GLDC Annual Report 2018

CGIAR

RESEARCH PROGRAM ON
Grain Legumes and Dryland Cereals

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

IITA
Research to Nourish Africa

ICARDA
Science for resilient livelihoods in dry areas

World Agroforestry Centre

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

Bioversity International

CSIRO

IRD
Institut de Recherche pour le Développement
FRANCE

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CGIAR Research Program on Grain Legumes and Dryland Cereals

The CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC) is an international consortium led by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and CGIAR implementing partners, including the International Institute of Tropical Agriculture (IITA), International Center for Agricultural Research in the Dry Areas (ICARDA), World Agroforestry Centre (ICRAF), International Livestock Research Institute (ILRI) and Bioversity International. In addition to the CGIAR, the CRP-GLDC is implemented by L' Institut de Recherche pour le Développement (IRD) and Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) from France and Commonwealth Scientific and Industrial Research Organisation (CSIRO) from Australia, and various Non-Governmental Organizations (NGOs), national agricultural research system (NARS) and private sector partners. This consortium strives to support beneficiaries in 13 priority countries in South Asia (SA) and Sub-Saharan Africa (SSA) with a mission of delivering improved rural livelihoods and nutrition by prioritizing demand-driven innovation to increase production and market opportunities along value chains.

http://gldc.cgiar.org

Lead Center: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

Flagship Program 1: Priority Setting & Impact Acceleration
CGIAR Center: International Institute of Tropical Agriculture (IITA)

Flagship Program 2: Transforming Agri-food Systems*

Flagship Program 3: Integrated Farm and Household Management
CGIAR Center: World Agroforestry Centre (ICRAF)

Flagship Program 4: Variety and Hybrid Development
CGIAR Center: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

Flagship Program 5: Pre-breeding and Trait Discovery
CGIAR Center: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

Other participating institutions: CSIRO, IRD, CIRAD, ICARDA, Bioversity International and ILRI.

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*The Flagship Program 2 on Transforming Agri-food Systems did not receive W1/W2 funding in 2018. However, some of the planned activities were carried out with Bilateral funds. Starting 2019, key activities planned under this Flagship will be implemented through a new cross-cutting theme on Markets and Partnerships in Agri-Business (MPAB).

Contents

Abbreviations and Acronyms

AGRA: Alliance for a Green Revolution in Africa
AIP: Agribusiness and Innovation Platform of ICRISAT
AMF: Arbuscular mycorrhizal bio fertilizer
ARC: Agricultural Research Cooperation
ArES: Agricultural Research e-Searker
ARIs: Advanced Research Institutes
AVISA: Accelerated Varietal Improvement and Seed Delivery of Legumes and Cereals in Africa
BCNAM: Backcross nested association mapping
BGM: Botrytis Grey Mould
BMGF: Bill & Melinda Gates Foundation
BMI: Body mass index
BMS: Breeding Management System
BPP: Breeding Product Profiles
Ca: Calcium
CBCC: Center for Behavior Change Communication
CCSHAU: Chaudhary Charan Singh Haryana Agricultural University
CERAAS: Centre d'étude régional pour l'amélioration de l'adaptation à la sécheresse
CIRAD: Centre de cooperation international en recherché agronomique pour le développement
CKAN: Comprehensive Knowledge Archive Network
CNGs: Crop Network Groups
CoAs: Clusters of activities
CoE: Centre of Excellence
CRP-A4NH: Agriculture for Nutrition and Health
CRP-GLDC: CGIAR Research Program on Grain Legumes and Dryland Cereals
CRP-PIM: CGIAR Research Program on Policies, Institutions and Markets
CRP-RTB: CGIAR Research Program on Roots, Tubers and Bananas
CSIRO: Commonwealth Scientific and Industrial Research Organisation
CSIR-SARI: Council of Scientific and Industrial Research - Savanna Agricultural Research Institute
CWR: Crop wild relatives
DAR: Department of Agricultural Research
DDG-R: Ddeputy Director General - Research
DEME: Design, Execution, Monitoring, and Evaluation
DryDev: Drylands Development Program
DSR: Direct Seeded Rice
EiB: Excellence in Breeding
EMRS: Ekalavya Model Residential Schools
ENDF: Energy and nutrient dense Food
ESA: Eastern and Southern Africa
Fe: Iron
FPOs: Farmer Producer Organizations
FtF: Feed the Future
GxE: Genotype x Environment
GxExM: Genotype x Environment x Management
GOBii: Genomic Open-Source Breeding Informatics Initiative
GREAT: Gender-Responsive Researchers Equipped for Agricultural Transformation
GS: Genomic selection

Ha: Hectare
HIGS: Host Induced Gene Silencing
HTGP: High Throughput Genotyping Platform
HOPE 2: Harnessing Opportunities for Productivity Enhancement – Phase 2
HPRC: Hybrid Parents Research Consortium
IA: Intellectual assets
IAC: Independent Advisory Committee
IAFS: India Africa Forum Summit
IAR: Institute of Agricultural Research
IAVAO: Innovation et amelioration variétale en Afrique de l'Ouest
ICAR: Indian Council of Agricultural Research
ICARDA: International Center for Agricultural Research in the Dry Areas
ICRAF: World Agroforestry Centre
ICRISAT: International Crops Research Institute for the Semi-Arid Tropics
ICRISAT OAR: ICRISAT Open Access Repository
IDO: Intermediate Development Outcomes
IER: Institut d'Economie Rurale
IITA: International Institute of Tropical Agriculture
ILRI: International Livestock Research Institute
IMPACT: International Model for the Policy Analysis of Agricultural Commodities and Trade
INERA: Institut de l'Environnement et Recherches Agricoles
INRAN: Institut National de la Recherche Agronomique du Niger
IPR: Intellectual Property Rights
IRD: L' Institut de recherche pour le développement
ISRA: Institut Sénégalais de Recherches Agricoles
ISSDP: Integrated Seed Sector Development Program
ITDA: Integrated Tribal Development Agency
ISPC: Independent Science and Partnership Council
KVKs: Krishi Vigyan Kendras
LERs: Land equivalent ratios
M: Million
MABC: Marker-assisted backcrossing
MARLO: Managing Agricultural Research for Learning and Outcomes
MEIAL: Monitoring, Evaluation, Impact Assessment and Learning
MEL: Monitoring, Evaluation & Learning
MIS: Management Information System
MISST: Malawi Improved Seed Systems and Technologies
MLT: Multi-Location Testing
MMS: Mahila Mandal Samaikya
MPAB: Markets and Partnerships in Agri-Business
MUAC: Mid Upper Arm Circumference
NARO-NaSSARI: National Agricultural Research Organisation-National Semi-Arid Resources Research Institute
NARS: national agricultural research system
NARES: National Agricultural Research and Extension System
NASFAM: National Smallholder Farmers' Association of Malawi
NCBI: National Center for Biotechnology Information
NFHS: National Family Health Survey

NIRS: Near-Infrared Spectroscopy
NGOs: Non-Governmental Organizations
NPK: Nitrogen phosphorus potassium
NPK: NutriPlus Knowledge Program
NPT: National performance trials
NRM: Natural resource management
NOW: Netherlands Organisation for Scientific Research
OFID: OPEC Fund for International Development
OSA: Optima Soy Africa
OPVs: Open Pollinated Varieties
PAU: Punjab Agricultural University
PMHPRC: Pearl Millet Hybrid Parents Research Consortium
PMU: Program Management Unit
PVS: Participatory varietal selection
QC: Quality Control
QTLs: Quantitative Trait Loci
RBM: Results-Based Management
RGA: Rapid generation advancement
RMC: Research Management Committee
RUFORUM: Regional Universities Forum for Capacity Building in Agriculture
SA: South Asia
SDG: Sustainable Development Goals
SHGs: Self-help groups
SI: Sustainable intensification
SIL: Soybean Innovation Lab
SLO: System level outcome
SLU: Swedish University of Agricultural Sciences
SMO: System Management Office
SMEs: Small and medium enterprises
SNP: Single nucleotide polymorphism
SOP: Standard Operating Procedures
SSA: Sub-Saharan Africa
ST: Scheduled Tribes
TE: Transpiration efficiency
TL III: Tropical Legumes - Phase III
TRICOR: Tribal Cooperative Finance Corporation Ltd
TRICOT: Triadic Comparisons of Technologies
UNB: Université Nazi Boni
VPD: Vapor pressure deficit
WCA: West and Central Africa
WUE: Water use efficiency
WUR: Wageningen University & Research
XRF: X-ray fluorescence
Zn: Zinc

EXECUTIVE SUMMARY

The CRP-GLDC envisions to increase the productivity, profitability, resilience and marketability of critical and nutritious grain legume (chickpea, cowpea, pigeonpea, groundnut, lentil, soybean) and cereal (sorghum, pearl millet, finger millet) crops grown in the semi-arid and sub-humid dryland agroecologies of Sub-Saharan Africa (SSA) and South Asia (SA), where poverty, malnutrition, climate change and soil degradation are most acute. Improved innovation capacities within agri-food systems of key cereal and legume crops are expected to enable coherent and integrated research and development, production and market and policy reforms that deliver resilience, inclusion, poverty reduction, nutritional security, environmental sustainability and economic growth.

The CRP-GLDC is an international consortium led by ICRISAT and CGIAR partners including IITA, ICARDA, ICRAF, ILRI and Bioversity International, and implemented together with IRD and CIRAD (France), CSIRO (Australia), NGOs, NARS, and private sector partners. The Program supports beneficiaries in 13 priority countries in SA and SSA to deliver improved rural livelihoods and nutrition by prioritizing demand-driven innovation to increase production and market opportunities along value chains. It is structured on five Flagship Programs: FP1: Priority Setting and Impact Acceleration; FP2: Transforming Agri-food Systems (remains unapproved for W1/W2 funding but a number of bilateral projects are mapped to it); FP3: Integrated Farm and Household Management; FP4: Variety and Hybrid Development and FP5: Pre-breeding and Trait Discovery. Following are the results obtained during the first year of operations of this CRP that began in 2018.

To enhance the relevance and impacts of GLDC research through improved targeting and priority setting, an ex-ante poverty impact evaluation showed that early-maturing and drought-tolerant GLDC varieties and hybrids with resistance to pests and diseases are the priority research and technology options. The drivers of adoption and producer and end-user preferences ensure alignment between end-user demand and breeding targets and facilitate scaling of GLDC innovations. Gender research established the roles of gender norms and social change in technology adoption and distribution of the benefits from adoption. Modelling frameworks are being considered to evaluate the trade-offs and co-design farming systems for enhanced resilience and income, besides looking at portfolios of household activities, enterprises and management practices that enhance livelihoods while minimizing negative externalities. The integration of cropping system modelling tools into breeding programs can be important for decision making on optimizing GxExM for target crop populations. Expansion of multilocation and national testing sites resulted in the commercialization of 73 cultivars of 9 GLDC crop commodities in 16 target countries of Africa and Asia. This included biofortified cultivars of sorghum (India), pearl millet (Kenya) and lentil (Bangladesh, Nepal). Breeding for heat tolerance in chickpea and pearl millet and for low nutrient adaptation in cowpea and groundnut were mainstreamed. Machine-harvestable chickpea and lentil can promote youth and women entrepreneurship, while high oleic groundnut and grain sorghum suitable for brewing are market traits of industrial importance.

Crop network groups supported as platforms for crop product design, development, testing, advancements and delivery involved engagement of multi-stakeholders. Breeding efforts are being supported by trait discovery/mapping/dissection, functional validation of traits and pre-breeding by exploiting natural and/or systematically induced variations for prioritized traits together with modern genomics, transgenics, phenomics and breeding tools. This included the characterization and advancement of developed transgenic events for insect resistance in chickpea, pigeonpea and cowpea, and aflatoxin resistance in groundnut. These activities were supported by capacity development of students and NARS researchers, training courses, seminars, workshops, symposia and exchange visits, besides knowledge sharing, data management and new partnerships.

Part A: NARRATIVE SECTION

1. Key Results

(CRP-GLDC has been operational since 2018. However, the work carried out by CRPs DC, GL and DS are being reported in the CRP-GLDC.)

1.1 Progress towards SDGs and SLOs

1. Impact of ICRISAT Pearl Millet Hybrid Parents Research Consortium (PMHPRC) on the Livelihoods of Farmers in India

A third-party evaluation of the on-farm impact of pearl millet hybrids developed under PMHPRC by member partners during 2000-2010 (directly or indirectly based on ICRISAT breeding lines) in India was carried out in 2015 and published in 2018 (Venkata Rao et al. 2018). The study covering 563 pearl millet growers spanning 57 villages and 25 mandals in three states (Rajasthan, Gujarat and Uttar Pradesh) in India, revealed that PMHPRC hybrids covered about 60% of the pearl millet hybrid area during 2013-14. These hybrids provided at least 20% higher grain and fodder than the varieties/other hybrids they replaced. The total benefits that accrued due to these hybrids in the three states added up to US$ 133.7 million (M) per year. The overall benefits at the country level could surpass US$ 150 M per year if contributions of HPRC hybrids are accounted for in other states of India as well. Considering the average landholding of less than 2 hectares (ha) per farm family, the number of households planting improved varieties would be 1.5 M farm families, assuredly 8 M people.

