# **Cluster of Activities Report Template**

**Cluster annual report - 2018**

**FP4.2– Breeding Pipeline**

Shiv Kumar Agrawal [sk.agrawal@cgiar.org](mailto:sk.agrawal@cgiar.org) and Jan Debaene [J.Debaene@cgiar.org](mailto:J.Debaene@cgiar.org)

# MAIN ACHIEVEMENTS

CoA4.2 focused on 67 research outputs, following a product-delivery pipeline for nine target crops. This CoA has leveraged on the breeding populations and techniques developed during the first phase of CRP on Grain Legumes and the CRP on Dryland Cereals as a continuum. This has resulted in the development of 73 improved varieties of chickpea (11), pigeon pea (3), groundnut (25), cowpea (2), soybean (6), lentil (4), sorghum (6), pearl millets (10) and finger millets (6) in 18 South Asian and Sub-Saharan African countries besides generation of advanced breeding lines/hybrids/populations/parents of target crops for testing and evaluation as International nurseries. Major traits of breeding programs across the crops were earliness, heat and drought tolerance, resistance to key diseases and insect pests, machine harvestability, herbicide tolerance, phosphorus use efficiency, and grain quality. In order to accelerate the genetic gain, novel approaches such as use of crop wild relatives and off-season nursery, precision phenotyping, genomic selection, diversification of CMS in hybrids, development of breeding product profiles and use of molecular markers in breeding programs were integrated. Attempts to identify **new male sterility sources for the hybrid pigeon pea** produced successful F1 progeny from crosses of A2 (*Cajanus scarabaeoides* and A4 (*C. cajanifolius*) cytoplasm. Thirty-six **elite groundnut lines** for early maturity, high pod yield, high shelling percent, seed size, drought tolerance, disease resistance and high oleic content evaluated in target environments for yield performance. **Introgression lines of sorghum carrying shoot fly resistance** QTLs through MABC and **genomic selection model using rad-GBS and y-GBS for use in hybrid pearl millet, association mapping for biotic stresses with DArTseq markers, mapping of QTLs associated with drought and cold tolerance in chickpea** are examples of the successful use of molecular techniques for precision breeding. Lentil lines with machine harvestable and herbicide tolerance and super earliness with high iron and zinc content evaluated for their yield performance in target regions.Screening of germplasm and elite lines have also resulted in identification of new donors for target traits in nine crops.

# Outcome cases and policy influenced (proposed)

Revise and complete the suggested list of outcome cases and policies to be documented

|  |  |  |
| --- | --- | --- |
| **Title of Outcome/ Impact Case Report (OICR) (30 words)** | **Description**  **(up to 80 words)** | **Geographic scope**  **(Specify if regional, national, sub-national and provide list of regions/countries)** |
| Biofortified GLDC crops commodities for nutritional security. | Biofortification with iron and zinc content has been mainstreamed across the crops as reflected in target traits of 15 outputs (FP4.2.2-chickpea, FP4.2.41-lentils, FP4.2.4, FP4.2.7 & FP4.2.47-groundnut, FP4.2.52 & FP4.2.57-pigeonpea, FP4.2.25 & FP4.2.60-sorghum, FP4.2.29, FP4.2.31, FP4.2.32, FP4.2.44 & FP4.2.45-pearl millets, FP4.2.38-finger millets). Biofortified varieties in sorghum (Parbhani Shakti in India), lentil (Barimasur 9 in Bangladesh and Khajuro Masuro 4 in Nepal, IPL220 in India), pearl millet (EUFM 403 in Kenya), low oleic acid lines of groundnut (MGV8 in Zambia) are noteworthy. Biofortified varieties emanating from the first phase of CRP has already grown on large scale in target countries with positive outcome in terms of higher production, income and livelihood (CoA 4.2 report).  <https://mel.cgiar.org/preplanning/relatedfiles/id/482/entity/actionsite> | Regional (South Asia and Sub-Saharan Africa |
|  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Name and description of policies modified in design**  **or implementation, informed by CGIAR research (20-50 words, ideally around 30 words)** | **Type**  **(policies/ strategies / laws/ regulations/ budgets/ investments/ curricula)** | **Whose policy is this?**  **The primary organization(s) either designing/promulgating the policy, law, investment (e.g. national government) etc. and/or within which it is operating.** | **Geographic scope**  **(Specify if regional, national, sub-national and provide list of regions/countries)** |
|  |  |  |  |
|  |  |  |  |

