Annual Report

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CGIAR Excellence in Breeding Platform

2020 Annual Report submitted to the CGIAR

CGIAR | Excellence in Breeding Platform

EiB 2020 Platform Annual Report

The CGIAR Excellence in Breeding (EiB) Platform is accelerating the modernization of crop breeding programs that serve farmers in low- and middle-income countries. To combat hunger, poverty and climate change, farmers need diverse and continually improving crop varieties. Drawing on public and private sector innovations, EiB partners with breeding programs to deliver system-level coordination, shared services, expert guidance, resources, and access to cutting-edge technologies and practices.

EiB is housed at the International Maize and Wheat Improvement Center (CIMMYT).

Funding:

Funding for the Excellence in Breeding EiB) Platform comes from CGIAR and generous donors including national governments, foundations, development banks and other public and private agencies, as well as the Crops to End Hunger initiative.
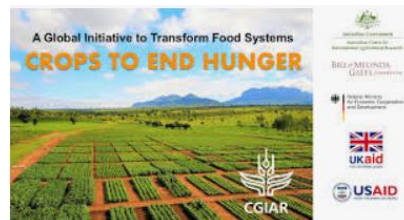
Participating Centers and other key partners:

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EXECUTIVE SUMMARY

1. Key Results

1.1 Highlight Platform Achievements

In 2020, EiB made important progress towards enabling transformative change across CGIAR and National Agricultural Research System (NARS) breeding, realizing the full potential of Crops to End Hunger (CtEH) investment and laying the groundwork for a successful transition to the One CGIAR model. To support this work, the EiB team underwent significant expansion, increasing both direct engagement with breeding programs and taking on a strategic planning role for cross-CGIAR investment in centralized breeding capacities and services.

Key performance indicators were developed and adopted to track breeding program performance across CGIAR. Direct collaboration with breeding programs led to the identification of 320 unique sub-regional market segments and 120 breeding pipelines; with greater alignment between breeding pipelines, market segments and product profiles, it will be possible for investment to be directly targeted to improve food security and livelihoods in priority areas.

EiB worked directly with breeding programs to standardize the documentation of breeding schemes and identify areas for improvement using Lean methodologies; breeding program simulations were used to predict results and support adoption by 11 CGIAR breeding programs.

Shared genotyping services advanced with the launch of a mid-density service, while the existing low-density service avoided disruptions during the COVID-19 pandemic and continued to meet business volume growth goals.

EiB provided technical and managerial support to major phenotyping, operations and infrastructure upgrades across breeding programs in Africa. A shared high-throughput phenotyping service was initiated, and a breeding program costing process began rollout. Three continuous improvement projects were started with CGIAR breeding teams, while further training in continuous improvement and Lean methodologies was provided to 75 CGIAR staff and 120 NARS staff.

Development of the Enterprise Breeding System (EBS) was fully incorporated into EiB, which now has a direct role in implementing integrated data management systems, biometrics and bioinformatics, which also the establishment of the Breeding Informatics Network in 2020.

New webinar series and working groups were convened, not only overcoming potential disruptions owing to the global COVID-19 outbreak but creating improved collaboration that will support the transition to One CGIAR. A new model for CGIAR NARS collaboration was introduced that provides clearer definitions of roles and responsibilities in breeding, along with a network of regionally based specialists that will directly support the modernization of NARS breeding.

The [EiB annual meeting](#) took on a virtual format, with 264 participants from around the world sharing updates and 11 stories of breeding excellence.

1.2 Platform Progress towards Outputs and Outcomes (spheres of control and influence)

1.2.1 Overall Platform progress

In 2020, EiB increased direct collaboration with breeding programs to generate long-term changes, leveraging increased CtEH funding to implement major capacity enhancement across CGIAR and NARS breeding programs in line with priority targets.

Crop-level breeding improvement plans continued to be revised and updated, in particular for the nine breeding programs identified in the CtEH prioritization exercise as having high potential impact on food security and livelihoods. A further 11 NARS breeding programs were assessed to develop improvement plans and deliver on the main priorities for modernization that were identified.

In addition to targeted investment in breeding program improvements, EiB is developing plans for investments in breeding infrastructure, machinery and equipment across Africa at key research CGAIR research centers and in line with the crop improvement plans. In that context EiB will guide the development of cross-CGIAR trait introgression and genotyping services, and development of centralized breeding operations service units to support goals such as increased heritability, early generation multi-location testing, rapid generation advancement (RGA) and improved health, safety and environment (HSE) practices.

To better track progress and set targets, key performance indicators (KPIs) were developed and integrated into a dashboard to assess the functionality of individual breeding programs. Progress in 2020 has set the groundwork for breeding pipeline investment cases to become the new unit of investment in breeding, pending improved alignment with market segments.

Across all areas of work, adaptations were made to ensure delivery of results despite the potential for disruption due to Covid 19-related restrictions, while at the same

time creating new and improved cross-CGIAR collaboration initiatives that will support the transition to the One CGIAR model.

The [EiB team](#) underwent significant expansion to support the magnitude and scope of the changes being driven by the Platform, and funded by over $35 million USD in CtEH funding; however, it should be noted that EiB remains under-capacity considering the level of direct collaboration with breeding programs that is also taking place.

COVID-19

Restrictions to travel and workplace activities caused by the global pandemic required the adaptations to several EiB activities, and stress-tested EiB's ability to provide cross-CGIAR services.

To ensure continuous direct engagement with NARS breeding programs, a regional network of consultant specialists was contracted to provide in-person support to breeding programs. Workshops and trainings shifted to an online format, as did the Annual Meeting, which trialed new formats to provide rich experiences to online events (including concurrent sessions, multiple time-zone support, chat rooms, one-on-one chats and online exposition booths). Each of these measures proved to be more than adaptations but offer new tools and resources to deliver on EiB's mission in the future; the network of in-person support specialists will be maintained, and the EiB Toolbox and Learning Management System (LMS) was further developed.

The Low-density SNP Genotyping (LDSG) service provided by EiB was able to avoid disruptions to service provision due to the direct intervention of EiB to implement contingency plans and ensure stocks of laboratory inputs used by service providers.

1.2.2 Progress by modules

Product design & management (Module 1)

In 2020, EiB advanced toward the alignment of product profiles, market segments and breeding pipelines, assessment and modernization of NARS breeding programs, and promotion of a more effective NARS-CGIAR collaboration model. COVID 19-related challenges were overcome by developing a network of regional consultants to engage partners, a multitude of virtual meetings and launching a webinar series.

Key results included the identification of 320 sub-regional market segments across 26 crops by EiB partners. Each market segment reflects a unique combination of grower and consumer needs and all are gender-inclusive. The value of each market segment can be calculated based on factors captured, such as number of hectares,

average crop yield and average selling price. Potential impact was then calculated using the number of people, number of people in poverty and the number of undernourished people in each segment. Existing target product profiles will be updated based on this exercise. The main learnings were the need for additional metrics to understand the "impact" of an investment in developing products for a market segment and the need for broader involvement of social scientists, economists and gender specialists.

Across all CGIAR Centers, 120 breeding pipelines were identified and characterized. In the final quarter of 2020, the focus was on aligning these pipelines to market segments, as not all market segments were associated with a pipeline and some pipelines were associated with multiple market segments. The groundwork was laid for EiB to complete the task of developing the first round of pipeline investment-to-impact cases within the first half of 2021.