2. Bhoosamrudhi - Improving Rural Livelihoods through Innovative Scaling-up of Science-led Participatory Research for Development

The program was piloted in eight districts representing four revenue divisions of Karnataka state in India. It covered 80,000 ha and has been promoting innovative technologies in the state since 2012. Interventions such as integrated nutrient and pest management, water management, mechanization, crop intensification, crop diversification and fodder development were promoted through a consortium of national and international research institutes to scale-up natural resource management (NRM) technologies. Best management practices along with improved cultivars increased crop yields by 15-40%; enhanced land and water use efficiency by 15-20% and gave an additional income ranging from US$ 120 to US$ 150/ha to farmers. Pearl millet HHB 67, a cultivar bred using marker-assisted breeding, demonstrated benefits by reducing downy mildew infection and enhancing crop yields. Farmers benefitted from improved cultivars of finger millet which increased yields by 63% over local cultivars. Under crop intensification, rice and maize fallows used to grow green gram, chickpea and vegetable cowpea provided an additional income ranging from US$ 220 to US$ 295/ha to the farmers. Direct Seeded Rice (DSR) increased water use efficiency (WUE) to 0.53 kg/m^3 of water compared to 0.36 kg/m^3 in transplanted paddy. With drip, for DSR with laterals at 80 cm, WUE increased to 1.5-2.0 kg/m^3 of water resulting in 60% savings in water and yielding US$ 560 net income per acre as compared to an income of US$ 325/ ha under transplanted rice. Pigeonpea hybrids ICPH 2611 and ICPH 2740 were preferred by farmers across the districts as they produced 25 to 66% more than local cultivars. Mechanization benefitted farmers by enhancing WUE by 15 to 20%. Using power weeders, farmers could save US$ 60 to US$ 75/ha in cash crops like sugarcane and cotton. Manually-operated Easy Planters saved US$ 45 to US$ 60/ha on transplanting as well as dibbling of seeds using a seed dibbler. Nipping machines helped slash labor costs on apical bud nipping operations in pigeonpea and increased crop yields by 7 to 8%. Program final results were published in 2018.

3. A Game Changer for Smallholder Farmers: Poverty Reduction through Chickpea Adoption in Ethiopia

A new study published in 2017 (Verkaart et al. 2018) established the welfare impacts of chickpea adoption in rural Shewa region of Ethiopia, where an increasing number of farmers adopted improved varieties. The positive linkages between technology adoption and household incomes of smallholder farmers was demonstrated using panel data collected between the 2006-07 and 2013-14 seasons (Verkaart et al. 2019). While in 2006-07, only 31% of farmers planted improved chickpea, by 2013-14 this share rose to almost

80%. Furthermore, many households started planting chickpea, bringing the share of chickpea growers up to 90% from an initial 65%. The area dedicated to improved chickpea rose from an average 0.17 ha per household to more than 0.4 ha by 2014 (Michler et al. 2018). The adoption of improved chickpea significantly increased household income while also reducing poverty. The study found that a 10% increase in the area planted with improved chickpea is associated with a 12.6% increase in income per capita and a 12.3% increase in total income while also reducing the probability of being below the US$ 1.25 poverty line by 3.9%. Overall, increasing access to improved chickpea appears to be a promising pathway for rural development in Ethiopia.

1.2 CRP Progress towards Outputs and Outcomes

1.2.1 Overall CRP Progress

FP1: This Flagship aims to enhance the relevance and impacts of GLDC research through improved targeting and priority setting. An ex-ante poverty impact evaluation was conducted to identify research options with the greatest potential for poverty reduction. In general, early-maturing and drought-tolerant GLDC varieties and hybrids with resistance to pests and diseases are the priority research and technology options across regions in Sub-Saharan Africa and South Asia. Market studies are building the evidence base on the drivers of adoption and producer and end-user preferences to ensure alignment between end-user demand and breeding targets and to facilitate scaling of GLDC innovations. Gender research teams are establishing the roles of gender norms and social change in technology adoption and distribution of the benefits from adoption. A study conducted in India showed how the adoption of pro-poor innovations by women in India could bring about women's empowerment even in communities where there is female seclusion. A global literature review pointed to the need for increased technological and policy interventions to improve agricultural productivity for women who take over farm tasks following outmigration of men to urban centers. As part of a larger effort to document the enabling conditions for technology scaling and generating evidence of impact of GLDC technologies, an impact study of improved cowpea was conducted in Nigeria, where the results showed that 29% of the cowpea area was planted to improved varieties, where adoption of these varieties increased cowpea yields by 29-40% and incomes by 26-28%.

FP2: While the FP2 did not receive W1/W2 funds, several bilateral projects were mapped to this flagship. A brief description of achievements in these bilateral projects is provided below.

The Agribusiness and Innovation Platform (AIP) at ICRISAT works for the benefit of smallholder farmers through an inclusive market-oriented approach comprising of agri-entrepreneurship development, community-level sustainable agribusiness models, and nutrition improvement. As a Centre of Excellence in Tribal Development designated by the Government of India, AIP is building strong partnerships with the Government of Telangana in India for the development of tribal farmers and to improve dietary diversity among tribal communities. Nutrition studies were undertaken to generate metrics of women and children, leading to appropriate nutritional interventions. AIP has been promoting value-addition opportunities for farmer groups and linking them directly to markets in Telangana, Andhra Pradesh and Tamil Nadu in India. In 2018, projects undertaken by AIP impacted 2,000 farmers through training and capacity building, offered nutritional support to 18,000 women and children, and provided sustainable business models to the farmer community of 50,000 members, and women self-help group with 700 members. Its Agri-Business Incubator incubated 11 ag-tech start-ups that generated 792 jobs and benefited 2.8 M farmers across India from their products and technologies. AIP also provided Intellectual Property Rights (IPR) services to 100 users, for filing of patents, trademarks, design and geographical indications including capacity building on research commercialization and the use of IPRs benefiting 700 users directly and 3,000 indirectly.

FP3: Efforts were made in Burkina Faso and Senegal during the 2018 cropping season to achieve the planned outcomes of enhancing soil-crop-water and nutrient interactions, revealing increased soil carbon stock, millet yield, NPK (nitrogen phosphorus potassium) fertilizer efficiency, performance of millet/ cowpea association and millet/peanut rotation which might have all resulted from improved nutrients and

water efficiency. It also addressed biotic stresses by reducing agro-chemical inputs in controlling pests and diseases by tailoring their management to the regions. A network of participatory field trials was initiated under smallholder conditions in Malawi during the 2017/2018 cropping season across various livelihood contexts where land equivalent ratios (LERs) of all intercrop combinations were found to be greater than unity, thereby indicating more efficient and productive use of environmental resources by intercrops. The economic returns and benefit-cost ratios were greater for intercrops than either sole crop. Efforts were made in Mozambique, Malawi, Rwanda and Uganda to determine portfolios of household activities, enterprises and management practices that materially and equitably enhance livelihoods while minimizing negative externalities. This work (in progress) is part of trade-off analysis/household modelling and is being undertaken in India with Krishi Vigyan Kendras (KVKs) and in Niger and Burkina Faso (in association with Crop-livestock value chain project). The field work was carried out during July to November concurrently in both the locations and initial scenario were developed in November-December. A set of activities was also devoted to identifying the right criteria/indicators to be used in any impact assessment activity. Activities also included modelling frameworks to evaluate the trade-offs and co-design farming systems for enhanced resilience and income. Cropping system modelling tools were assessed/validated in India for their integration into breeding programs as a decision-making support tool on optimization of Genotype x Environment x Management (GxExM) for target population of environments. This work is still in progress and is being undertaken in India currently and is a continuous activity. Field testing of co-designed improved farm systems on integrated crop, composting and animal feeding is ongoing with Malian farmers.

FP4: To address Genotype x Environment (GxE) interactions for efficient selection decisions by deploying cost-effective genotyping in soybean, cowpea, groundnut and pigeonpea, multilocation testing sites were expanded in partnership with the national agricultural research system (NARS). The multilocation and national testing resulted in the commercialization of 73 cultivars of 9 GLDC crop commodities in 16 target countries of Africa and Asia. This included biofortified cultivars like Parbhani Shakti sorghum (India), EUFM 403 pearl millet (Kenya), Barimasur 9 lentil (Bangladesh) and Khajuro Masuro 4 lentil (Nepal). Biofortification was mainstreamed especially in sorghum, lentil, soybean and pearl millet that were released to contribute to the Program-level outcome of value chains and consumption of nutritious GLDC crops. Favour variety of soybean with high protein content is driving women and youth entrepreneurship. Robust and non-destructive phenotyping tools like Near-Infrared Spectroscopy (NIRS) and X-ray fluorescence (XRF) were optimized to enhance selection efficiency for grain quality. Collaborations with FP5 were enhanced to deploy diagnostic single nucleotide polymorphism (SNP) markers in soybean, cowpea and groundnut for early generation selection. Improved genetics for climate resilience is a key delivery that contributes to the Program outcome of expanded and resilient production of GLDC crops. Adaptation to water deficit stress is targeted in eight crop commodities and heat tolerance is critical for expanding production across seasons and emerging areas such as off-season pearl millet cultivation in WCA and SA. Heat tolerance in chickpea and pearl millet breeding pipelines was mainstreamed in SA for specific target sites, and breeding for low nutrient adaptation was targeted in crops like cowpea and groundnut. Machine-harvestable chickpea and lentil have the potential to promote youth and women entrepreneurship, while high oleic groundnut and grain sorghum suitable for brewing are market traits of industrial importance. Crop Network Groups (CNGs) as a platform for crop product design, development, testing, advancement and delivery enhanced multi-stakeholder engagement. Product design also involved collaboration with FP1 and FP2.

FP5: Advances in genomics, trait mapping, breeding and enabling tools/technologies provide excellent opportunities to impact the rate of genetic gains in GLDC crops. The focus of this Flagship was on trait discovery/mapping/dissection, functional validation of traits and pre-breeding by exploiting natural and/or systematically induced variations for prioritized traits in combination with modern genomics, transgenics, phenomics, and breeding tools for accelerated, precise, cost-effective and efficient breeding of new varieties. Prioritized traits (Botrytis Grey Mould – BGM in chickpea and heat tolerance in pearl millet) were advanced through ongoing pre-breeding by exploring the natural diversity in wild/unadapted germplasm. In addition, the focus was on the characterization and advancement of already developed transgenic events for traits such as insect resistance in chickpea, pigeonpea and cowpea, and aflatoxin resistance [Host Induced Gene Silencing (HIGS) approach] in groundnut, where natural diversity is not

available. The trait discovery cluster focused on mapping and dissection of top priority traits such as high oleic in groundnut and stay-green in sorghum for marker development and validation. Significant advances were also made in the development and validation of genomic selection (GS) models in chickpea. Molecular breeding lines harboring Quantitative Trait Loci (QTLs)/genomic regions controlling desired traits such as high oleic in groundnut, drought tolerance in chickpea, stay-green in sorghum and downy mildew/blast resistance in pearl millet were advanced in elite lines. Besides, enabling technologies involving standardizing protocols, establishing proof-of-concept in genome editing, second generation transformation (QuickCrop from Corteva Agriscience), systematic mutant population and rapid generation advancement (RGA) were initiated in collaboration with advanced private sector partners. Research activities also included capacity development by supporting the training of students and researchers (especially NARS partners), training courses, seminars, workshops, symposia, and exchange visits, besides knowledge sharing and data management.

1.2.2 Progress by Flagships (optional)

For a more detailed progress by Flagship, please follow the following links:

FP1: http://gldc.cgiar.org/progress-in-fp1-priority-setting-and-impact-acceleration-2018/

FP2:http://gldc.cgiar.org/progress-in-fp2-transforming-agri-food-systems/

FP3: http://gldc.cgiar.org/progress-in-fp3-integrated-farm-and-household-management/

FP4: http://gldc.cgiar.org/progress-in-fp4-variety-and-hybrid-development-2018/

FP5: http://gldc.cgiar.org/progress-in-fp5-pre-breeding-and-trait-discovery/

1.2.3 Variance from Planned Program for this Year

(a) Have any promising research areas been significantly expanded? If so, for each example, please explain clearly where the demand came from (promising research results, demand from partners etc.). Where has the money for expansion come from?

FP1: There were no research areas that were significantly expanded or that have been dropped or significantly cut back. Given that 2018 was the first year of GLDC, no Flagships or specific research areas changed direction.

FP2: FP2 remained unfunded. However, to capitalize on the tenants of this flagship, several bilateral projects were mapped to it, besides the resolve to create a new cross-cutting theme on markets and partnerships in 2019.

FP3: There seems to be a huge demand for identifying criteria for sustainable intensification, with parallel initiatives by CRP-Roots Tubers and Bananas, CRP-Maize and CRP-Wheat and interest from partners like Wageningen University & Research (WUR) and Swedish University of Agricultural Sciences (SLU). Such interest manifested itself through AgriFoSe (Swedish funding) to conduct a literature review on SI indicators for smallholder agriculture in Sub-Saharan Africa and apply our adapted SI framework to a case study to assess the effects of SI interventions in multiple dimensions. Similarly, funds were secured by Prof. Ken Giller (WUR) from the Senior Expert Program of Netherlands Organisation for Scientific Research (NWO) to contribute to SI indicator framework activities, like a joint workshop.

FP4: Biofortification and targeting grain and fodder quality traits to meet market needs have been expanded or mainstreamed in GLDC crop breeding pipelines. Availability of rapid and non-destructive methods like NIRS and XRF has enabled routine phenotyping for nutrition quality traits in most of the crop breeding programs. Biofortification has been mainstreamed in the pearl millet breeding pipeline and expanded market traits like high oleic trait in groundnut. The investment for biofortification in pearl millet and sorghum came from HarvestPlus and the Government of India, and for high oleic trait in groundnut from grants from the Government of India and MARS. Crop networks can be platforms to attract investment from the private sector for market traits, particularly from processors requiring specific

quality traits in the commodity. Quality traits can also drive new value chains such as youth and women entrepreneurs for high protein soybean and interest from some start-ups for high oleic groundnut oil. Improved grain iron (Fe) and zinc (Zn) content is a target for seven GLDC crop commodities where crop biofortification will be an integral part of future crop improvement strategies. Multilocation testing in collaboration with the National Agricultural Research and Extension System (NARES) has been expanded for the GLDC crops with support from bilateral projects. Crop Network Groups are expected to attract financial support for testing as they establish themselves as a viable multi-stakeholder platform and linkages with the crop improvement modernization efforts through bilateral and W3 funds.

(b) Have any research lines been dropped or significantly cut back? (Please note that cutting research lines which do not seem to be delivering is seen by Funders and System Organization as a sign of good management, not of failure.) If so, please give specific examples and brief reasons. If funding was reallocated to other work, where did the money go?

FP4: The flagship activities are mapped to priority setting and focus traits for improvement of GLDC crops (Swamikannu et al. 2019), and no research lines were dropped.

(c) Have any Flagships or specific research areas changed direction? If so, please describe how, and the reason.

FP3: During the FP3 launch workshop in Nairobi during 1-2 October 2018, the rationale for the numbering of clusters of activities (CoAs) was questioned and a different numbering proposed. Participants agreed that CoA 3.2 which operates at plot level should be the first cluster and coded CoA 3.1 while former CoA 3.1 will become CoA 3.2.

FP4: The Flagship has changed direction by enhancing its engagement with the crop value chain stakeholders of GLDC crops through CNGs. The CNG model enables a structured and regular engagement with the private seed sector including small- and medium-scale seed industries to sustain seed system innovations. CNGs engage through crop product design, development, testing, advancement and delivery. The investment to support CNGs came from the Innovation Funds of CRP-GLDC for Africa. Besides, the existing networks like Innovation et amelioration variétale en Afrique de l'Ouest (IAVAO) for multi-crop commodities in WCA, Hybrid Parents Research Consortium (HPRC) of sorghum, pearl millet and pigeonpea in SA and CNG for groundnut in Asia as part of the OPEC Fund for International Development (OFID) project are also used to link to the CNGs. These CNGs will play an important role in modernizing crop improvement of GLDC crops and their seed systems.

1.2.4 Altmetric and Publication Highlights

While CRP-GLDC did not subscribe to Altmetrics, ILRI and ICARDA developed a low-cost user-friendly tool to review the score: ArES (Agricultural Research e-Searker) based on the free Altmetrics version. The tool will be improved with ICRISAT Open Access Repository (OAR) in 2019. Since 2017 was a gap year when there was no CRP on Grain legumes and Dryland Cereals, during the current reporting period, publications from 2017 and 2018 that are attributed or linked to GLDC crops have been considered for reporting. Hence, during 2017 and 2018, the CRP-GLDC produced 252 peer-reviewed publications of which 62% are ISI and 63% Open Access. All the Altmetric scores collected come from peer-reviewed publications and only one working paper with average values.

For each information product (Table 6), the scores reflect the calculation for the Altmetric valuing. High "Mentions" are generally paired with a similar high Altmetric Score while the "Readers" value is almost independent. One exception is the Journal Article "How immediate and significant is the outcome of training on diversified diets, hygiene and food safety? An effort to mitigate child undernutrition in rural Malawi" showing a significant disproportion between the Altmetric Score and its Mentions, highlighting an uptake in news and blogs which are more valuable than other media in the Altmetric index.

There is no evident trend among the records to be evaluated, since the scores look independent from ISI status or Impact Factor amount.

Among the key publications with potential for increasing metric over time, we highlight Sita et al. 2018 and Gaddameedi et al. 2018. The focus of the papers is on (a) improved genetics of GLDC crops for climate resilience and biofortification as focus research areas under FP4 contributing to IDOs; (b) increased resilience to climate change through climate-tailored varieties and (c) improved diets. The first paper highlights heat-tolerant lentil genotypes that have better coping mechanisms for seed filling, quality and yield compared to sensitive genotypes, suggesting the opportunity to improve tolerance to high temperatures, which drastically reduce biomass and seed yield in lentil. The second paper on grain Fe and Zn inheritance and gene action studies guide the breeding program to use reciprocal recurrent breeding strategies to enhance genetic gain for mineral composition in hybrids and Open Pollinated Varieties (OPVs) in sorghum. Looking at 2017 publications, we noted that a paper such as "Peanuts that keep aflatoxin at bay: A threshold matters" reached a very high level of mentions with a good number of citations.

1.3 Cross-cutting Dimensions

1.3.1 Gender

The CRP-GLDC continues to be committed to an *'inclusive and equitable innovation system for accelerating impacts for women and young people'* in the drylands. The GLDC gender research agenda was designed to be unique for each FP, aligned to the key issues on the impact pathway. The issues are assumed to be distinct enough to implement different activities in each FP. GLDC has five strategic areas: (i) traits, preferences and breeding product profiling (FP5 and FP4); (ii) inclusive seed delivery systems (FP4); (iii) gender gaps in cereals and legume production systems (labor, decision-making, knowledge access, yield, participation) and nutrition (FP3); (iv) gendered value chain development, learning and impacts and (v) social norms and behavior change for men and women to support women empowerment and impacts on delivery of GLDC research outputs (FP1).

In 2018, CRP-GLDC participated in the global process of preparing gender-responsive product profiling and gender-responsive customer profiling tools through the 'Gender and Breeding Initiative of the CRPs (currently hosted by CRP-RTB). These tools guide practices and application in the Gender-responsive plant breeding process and align to the excellence in breeding module 1 processes. This will result in the inclusion of women in participatory varietal selection (PVS) and gender-disaggregation of trait preferences in the CRP-GLDC crops and varieties. Women are a catalyst for adoption and use of local seeds as well as improved varieties, and consideration of their needs in breeding prioritization contributes to impact acceleration in the use of improved varieties.

CRP-GLDC is designed for inclusion and equity among female and male beneficiaries and stakeholders, adapting capacities and strengthening institutions to ensure (i) a convincing evidence-base on strategic gender topics; (ii) mainstreaming gender analysis across CRP-GLDC research areas; (iii) enhancing gainful participation of women and youth in CRP-GLDC value chains and (iv) developing interventions that are responsive to gender and social inclusion interests. In 2018, CRP-GLDC partnered with Gender-Responsive Researchers Equipped for Agricultural Transformation (GREAT) through the Tropical Legumes project (www.greatagriculture.org), where GREAT delivers training to agricultural researchers from SSA in the theory and practice of gender-responsive research, seeking to increase opportunities for equitable participation and sharing of benefits from agricultural research and improve the outcomes for smallholder women farmers, entrepreneurs and farmer organizations across SSA. Fifteen teams of breeders and social scientists from seven SSA national breeding programs that aligned to CRP-GLDC were trained in a customized session with a view to building a community of practitioners who can implement gender-responsive breeding projects as a norm. This provided a better understanding of empowerment as a framework of reaching, benefiting and empowering.

In 2018, CRP-GLDC initiated a Gender Internship Program to expand the capacities of young scientists and mentoring them to contribute to the gender research agenda. Two emerging scientists (one male and one female) have been mentored to grow their skills in research designing and planning of gender research, field level collection of qualitative and quantitative data and training on analysis and interpretation of results. One of the interns will be presenting a paper at the upcoming 'Seeds of change' conference at

the University of Canberra, Australia. We envisage that their internships will ground them to be future pioneers of gender research and contribute to a more sustainable GLDC farming and agri-food systems.

In 2018/2019, CRP-GLDC concluded a postdoctoral fellowship that was initiated in the first phase of the CRP-Grain Legumes (GL) on 'Understanding of gender gaps among men and women in legumes and cereals production systems'. This resulted in two gender disaggregated datasets (groundnut in Malawi and sorghum in Uganda), two book chapters, two journal papers at different stages of preparation and a policy brief. The work has confirmed that there are gender gaps in legumes and cereals production, ranging from 30-40%. Patriarchal and matrilineal kinship structures have different outlays of assets and power relations; and much as we would expect women in matrilineal kinship structures to be more empowered and produce more groundnuts than men, it turns out that the men in the matrilineal systems are the highest producers of groundnuts. In Uganda, commercialization of sorghum by the Nile Breweries is leading to two different pathways to realignment of gender roles vis-à-vis the crop in the households. In one area where men have one wife, they are taking over from women (even though sorghum was a women's crop), while in the other area where men are polygamous, sorghum production is done jointly.

1.3.2 Youth and Other Aspects of Social Inclusion/"Leaving No-one Behind[1]"

Youth Transitions in the Drylands: Understanding the Realities, Aspirations, Challenges and Opportunities

The source of future jobs, the role of youth in agriculture, the future of agriculture in dryland areas and how the next generation will be fed are major concerns for researchers, policymakers and governments internationally. The dryland areas account for three-quarters (66%) of SSA cropland and is home to about 500 M people (USAID 2014). The non-involvement of young people in agriculture, compounded by the lack of interest among the youth to pursue agricultural-based livelihood careers (Swarts and Aliber 2013), has resulted in an increasingly ageing population (Giuliani et al. 2017) which is getting feminized more and more as men migrate from the rural areas. It is feared that very few young people are pursuing agriculture and that there is likely to be a few experienced youths to take over agricultural-related activities, resulting in the reduction of knowledge transfer from the ageing farmers to the next generation of farmers. However, stakeholders believe that the formulation of youth-oriented policies and innovations can bring new hope of improving agricultural productivity, fighting poverty and food insecurity in these areas.

In responding to the System Management Office (SMO) guidelines of demonstrating how CRPs are engaging with the youth, CRP-GLDC committed resources towards a four-step process of designing a strategy for Youth Research in the Drylands. The first step included recruiting a team of young and emerging scientists to contribute to the implementation of the study with a youth perspective. An MSc level graduate intern and a PhD student were identified through a competitive process and tasked with putting together a literature review on 'Youth Transitions in the drylands: realities, aspirations, challenges and opportunities'. The report proposes a framework of field level data collection among the youth and persons of older ages, who will share their 'youth transition' steps of life for analysis and insights. In early 2019, partnerships will be initiated with university programs in Ethiopia, Tanzania and Uganda for primary level data collection. A workshop on conceptualization of the study methodology and operationalization of the process will be held for field team members from the three countries in early 2019. We anticipate that field level data will be collected in selected dryland areas of the selected countries, including Amhara and Tigray in Ethiopia, Dodoma and Shinyanga regions in Tanzania as well as North and East Regions of Uganda. The primary data collection in the three countries will be implemented in 2019.

[1] Leaving no-one behind is a key facet of the SDGs: https://unstats.un.org/sdgs/report/2016/leaving-no-one-behind

Understanding Adolescent Nutrition in South Asia

There is a gap in the availability of global datasets on adolescent nutrition and nutrition outcomes for most countries. This is primarily because most global studies focus on children below the age of 60months and women of reproductive age. Realizing this gap, ICRISAT invested in understanding the nutrition status of adolescent girls in the state of Telangana, India, where the first dataset shows 67% of them to be underweight. A multi-pronged approach to improve the nutritional status is being adopted, which includes the consumption of nutrient-rich and nutrient-dense CRP-GLDC crops as part of the state feeding program; improving nutrition education and literacy through messaging and contributing to changes in appreciation of diet quality through Behavior Change Communication. Nutritional outcomes are being monitored in 2019.

1.3.3 Capacity Development

Capacity development is an integral part of the CRP with over 75% of the activities focused on the development of diverse capacities as their main objective. In 2018, CRP-GLDC conducted 15 training programs for NARS and private sector partners on advanced breeding technologies, seed systems, farming practices, modelling, as well as research and analytical methods. Remarkable among these is the training program under FP3 which allowed 1198 men and 941 women to learn improved agronomic practices related to GLDC technologies. In addition, Flagships 1, 3 and 4 started to implement different types of multi-stakeholder innovation platforms. Many activities focused on supporting the growth of future research leaders through scholarships and exchange programs. Ten Ph.D. and at least eight M.Sc. students received support and contributed with their projects to CRP-GLDC outputs. One student was trained at Corteva Agriscience on quick crop transformation techniques for sorghum and pearl millet. Noteworthy was the cooperation with Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) using the GLDC Innovation Fund to support the involvement of students from Kenya, Uganda and Nigeria in GLDC activities.

The CRP-GLDC Capacity Development Task force supported Flagship scientists in their capacity development efforts. It used multiple occasions to raise awareness on the diversity of capacity development interventions by supporting a less opportunistic and more strategic view of scientists on the topic. Efforts were made to better understand the nature of capacity development activities, besides exploring the perceived demands for support in such activities. In addition, the Task Force developed the technical foundation for a GLDC E-Learning platform to be implemented in 2019. A paper has been published on the role of stakeholder involvement in trans-disciplinary research processes (Schmidt et al. 2018).

1.3.4 Climate Change

The activities of FP3 contributing to climate change issues were around analyzing the impacts of long-term weather datasets on the incidence of diseases of chickpea (1975 to 2017) and pigeonpea (1972 to 2017) in India. The results indicated that pigeonpea is predisposed to Phytophthora blight disease within 5-7 days of rainfall (>300 mm), and that Fusarium wilt-resistant cultivars succumb to dry root rot at temperatures >33°C. Resilient and disease-tolerant soybean, cowpea, groundnut, pigeonpea and other legume varieties have been identified and promoted for integration into cropping systems. Crop production practices that encourage soil cover at all times to minimize soil moisture loss and other water management measures such as water harvesting, erosion control and appropriate planting time to increase water use efficiency were promoted. FP3 research developed and piloted systems modelling frameworks (crop modelling and whole farm bio-economic modelling) to support the upscaling of climate smart agriculture in semi-arid India, that parameterized and validated the whole farm bio-economic model for six locations in Telangana and Maharashtra states of India. Building the extension system's capacity on systems modelling tools has also been initiated. The multi-model systems analysis was used to identify Low Emissions Development Pathways to explore synergies and trade-offs in Mahbubnagar district of Telangana in India. The case study 'Identifying Low Emissions Development Agricultural Pathways in Semi arid Tropics' was presented at the Independent Science and Partnership Council (ISPC) Science Forum 2018.

2. Effectiveness and Efficiency

2.1 Management and Governance

The entire governance structure of the CRP-GLDC was new as it was launched during 14-16 February 2018. Guidance and approval were solicited from the 12-member Independent Advisory Committee (IAC) which includes 7 non-CGIAR members and 5 ex-officio CGIAR members. One of the ex-officio members is the Director General of the lead center. A preliminary IAC meeting was held on 14 February 2018 to seek guidance on filling the remaining membership seats with emphasis on gender balance. Women now constitute 42% of the IAC. The IAC's first meeting was held virtually in September 2018 followed by an in-person meeting in October 2018.

The Director of CRP-GLDC who is also the Deputy Director General for Research at ICRISAT, reports to the Director General of ICRISAT and chairs the Research Management Committee (RMC) where the responsibility of implementation of the CRP-GLDC resides. The RMC has 14 members, including five Flagship Program (FP) Leaders, the Senior Gender Scientist, three Center Focal Points and the CRP-GLDC Director. Leadership of the FPs rest with: FP1: IITA, FP2: CSIRO (remains unapproved), FP3: ICRAF, FP4: ICRISAT and FP5: ICRISAT. In addition, the RMC includes three non-CGIAR partners. The RMC was primarily responsible for the establishment, execution and monitoring of the CRP research portfolio, strategy, workplans and annual budgets. In 2018, ten meetings of the RMC were held, including an in-person joint meeting of RMC and IAC in October 2018.

Overall, FP management is the responsibility of the FP Leader who is supported by the CoA co-leaders of the respective Flagship. The FP and CoA co-leaders devote at least 40% of their time on the CRP-GLDC, funded from W1, W2, W3 and bilateral projects. These CRP leadership positions combine management responsibilities with active research leadership.

2.2 Partnerships

2.2.1. Highlights of External Partnerships

External partnerships are fundamental for accomplishing scale-out and scale-up of CRP-GLDC outcomes, besides addressing operational arrangements with non-CGIAR partnerships. Key partnerships involved:

- Household aspirations with Cynefin Centre using the Sensemaker method adjusted for agricultural settings.
- The gender and youth team with Makerere University (Uganda), Haramaya University (Ethiopia), Sokoine University of Agriculture (Tanzania) and the University of Nairobi (Kenya).
- A synthesis of impact studies and scaling approaches with University of Wisconsin, USA.
- Cowpea adoption and impact study by IITA and AR, Nigeria to develop and disseminate improved varieties and agronomic practices.
- Testing of soybean to identify high-yielding drought and disease-tolerant varieties for agro-ecologies across Africa including Mozambique with the Soybean Innovation Lab and Syngenta Foundation.
- Partnerships with the National Smallholders Farmers Association of Malawi (NASFAM) and the Ekwendeni Hospital Soils and Health Project to improve farmers' knowledge and skills in improved crop production practices in Malawi.
- Research and student training at the Institute for Rural Development at Université Nazi Boni (UNB).
- Sustainable intensification framework and sustainability assessment research between ICRISAT, ICARDA, WUR and SLU.
- Training workshop on Systems modelling and capacity building with CSIRO, Australia.
- Contextualizing research, capacity building, linking with farmers and NARS in Burkina Faso (INERA), Mali (IER), Niger (INRAN), Senegal (ISRA), India (ICAR), Tunisia, Syria and Sudan.

- Testing and delivery of CRP-GLDC crops with CNGs, ADVANTA, Seed Co. and Syngenta Foundation.
- Understand gender dynamics in African seed systems with National Agricultural Research Organisation-National Semi-Arid Resources Research Institute (NARO-NaSSARI), Makerere University, and Center for Behavior Change Communication, Kenya.
- Phenotyping for heat with PAU, India and ARC, Sudan, and disease and low nutrients in lentil with BCKVV, India.
- HPRC-ICRISAT being strengthened and extended to SSA.
- Access to knowledge and cutting-edge technologies for crop improvement from Corteva Agriscience.
- In pearl millet, heat screening with Pioneer Hi-bred Pvt. Ltd., Bayer BioScience Pvt. Ltd. and Metahelix, India and drought screening with CCSHAU, India.

2.2.2. Cross-CGIAR Partnerships

A partnership with CRP-PIM (Policies, Institutions and Markets) has enabled updating of the GLDC database of the International Model for the Policy Analysis of Agricultural Commodities and Trade (IMPACT) for foresight modelling and ex-ante analysis for priority setting. Gender researchers attended the scientific conference and capacity development workshops of the CGIAR Collaborative Platform for Gender Research. A new partnership between ICRAF, ICRISAT and Cynefin Center is providing insights on how multiple income streams interact and the role they play in determining household aspirations. Cynefin Center's distributed ethnography tools and ICRAF and ICRISAT's deeper understanding of the farming system in developing countries together allow the team to conduct ethnography at scale. Interactions have been initiated with CRP-RTB, CRP-Maize and CRP-Wheat to identify criteria and indicators to assess sustainability across farming systems/regions.

Engagement with the Excellence in Breeding (EiB) platform to drive innovation in designing product profiles, adopting stage-gate system, phenotyping, genotyping and knowledge sharing is ongoing. The High Throughput Genotyping Platform (HTGP) of EiB was deployed in crop breeding pipelines, particularly for early generation testing. Arrangements are on with the CGIAR Genebank Platform to tap novel diversity of GLDC crops and evaluate finger millet accessions for fodder and nutritional quality traits in breeding programs. With the Platform for Big Data in Agriculture, Digital Seed Road Maps were rolled out to support seed systems in Africa. For effective and timely delivery, expertise of EiB modules were leveraged for the development of product profiles, stages and gateways, genotyping/sequencing related services, phenotyping and data management. A new partnership is under development between Corteva-ICRISAT-EiB for pearl millet improvement.

2.3. Intellectual Assets

(a)Have any intellectual assets been strategically managed by the CRP (together with the relevant Center) this year? E.g. taking out intellectual property rights, licensing, new innovative practices. (Strategic management implies involvement of PMU, Flagship or cluster leaders in decision making, in furtherance of the CRP Theory of Change.)

CRP-GLDC planned and implemented intellectual assets (IA) generation (primary data collection, curation, storage and dissemination) with IA management units of centers, SMO and the Platform for Big Data in Agriculture to mainstream good practices in asset management, including storing and sharing of information. The major outputs were:

- 55 cultivars of five crop commodities released by ICRISAT with NARS and other partners.
- Two cowpea breeding lines, IT07K-297-13 and IT08K-150-12, released as SAMPEA 18 and SAMPEA 19 in Nigeria.
- TG x 1844-22E with women-preferred nutritional traits released as 'Favour' by the Council of Scientific and Industrial Research - Savanna Agricultural Research Institute (CSIR-SARI), Ghana and distributed through IITA Soybean International Trials.

- Sequenced the pearl millet downy mildew pathogen (Chandra Nayaka et al. 2017).
- The genome information of the downy mildew pathogen made available in the National Center for Biotechnology Information (NCBI) genebank database.
- Two Data Hackathons were conducted in India and Malawi along with the Platform for Big Data in Agriculture with 49 participants submitting over 100 datasets (75 linked to publications).
- 252 peer-reviewed publications in reputed international journals have been uploaded on each participating institution's repository and harvested in MEL. Of these, 83 peer-reviewed publications from 2017 have also been included since the CRP-GLDC did not exist in 2017. More details are available in Table 6.

CRP-GLDC focused on traditional knowledge related to norms surrounding the gender division of roles in lentil production, farm-related decisions, extension services and innovations. The findings were shared to confirm that the research team accurately understood the reality and to raise local awareness of the implications of gender inequality on lentil production and to uphold the community's rights.

b) If relevant, indicate any published patents and/or plant variety right applications (or equivalent) associated with intellectual assets developed in the CRP and filed by Centers and/or partners involved in the CRP, giving a name or number or link to identify them.

N/A

c) List any critical issues or challenges encountered in the management of intellectual assets in the context of the CRP (or put N/A).]

N/A

2.4 Monitoring, Evaluation, Impact Assessment and Learning (MEIAL)

CRP-GLDC established a cross-institutional working team housed within FP1 and supported by the PMU. Constituent organizations strengthened their institutional framework with the establishment of institutional M&E teams across Programs and Projects (e.g. IITA, ICARDA). The award-winning Management Information System (MIS) MEL was adopted and collaborated with CRP-RTB and CRP-FISH for future enhancements while supporting the SMO in its effort to establish CLARISA, a common dashboard. This contribution will be completed in 2019. Joint efforts for common Results-Based Management (RBM) Framework review took place with CRP-RTB and CRP-A4NH (Agriculture for Nutrition and Health), benefiting from organizations working in both CRPs (e.g. IITA and CIRAD). This support was provided to the CRP-GLDC teams in India, Kenya, Morocco, Niger and France, and other colleagues through video-conference support, online tutorials and guides. Planned Outcome and Impact exercises have been extended to 2019 for reasons detailed in Table 11. A few effectiveness and adoption studies have been completed as mentioned in the FP1 narrative and related table. In 2019, the focus will be on ensuring a more systematic approach of additional work and leveraging joint exercises across partners and programs.

2.5 Efficiency

Adoption of an MIS[2] led to efficiency gains by moving from conventional reporting, besides automating and harmonizing CRP-GLDC management. Some planning and reporting will still require conventional processes of compiling and editing. However, the number of emails on reporting preparations dropped by 70% since the planning stage (when it was done through exchange of files and notes by emails) to now.

[2] MEL: https://mel.cgiar.org/

Implementation of strong data management and analytical research support tools have taken crop breeding activities to the next level. This includes the Breeding Management System (BMS)[3], Genomic Open-Source Breeding Informatics Initiative (GOBii), a genomic data management system and public data sharing portals such as Dataverse and Comprehensive Knowledge Archive Network (CKAN). Such databases render crop breeding highly efficient through access to pedigrees, electronic field books, in-field auto data validation, automated workflows to generate barcodes, tools for auto-generation of field books with updated records of pedigree data and quick exploratory statistical analysis. Electronic field books have eliminated the need to key in data and enabled the availability of data in the database immediately after recording. This reduces the time in breeding decisions and incorporates greater rigor by integrating high quality statistical data analysis. As each plot is barcoded (and even plants in some cases), researchers can perform genomic selection in routine breeding by linking barcodes from phenotypic databases to genomic databases.

More frequent virtual RMC and IAC meetings have improved financial savings as well as knowledge exchange and quality assurance processes.

2.6 Management of Risks to CRP

The CRP-GLDC Director's 20% role undertaken by the Deputy Director General-Research (DDG-R) of ICRISAT, is supported by a full-time Program Manager. The CRP-GLDC management will be reviewed in 2019 after 12 months' operations to ensure that the governance structure supports good decision making in a transparent, fair and efficient manner for success. While this CRP continued to operate with the unfunded FP2 in 2018, projects worth US$ 7.5 M supported through W3/Bilateral funds were mapped to FP2, which risks numerous disjointed projects with potential for duplication of efforts. Such mapped projects have little incentive to engage in the administrative burden without a fully functional Flagship supported with W1 and W2 funding.

Although a new Flagship (FP6) on Common Bean for Markets and Nutrition led by CIAT has been integrated with CRP-GLDC, concerns with regard to transaction costs, including governance challenges, hosting arrangement and management information system Managing Agricultural Research for Learning and Outcomes (MARLO) remain unresolved and could present potential risk for the remaining period of CRP-GLDC.

2.7 Use of W1/W2 Funding

To enhance the relevance and impacts of GLDC research through improved targeting and priority setting, W1/W2 funding was used for strategic ex-ante poverty impact evaluation to identify research options with greatest potential for poverty reduction. This funding along with other resources supported graduate students and interns to undertake work on an improved understanding of youth realities, youth aspirations and transitions in the drylands.

Enhancing soil-crop-water-nutrient interactions and ways to reduce agro-chemical inputs in controlling pests and diseases, evaluation of LERs of intercrop combinations and their economic returns and benefit-cost ratios, and portfolios of household activities, enterprises and management practices that enhance livelihoods while minimizing negative externalities were supported by W1/W2 funds. Identification of criteria/indicators for impact assessments and evaluation of trade-offs of co-designed farming systems for enhanced resilience and income using modelling were also supported.

[3] BMS: http://bms.icrisat.org:48080/ibpworkbench/controller/auth/login ; http://bms.icarda.org:48080/ibpworkbench/controller/auth/login;jsessionid=9FF0D7799109CC7A2F3B535755139651 / Dataverse-CKAN: http://dataverse.icrisat.org/ ; http://data.mel.cgiar.org/ ; https://dataverse.harvard.edu/dataverse/icraf ; https://dataverse.harvard.edu/dataverse/Bioversity ; http://data.iita.org/ ; http://data.ilri.org/portal/

The W1/W2 fund supported CNG platforms, a seed inventory management system towards modernizing crop breeding operations and the establishment of multilocation testing sites. While yield remains the basic trait, other value-added traits like nutrition quality and traits of gender relevance, and Quality Control to assess genetic purity of parental lines were prioritized with these funds.

W1/W2 funds were mainly utilized to support and leverage the W3/bilateral projects in the strategic/ priority areas of ongoing activities in pre-breeding, transgenics, marker development and deployment, genomic selection and markers-based introgression of QTLs/genomic regions in elite lines. Support for new partnerships in enabling technologies such as next generation transformation platforms, mutant populations and genome editing were partly supported.

3. Financial Summary

The CRP-GLDC budget of US$ 7.90 M was expressed in PoWB 2018.The guidance on Stretch Funding Target received from SMO on 3 January 2019 affected the overall budget of US$ 7.90 M for 2018 by 10.17%. The final receipt of funds for 2018 was closed at US$ 7.12 M. W1/W2 budget of US$ 7.12 M was spent at 97.28% and the remaining unspent budget of 2.72% will be carried forward to 2019. The total budget for W3/bilateral was planned at US$ 59.39 M and was spent at 80.49% in 2018.

Part B: TABLES

Table 1: Evidence on progress towards SRF targets (Sphere of interest)

SLO Target (2022)	Brief summary of new evidence of CGIAR contribution [Put N/A if the specific SRF target is not applicable to your FP. Put "No new evidence in 2018" if the target is potentially relevant, but there is no new evidence available. *Spell out all acronyms.]* *Maximum 150 words per entry.*	Expected additional contribution before end of 2022 (if not already fully covered). **Optional narrative. Evidence not required.** *Max. 100 words*
1.1. 100 million more farm households have adopted improved varieties, breeds, trees, and/or management practices	361,000 ha of chickpea in Myanmar is under improved cultivars, released through a partnership between Department of Agricultural Research (DAR) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).http://oar.icrisat.org/10926 1.845 M ha area in India is covered by pearl millet hybrids commercialized under the Hybrid Parents Research Consortium (HPRC). http://oar.icrisat.org/10626; http://hdl.handle.net/20.500.11766.1/4c6279 572,000 households benefited directly from the adoption of innovative technologies in Karnataka state, India. http://hdl.handle.net/20.500.11766.1/69f7df	Crop Network Groups (CNGs) engage the private seed sector to promote seed systems and contribute to adoption of new varieties in target countries. http://hdl.handle.net/20.500.11766.1/4796ca The potential area over which CRP-GLDC crops might be adopted in the target countries in 2022 is 0.97 M ha. https://dx.doi.org/20.500.11766/9849
1.2. 30 million people, of which 50% are women, assisted to exit poverty	In India, 1.845 M ha of HPRC pearl millet hybrids resulted in an additional income of US$ 74/ha, equivalent to a total benefit of US$ 133 M per year. http://oar.icrisat.org/10626; http://hdl.handle.net/20.500.11766.1/4c6279	
2.1. Improve the rate of yield increase for major food staples from the current <1% to 1.2-1.5% per year	In Myanmar, by adopting new varieties chickpea farmers harvested double the yields, from 660 kg/ha in 1998 to 1,400 kg/ha in 2017. http://oar.icrisat.org/10926 A 20% increase in pearl millet grain and fodder yields in farmers' fields in India through the Hybrid Parents Research Consortium. http://oar.icrisat.org/10626; http://hdl.handle.net/20.500.11766.1/4c6279	
2.2. 30 million more people, of which 50% are women, meeting minimum dietary energy requirements	No new evidence in 2018.	

Continued...

...Continued

Table 1: Evidence on progress towards SRF targets (Sphere of interest)		
SLO Target (2022)	**Brief summary of new evidence of CGIAR contribution** [Put N/A if the specific SRF target is not applicable to your FP. Put "No new evidence in 2018" if the target is potentially relevant, but there is no new evidence available**.** *Spell out all acronyms.]* *Maximum 150 words per entry.*	**Expected additional contribution before end of 2022** (if not already fully covered). **Optional narrative. Evidence not required.** *Max. 100 words*
2.3. 150 million more people, of which 50% are women, without deficiencies in one or more essential micronutrients	Improved nutritional quality is the key focus of GLDC product development. http://oar.icrisat.org/10866 https://dx.doi.org/20.500.11766/9284; http://oar.icrisat.org/10849 Dhanashakti, a biofortified pearl millet cultivar, was adopted by more than 35,000 farmers on >65,000 ha in India. https://www.icrisat.org/biofortified-pearl-millet-varieties-to-fight-iron-and-zinc-deficiencies-in-india New biofortified cultivars of sorghum (Parbhani Shakti in India), lentil (Barimasur 9 in Bangladesh and KhajuroMasuro 4 in Nepal), pearl millet (EUFM 403 in Kenya) released in 2018 contribute to improved diets. https://mailchi.mp/illinois/new-published-research-tasty-soy-badjias-in-sils-weekly-digest?e=ef90aaaeb5 https://www.icrisat.org/india-gets-its-first-biofortified-sorghum/	
3.1. 5% increase in water and nutrient efficiency in agroecosystems	Adaptation of GLDC crop cultivars to water deficit stress and climate change effects is the focus of the GLDC breeding pipelines. http://oar.icrisat.org/10619; https://dx.doi.org/20.500.11766/9639 https://dx.doi.org/20.500.11766/9285	
3.2. Reduction in 'agriculturally'-related greenhouse gas emissions by 5%	System level outcome (SLO) target not addressed (CRP Proposal, Page 12-13). https://hdl.handle.net/10947/4522	
3.3. 55 M ha degraded land area restored	System level outcome (SLO) target not addressed (CRP Proposal, Page 12-13). https://hdl.handle.net/10947/4522	
3.4. 2.5 M ha forest saved from deforestation	System level outcome (SLO) target not addressed (CRP Proposal, Page 12-13). https://hdl.handle.net/10947/4522	

Table 2: Condensed list of policy contributions in this reporting year (Sphere of Influence)							
Column 1	**Column 2**	**Column 3**	**Column 4a**	**Column 4b**	**Column 4c**	**Column 4d**	**Column 4e**
Name and description of policy, legal instrument, investment or curriculum to which CGIAR contributed (20-50 words, ideally around 30 words) ***Spell out acronyms in every row***	**Level of Maturity**	**Link to sub-IDOs (max. 2)**	**CGIAR cross-cutting marker score** **Gender**		**Youth**	**Cap Dev**	**Climate change**	**Link to OICR (obligatory if Level of Maturity is 2 or 3) or link to evidence** **(e.g. PDF generated from MIS)**
FP3: Modules of Arbuscular mycorrhizal bio fertilizer (AMF) inoculum use, and production have been incorporated into the curriculum at Makerere University, Uganda	1	- 1.4.5 Increased access to productive assets, including natural resources. - 2.2.1 Reducing biological and chemical hazards in the food system.	0	1	2	0	http://dx.doi.org/20.500.11766/9746
FP3: Minimum Standards on Iron and Zinc Established in Pearl Millet National Cultivar Release Policy (India)	1	2.1.1 Increased availability of diverse nutrient-rich foods.	2	1	1	1	http://dx.doi.org/20.500.11766.1/49b0d3 http://dx.doi.org/20.500.11766/9874

Table 3: List of outcome/impact case reports from this reporting year (Sphere of Influence)		
Column 1	**Column 2**	**Column 3**
Title of Outcome/Impact Case Report (OICR) with link (e.g. to CLARISA dashboard, MARLO).	**Maturity level drop down for: 1, 2, or 3**	**Indicate if this is: (drop down)** **– New outcome** **– updated Case- same level of maturity** **– updated Case- new level of maturity**
Talking Nutrition with Adolescents in the Adilabad District of Telangana. MEL link (96): http://hdl.handle.net/20.500.11766.1/428fc1	1	New outcome
Safer and More Accessible Food by 2020: Bringing the Arbuscular Mycorrhiza (AM) Biofertilizer in Uganda. MEL link (97): http://hdl.handle.net/20.500.11766.1/9e04e1	1	New outcome
Scaling-up and Popularization of High Yielding Pigeonpea Hybrids for Enhancing Productivity of Smallholder Farmers. MEL Link (98): http://hdl.handle.net/20.500.11766.1/88bab5	3	New outcome
Efficient Legume Seed Systems for Better Smallholder Farmers' Livelihoods in the Semi-Arid Tropics. MEL link (101): http://hdl.handle.net/20.500.11766.1/278ed8	1	New outcome
Strengthening quality seed production and delivery of improved varieties of dryland cereals for better smallholder livelihoods. MEL link (102): http://hdl.handle.net/20.500.11766.1/41b621	1	New outcome
Biofortified Grain Legumes and Dryland Cereals for nutritional security and wellness. MEL link (104): http://hdl.handle.net/20.500.11766.1/4c4d70	1	New outcome
Empowerment of Farmers Producers Organizations (FPOs) through Capacity Building Activities and Digital Tools. MEL link (105): http://hdl.handle.net/20.500.11766.1/80cf33	3	New outcome
A Game Changer for Smallholder Farmers: Poverty Reduction through Chickpea Adoption in Ethiopia MEL Link (106): http://hdl.handle.net/20.500.11766.1/e5dd5e	3	New impact
Impact of ICRISAT Pearl Millet Hybrid Parents Research Consortium (PMHPRC) on the Livelihoods of Farmers in India. MEL Link (107): http://hdl.handle.net/20.500.11766.1/4c6279	3	New impact
Bhoosamrudhi: Improving Rural Livelihoods through Innovative Scaling-up of Science-led Participatory Research for Development. MEL Link (108): http://hdl.handle.net/20.500.11766.1/69f7df	3	New impact
Policy favours biofortified pearl millet in India to combat Fe and Zn deficiencies. MEL Link (133): https://hdl.handle.net/20.500.11766.1/49b0d3	3	New outcome

Table 4: Condensed list of innovations by stage for this reporting year			
Column 1	**Column 2**	**Column 3**	**Column 4**
Title of innovation with link (e.g. to CLARISA dashboard, MARLO, MEL).	Innovation Type	Stage of innovation	Geographic scope (with location)
Multi-model systems analysis was used to identify Low Emissions Development Pathways – exploring synergies and trade-offs in Mahbubnagar District, Telangana, India. MEL link (49): https://mel.cgiar.org/innovation/addinnovation/id/96	Research and Communication Methodologies and Tools	Stage 1	Global
The Crop Network Group (CNG) as a platform for crop Product design, development, testing advancement and delivery in Africa. MEL link (55): https://mel.cgiar.org/innovation/addinnovation/id/104	Genetic (varieties and breeds)	Stage 2	Global
Introgression of high oleic trait in groundnut. MEL Link (162): https://mel.cgiar.org/innovation/addinnovation/id/162	Genetic (varieties and breeds)	Stage 3	Global

Table 5: Summary of status of planned outcomes and milestones (Sphere of Influence-Control)						
Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
1	Outcome 1. Improved targeting and responsiveness of research to market and household demands in the face of climate change for greater technology adoption, food and nutrition security, resilience and poverty reduction.	With the identification of priority GLDC crops and countries based largely on the initial foresight and ex-ante impact evaluation work, a sound foundation has been laid to enhance the targeting, responsiveness, and impacts of CRP-GLDC research.	Expanded foresight and ex-ante evaluation of CRP-GLDC research and technology options conducted and preliminary results shared on the potential poverty reduction impacts.	Complete	Results of the ex-ante economic and poverty impact evaluation of CRP-GLDC research and technology options were shared with GLDC researchers and stakeholders at the annual review and planning meeting in 2018. A draft report is also available. https://dx.doi.org/20.500.11766/9469 Note: The work was expanded in 2019 to include a nutrition impact dimension in addition to the planned ex-ante economic and poverty reduction impact assessment.	G: 0 Y: 0 CD: 0 CC: 1
1	Outcome 2. Market and household demands identified, and trade-offs assessed for more inclusive value chains that improve income and nutrition status in target regions.	Building on past market and value chain studies documenting market and household demands and preferences, the ongoing work introduces new dimensions such as household aspirations to better identify end-user demands and profile.	Diversity of farm household preferences vis-a-vis market demand by context outlined in view of research in CRP-GLDC.	Extended	(7. Other, please state): Ongoing work. As 2018 was the first year of CRP-GLDC, the work started in March/April and the milestone was planned to be completed only in 2019.	G: 1 Y: 1 CD: 1 CC: 0
1	Outcome 3. Inclusive and equitable technologies and innovation systems established for accelerated and broadened impact across the agri-food system.	By enhancing our understanding of the participation of women and youth in CRP-GLDC value chains as well as in technology and support service delivery, ongoing strategic gender research is generating insights that lead to inclusive and equitable technologies and innovation Systems.	Inclusive and equitable innovation system to accelerate impacts for women and young people designed and piloted, underlying design principles proven.	Extended	(7. Other, please state): Ongoing work. As 2018 was the first year of CRP-GLDC, the work started in March/April and the milestone was planned to be completed only in 2019.	G: 2 Y: 1 CD: 1 CC: 0

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Table 5: Summary of status of planned outcomes and milestones (Sphere of Influence-Control)						
Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
1	Outcome 4. Strong project design, execution, monitoring and evaluation systems and tools consistently applied in GLDC scaling projects, with demonstrable progress on enhanced adoption and impact.	By identifying successful approaches to technology scaling and the underlying institutional and policy contexts, the ongoing review of scaling approaches and impact evaluations is generating useful lessons for increased technology adoption and impact.	Joint systematic review with CoA 1.2.	Extended	(7. Other, please state): Ongoing work. As 2018 was the first year of CRP-GLDC, the work started in March/ April and the milestone was planned to be completed only in 2019.	G: 1 Y: 0 CD: 1 CC: 1
1	Outcome 4. Strong project design, execution, monitoring and evaluation systems and tools consistently applied in GLDC scaling projects, with demonstrable progress on enhanced adoption and impact.	By identifying successful approaches to technology scaling and the underlying institutional and policy contexts, the ongoing review of scaling approaches and impact evaluations is generating useful lessons for increased technology adoption and impact.	Evaluation designed and implementation underway to evaluate current CRP-GLDC scaling approaches & associated impact evidence.	Extended	(7. Other, please state): Ongoing work. As 2018 was the first year of CRP-GLDC, the work started in March/ April and the milestone was planned to be completed only in 2019.	G: 1 Y: 0 CD: 1 CC: 1
1	Outcome 4. Strong project design, execution, monitoring and evaluation systems and tools consistently applied in GLDC scaling projects, with demonstrable progress on enhanced adoption and impact.	By identifying successful approaches to technology scaling and the underlying institutional and policy contexts, the ongoing review of scaling approaches and impact evaluations is generating useful lessons for increased technology adoption and impact.	Scaling toolkit for Design, Execution, Monitoring, and Evaluation (DEME) content agreed to support improved horizontal and vertical scaling of CRP-GLDC commodities and management practices.	Extended	(7. Other, please state): Ongoing work. As 2018 was the first year of CRP-GLDC, the work started in March/ April and the milestone was planned to be completed only in 2019.	G: 1 Y: 0 CD: 1 CC: 1

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Table 5: Summary of status of planned outcomes and milestones (Sphere of Influence-Control)						
Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
3	FP3.O1. Cropping systems sustainably intensified and diversified.	Several participatory field trials on crop rotation, intercropping and agro-pastoral systems were conducted under smallholder production systems. Crop yields under intensified and diversified systems were higher than under conventional practice; land equivalent ratios for intercrops were greater than unity indicating efficient and productive use of resources.	Participatory field trials under smallholder conditions in different cropping systems and environments evaluated.	Extended	(7. Other, please state): This is a long-term study that will generate more data over time. As we initiated the study in the first year, we expect to provide an update (sharable link) in 2019.	G: 1 Y: 0 CD: N/A CC: 1
3	FP3.O1. Cropping systems sustainably intensified and diversified.	Over 2,849 farmers gained knowledge and skills in Mozambique and Malawi through training on improved agronomy including rotation sequence, cropping patterns in intercrops, variety selection, appropriate planting time, row spacing and plant population, fertilizer and inoculant application, integrated pest and disease management and aflatoxin management in groundnut and post-harvest management of legumes.	3,000 farmers trained in the use of crop mixes and sequences which have been jointly identified with the researcher for better water and soil management.	Complete	Refer to narrative statement. Evidence available for internal use in MEL.	G: 1 Y: 0 CD: 2 CC: N/A

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Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
3	FP3.O2. Pest and diseases controlled safely and with reduced agro-chemical inputs.	Reported work covers West Africa and South Asia and includes testing the efficiency of plant extracts, parasitoids, fungicides, genetics for both varieties and pathogens and changes in disease incidence linked with climate change.	1. Pest and diseases management components for the target pests and, 2. Resource and soil management options in different regions fine-tuned.	Extended	(7. Other, please state): During the FP3 meeting in Nairobi early October 2018, CoA 3.2 has reoriented its activity portfolio into two major clusters, abiotic and biotic stresses. To reflect the re-orientation, the milestone for 2019 has been reworded to read "Efficacy of (1) selected pest and diseases management options and (2) resource and soil management options confirmed at pilot scale". Hence, we expect to be able to assess the efficacy of at least one plant growth promoting micro-organism and to target recommendations for organic fertilizers at pilot scale. Also, the impact of released biological control organisms, particularly against the cowpea pod borer, will be evaluated at selected sites, while novel diagnostic tools and protocols will be made available for emerging biotic threats.	G: 1 Y: 1 CD: 1 CC: 1
3	FP3.O2. Pest and diseases controlled safely and with reduced agro-chemical inputs.		Pest and diseases management components for the target pests in different regions evaluated.	Cancelled	(7. Other, please state): This milestone has been replaced by the new re-oriented activity portfolio, as described above.	G: N/A Y: N/A CD: N/A CC: N/A

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Table 5: Summary of status of planned outcomes and milestones (Sphere of Influence-Control)						
Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply		Breeding lines from Phase I of the CRP being tested by NARS and CGIAR; 8 crops × 3 trait clusters × 2 regions advanced.	Cancelled	(7. Other, please state): Moved from CoA 4.1 to 4.3.	G: N/A Y: N/A CD: N/A CC: N/A
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply.		Phase I genetic materials deployed in CRP-GLDC crop improvement by CGIAR centers; annually 8 crops × 3 trait clusters × 2 regions tested by NARS.	Cancelled	(7. Other, please state): Moved from CoA 4.1 to 4.2.	G: N/A Y: N/A CD: N/A CC: N/A
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply.		Breeding lines from Phase I enter the National Performance Trials (NPT) or release; 8 crops × 3 trait clusters (3-4 lines per trait) × 2 regions entered in NPT.	Cancelled	(7. Other, please state): Moved from CoA 4.1 to 4.3.	G: N/A Y: N/A CD: N/A CC: N/A

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Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply.		Nursery management strengthened to support early generation seed availability for evaluations; 9 crops × 2 priority trait clusters (1° & 2°)- 20 lines per trait × 2 regions supplied.	Cancelled	(7. Other, please state): Moved from CoA 4.1 to 4.2.	G: N/A Y: N/A CD: N/A CC: N/A
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply.	Drone equipment was acquired; data acquisition and calibration completed. Two training programs on the use of drones were done at ISRA, CERAAS and CIRAD in Senegal. The first training on "Roots phenotyping" was done in Thiès (28-30 March 2018) with 16 participants and the second training on phenotyping using drones with 13 participants hosted at ISRA research station, Bambey.	Initial steps to generate crop indices from drone-based imaging in place in Senegal.	Complete	Refer to narrative statement. Evidence available for internal use in MEL.	G: 0 Y: 0 CD: 1 CC: 0
4	FP4.O2. Robust and responsive global to national breeding systems produce and deliver novel varieties and allied innovations at appropriate scale and scope.		Studies conducted to inform the seed systems strengthening areas for target cereals and legumes; at least 1 study per crop x agri-food systems x region.	Cancelled	(7. Other, please state): Moved from CoA 4.2 to 4.4.	G: N/A Y: N/A CD: N/A CC: N/A

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Table 5: Summary of status of planned outcomes and milestones (Sphere of Influence-Control)

Flagship	2022 FP Outcomes	Summary narrative on progress against each FP outcome this year	Milestone	Milestones status @ Reporting Year (complete, extended, cancelled or changed)	Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.	OECD Marker
4	FP4.O2. Robust and responsive global to national breeding systems produce and deliver novel varieties and allied innovations at appropriate scale and scope.		Complementary partners engaged to support scaling efforts based on country strategies.	Cancelled	(7. Other, please state): Moved from CoA 4.2 to 4.4.	G: N/A Y: N/A CD: N/A CC: N/A
4	FP4.O2. Robust and responsive global to national breeding systems produce and deliver novel varieties and allied innovations at appropriate scale and scope.		Gender studies and opportunities for youth in agriculture conducted. At least 2 interventions per region studied, 2 in Africa and 2 in Asia.	Cancelled	(7. Other, please state): Moved from CoA 4.2 to 4.4.	G: N/A Y: N/A CD: N/A CC: N/A
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply.	Elite lines and donors for target traits used as parents in crop hybridization. Heat-tolerant donors of chickpea, lentil, pigeonpea, groundnut, cowpea, sorghum and pearl millet are used in breeding. High Iron (Fe) and Zinc (Zn) donors are used as parents in seven GLDC crops. The information on inheritance studies guides the breeding strategy to achieve enhanced genetic gain, as in the example of recurrent selection for enhancing grain Fe and Zn in sorghum.	Phase I genetic materials deployed in GLDC crop improvement by CGIAR centers; annually 8 crops × 3 trait clusters × 2 regions tested by NARS.	Complete	https://dx.doi.org/20.500.11766/9269; https://dx.doi.org/20.500.11766/9283; http://oar.icrisat.org/10866	G: N/A Y: N/A CD: 1 CC: 0

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Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply.	International training course on Breeding approaches for enhancing genetic gains in Grain Legumes and Dryland Cereals for the NARS partners of ESA, WCA and SA working in nine GLDC crops provided a platform for exchange of knowledge on best practices to modernize breeding programs. Standard operating procedures for crop breeding and testing pipelines were valuable resources for the NARS partners. The training was unique in that it leverages the capacities of the Indian Council of Agricultural Research (ICAR) in high-throughput phenotyping.	Nursery management strengthened to support early generation seed availability for evaluations - 9 crops × 2 priority trait clusters (1° & 2°) - 20 lines per trait × 2 regions supplied.	Complete	https://dx.doi.org/20.500.11766/9663; https://mel.cgiar.org/capdev/capdev/type / crp/id/3685# (This link is accessible only with MEL active credentials in order to protect personal identifiable information – ref. EU-GDPR compliance)	G: N/A Y: N/A CD: N/A CC: 2
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply.	Developed breeding material for improved quality traits and for tolerance to heat, drought, water-logging and short duration in target crop and shared with the NARS.	Breeding lines from Phase I of the CRP being tested by NARS and CGIAR; 8 crops × 3 trait clusters × 2 regions advanced.	Complete	https://dx.doi.org/20.500.11766/9285; https://dx.doi.org/20.500.11766/9194	G: 1 Y: N/A CD: N/A CC: 1

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Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
4	FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilizing food supply.	Based on the data from national testing and participatory varietal selection, 73 cultivars of chickpea (11), pigeonpea (3), groundnut (25), cowpea (2), soybean (6), lentil (4), sorghum (6), pearl millets (10) and finger millets (6) breeding lines were developed from Phase 1 of the CRP in 16 countries of South Asia and Sub-Saharan Africa.	Breeding lines from Phase I enter the National Performance Trials or release; 8 crops × 3 trait clusters (3-4 lines per trait) × 2 regions entered in NPT.	Complete	https://mailchi.mp/illinois/new-published-research-tasty-soy-badjias-in-sils-weekly-digest?e=ef90aaaeb5 http://www.ghananewsagency.org/economics/csir-sari-introduces-new-soybean-variety-to-stakeholders-140278 https://www.icrisat.org/india-gets-its-first-biofortified-sorghum/	G: 1 Y: N/A CD: N/A CC: 1
4	FP4.O2. Robust and responsive global to national breeding systems produce and deliver novel varieties and allied innovations at appropriate scale and scope.	Seed value chain studies in Uganda showed potential for lateral and vertical growth for GLDC crops. Digital Seed Road Map a strategy to anchor GLDC seed systems.	Studies conducted to inform seed systems strengthening areas for target cereals and legumes - at least 1 study per crop x agri-food systems x region.	Complete	http://seedsystems.icrisat.org/	G: 1 Y: 1 CD: 1 CC: N/A

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4	FP4.O2. Robust and responsive global to national breeding systems produce and deliver novel varieties and allied innovations at appropriate scale and scope.	Training stakeholders of seed systems and enhancing engagement with private seed sector partners. Optima Soy Africa (OSA), a crop network group (CNG), is a platform to harness partnerships to ensure the development of market-driven soybean varieties and technologies and their dissemination. The platform is an innovative initiative by CRP- GLDC, AGRA and IITA that will provide leadership and facilitate the co-ordination and engagement of industry stakeholders to support increased and stable upscaling of soybean research outputs.	Complementary partners engaged to support scaling efforts based on country strategies.	Complete	https://www.icrisat.org/training-on-digital-seed-roadmap-use-enables-delivery-of-quality-seeds-to-smallholder-farmers/ http://gldc.cgiar.org/optima-soy-africa-launched-to-scale-up-production-and-commercialization-of-industrial-soybean-varieties/	G: 0 Y: 2 CD: 2 CC: N/A

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Table 5: Summary of status of planned outcomes and milestones (Sphere of Influence-Control)						
Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
4	FP4.O2. Robust and responsive global to national breeding systems produce and deliver novel varieties and allied innovations at appropriate scale and scope.	Gendered aspirations and occupations among rural youth, in agriculture and beyond studied in India, Mali, Nigeria and Malawi showed that young rural women and men predominantly aspire for formal blue- and white-collar jobs. Various gender norms that discriminate against women in agriculture dissuade young women from aspiring for agriculture-related occupations. Gender analysis of trait preferences was conducted to guide the design of crop Product Profiles for crop breeding programs in Asia.	Gender studies and opportunities for youth in agriculture conducted. At least 2 interventions per region studied- 2 in Africa and 2 in Asia.	Complete	Refer to narrative statement. Evidence available for internal use in MEL.	G: 2 Y: 2 CD: 1 CC: N/A
5	FP5.O1. Pre-breeding products through the use of gene banks and other sources and modern tools to increase genetic diversity in breeding programs globally.	Work related to Botrytis grey mould in chickpea and blast/heat tolerance in pearl millet advanced by using wild germplasm.	Prioritization of 2 traits in one crop for pre-breeding and identification of germplasm and cultivars to initiate pre-breeding.	Complete	http://oar.icrisat.org/10472/http://oar.icrisat.org/10509/http://oar.icrisat.org/10531/http://oar.icrisat.org/10578/http://oar.icrisat.org/10747/http://oar.icrisat.org/10805/http://oar.icrisat.org/10920/http://oar.icrisat.org/10941/http://oar.icrisat.org/10884/	G: N/A Y: N/A CD: N/A CC: N/A

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Table 5: Summary of status of planned outcomes and milestones (Sphere of Influence-Control)

Flagship	2022 FP Outcomes	Summary narrative on progress against each FP outcome this year	Milestone	Milestones status @ Reporting Year (complete, extended, cancelled or changed)	Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.	OECD Marker
5	FP5.O2. Trait discovery and development based on genomics and phenomics to generate new markers to support trait integration through the use of modern enabling technologies and forward breeding.	Priority traits for each CRP-GLDC crop were identified and discovery/mapping work is in progress.	Germplasm reference sets, other germplasm sets, mapping populations assembled, and traits prioritized for discovery research in 3 legumes (chickpea, pigeonpea and groundnut) and 3 cereals (sorghum, pearl millet and finger millet).	Complete	http://oar.icrisat.org/10381/http://oar.icrisat.org/10419/http://oar.icrisat.org/10426/http://oar.icrisat.org/10427/http://oar.icrisat.org/10455/http://oar.icrisat.org/10466/http://oar.icrisat.org/10469/http://oar.icrisat.org/10473/http://oar.icrisat.org/10516/http://oar.icrisat.org/10542/http://oar.icrisat.org/10568/http://oar.icrisat.org/10577/http://oar.icrisat.org/10621/http://oar.icrisat.org/10623/http://oar.icrisat.org/10624/http://oar.icrisat.org/10632/http://oar.icrisat.org/10659/http://oar.icrisat.org/10660/http://oar.icrisat.org/10661/http://oar.icrisat.org/10679/http://oar.icrisat.org/10767/http://oar.icrisat.org/10776/http://oar.icrisat.org/10777/http://oar.icrisat.org/10810/http://oar.icrisat.org/10844/http://oar.icrisat.org/10849/http://oar.icrisat.org/10857/http://oar.icrisat.org/10858/http://oar.icrisat.org/10859/http://oar.icrisat.org/10871/http://oar.icrisat.org/10898/http://oar.icrisat.org/10905/http://oar.icrisat.org/10911/http://oar.icrisat.org/10925/http://oar.icrisat.org/10965/http://oar.icrisat.org/10986/http://oar.icrisat.org/10999/http://oar.icrisat.org/11011/http://oar.icrisat.org/11012/http://oar.icrisat.org/11045/http://oar.icrisat.org/11085/	G: N/A Y: N/A CD: 1 CC: N/A

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Table 5: Summary of status of planned outcomes and milestones (Sphere of Influence-Control)						
Flagship	**2022 FP Outcomes**	**Summary narrative on progress against each FP outcome this year**	**Milestone**	**Milestones status @ Reporting Year (complete, extended, cancelled or changed)**	**Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed.**	**OECD Marker**
5	FP5.O3. Development of enabling technologies and platforms to be used for rapid trait discovery, trait validation, trait development, and trait introgression.	Public-private partnerships established to access and expedite development of enabling technologies such as gain/loss of function and genome editing.	Public-private partnerships established. Data management in at least 3 of the CRP-GLDC crops (sorghum, chickpea and groundnut) digitalized.	Complete	http://oar.icrisat.org/10432/http://oar.icrisat.org/10474/http://oar.icrisat.org/10510/http://oar.icrisat.org/10569/http://oar.icrisat.org/10593/http://oar.icrisat.org/10625/http://oar.icrisat.org/10667/http://oar.icrisat.org/10786/http://oar.icrisat.org/10820/http://oar.icrisat.org/10821/http://oar.icrisat.org/10863/http://oar.icrisat.org/10864/http://oar.icrisat.org/10993/http://oar.icrisat.org/11010/http://oar.icrisat.org/11062/	G: N/A Y: N/A CD: 1 CC: N/A

Table 6: Numbers of peer-reviewed publications from current reporting period (Sphere of control)						
	2017	**Percent**	**2018**	**Percent**	**2017-2018**	**Percent**
Peer-reviewed publications	83	100%	169	100%	252	100%
Open Access	61	73%	98	58%	159	63%
ISI	53	64%	103	60%	156	62%

Full list of publications available at: https://mel.cgiar.org/reporting/download/report_file_id/14261

Table 7: Participants in CapDev activities		
Column 1	**Column 2**	**Column 3**
Number of trainees	Female	Male
In short-term programs facilitated by CRP-GLDC	2417	2734
In long-term programs facilitated by CRP-GLDC	22	25

Full list of capacity development activities available at: https://mel.cgiar.org/reporting/download/report_file_id/14269

Table 8: Key external partnerships			
Col.1	**Column 2**	**Column 3**	**Column 4**
Lead FP	Brief description of partnership aims (30 words)	List of key partners in partnership. Do not use acronyms.	Main area of partnership (may choose multiple), dropdown: Research/ Delivery/Policy/ Capacity Development/Other, please specify_
1.4	Household aspirations	Cynefin Center	Research
1.4	Synthesis of impact studies and scaling approaches in GLDC projects	University of Wisconsin, IAR	Scaling up strategies
1.4	Cowpea adoption and impact assessment	Nigeria's Institute of Agricultural Research	Research
1.4	Gender and youth	Makerere University in Uganda, Haramaya University in Ethiopia, Sokoine University of Agriculture in Tanzania and University of Nairobi in Kenya	Research
3.1	Contextualizing research, capacity building, linking with farmer communities	National agricultural research institutes (NARS) in Burkina Faso [Institut de l'Environnement et Recherches Agricoles (INERA)], Mali [Institut d'Economie Rurale (IER)], Niger [Institut National de la Recherche Agronomique du Niger (INRAN)], Senegal [Institut Sénégalais de Recherches Agricoles (ISRA)], India [Indian	Innovation Platform
		Council of Agricultural Research (ICAR)], Tunisia [Institut National de la Recherche Agronomique de Tunisie (INART)], Syria [General Commission for Scientific Agricultural Research(GCSAR)]and Sudan[Agricultural Research Corporation (ARC)]	
3.1	Systems modelling and capacity building through workshops	Commonwealth Scientific and Industrial Research Organization (CSIRO)	Capacity development
3.1	Collaborative work on SI framework and sustainability assessment	Wageningen University, Swedish University of Agricultural Sciences	Research

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Table 8: Key external partnerships			
Col.1	**Column 2**	**Column 3**	**Column 4**
3.1	Testing soybean varieties to identify high-yielding drought and disease-tolerant varieties adapted to various agroecologies across several African countries, including Mozambique	Soybean Innovation Lab and Syngenta Foundation	Research and capacity building
3.1	Partnership to improve farmers' knowledge and skills in improved crop production practices in Malawi	National Smallholder Farmers' Association of Malawi (NASFAM)	Capacity building
3.1	Partnerships on research and graduate student training at the Institute for Rural Development at Université Nazi Boni (UNB)	Institute for Rural Development at Université Nazi Boni, Burkina Faso	Research and capacity building
3.2	Research conducted in partnership	The national agricultural research institutes in West Africa [Institut de l'Environnement et Recherches Agricoles (INERA) for Burkina Faso and Institut Sénégalais de Recherches Agricoles (ISRA) for Senegal]	Research and Capacity development (PhD)
4.2	Donors for heat tolerance and research article on basic knowledge about heat tolerance in lentil	Panjab Agricultural University (PAU), India and Agricultural Research Cooperation (ARC), Sudan	Research
4.2	Improving nitrogen and phosphate use efficiency of lentil in rice fallows	Bidhan Chandra Krishi Vishwavidyalaya, India	Research
4.4	To scale out Triadic Comparisons of Technologies (TRICOT)	Integrated Seed Sector Development Program (ISSDP)	Delivery
4.4	To develop tools that will influence behavior change	Centre for Behavior Change and Communication (CBCC)	Delivery
4.4	Collect and analyze household data	Makerere University, Uganda	Research
5.1	Partnership on research around access to cutting edge technologies, knowledge from industry for translating to crop improvement efforts in sorghum and pearl millet, the major food security crops in Asia and Africa	Corteva Agriscience	Research
5.1	Pearl millet heat screening trials conducted in collaboration with the private sector	Pioneer Hi-bred Pvt. Ltd., Bayer BioScience Pvt. Ltd., Metahelix and Chaudhary Charan Singh Haryana Agricultural University (CCSHAU)	Research

Table 9: Internal cross-CGIAR collaborations		
Brief description of the collaboration	**Name(s) of collaborating CRP(s), Platform(s) or Center(s)**	**Optional: Value added, in a few words e.g. scientific or efficiency benefits**
FP1: A partnership with CRP-PIM has enabled researchers in FP1 to update the CRP-GLDC database of the International Model for the Policy Analysis of Agricultural Commodities and Trade (IMPACT) for foresight modelling and ex-ante analysis for priority setting. Researchers in FP1 work closely with the CGIAR Collaborative Platform for Gender Research. A number of gender researchers from CGIAR (plus an equal number from outside the system) attended the platform's scientific conference and capacity development workshops. In 2018, gender researchers in FP1 attended the Annual Scientific Conference and Capacity Development Workshop on 25-28 September in Addis Ababa, Ethiopia. A new partnership between World Agroforestry Centre (ICRAF), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Cynefin Center is shedding light on how multiple income streams interact and the role they play in determining household aspirations. The combination of Cynefin Center's distributed ethnography tools and ICRAF and ICRISAT's deeper understanding of the farming system in developing countries now allows the team to conduct ethnography at scale.	GLDC, PIM, ICRAF, ICRISAT,	Research
FP1: CRP-GLDC provided updated values on production and consumption of GLDC crops in Sub-Saharan Africa and South Asia. In return, International Livestock Research Institute (ILRI) provided updated values on the production of livestock feed from GLDC crops.	GLDC, ILRI	Research
FP3: Interactions were also initiated with CRP-Roots, Tubers and Bananas (RTB), CRP-Maize and CRP-Wheat to identify criteria and indicators and assessing sustainability across farming systems/regions.	GLDC, RTB, MAIZE, WHEAT	Research
FP3: Collaboration on Sustainable Intensification options and cropping systems, including identifying appropriate legumes to diversify cereal-based systems.	GLDC, MAIZE	Outreach
FP3: Target to combine farm-level models with agent-based models to assess trade-offs and synergies across scales from farm performance and household livelihoods to landscape or community-level benefits. Identify criteria and indicators and assess sustainability across farming systems/ regions.	GLDC, RTB, MAIZE, WHEAT	Research

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Table 9: Internal cross-CGIAR collaborations		
Brief description of the collaboration	**Name(s) of collaborating CRP(s), Platform(s) or Center(s)**	**Optional: Value added, in a few words e.g. scientific or efficiency benefits**
FP4: 1. With the CGIAR Excellence in Breeding (EiB) platform, to drive innovation in designing product profiles, adopting stage-gate system, phenotyping and genotyping and as source of knowledge. The High Throughput Genotyping Platform (HTGP) of EiB was deployed in crop breeding pipelines, particularly for early generation testing. 2. With the CGIAR Genebank Platform, to tap novel diversity of GLDC crops and evaluate finger millet accessions for fodder quality traits to identify lines for use as parents in breeding programs. 3. With ILRI, to test fodder samples of three crop commodities from West and Central Africa, Eastern and Southern Africa and South Asia. 4. With the CGIAR Platform for Big Data in Agriculture, rolled out the Digital Seed Road Maps to support seed systems in Africa.	GLDC, EiB, ILRI, Big Data	Research
FP5: 1. Worked closely with EiB platform, and scientists attended several meetings with teams of various EiB modules to leverage expertise and activities such as the development of product profiles, stages and gateways, genotyping/sequencing related services, phenotyping and data management. 2. Partnership under development between Corteva Agriscience-ICRISAT-EiB for the pearl millet improvement program.	GLDC, EiB, ICRISAT	Research

Table 10: Monitoring, Evaluation, Learning and Impact Assessment (MELIA)			
Column 1	**Column 2**	**Column 3**	**Column 4**
Studies/learning exercises planned for this year (from POWB)	**Status** complete, extended, cancelled, changed	**Type of study or activity** **Dropdown: ePIA, Adoption survey. Effectiveness study, Quali Outcome study, Program evaluation, Synthesis, Other MELIA activity**	**Please include links to MELIA publications here.** **Also, optional space for comments: e.g. any interesting findings and lessons from a particular study that you would like to share (indicative 100 words)**
Uptake of improved varieties of cowpea and pigeonpea among households in the Drylands Development Program's (DryDev) catchment area (ICRAF)	Changed	**Adoption study**: Ex- post adoption survey (at scale)	Part of "DryDev five country impact assessment"
Uptake of improved varieties of sorghum and groundnut among households in DryDev's catchment area (ICRAF)	Changed	**Adoption study**: Ex- post adoption survey (at scale)	Part of "DryDev five country impact assessment"
Uptake of improved varieties of sorghum, pearl millet, groundnut, cowpea and soybean among households in DryDev's catchment area (ICRAF)	Changed	**Adoption study**: Ex- post adoption survey (at scale)	Part of "DryDev five country impact assessment"
Uptake of improved varieties of pearl millet, groundnut and cowpea in DryDev's catchment area (ICRAF)	Changed	**Adoption study**: Ex- post adoption survey (at scale)	Part of "DryDev five country impact assessment"
Uptake of improved varieties of sorghum, pearl millet, groundnut and cowpea among households in DryDev's catchment area (ICRAF)	Changed	**Adoption study**: Ex- post adoption survey (at scale)	Part of "DryDev five country impact assessment"
What do we really know about the impacts of improved grain legumes and dryland cereals: A critical review of 18 impact studies (ICRAF)	Extended	**Synthesis**: reviews, systematic reviews, evidence gap maps	
Review of scaling approaches applied in GLDC scaling projects: Tropical Legumes III, Harnessing Opportunities for Productivity Enhancement 2, Feed the Future initiatives and DryDev (ICRAF)	Extended	Synthesis: **reviews**, systematic reviews, evidence gap maps	
DryDev five country impact assessment (ICRAF)	Extended	EPIA: Ex-post **Impact assessment** (at scale)	

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Table 10: Monitoring, Evaluation, Learning and Impact Assessment (MELIA)			
Column 1	**Column 2**	**Column 3**	**Column 4**
Studies/learning exercises planned for this year (from POWB)	**Status** complete, extended, cancelled, changed	**Type of study or activity** **Dropdown: ePIA, Adoption survey. Effectiveness study, Quali Outcome study, Program evaluation, Synthesis, Other MELIA activity**	**Please include links to MELIA publications here.** **Also, optional space for comments: e.g. any interesting findings and lessons from a particular study that you would like to share (indicative 100 words)**
Unplanned: Who is quitting? An analysis of the dis-adoption of climate smart sorghum varieties in Tanzania (ICRAF)	Completed	**Adoption study**: Ex- post adoption survey (at scale)	https://dx.doi.org/20.500.11766/9414
Unplanned: A recipe for success? Learning from the rapid adoption of improved chickpea varieties in Ethiopia (ICRAF)	Completed	Effectiveness study (development project-level **adoption** and impact **studies**)	https://dx.doi.org/20.500.11766/9403
Unplanned: Money matters: The role of yields and profits in agricultural technology adoption (ICRAF)	Completed	Effectiveness study (development project-level **adoption** and impact **studies**)	https://dx.doi.org/20.500.11766/9410
Adoption and impacts of groundnuts in Tanzania and Nigeria (ICRISAT)	Extended	EPIA: Ex-post **Impact assessment** (at scale)	Staff turnover delayed data analysis and publications. Research design and data collection completed. New date of delivery is December 2019.
Adoption and impacts of chickpea in Ethiopia (ICRISAT)	Extended	**Other MELIA activity:** Ex-post Impact Assessment – at national level	Changes in external consultants led to delayed data analysis and report writing. On track to complete it in the second quarter of 2019.
Adoption and impacts of improved cowpea varieties in Nigeria (IITA)	Extended	Effectiveness study (development project-level **adoption and impact studies**)	A paper has been prepared and submitted to a journal and is undergoing peer review after which it should berevised and resubmitted for publication.
Adoption and impacts of improved soybean varieties and agronomic practices in Malawi (IITA)	Extended	Effectiveness study (development project-level **adoption and impact studies**)	A paper has been prepared and submitted to a journal and is undergoing peer review after which it should berevised and resubmitted for publication.

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Table 10: Monitoring, Evaluation, Learning and Impact Assessment (MELIA)			
Column 1	**Column 2**	**Column 3**	**Column 4**
Studies/learning exercises planned for this year (from POWB)	**Status** complete, extended, cancelled, changed	**Type of study or activity** **Dropdown: ePIA, Adoption survey. Effectiveness study, Quali Outcome study, Program evaluation, Synthesis, Other MELIA activity**	**Please include links to MELIA publications here.** **Also, optional space for comments: e.g. any interesting findings and lessons from a particular study that you would like to share (indicative 100 words)**
Impact assessment of N2Africa project (IITA)	Extended	EPIA: Ex-post **Impact assessment** (at scale)	Data Analysis is progressing and peer-review submission is expected in 2019.
Analysis of advantages and disadvantages of rice fallow vs rice-legumes (ICARDA)	Cancelled	Effectiveness study (development project-level **adoption** and impact **studies**)	Bilateral funding not received to initiate the study.
Is DNA fingerprinting the gold standard for estimation of adoption and impacts? A case of lentils in Bangladesh (ICARDA)	Completed	Effectiveness study (development project-level **adoption and impact studies**)	https://dx.doi.org/20.500.11766/9155
MIS system configuration and training (MEL)	Completed	Other MELIA activity: Installation of MIS and Training in MEL	https://mel.cgiar.org Few adjustments are required once SMO complete template and indicator definitions. More collaboration is expected around CLARISA.

Table 11: Update on actions taken in response to relevant evaluations
CRP-GLDC started in 2018. The evaluations conducted in Phase-I are not applicable to the current arrangements, both at the managerial and research levels.

Table 12: Examples of W1/W2 use in this reporting period (2018)	
Column 1	**Column 2**
Please give specific examples, one per row (including through set aside strategic research funds or partner funds)	**Select broad area of use of W1/2 from the categories below - (drop down) Select only one category.**
FP1: As part of a larger effort to enhance the relevance and impacts of GLDC research through improved targeting and priority setting, a strategic ex-ante poverty impact evaluation was undertaken to identify research options with the greatest potential for poverty reduction.	Research
FP1: Involved graduate students and interns to undertake characterization work on youth in the drylands for an improved understanding of their realities, aspirations and transitions. While the W1/W2 resources were used to support graduate students and interns, operational resources were leveraged from other activities.	Capacity development
FP3: Soil-crop-water-nutrient interactions, pests and diseases, land equivalent ratios, returns and benefit-cost ratios and trade-offs.	Research
FP3: Identification of criteria for sustainable intensification.	Partnerships
FP3: Modules of AMF inoculum production and use incorporated into the curriculum at Makerere University (Uganda) MSc and PhD as well as vocational trainings.	Capacity building
FP3: Training workshop on Systems modelling and capacity building.	Capacity building
FP4: Crop Network Groups (CNGs) represented by NARS, CGIAR, Advance Research Institutes (ARIs), Feed the Future Innovation Labs, NGOs, private seed sector, processing industries, etc. is a platform for product design, development, testing, advancement and delivery, enabling an end-use driven seed system. Set up OPTIMASOY, a CNG for soybean in ESA; first meeting held in December 2018 at Nairobi.	Partnerships
FP4: Establishing Multi-Location Testing (MLT) sites for GLDC crop commodities to enhance selection efficiency. Data from the testing addresses G x E. The data is useful for selecting parents for hybridization. Recycling elite parents in hybridization results in the accumulation of favorable alleles, enhancing genetic gains. CNGs contribute to furthering multilocation testing.	Research
FP4: Seed Inventory Management System was prioritized at ICARDA, IITA and ICRISAT for safe storage of breeding lines and genetic populations and transparent global seed inventory. The seed inventory module of Breeding Management System (BMS), coupled with barcode labelled sample covers and seed weight tracking, will enable seed volume monitoring and alert breeding teams to initiate multiplication when volumes are critical.	Other: Modernizing crop breeding operations

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Table 12: Examples of W1/W2 use in this reporting period (2018)	
Column 1	**Column 2**
Please give specific examples, one per row (including through set aside strategic research funds or partner funds)	**Select broad area of use of W1/2 from the categories below - (drop down) Select only one category.**
FP4: Quality Control (QC) for genetic purity assessment of parental lines and for tracking the genetic background of commercial hybrids of pearl millet and sorghum. QC ensures genetic purity of the lines and thus the authenticity of the traits for which a line is chosen for use as parent.	Research
FP4: Release of gender relevant varieties: (a) In soybean variety Favour released in Ghana, the quality of soymilk processed at village level provides nutrition security at household level, especially for women and children in school feeding programs where soybean flour was found to be a cost-effective way of adding protein to school lunches in developing countries (https://mailchi.mp/illinois/new-published-research-tasty-soy-badjias-in-sils-weekly-digest?e=ef90aaaeb5) and (b) biofortified sorghum, pearl millet and lentil varieties released in India, Kenya, Bangladesh and Nepal.	Research
FP5: Development and validation of molecular markers in top priority traits in at least 2 CRP-GLDC crops, groundnut and sorghum.	Research
FP5: Public-private partnership to access and proof of concept experiments of next gen technologies such as genome editing, quick crop transformation.	Partnerships
FP5: Training courses for advance R in QTLs, basic/advanced training for molecular markers in crop improvement.	Capacity building
Installation of MIS and training in MEL.	Monitoring, Evaluation, Learning and Impact Assessment (MELIA)
Involved in preparing gender-responsive product profiling and gender-responsive customer profiling tools through the 'Gender and Breeding Initiative of the CRPs (currently hosted by CRP-RTB)'; Partnered with GREAT to train agricultural researchers from SSA in gender-responsive research; initiated the GLDC-Gender Internship Program and concluded a postdoctoral fellowship on 'Understanding of Gender gaps among men and women in legumes and cereals production systems'.	Gender
Youth engagement: An MSc level graduate intern and a PhD student were tasked with putting together a literature review on 'Youth transitions in the drylands: realities, aspirations, challenges and opportunities'.	Youth

Table 13: CRP Financial Report									
Amount in US$									
	Planned budget 2018			Actual expenditure 2018*			Difference		
Flagship	**W1/2**	**W3/bilateral**	**Total**	**W1/2**	**W3/bilateral**	**Total**	**W1/2**	**W3/bilateral**	**Total**
FP1	796,963	7,823,800	8,620,763	782,247	7,677,984	8,460,231	14,716	145,816	160,532
FP2	-	5,412,776	5,412,776	-	4,322,601	4,322,601	-	1,090,175	1,090,175
FP3	1,573,215	15,439,820	17,013,035	1,520,881	12,285,701	13,806,582	52,334	3,154,119	3,206,453
FP4	2,593,175	21,563,790	24,156,965	2,570,252	15,692,745	18,262,997	22,923	5,871,045	5,893,968
FP5	1,207,959	9,157,247	10,365,206	1,160,105	7,829,469	8,989,574	47,854	1,327,778	1,375,631
Strategic Competitive Research Grant	480,000	-	480,000	480,000	-	480,000	-	-	-
CRP Management & Support Cost	469,811	-	469,811	413,909	-	413,909	55,902	-	55,902
CRP-GLDC Total	**7,121,123**	**59,397,433**	**66,518,556**	**6,927,394**	**47,808,500**	**54,735,894**	**193,729**	**11,588,933**	**11,782,661**

Part C: Additional evidences are accessible through Management Information system and relevant links are provided in the report

RESEARCH PROGRAM ON
Grain Legumes and Dryland Cereals

CGIAR

http://gldc.cgiar.org

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