# MAIN ACHIEVEMENTS WITH GENDER RELEVANCE

Development of easy stripping of pods (threshability) in groundnut (FP4.2.3), machine harvestable and herbicide tolerant lentils (FP4.2.64) and chickpea (FP4.2.11) are key gender traits to reduce drudgery of women. Groundnut cultivar, ICGV 030353 (GJG 32) has combined the easy threshability. Forty new populations developed using 5 female and 12 parents to widen the genetic base for easy stripping of pods. Fifteen elite lentil lines amenable to machine harvest were identified with above 10% yield advantage over the best check. Breeding lines with improved grain quality have desired effect on the health of women and children. Biofortification with iron and zinc content has been mainstreamed across the crops as reflected in target traits of 15 outputs (FP4.2.2-chickpea, FP4.2.41-lentils, FP4.2.4, FP4.2.7 & FP4.2.47-groundnut, FP4.2.52 & FP4.2.57-pigeonpea, FP4.2.25 & FP4.2.60-sorghum, FP4.2.29, FP4.2.31, FP4.2.32, FP4.2.44 & FP4.2.45-pearl millets, FP4.2.38-finger millets). Biofortified varieties in sorghum (Parbhani Shakti in India), lentil (Barimasur 9 in Bangladesh and Khajuro Masuro 4 in Nepal), pearl millet (EUFM 403 in Kenya), low oleic acid lines of groundnut (MGV8 in Zambia) are noteworthy. In addition, breeding populations/lines biofortified with Fe, Zn and protein contents in chickpea, lentil, pigeonpea, groundnut, pearl millet, sorghum, and finger millets are at various stages of development.

# MAIN ACHIEVEMENTS WITH Youth RELEVANCE

Mechanization, hybrid seed production and biofortification offer scope for entrepreneurship to youth and bring them back in agriculture. Development of easy stripping of pods (threshability) in groundnut (FP4.2.3), machine harvestable and herbicide tolerant lentils (FP4.2.64) and chickpea (FP4.2.11) are the main achievements with youth relevance. Biofortified varieties (outputs of 15 research activities under this CoA have potential relevance for youth to market them as specialty products. In addition, hybrid seed production of pigeonpea, sorghum, and pearl millets could provide opportunity for youth to get involved in agriculture for higher returns.

# MAIN ACHIEVEMENTS WITH CAPACITY DEVELOPMENT RELEVANCE

SNP platform through service provider (Intertek) in groundnut (FP4.2.4 & FP4.2.47), standardization of GS model using rad-GBS and t-GBS (FP4.2.61) and forward breeding (FP4.2.62) in pearl millet and association and QTL mapping in chickpea (FP4.2.65 and FP4.2.66) and development of mapping populations have direct relevance with capacity development of NARS partners. Outputs related to grain quality analysis using NIRS and ICP at ICRISAT and ICARDA quality labs also provided opportunity to NARS partners for capacity development in biofortification of target crops. Legume breeder, Nigusie Girma from Ethiopia trained in breeding techniques and selection methods in lentil and chickpea and two technicians from IER trained on striga infestation method and data collection and analysis in sorghum. A large number of students, namely Tracy El Haber (F) for Evaluation of cultivated and wild relatives of lentil for heat and drought tolerance (MSc degree), Rind Balech (F) for Genotyping by sequencing of Lentil for tolerance to Metribuzin and Imazethapyr (PhD), Aouatif Benali (F) for Evaluation of phenological, physico-chemical and quality traits in chickpea Seeds (PhD), Hasnae Choukri (F) for Genetic and molecular characterization of iron and zinc contents in lentil (PhD), Kamal Hejjaoui (M) for Phenotypic and genotypic characterization of lentil germplasm for traits associated with machine harvestability (PhD), Noureddine El Haddad (M) for Physiological, genetic and molecular characterization of heat and drought stress tolerance in lentil, Colette Ouedraogo (F) for Advancing and identification of sorghum varieties with drought tolerant traits including stay green, chlorophyll content and transpiration efficiency (PhD), and Amadou Mahamane (M) for Estimation of genetic gains in pearl millet will enable these partners to strategize the trait-prioritization in breeding programs. Financial support was extended to NARS partners for their participation in the IFLRC-VII conference held in Marrakesh, Morocco in May 2018. A field visit to food legumes research program was arranged for NARS partners to make selections of improved germplasm relevant to their program. NARS partners from Ethiopia and India were given one-week training on food legumes. ICARDA Team visited Indian research program for joint selection with NARS partners. Modernization of seed store and digitalization of chickpea and lentil breeding program was completed in ICARDA.