This progress is key and will be the foundation to providing direction to the Genetic Innovations Group within the One CGIAR organization. Solid and well-described market segments and product profiles will allow clear metrics to be established to monitor and report on the progress being made.

EiB collaborated with the Seeds2B from the Syngenta Foundation for Sustainable Agriculture group to standardize product advancement processes and associated terminologies and participated in several CGIAR product advancement meetings to better understand this process. EiB's involvement resulted in a significant effort in late 2020 to develop a plan to broaden the engagement of social scientists and gender specialists in the identification and description of market segments and the development of target product profiles.

EiB completed baseline assessments and improvement plans for 11 NARS breeding programs for priority crops in Africa and India. Modernization priorities were acted on to implement product profiles (for 7 breeding programs), mainstream quality control and quality assurance (QC/QA) genotyping (8), quantitative trait loci (QTL) profiling of elite parents (8), program costing (2), data management (4) and information sharing, with 97 attendees to a webinar on Continuous Improvement and 152 to a webinar on Genetic Gains.

In-country experts were contracted as consultants to provide engagement despite COVID-19 restrictions; the success of this initiative will be maintained in the post-pandemic context. A new model outlining clear roles in CGIAR-NARS breeding networks breeding networks was developed in consultation with stakeholders and adopted by several CGIAR projects.

Breeding scheme optimization (Module 2)

In 2020, EiB made important progress towards the goal of optimizing breeding schemes to improve rates of genetic gain.

The most important achievement was a growth in direct engagement with breeding teams, applying Six-Sigma methodologies to document breeding schemes and identify areas for improvement. This was used to simulate possible solutions (drawing from an EiB supplemental grant) and working with teams to execute plans to fill identified gaps. A library of these simulation results and discussion of implications for individual breeding programs is available in the EiB Toolbox.

Through this engagement, important action areas were identified to optimize CGIAR breeding programs: 1) options to reduce cycle time, 2) adoption of selection indices to summarize multi-trait data, 3) optimal program size (# parents, crosses and progeny cross, 4) adoption of reciprocal recurrent selection in hybrid programs, 5) proper implementation of genomic selection, and 6) the use of modern experimental designs for field trials to evaluate variety performance. The simulated results of these choices have led to adaptations in IITA-Cassava, IITA-Banana, IITA-Yam, CIAT-Forages, CIAT-Beans, CIMMYT-Maize, CIMMYT-Wheat, CIP-Potato, CIP-Sweetpotato, IRRI-Rice and AfricaRice breeding programs.

EiB published four best practices and guidelines on breeding scheme optimization in the Toolbox, in addition to Six-Sigma training materials, growing the user-base by 55%. This included best practices to assess genetic gain as part of a continuous assessment process, implementation of predictive tools such as marker assisted selection (MAS), genomic selection (GS) and QC applications, calculation of genetic gain (with accompanying R scripts), and practical recommendations for trials to increase linkage between phenotypic datasets.

COVID-19 related challenges led to greater emphasis on virtual over physical interactions, greater output of digital learning material and focus on developing content and functionality of the EBS LMS.

Genotyping and sequencing tools and services (Module 3)

In 2020, EiB launched the Mid-density SNP Genotyping (MDSG) platform, following a year of strategic planning and demand forecasting. MDSG provides a low cost ($10 per sample) and highly scalable genotyping service to meet the growing demand for DNA profiling and the ambition to mainstream routine genomic selection in CGIAR and NARS breeding programs.

Key features of the MDSG platform are: (1) a fully sustainable business model, (2) high-throughput capacity for up to 2.4M samples per annum, (3) zero lab setup cost for users, and (4) high data interoperability across various genotyping platforms.

The EiB LDSG platform was fully operational despite COVID challenges in 2020, ensuring no loss of a critical service to maintain marker-assisted selection and genetic QC in breeding programs. This was achieved through contingency plans to accommodate logistics delays and supply shortage, such as extending the sample forecast period and working with vendors to stockpile common laboratory inputs. By the end of 2020, LDSG remained on-track to maintain the required annual business volume of over US $1M, a 25% increase over the previous year.

EiB was involved in several initiatives to promote the sustainable adoption of shared genotyping services and greater alignment with One CGIAR and CtEH priorities, as follows:

A CGIAR-wide trait and marker development working group was initiated to develop strategies and investment plans for centralized trait augmentation hubs.

A new funding mechanism was created to leverage US $1M of CtEH resources to support the transition of various crop genotyping operations into a centrally coordinated network; a step toward the eventual centralized funding and allocation of genotyping resources by data points.

Crop breeding programs identified as CtEH priorities were supported, including smaller-scale crop breeding programs such as yam and cowpea with limited internal genomics capacity, by linking and contracting external technical experts on marker design and optimization.

Existing shared services were expanded to include new use cases, for example through co-development of the BMGF IMAGE project to provide DNA solutions for varietal adoption studies in Africa. This expansion is forecasted to increase business volume by US $300,000 per annum for the next five years.

Both LDSG and MDSG expanded to external crops and projects with key partners including United States Department of Agriculture (USDA) Breeding Insights (6 new species) and the Feed the Future Innovation Lab for Crop Improvement (ILCI) project (sorghum).

Breeding operations & phenotyping (Module 4)

In 2020, EiB facilitated access to infrastructure and capacity development to improve breeding operations and phenotyping at CGIAR and NARS breeding programs to provide more reliable data for breeding. This has taken place according to the

prioritizations identified by EiB Modules 1 & 2, the shared services model of Module 3, and the digital phenotyping strategy developed with Module 5. Future efforts will put greater emphasis on implementing breeding operations performance metrics.

The EiB Breeding Operations and Phenotyping Assessment continued in new locations, delivering reports for two AfricaRice stations (Senegal and Ivory Coast), two NARS stations in Ghana (Council for Scientific and Industrial Research [CSIR], Kumasi and Savanna Agricultural Research Institute [SARI], Tamale).

As a result of these assessments and the original Breeding Program Assessment Tool (BPAT) reports delivered by the University of Queensland, Australia, EiB has prioritized technical interventions to improve data quality, sustainability and throughput of phenotyping operations, and interventions to improve the management of breeding operations.

Targeted technical interventions supported by EiB in CtEH priority crop breeding programs included improved irrigation design, design and CtEH funding of seed drying facilities, design and CtEH funding of biotic stress screening facilities, design of seed processing infrastructure, soil management recommendations, nutritional trait phenotyping recommendations and GPS recommendations as summarized in the table below.

Breeding Program	Improvement Plan statement	Support Given by EIB Module IV	Expected Output/ Outcome
CIMMYT Maize	Improve phenotyping capacity and heritability for key traits.	Irrigation design for 3 key stations (Kenya, Zimbabwe and Ethiopia). Implementation supported by CtEH. Drying capacity for Kenya and Zimbabwe sites (design and CtEH fund). Biotic stress screening facility – Eastern Africa – CtEH fund. Soil Management recommendation for Kenya site.	Increase heritability from 0.4 to >0.6 through mechanization, facilitating more consistent higher quality data generation. Filling capacity gaps.

IITA (various)	Enhanced selection efficiency from improvements in field sites and their management.	Irrigation design at three key stations in Nigeria (Ikenne, Kano and Ibadan). Supported cassava program with technical recommendations with phenotyping techniques for nutritional traits. Initiated a project to define the requirements for improving efficiencies of clonal multiplication process (project ongoing).	Increase heritability. Increase capacity. Enhanced effectiveness of breeding at hubs through sharing of improved germplasm.
ICRISAT	Capacity building at Regional Crop Improvement Hubs by improving breeding facility.	Irrigation design for Kenya, Zimbabwe and Mali stations. GPS recommendations for Mali station. Soil management recommendations for Kenya station.	Increase heritability. Increase capacity.
AfricaRice	Optimize centralized breeding processes, deploy modern and cost-efficient breeding approaches, and develop capacities for rapid generation advance (RGA) and seed storage.	Design the seed process infrastructure improvement (engineering service).	Increase sustainability.

Broader improvements were brought to the CGIAR through the acquisition of digitization devices (17 package printers, 21 seed counters, 22 label printers, 48 printers and 285 handheld devices) for 24 breeding programs using CtEH funding, each with agreed adoption and impact metrics. A shared high throughput phenotyping service offering digital image analysis was also created with two

vendors (Hiphen and Corteva), which will start by developing business use cases toward the goal of developing full shared services.

Related to the management component, three continuous improvement projects were started with operational staff at IRRI, aligned with the Center breeding program improvement plan and accompanied by training in Lean methodologies for 25 IRRI staff. A webinar in Lean methodologies reached a further 50 CGIAR staff, while over 120 NARS staff participated in a Continuous Improvement webinar that included Lean methodology components.

From the development of pipeline investment cases by EiB, methodologies will be developed to develop operational costing procedures. In 2020, rollout of this template started with the CIMMYT maize and IITA cassava breeding programs. IRRI and ICRISAT were supported in improved operational cost procedures, while IITA was also supported to initiate the deployment of centralized operations.

Bioinformatics, biometrics and data management (Module 5)

In 2020, Module 5 underwent a large restructuring and increase in responsibilities. The EBS was incorporated into Module 5 in October, as EiB took on oversight and funding supported by a supplemental grant of US $6.5M covering the period November 2020 - October 2022. A full time Biometrics lead was hired in June 2020, who subsequently took on responsibilities as Module 5 Lead; initial activities have included familiarization with existing software development projects and analysis of strategic plans for EBS integration.

The scope of Module 5 objectives also expanded, from primarily being a source of influence and advice to being responsible accountable for cross-Center strategies, resources and tools to develop and deploy breeding data management systems, develop integrated and centralized biometrics and bioinformatics capacities and coordinate long-term data management system strategies.

The Cornell University Genomic Open-source Breeding informatics initiative (GOBii) development team was integrated with the EiB team during 2020, in preparation to incorporate the GOBii Genomic Data Management System (GOBii-GDM) into EBS. To accommodate the growth of the EBS team, training was provided to adopt improved ways of working, such as Continuous Integration / Continuous Delivery (CI/CD) practices to keep the project on-track.

The CIMMYT EBS team developed the Service Gateway and Implemented authentication management. EBS version 2.1 was deployed by CIMMYT, bringing experiment design and management features into the CIMMYT operating environment, with maize and wheat germplasm databases integrated, and available

for adoption activities to commence. Development began on analytics capabilities, and appropriate use cases were identified with partners to analyze breeding program workflow requirements. A standalone version of GOBii was maintained for existing customers. The Breeding for Results (B4R) software was refactored to offer support to maize and wheat.

Difficulties associated with COVID-19 pandemic made most planned biometrics and bioinformatics in-person activities unfeasible, so that collaboration efforts were focused on strategies for cross-Center coordination of teams across the CGIAR, primarily through the creation of a Breeding Informatics Network in Q1 2021.

The Breeding Informatics Network has a core contributing community of ~30 implementers, including CGIAR biometricians, quantitative geneticists, and bioinformaticians, the EBS Analytics Framework development team, and external partners from Bayer, ILCI, Breedbase, Breeding Insight, and VSN International Ltd (VSNi). Working groups on best practices will be sponsored to address priorities identified in Center-level breeding improvement plans, and the results incorporated in the EBS. The network was launched with the aligned support of all Centers with biometrics or bioinformatics capacity, replacing the former Communities of Practice, and represents a first step towards the eventual realization of a centralized global team within One CGIAR.

1.2.3 Variance from Planned Program for this year

Module 1

Although Module 1 was understaffed throughout much of 2020 due to the departures of key staff, a consultant was hired as an acting lead for Module 1 in May 2020 and was instrumental in opening up new areas of work in the identification of market segments and the development of pipeline investment cases, while building on previous work in the area of product profiles. Due to prioritization of the above task, the implementation of a stage-gate process for product advancement was deferred to a later stage, although EiB collaborated with the Seeds2B working group to align methodologies and terminologies and participated in several product advancement meetings.

Module 2

Some of the development of capacity in the toolbox were de-emphasized to address COVID related re-prioritization of digital learning systems. Work proposed for later in the project was brought forward to facilitate better digital capacity building backstopping. Additionally, the groundwork was developed for trait discovery and

deployment scheme mapping with the aim of breeding pipeline segmentation within Module 1. These efforts position us well to deliver the desired outputs in 2021 along with those already scheduled for 2021.

Module 3

Some of the planned outputs and outcomes in Module 3 were altered to meet the One CGIAR transition and CtEH targets. The Module 3 lead took on a new and significant role in supporting the management and coordination of CtEH investments in sub-Saharan Africa and South Asia alongside EiB leadership. New key outcomes include: (i) establishment of centralized trait augmentation services with rice as a pilot case, (ii) development of charge account framework to minimize administrative costs associated with outsourcing, (iii) infrastructure and capacity development at key regional hubs (in collaboration with breeding leads, EiB NARs and Module 4), (iv) the development of better linkages and new use cases for the shared genotyping platform, (v) co-leadership of a trait and marker development working group with Module 5 and partners from various CGIAR centers to design an effective marker deployment strategy.

Module 4

Due to COVID-19 restrictions, face-to-face interactions and visits were replaced with virtual interactions and a reprioritization of the programs being supported. The definition of preferred vendors to provide lab services and mechanization support is delayed, in particular due to challenges faced in defining potential demand given the impact of COVID-19 on breeding program activities.

The adjustments made to the Module 4 work plan allowed for faster progress in the development and delivery of e-learning and virtual training. This means that EiB is on-track to launch a Breeding Operation Exchange Program and e-learning courses in Lean methodologies and continuous improvement in 2021.

Module 5

The EBS project, prior to EiB management, was never formally managed as a project with stated timelines, workplans and deliverables. As such, it suffered from scope creep and is behind in its delivery of usable software. We have identified that project management is one key lacking area and have hired a senior project manager. We have also engaged a cloud IT consulting company (Ocelot Consulting of St Louis USA, 75% of current staff were recruited out of Monsanto/Bayer IT) to also assess the project's current roadmap and ways of working and offer recommendations for increasing the team's agility and effectiveness.

In Biometrics and Bioinformatics, we have completely redefined our agenda. Module 5 will focus on setting up a precursor to a global shared service for analytics and data management in One CGIAR in 2021-2022.

1.2.4 Altmetric and Publication highlights

Four manuals and guidelines to optimize breeding schemes were published in the EiB Toolbox:

Guidelines for germplasm and trait introgression.

Estimating surrogates of genetic value.

Selection intensity.

Genetic gain as a high-level key performance indicator.

1.3 Cross-cutting dimensions (at Platform level)

1.3.1 Gender

EiB promotes gender-responsive breeding by supporting breeding programs to target well-defined market segments characterized by the requirements of end users in the value chain (e.g., producers, processors, consumers, industry, etc.), and to design product profiles that meet the different needs of these users, who should be identified using gender- and age-disaggregated datasets. EiB's work in this area is inclusive of the tools and training provided by the Gender in Breeding Initiative (GBI, led by RTB), for example the G+ product profile tools that introduce gender-sensitive traits and principles, such as do no harm to breeding.

In 2020, several meetings were held with gender specialists and social scientists to understand the scope of their work and identify opportunities for alignment and integration of workstreams to develop inclusive and robust market segments and target product profiles. EiB actively participated in a Hackathon event organized by CIP and RTB which focused on case studies of identifying market segments and target product profiles. The crops covered by these groups (potatoes, sweet potatoes, yams. cassava, bananas and plantains) are mainly consumed as fresh products and understanding and meeting the needs of consumers is critical to the success of new products. A key output of these meetings was the realization that a diverse team of specialists, including gender experts, should be involved in reviewing and updating the first round of market segmentation driven by EiB across the CGIAR.

1.3.2 Youth and other aspects of Social inclusion / "Leaving No-one Behind"

EiB supports CGIAR and NARS breeding to respond to youth and other aspects of social inclusion by supporting breeding programs to target well-defined market segments. This includes translating data disaggregated by age, household poverty, crop consumption and role in commodity value chains into realistic breeding targets, including through the involvement of socioeconomics, market and value chain experts, so that investment in these individual breeding pipelines is directly linked to the creation of benefits for marginalized groups.

1.3.3 Capacity Development

Module 1 provided informational and training sessions on market segments, pipeline investment cases and target product profiles to several CGIAR centers during 2020 as well as to USAID, HarvestPlus and Seeds2B. Module 1 actively participated in a two-day Hackathon event organized by the RTB group on market segments and product profiles.

EiB published four best practices and guidelines on breeding scheme optimization in the Toolbox, in addition to Six-Sigma training materials, growing the user-base by 55%. This included best practices to assess genetic gain as part of a continuous assessment process, implementation of predictive tools such as MAS, GS and QC applications, calculation of genetic gain (with accompanying R scripts), and practical recommendations for trials to increase linkage between phenotypic datasets.

Capacity development in genotyping and sequencing primarily focused on sampling logistics and ensuring better utilization and adoption of genotyping tools. Due to COVID restrictions, all face-to-face training workshops were canceled. A series of training tutorials were developed and made available to support genotyping users on sampling.

Approximately 70 staff have now received a 32-hour training in Continuous Improvement culture and Lean methodologies. A webinar to promote the adoption of continuous improvement methodologies was attended by 130 participants from NARS partners and CGIAR staff.

2. Effectiveness and Efficiency

2.1 Management and governance

In 2020, in addition to the Steering Committee, a CteH Committee was created as a mechanism to keep the CGIAR Centers for the progress in their Improvement Plans.

Donors and key Center breeding leads participate in the CteH Committee. Key performance indicators were developed and implemented to track CGIAR breeding program performance and help. Efforts to characterize breeding pipelines and market segments will eventually result in new breeding program management tools greater transparency and accountability for impact.

The EiB Lean Practitioner training took place from Aug 31 to Oct 1, 2020. There were 21 EiB members in the class divided into three project teams. The remote class was conducted in two, 3-hour sessions 2-3 days a week to accommodate time zones, for a total of 11 sessions. The projects were focused on processes within EiB. The projects the teams worked on were Better Coordination Across EiB Modules, Improving Workflows for EiB Processes (focused on the procurement process), and Improving the Adoption Rate of Proposed Solutions.

EiB hired a Deputy Director to help manage the team and support the development of the team members. The EiB leadership team participated in the training in order to demonstrate commitment to continuous improvement and support the success of the projects that were developed.

2.2 Partnerships

2.2.1. Highlights of External Partnerships

A network of partnerships was established with consultants throughout Africa to interact with and deliver training to NARS. Module 1 established partnerships with consultants throughout Africa to interact with and deliver training to NARS. A network of consultants collaborates with EiB to assess and provide recommendations and capacity development services to CGIAR and NARS in areas including soil management, irrigation and continuous improvement.

The EiB MDGS platform was successfully launched in 2020. The MDSG platform is established purely through private outsourcing and supported by genotyping demands from various crop projects. MDSG is expected to provide high quality and fast turnaround mid-density solutions to serve the growing needs of various crops in carrying out genomic selection. MDSG also secured strong support from various non-CGIAR initiatives, including the USDA Breeding Insight project and the USAID ILC project.

The adoption of high-throughput phenotyping tools, such as image analysis are in the early stage in the public breeding programs. Collaborations were initiated with

Corteva Agriscience to promote the adoption of image analysis as a service for breeding programs, the ongoing project started last year in pilot phase with the CIMMYT maize breeding program.

2.2.2. Cross-CGIAR Partnerships

Building on the existing engagements with various CGIAR breeding teams, EiB had successfully rolled out multiple modernization grants with the support of the CtEH initiative. These modernization grants are expected to contribute towards operationalizing many of the improvement recommendations derived from the six CGIAR funders' requests. A Breeding Informatics Network was established with support from all CGIAR breeding programs with bioinformatics capacity.

2.3. Intellectual Assets

To contribute to the Intermediate Development Outcomes (IDOs) of the Agri-Food System CRPs, and thereby to the Systems Level Outcomes (SLOs) of the CGIAR, EiB has implemented the EiB Toolbox, a knowledge database that allows EiB members, contributors, and third parties, to access different types of Intellectual Assets (IA) in support of breeding activities. The Toolbox gathers IA developed by CGIAR Centers and a variety of partners; and therefore, various licensing schemes. To enhance adequate IA management, the toolbox management team adopted the following measures:

- Content hosted and directly made available through the EiB Toolbox is restricted to content available through standard open licenses or managed as International Public Goods and developed by the EiB Lead Center.
- For content owned by EiB Members to ensure proper attribution, access to the most updated version and the associated license, the Toolbox provides links to the repositories where the IA is made available.

EiB relies on the distribution of good quality knowledge, know-how, information, and tools, with the least possible restrictions. Thus, EiB requires active sharing from a wide community. To balance the need of sharing different types of IA with the stewardship associated with hosting and making IA available, controls in place include the management of the Toolbox through different level of permissions to users and members, with special emphasis on ability to share or access IA in the Toolbox.

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

N/A.

2.5 Efficiency

EiB spearheaded an effort to improve efficiency and accountability at a CGIAR-wide level through the establishment of KPIs, a dashboard and monitoring mechanism to assess progress and health of CGIAR breeding programs. A framework was developed and adopted to create a consistent approach to the identification of market segments, breeding pipelines and associated target product profiles. A template was created to calculate pipeline investment cases, which will allow investment in individual breeding pipelines according to potential impacts, and the adoption of important metrics such as cost per unit. Infrastructure projects and training in continuous improvement supported by EiB also targeted efficiency improvements.

2.6 Management of Risks to Your Platform

A key risk for EiB is the requirement that breeders must be adequately funded and willing to learn, adopt and adapt documented tools. EiB has therefore developed a key role as interlocutor between breeding programs and funders, using virtual meetings and visits to identify bottlenecks to progress, supporting the development of improvement plans to identify strategic investments and supporting activities that will improve the likelihood of investment success, including distinct improvement steps, expected costs, timeframes, roles and responsibilities, and the alignment of these suggested improvements with BPAT recommendations or other recommendations as appropriate.

A second key risk is the need for management buy-in, support and leadership of breeding program modernization. EiB's more direct role in providing advice and funding for key improvements provides greater influence over outcome than previously. To further mitigate this risk in 2020, the CtEH Committee was created.

Module 1 is currently without full-time leadership (from Q1 2020): this risk has been mitigated by hiring an interim Consultant and an external headhunter to assist in the recruitment process and sourcing a highly experienced expert consultant to fill the gap while a replacement leader is still to be hired.

2.7 Use of W1-2 Funding (

In 2020, EiB received US $3.34M, where main W2 support came from UK (Department for International Development [DFID]) and USA (USAID) and US $0.85M from W1 funding, there was also additional W2 funding for the CtEH initiative (DFID and USAID)

Initial Financial Plan for 2020 was set at US $1.76M and increased to US $3.34M by the end of the year.

Actual expenses were 58% lower than total budget due primarily to lower travel, other expenses and the delay of some subgrants because of COVID-19 contingency.

3. Financial Summary

Excellence in Breeding platform
Total Budget Vs. Actual Expenditures 2020

Fund Source	Classification	Total Budget 2020	Actual Expenses	Balance 2020	BURN RATE
			As of DEC 31st, 2020		
W1 & W2	EiB Platform - Research				
Total EiB Research		5,901,140	2,473,578	3,427,562	41.9%

Part B. TABLES

Table 1: Condensed list of policy contributions in this reporting year (Sphere of Influence)

Title of policy, legal instrument, investment or curriculum to which CGIAR contributed (max 30 words)	Description of policy, legal instrument, investment or curriculum to which CGIAR contributed (30 words). See guidance for what to cover.	Level of Maturity	Link to sub-IDOs (max. 2)	CGIAR cross-cutting marker score				Link to OICR (obligatory if Level of Maturity is 2 or 3) or link to evidence (e.g. PDF generated from MIS)
				Gender	Youth	Capdev	Climate Change	
701 - Breeding Operation - Centralized Service	How to structure centralized service to support CGIAR breeding programs. Mirroring the success of IRRI and more recently ICRISAT in the implementation of centralized services, IITA initiated the implementation.	Level 1	Enhanced institutional capacity of partner research organizations Adoption of CGIAR materials with enhanced genetic gains Increased capacity for innovations in partner research organizations	To be defined	To be defined	To be defined	To be defined	OICR4057

Table 2: List of Outcome/ Impact Case Reports from this reporting year (Sphere of Influence)

Title of Outcome/ Impact Case Report (OICR)	Link to full OICR	Maturity level
OICR4027 - How to embed continuous improvement in a breeding organization	Link	Level 3
OICR4057 - Implementation of centralized service for breeding programs at CGIAR center	Link	Level 1

Table 3: Condensed list of innovations by stage for this reporting year

Title of innovation with link	Innovation Type	Stage of innovation	Geographic scope (with location)
2107 - Adoption of lean methodologies to manage public breeding operations	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global

Table 4: Summary of status of Planned Outcomes and Milestones (Sphere of Influence-Control)

Module	Module Outcomes 2022	Sub-IDOs	Summary narrative on progress against each Module outcome this year.	Milestone	2020 milestones status	Brief Explanation	Link to evidence
1	CGIAR and NARS breeders develop and identify cultivars more efficiently, with clearer targets for men and women farmers, and optimized breeding pipelines that result in accelerated breeding cycles and rates of genetic gain per unit time of at least 1% annually and at least double pre-2018 levels under typical farmers conditions. Outcome should be variety turnover.	Adoption of CGIAR materials with enhanced genetic gains Enhanced individual capacity in partner research organizations through training and exchange	320 unique regional market segments were identified across 26 crops and basic information was collected to describe the value of each market segment	2020 - "(i) Member programs mentored in defining improved targeted product profiles aligned with existing information on environmental, market and gender preferences. Product profiles are developed by a cross functional group including NARS partners. (ii) Collection of improved gender disaggregated market information which considers variety replacement decisions of seed producers, farmers, processors and consumers; scope depends on funding availability."	On Going	A compilation file of the first round of market segments was created and distributed. It was apparent more structure was needed for example a consistent approach to regions and subregions. A second of this effort was initiated late 2020 and will be completed mid 2021.	Link to compilation file
			The stage gate process was finalized but due to staff departures was not formally rolled out.	2020 - "(i) 1st round of peer review of formal advancement program; recommendation for improved approaches. (ii) Collect feedback from member programs on stage-gate systems and further optimize and incorporate idiosyncrasies of specific crops. (iii) Collect feedback from member breeding management teams on implementation of breeding team	On Going		

				member incentivization and performance evaluation processes."			
			This was completed and included in the compilation file of market segments.	2020 - "(i) Accumulate published genetic gains assessments in Toolbox. (ii) Mentor implementation of genetic gains assessments for more challenging specific cases where broadly applicable documentation describing methods for assessing genetic gains may not be applicable."	On Going		link to compilation file
			This effort was significantly impacted by COVID restrictions.	2020 - 1. Breeding programs access advice or visit to best-practices sites on a self-funded basis. 2. Portfolio strategy and gap analysis drives support for program improvements including by informing the Platform agenda and priorities	On Going		
			This effort was significantly impacted due to COVID restrictions.	2020 - (i) In collaboration with B&MGF, ensure all CGIAR breeding programs have completed BPAT assessments; (ii) continuously update common and commodity-specific areas of improvements (GAP analysis); (iii) use insights to update priority setting of various modules; and (iv) agree with breeding programs on specific improvement strategies that are to be supported by the Platform (all Modules).	On Going		
				2020 - "(i) CGIAR breeding programs with BPAT assessments completed finalize improvement/ optimization plans for (a) current resource levels	On Going		

				and (b) current resources plus a one-time grant for capital and training. (ii) Members initiate improvement/ optimization plans, in terms of capital and training. Progress is monitored jointly with research leaders."			
				2020 - Improvement plans developed with at least 4 NARS in SA and SSA.	On Going		
2	Increased rates of genetic gain through use of best practices, optimization of breeding strategy and more effective use of resources (time, finances).	Enhanced institutional capacity of partner research organizations Reduced smallholders production risk	Milestones have progressed at the rate expected. The milestones have influenced the direction of the project.	2020 - 2020 - (i) A 50% increase from previous year in number of tools and best practices documented and available through the EiB platform; use cases developed around missing features and work prioritized with relevant Modules. incorporate new components, upgrade workflows, remove obsolete components; engage students in developing such information. (ii) A 20% increase in number of active platform users. (iii) Members downloading resources from the web platform and reporting implementation in their breeding programs; (iv) Existing projects: Tools developed by Seeds of Discovery, GenomeHarvest, GS-RUSE and other projects submitted with documentation to the toolbox and, as applicable, integrated in Galaxy/Taverna.	Complete	32 new resources were added to the Toolbox; almost a 50% increase in tools and best practices. The EIB toolbox had 942 registered users at the end of 2020, an increase in 55% from the end of 2019, with high numbers of visitors and visit times. Members are accessing directly and linking out to resources as part of communities of practice activities, training and during implementation of activities. Specific user-group resources are being added according to priorities and community needs.	https://excellenceinbreeding.org/toolbox
			Part (i) has been formally integrated into	2020 - 2020 - (i) CoPs document "missing" features in trait discovery,	Changed	A number of training videos were uploaded to	https://excellenceinbreeding.org/toolbox

			Module 5 associated with EBS, while Part (ii) is an integral component of all modules. Part (iii) was completed. Part (iv) was affected by COVID-19 constraints, with a focus on virtual training.	mobilization and precision breeding applications, including prioritization of needs across AFS and CoPs, develop use cases around missing features and work with the Bioinformatics Module to support the formation of technical user requirements for new bioinformatics and/or biometrics tools and approaches. (ii) CoPs provide user-based feedback on tools, workflows, suppliers and pipelines. (iii) Training and documentation of end user tools and pipelines through webinars, "YouTube" modules, and implementation guides. (In 2018 & 2019 co-funded with GOBII). (iv) In-depth training courses/ workshops linked to large meetings.		the Toolbox, reviewing the use and application of specific resources contained therein. Virtual training was provided in continuous improvement and lean methodologies.	https://excellenceinbreeding.org/toolbox/learning/continuous-improvement-tools-and-methods https://excellenceinbreeding.org/training/ci
			This work was not conducted due to re-prioritization of overhaul and enrichment of the Learning Management System to facilitate electronic learning across EiB and partners during the global COVID-19 pandemic.	2020 extended to 2021 - Review of user feedback conducted; specific needs communicated to respective modules/AFS/partners, selection of any tools/practices receiving poor review for removal from EiB web platform.	Extended		https://lms-dev.excellenceinbreeding.org/
			Best practices identified and resources implemented in Learning Management System. Lists of potential resources of	2020 extended to 2021 - 2020 - (i) Development of best practice documentation for e-learning based on materials used at regional workshops (ii) Identification of, and links to	Extended	Learning Management System has been redeveloped, owners of resources to be added are being contacted to	https://lms-dev.excellenceinbreeding.org/

			targeted online learning in plant breeding are being developed.	relevant external e-modules and courses (iii) Collection of member feedback to material provided (iv) Use of materials by AFS own training programs, BecA and other networks		establish usage rights/potential in 2021.	
			The predictive tools have been documented in the main breeding pipelines resulting in discovery phase and few in validation stage.	2020 - 2020 - Members use guidelines to document predictive tools used in their breeding programs, grouped into discovery, validation and in-use stage	Complete		https://excellenceinbreeding.org/toolbox
				2020 extended to 2021 - Members document use of trait pipelines within their breeding programs to discuss during annual meetings	Extended	Due to COVID-19 related engagement challenges this activity has been deferred to 2021.	
			This milestone was completed for many CGIAR programs across the CGIAR, including the implementation of selection indices, reduction of cycle time and program sizes.	2020 - 2020 - (i) Provide mentorship / consultation to Members needing assistance to implement changes. (ii) Readdress breeding schemes with the implementation of new breeding tools (i.e. MAS, better field designs, mechanized field testing, genomic selection)	Extended	This milestone requires extension to allow time for breeding schemes to be readdressed.	https://excellenceinbreeding.org/toolbox
				2020 - 2020 - Physical and virtual blue-sky discussions associated with scientific meetings, to raise and discuss ideas for high-payoff approaches and discuss and design the incubation of project ideas. Allocation of modest resources to validate technologies in the incubator	Cancelled	This work was not conducted due to re-prioritization of efforts and scope of EiB	

			while jointly seeking additional funding to test more substantive game changers.			
	Identification of high value predictive tools for use in member breeding programs	Increased household capacity to cope with shocks	Simulation is effectively established as tool to assess different breeding scheme options and return on investment	2020 - i) Use cases of successful implementation of predictive tools providing value towards breeding for product profiles documented. (ii) Use cases of failed attempts of development of predictive tools documented. (iii) Develop and document guidelines for the development, validation and implementation of any predictive tool into the breeding process. Guidelines will include assessment of the repeatability, genetic correlation with the target trait and a cost-benefit analysis.	Complete	The guidelines and case examples are available in the toolbox in the form of simulation reports and library.	https://excellenceinbreeding.org/toolbox/collection/244
	Documentation and implementation of best practices for trait breeding, aligned with core breeding strategies.	Increased capacity of beneficiaries to adopt research outputs	We have progressed in the optimization of the breeding strategy for the eight crop by region priorities defined by the donors. Programs have implemented the use of BLUP, selection indices, proper programs sizes.	2020 extended to 2021 - (i) Members document trait and core breeding pipelines in Toolbox. (ii) A framework of guidelines for integrating trait breeding with core breeding developed, documented and uploaded to the toolbox.	Complete	The core breeding pipelines of a number of programs have been documented, the documentation held in confidence with EiB and each of the relevant partners. Documentation was done using an excel template. Development of an online breeding scheme documentation tool to better enable the capture of core and trait breeding activities was initiated in 2020. The excel tool was uplifted	https://excellenceinbreeding.org/toolbox/ https://www.youtube.com/watch?v=JGI-MXmXdUo

					into a more interactive online tool over 2020, this will be completed and published to the toolbox in 2021. Documentation of trait pipelines was delayed due to COVID-19 limitations to interactions, this work is extended to 2021 with use of the new online tool facilitating information capture. An initial framework to conceptualize and demarcate trait development and deployment activities was developed and presented in the 2020 EiB virtual meeting. This framework is being extended in collaboration with trait experts in the CG system and partner organizations and will be published to the toolbox in 2021.	
	Breeding strategy optimization.	Increased household capacity to cope with shocks	Breeding schemes are documented enabling the clear side by side review of approaches and simulation of alternative approaches to identify highest	2020 - (i)Members document breeding strategy in Toolbox (ii) Discussion of alternative breeding schemes based on available tools, opportunities (e.g. partnerships, predictive tools) and logistical constraints (e.g. phytosanitary		Breeding schemes re documented and available in the Dropbox folder of the platform and will be available in the toolbox in 2021. Simulation reports	https://excellenceinbree ding.org/toolbox

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		return to investment interventions for optimization	delays) (iii) Identification of common questions to be resolved through simulation or further cost-benefit analyses		addressing the questions and recording of the discussions are available in the simulation library of the toolbox.	
Review mechanisms for tools and practices implemented in web based toolbox to provide electronic community based feedback to EiB recommendations.	Increase capacity of beneficiaries to adopt research outputs	We have made great progress in publishing "how to" manuals and software related to breeding scheme optimization together with face to face training on these resources.	2020 extended to 2021 - CoPs provide initial user-based feedback to documented tools and practices using online review system.	Extended	Online review system was not established due to reprioritization of efforts from review development to learning system roll out.	Not yet available.
Capacity development resources developed by EiB and reviewed by EiB made available to the community through the web-based platform.		Various enabling resources have been developed by EiB during 2020 from manuals to videos to structured content for electronic learning course construction. Many of these materials are available through the Toolbox and have been used by the community EiB works with. Electronic learning resources developed in 2020 will be assembled into courses in the EiB-LMS during 2021 to facilitTE greater reach of	2020 - (i) Identification of, and links to relevant external e-modules and courses (ii) Collection of member feedback to material provided (iii) Use of materials by AFS own training programs, BecA and other networks iv) Enhanced provision of short training and documentation of end user tools and pipelines through webinars, "YouTube" modules, and implementation manuals.	Complete	Manuals and short "how to" videos developed and loaded to the toolbox, these have been used widely and informal feedback provided as to the value of the resources. Learning management System redeveloped enabling the provision of more structured electronic learning courses.	https://excellenceinbreeding.org/toolbox

		capactiy development activities.					
3	Efficient and effective application of genomic technology in breeding is mainstreamed within AFS networks, accelerating the rate of genetic gain delivered in farmers' fields.	Adoption of CGIAR materials with enhanced genetic gains Reduce pre- and post-harvest losses, including those caused by climate change	The EiB LDSG and MDSG platforms are now fully self-sustaining in providing low cost and highly scalable genotyping solutions to various CGIAR, NARs and private users. These platforms enable rapid dissemination of genomic products to a larger audience along with a high degree of production standardization ensuring reliable data to support rapid breeding decisions. Due to OneCGIAR transition, many breeding programs are currently undergoing improvement plan reviews. Some of the milestones under M3 were affected/ changed to ensure alignment. M3 has also contributed significant staff time in supporting various programs in development of improvement plans to	2020 - (i) Comprehensive workshop on MAS/GS implementation conducted and planning for various crops applications. (ii) Genotyping application plans integrated into breeding team improvement plan documents	Complete	Due to COVID challenges, all face to face meetings and workshops were cancelled in 2020. In response, EiB M3 had developed a series of online modules to support sampling logistics as well as a dashboard of all available markers ready for production use on EiB Toolbox.	https://excellenceinbreeding.org/module3 https://excellenceinbreeding.org/toolbox/services/cowpea-mid-density-genotyping-services https://excellenceinbreeding.org/toolbox/services/wheat-mid-density-genotyping-services https://excellenceinbreeding.org/toolbox/services/potato-mid-density-genotyping-services TUTORIAL 1 https://www.youtube.com/watch?v=N3lgGHkv17M&t=1s [youtube.com] TUTORIAL 2 https://www.youtube.com/watch?v=8WmP9BxxWn8 [youtube.com] TUTORIAL 3 https://www.youtube.com/watch?v=GbIq2EGiV_A [youtube.com]

			address CtEH funders' requests.				
			Despite the COVID challenges, usage and adoption of low-density marker platform remained on track with a reported business volume of over $1M USD (25% increase from previous year). In addition, M3 launched the mid density service in July of 2020 and to date, a total of 6 crops (maize, rice, wheat, bean, cowpea and potato) had successfully developed mid density SNP panels on the shared platform.	2020 - (i) Discussion of successes and challenges during annual meetings; refine and increase use cases. (ii) A 25% increase from previous year in use of best practices and tools.	Complete		2020 Annual meeting postponed to March 2021 https://excellenceinbreeding.org/event/low-density-snp-genotyping-services-eib-launch-event
			This work is on-going and it is done in collaboration with various breeding leads and EiB members. Instead of focusing on deployment of genomic tools per se, under the OneCGIAR and Donor supported Crops to End Hunger initiative, modernization should focus on the 6 funders' request aimed at generating greater rate	2020 - Support to member breeding programs implementing cost-benefit analyses of MAS and GS workflows.	Changed	As mentioned in 2019 milestones, cost benefit analysis is no longer a standalone activity. For breeding programs to effectively deploy molecular tools, a holistic approach is needed to redesign the entire breeding pipeline.	https://www.cgiar.org/excellence-breeding-platform/crops-to-end-hunger/

			of genetic gain and stronger CGIAR and NARs breeding network.				
			Module 3 has been actively involved in reviewing and supporting the development of improvement plans by various CGIAR breeding programs.	2020 - Forward MAS and GS plans implemented for applications with greatest chance of success. Cost-effective MAS and GS plans developed for additional traits and crops. (i) Develop use cases and develop/contribute to implementation guidelines for genotyping application in discovery and breeding. (ii) Update and refine existing documents, remove those no longer appropriate/applicable or when reviews are negative. (iii) Contribute to courses and workshops.	Changed	Similar to milestone 5879-157-34613, greater uptake and effective use of molecular tools are no longer stand alone topics and would require holistic redesign of breeding pipelines.	https://www.dropbox.com/s/qefyx2d6032z781/EiB%20Special%20CtEH%20report%20to%20SMB%20May%202020.pdf?dl=0
			EiB LDSG service has been successfully renegotiated. The base price per sample for 10 SNP marker remained at $2.00 per sample whereas for higher number of SNPs, there's a reduction of cost between 25% to 40% depending on the job size. This reduction in pricing on higher SNP per sample is especially important for smaller users and many NARs partners which are starting to use the EiB	2020 - $1.50 SNP genotyped sample; $8 genome profile.	Changed	As the MDSG service was launched in July of 2020, it is too early for pricing renegotiation. To date, 6 crops (maize, rice, wheat, bean, cowpea and potato) have successfully developed mid density panels for genomic selection and genome profile use in 2021.	https://excellenceinbreeding.org/module3

			LDSG service for their QTL fingerprinting effort.				
			Despite COVID lockdowns which significantly affected many breeding operations globally, LDSG business volume remained at over $1M USD in 2020.	2020 extended to 2021 - 600K SNP genotyped samples; 125K genome profiles. (i) Obtain and aggregate AFS demand for supplies and services. Determine cross-AFS; Genotyping platform preferences, etc. (ii) Use collated demand information to broker potential arrangements with service providers and solicit pricing feedback from AFS. (iii) Finalize brokering of supplies and services and obtain minimum order commitments from AFS. (iv) Obtain feedback from service providers and AFS clients and document feedback collating to form a review for the Trait Discovery and Breeding Toolbox.	Extended	The MDSG service for genome profiling started in July of 2020. However, with the One CGIAR transition, many breeding programs are at the final year of CRP and bilateral project funding. The funding gap has prevented many programs to initiated large scale genomic selection and profiling work until new funding arrives in 2021.	https://drive.google.com/file/d/1XT-m-v22wxd2zegxcfnS0RBwgn1mcbBw/view?usp=sharing
4	Increased phenotyping throughput and accuracy accelerate genetic gains, achieving a stage 1 MET heritability > 0.6.	Adoption of CGIAR materials with enhanced genetic gains	Our target in 2020 was the translation of improvement plans, BPAT and module assessment into projects, targeting tier1 crop/region as first priority and customized support. Other crops (tier 2 and 3) were supported with spillover materials. We initiated the implementation of CtEH projects, focusing on infrastructure	2020 extended to 2022 - Based on available funding, (i) providers of priority equipment identified and user group defined (ii) service agreements for key phenotyping/mechanization approaches developed; (iii) related training of key technicians/scientists at sites; (iv) implementation of automation/ mechanization plans initiated (v) AFS reorient use of secondary traits (including HTP capabilities) to	Extended	Capacity development is an on-going process, some activities were delivered, however there are still some to be executed, especially training staff, which will be a strong component in 2021.	https://excellenceinbreeding.org/toolbox

			improvement. We also prioritized the engineering design and culture development.	those with greatest added value viz primary traits			
				2020 - (i) Negotiate contracts with prioritized laboratories. (ii) Establish logistical support in Toolbox. (iii) AFS use a wider range of NIRS analyses capabilities.	Extended		
				2020 - (i) Workshop to exchange best practices and challenges. (ii) Test and adapt alternative approaches in members' breeding programs; user feedback (Phenotyping). (iii) Discuss the development of ISO 9000 standards (Phenotyping).			
				2020 - (i) Testing and adaptation of best generic tools in interaction with distinct members – Trait set I. (ii) Integration in bioinformatics platform – Launch of Trait set I.			
				2020 - (i) Testing with members. (ii) Integration in bioinformatics platform. (iii) User survey and trouble-shooting.			
5	Genotypic, phenotypic, and pedigree data are fully integrated for use in real-time selection decisions by AFS breeding networks.	Enhanced institutional capacity of partner research organizations		2020 - Breeding use cases reprioritized based on progress.	On Going		

			2020 - i) BrAPI v2 defined ii) Workflows implemented for phase 1 use cases. (iii) Strategy to implement the Year 3-4 case studies defined. (iv) Implementation of BrAPI and local APIs for different systems.	New		
			2020 - Breeding management system: (i) Implement plan for maintaining the BMS; (ii) implement updated breeding management systems in appropriate member programs and obtain feedback; (iii) develop plan for maintaining GOBII including support for making critical enhancements needed to support GOBII users.	New		
			2020 - (i) Existing databases and tools assessed and updated (ii) Documented gap analysis for the Year 3-4 case studies. (iii) Development or acquisition of new database and tools	New		
			2020 - (i) Develop advancement tools to support key breeding uses cases. (ii) Train breeding teams in use of optimization tools and apply them to pipeline redesign.	New		
			2020 - (i) Strategy to manage and integrate meta-data reviewed and updated. (ii) Crop agronomy ontology defined.	New		

			2020 - (i) Protocols, manuals, and best practices based on recommendations of the CoPs developed and uploaded in Toolbox. (ii) Review of CoP effectiveness and modifications made as necessary. (iii) Software development rules updated as necessary. (iv) Common BrAPI updated as necessary. (v) Capacity development strategy updated. (vi) Support capacity building and the evaluation of new bioinformatics/biometrics tools and approaches in collaboration with distinct user groups and use cases prioritized in Modules 2-4. (vii) Training workshops for biometricians in CGIAR target countries to expand the number of resource persons. (viii) Broker access to proprietary software and computational capacity on a pay-per-use basis.	New	

Table 5: Numbers of peer-reviewed publications from current reporting period

Type	Number	Percent
Peer-Reviewed publications	0	0.0%
Open Access	0	0.0%
ISI	0	0.0%

Table 6: Participants in CapDev Activities

Number of trainees	Female	Male
In short-term programs facilitated by CRP/PTF	Module 1: Module 2: Module 3: N/A Module 4: 20 Module 5:	Module 1: Module 2: Module 3: N/A Module 4: 18 Module 5:
In long-term programs facilitated by CRP/PTF	Module 1: Module 2: Module 3: N/A Module 4: Module 5:	Module 1: Module 2: Module 3: N/A Module 4: Module 5:
PhDs	0	0

Table 7: Key external partnerships

Lead Module	Brief description of partnership aims (30 words)	List of key partners in partnership. Do not use acronyms.	Main area of partnership (may choose multiple)
2	Breeding program clients bringing their expertise and insights of CGIAR breeding and willingness to adapt and adopt breeding scheme changes	ICAR - Indian Council of Agricultural Research	Delivery
2	Breeding program clients bringing their expertise and insights of CGIAR breeding and willingness to adapt and adopt breeding scheme changes	KALRO - Kenya Agricultural and Livestock Research Organization	Delivery
2	Breeding program clients bringing their expertise and insights of CGIAR breeding and willingness to adapt and adopt breeding scheme changes	NARO - National Agricultural Research Organisation (Uganda)	Delivery
2	Breeding program clients bringing their expertise and insights of CGIAR breeding and willingness to adapt and adopt breeding scheme changes	CSIR - Council for Scientific and Industrial Research	Delivery
2	Support each other in the development of applied quantitative genetics knowledge	The Roslin Institute	Delivery Research
3	Joint usage and development of genotyping shared services. Bioinformatics support	USDA - U.S. Department of Agriculture Cornell University	Research Other
4	Webinar on continuous Improvement	Syngenta	Capacity Development
4	Supporting Infrastructure improvement at IITA	Bayer Crop Science	Capacity Development
4	Supporting the deployment of phenotyping services	Corteva	Capacity Development

Table 8: 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
Working together to optimize breeding schemes.	CIMMYT	Scientific knowledge.
Working together to optimize breeding schemes.	IRRI	Scientific knowledge.
Working together to optimize breeding schemes.	CIP	Scientific knowledge.
Working together to optimize breeding schemes.	CIAT	Scientific knowledge.
Working together to optimize breeding schemes.	AfricaRice	Scientific knowledge.
Working together to optimize breeding schemes.	ICARDA	Scientific knowledge.
Working together to optimize breeding schemes.	IITA	Scientific knowledge.
Access to genotyping shared services, joint development of marker resources, co-development of marker deployment strategy.	GLDC, Maize, Wheat, Rice, RTB	
Conducted the Breeding Operation and Phenotyping Assessment. Later supported them with technical recommendation and facilitated them to access the CtEH fund to improve field operations.	AfricaRice	Improve field operations, quality data and sustainability
Supporting IRRI Team to implement the culture of continuous improvement, supporting the execution of the following projects: - Addressing crop health through sustainable field - Addressing the year-end influx of sample submission - Reviewing the FCR rate on land rent in the IRRI farm	IRRI	Efficiency, better data, staff morale

Supported IITA to recruit and during the on board process of the new head of breeding operation, design irrigation infrastructure and review the quality and nutritional traits demand for the Cassava Program.	IITA	Efficiency
Supported CIMMYT team to design irrigation infrastructure (Kenya, Ethiopia and Zimbabwe), drying infrastructure (Kenya and Zimbabwe) and provided soil management recommendations Kiboko station (Kenya).	CIMMYT	Efficiency
Supported ICRISAT team to design irrigation infrastructure (Kenya, Mali and Zimbabwe) Supported ICRISAT with soil management recommendation for Kiboko station (Kenya)	ICRISAT	Efficiency, data quality

Table 9: Monitoring, Evaluation, Learning and Impact Assessment (MELIA)

Studies/learning exercises planned for this year (from POWB)	Status	Type of study or activity	Description of activity / study	Links to MELIA publications
S4028 - How to embed continuous improvement in a breeding organization	On Going	Program/project evaluation/review	This activity is to promote the adoption of Continuous improvement methodologies at CGIAR breeding operations	

Table 10: Update on Actions Taken in Response to Relevant Evaluations

Name of the evaluation	Recommendation number (from evaluation)	Text of recommendation (can be shortened)	Status of response to this recommendation	Concrete actions taken for this recommendation.	By whom (per action)	When (per action)	Link to evidence

N/A

Table 11: Examples of W1/2 Use in this reporting period (2019)

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.

N/A.

Table 12: Platform Financial Report

	Planned Budget 2020*			Actual expenditure*			Difference*			Comments
	W1/W2	W3/Bilateral	Total	W1/W2	W3/Bilateral	Total	W1/W2	W3/Bilateral	Total	
1 - Product Design and Management	US$ 2,588.00	US$ 3,741.00	US$ 6,329.00	US$ 295.00	US$ 1,254.00	US$ 1,549.00	US$ 2,293.00	US$ 2,487.00	US$ 4,780.00	No Comments.
2 - Trait Discovery and Breeding Tools and Services and Toolbox	US$ 558.00	US$ 1,571.00	US$ 2,129.00	US$ 387.00	US$ 576.00	US$ 963.00	US$ 171.00	US$ 995.00	US$ 1,166.00	No Comments.
3 - Genotyping/sequencing tools and services	US$ 372.00	US$ 924.00	US$ 1,296.00	US$ 230.00	US$ 339.00	US$ 569.00	US$ 142.00	US$ 585.00	US$ 727.00	No Comments.
4 - