAB (1), and UGCPA (2).
- Millet ISSFM kits were distributed to 335 farmers (288 men and 47 women) and 33 field days where conducted attended by 1,641 farmers (877 men and 764 women).
- Four seed fairs were organized in collaboration with local authorities and 5341 farmers (3225 men and 2116 women) participated.

4.3.3 Strengthening Seed Production and Delivery Systems for Improved Varieties

- A total of 1718 kg of breeder seed was produced from 6 varieties of pearl millet (SOSAT C-88, IKMP 5, MISARI 1, MISARI 2, ICMV IS 89305, and IKMV8201).
- 8764 kg of foundation seed from 6 varieties of pearl millet were produced: IKMP 5 (550 kg), IKMV 8201 (3365 kg), SOSAT C-88

(2407 kg), ICMV IS 89305 (598 kg), and MISARI 1 (1844 kg).

- As a result of the project partners (two private seed companies AGRISEM and FAGRI) and 4 farmers seed cooperatives (COPROSEL, AMSP, FEPAB, UGCPA) who were identified in 2016, a total of 27,100 kg of certified pearl millet were produced by from three varieties MISARI 1, SOSAT C-88, and IKMV8201 in 2017.
- A total of 801 small seed packs (400.5 kg) of 2 pearl millet varieties (MISARI 1 and IKMP5) were distributed to 801 farmers (229 women and 572 men).

4.3.4 Gender Integration into Variety Development, Adoption and Impact

- The program designed a questionnaire and carried out a rapid appraisal survey to investigate feedback from farmers on the new technology they had received. This survey started late and is ongoing.
- As for the feedback on the varieties which farmers received in small seed packs (SSPs) a semi-structured questionnaire was designed and used together with focused group discussions. The results reveal 52 farmers in the central and north appreciated group 4, group 1, and Misari 1 pearl millet varieties.
- In 2017, a survey was undertaken to understand the gender decision-making process in pearl millet production. The data was analyzed. The key finding was that the decision-making process for the production of improved varieties is usually carried out by the head of the household after consultation with other members of the family, in this case with the wives and the children.
- Similarly, Focus Group Discussions (FGDs) were carried out during the same year, data analyzed, and a report produced from this exercise. Generally, men, whether seed or grain producers, were found to have greater knowledge of varieties than women.
- As already mentioned, small seed packs were distributed to pearl millet farmers. On the same note, a survey was undertaken to understand the adoption of improved pearl millet varieties released among women farmers and the draft report is ready
- In 2017, results from the survey and the FGDs carried out in 2016 were synthesized. The best ranked pearl millet varieties were: Misari, IKMP5, IKMV8201, and Sosat. From the study that was conducted to understand preferences of industrialists and processors of pearl millet from a gender perspective, it was clear that pearl millet processors have very little knowledge of improved varieties. The Gender team put the processors and the UGCPA in touch for common activities with sorghum and millet varieties.

4.3.5 Strengthening Cereal Breeding Capacities of National Partners

- In addition, to the BMS training that was offered during 2016 where 4 technicians were trained, in 2017, two more trainings were conducted in: (i) new breeding tools (BMS, ODK, tablets, etc.) and (ii) data collection and management using new tools of the IBP Platform. Seventeen (2 women and 15 men comprising 3 scientists, 4 technicians and 10 students) attended the training. These trainings were instrumental in enabling the pearl millet program in Burkina Faso to institutionalize digital data collection and embrace the use of BMS.
- The program undertook a two-day self-assessment of the pearl millet breeding program at Kamboinse and Gampela research stations. The need to develop product profiles and organize the data collected in the field into BMS were the greatest needs identified.
- Renovations of the seed storage room and screen house were completed in 2017.

5.0. Project oversight and results-based management to ensure accountability, learning and scalability

- The project recruited an MLE scientist in the last quarter of year 2 and shared him with TL III. He customized the planning, monitoring, evaluation, accountability and learning (PMEAL) tools and indicators of TL III to meet HOPE II's specific needs.
- Working closely with the Digital Agriculture unit at ICRISAT HQ, these tools have been digitized and will be tested by partners in the upcoming annual review and planning workshop in Uganda before being rolled out in year 3.
- Approved capital items, specifically 4 vehicles for the coordination of project country activities, and 12 computers and 40 handheld devices for modernizing data collection and management were procured for NARS partners and satisfactorily distributed.
- Hitches were observed in timely obtaining of certificates of utilization of disbursed funds, mainly due to two factors: (1) the work time allocated to the project bookkeeping requirements by the NARS pool of accountants; and (2) accountants facing difficulties in accurately distributing expenditures using the reporting template.
- To smoothen data entry, computing, finalizing and submission of certificates of fund utilization to the project coordination office, a new simplified reporting template has been developed that takes into account the accountant's time, accuracy of expenditure distribution and calculations. The new template will be circulated to the partners after the first year 3 disbursements.
- A Communication Assistant was recruited who has drastically improved the visibility of the project's ongoing field and on-station activities. Objective leaders (partners and ICRISAT level), individual seed producers and farmer groups were met and interviewed, and audio/video recordings posted on the ICRISAT Workplace platform.

Information on the projects activities is regularly shared through many social media channels including:

Facebook: https://www.facebook.com/pg/Hope-II-Project-259217404568857/about/?ref=page_internal

Twitter: https://twitter.com/ICRISAT_HOPE

Flickr: https://www.flickr.com/photos/hope_project_2/

YouTube: https://www.youtube.com/channel/UC9NrtkeJ5mFxmhxwoGx49qg?view_as=subscriber

For example, to date, more than 500 photographs have been shared through Flickr and eleven videos are now publicly available on the YouTube channel.

- Selecting the number and level of degree trainees for funding under HOPE II in the project six countries, i.e. four PhD and four MSc candidates, were aligned with HOPE I achievements to balance the countries' chances of upgrading the academic level of their qualified research staff. Therefore, all NARS were equally notified on the opportunity to prorate their past benefits. Thus, the following allocation of HOPE II studentships was made (Table 59):
- All the 4 PhD students have been registered at the University of KwaZullu Natal in South Africa with the following research topics
    - "Identification of pearl millet (*Pennisetum glaucum* L.R. (Br.)) resistance source for *Striga hermonthica* (Del.) Benth. in Burkina Faso"
    - "Genotype wide association study for nitrogen and important agronomic traits in sorghum hybrids."
    - " Phenotyping and genotyping of Ethiopian finger millet landraces for blast resistance and quality traits"
    - "Characterization and genetic studies on nutritional quality traits of sorghum germplasm in Uganda "
- One MSc candidate has been registered for a degree in "Plant breeding and management plant genetic resources" in Ouagadougou, Burkina Faso. The student will conduct his research on Pearl millet breeding to enhance the capacity of Mali pearl millet breeding program after completing his studies. Registration of the other MSc candidates is underway.
- A training on the "Efficient use of the Integrated Breeding platform's Breeding Management System Software" was conducted from May 10-12 at Addis Ababa, Ethiopia. A total of 26 participants (24 men and 2 women) attended this course. In a second training, research technicians from all national breeding programs as well as ICRISAT were trained on the "Breeding Management System (BMS)" in Bamako, Mali (23-29 July 2017, jointly with TL III). The third training involved data management that was held from 26-30 June 2017 in Nairobi, Kenya. The workshop was specially designed for the project's research technicians of the national breeding programs. Participants were trained in the use of BMS, including creation of lists of germplasm, new trials (both single and multi-locational), importing existing trials and uploading data. New breeding locations were added to the existing database. Participants were also trained to use handheld devices for data collection using KSU Fieldbook. The workshop was attended by 15 technicians (2 women and 13 men) representing Nigeria, Ethiopia, Tanzania, Uganda and Burkina Faso.

The programs created for HOPE II project are in Table 60 and 53 trials and 8 nurseries have been loaded onto BMS.