# MAIN ACHIEVEMENTS WITH CLIMATE CHANGE RELEVANCE

Major achievements emanating from 17 research activities have climate change relevance as these activities dealt with development of breeding material with tolerance to heat, drought, waterlogging and short duration in target crops. To combat high-temperature stress in South Asia and Sub-Saharan Africa, screening for heat tolerance of chickpea, lentil, pigeonpea, groundnut, cowpea, sorghum, and pearl millet was undertaken under controlled and field conditions, resulting in identification of donors to heat tolerance. Selection criteria for heat tolerance was based on pollen viability, pod formation and grain yield at >35°C at flowering time. High-temperature screening of lentil genotypes at 35oC under controlled conditions identified four lines, ILL7814, ILL7835, ILL7833 and ILL7223, with pollen germination and pollen-tube growth at the highest tested temperatures of 35oC. In chickpea, two RIL populations phenotyped and genotyped with DArT and SNP markers for mapping QTL associated with drought and cold tolerance. Six peanut varieties carrying wild chromosome segments from *A. duranensis* or *A. ipaensis* with drought tolerance have been registered for cultivation in Senegal. MAGIC population (Postrainy traits) using eight diverse postrainy sorghum parents (High grain yield, white bold lustrous grain, shoot fly and drought tolerance) was taken to the next stage of development. Selection for drought tolerant traits including stay green, chlorophyll content, and transpiration efficiency was performed in BC1F4 populations in sorghum. 382 F5 progeny lines of finger millets were screened for tolerance to heat and selections from eight crosses (IE 3779 x KNE 741, IE 3779 x IE 6321, Emiroit x IE 3038, KNE 624 x IE 5165, KNE 624 x IE 6321, KNE 624 x KNE 741, KNE 624 x IE 3038 and KNE 622 x IE 6321) showed normal flowering and grain filling under high temperature. Super early pigeonpea, chickpea and lentil germplasm resulting from three research activities has the ability to escape terminal stress of heat and drought in post-rainy season crop.

MAIN GAPS AND CHALLENGES

Major gaps and challenges have been precision phenotyping for desired traits as screening for disease and insect pest tolerance was taken up under natural hot spots with limited control over the stress. In order to assess the effect of biofortified varieties on health and nutrition, efficacy trials with human subject need to be conducted.

# MEASURES TAKEN AND ADJUSTMENTS PROPOSED

MOAs have been signed with research partners having precision phenotyping facilities and well-established hot spots to screen germplasm and breeding material.

# PARTNESHIPS: ACHIEVEMENT AND CHALLENGES

Please list up to three important partnerships for 2018, using the following table.

|  |  |  |
| --- | --- | --- |
| **Brief description of partnership aims (30 words)** | **List of key partners in partnership (one or more partners). Do not use acronyms.** | **Main area of partnership (may choose multiple),**  **Research/Delivery/Policy/Capacity Development/Other, please specify** |
| Precision phenotyping and dissecting heat tolerance in lentil | Panjab University, India and Agricultural Research Cooperation, Sudan | Donors for heat tolerance and research article on basic knowledge about the heat tolerance in lentil |
| Improving nitrogen and phosphate use efficiency of lentil in rice fallow and Sustainable management of Stemphylium blight of lentil | Bidhan Chandra Krishi Vishwavidyalaya, India | Identification of lentil genotypes suitable for rice fallow eco- system, Identification of candidate genes and prediction of their putative function involved in N2 and Pi uptake as well as utilization in lentil, Stemphylium blight resistant genotypes, nature of diversity of the Stemphylium botryosum isolates,  Status of virulence of the studied isolates, development of weather-based disease prediction model against Stemphylium blight disease of lentil. |
|  |  |  |

Please include collaborations with one or more CRPs or Platforms – or in some cases with other Centers, if these are not already core partners for your CRP.

|  |  |  |
| --- | --- | --- |
| **Name(s) of collaborating CRP(s), Platform(s) or Center(s)** | **Brief description of the collaboration** | **Optional: Value added, in a few words** e.g. scientific or efficiency benefits |
|  |  |  |

# FUND RAISING

* ICARDA raised 200,000 US$ from OFID towards ‘Mainstreaming energy and labor-saving traits in food legumes for efficient and nutritious agri-food systems in South Asia’ for 2019-2020 and another 200,000 US$ from the Crop Trust towards ‘Dissemination of Interspecific lentil Varieties and Elites through Participatory Research for 2018-2020.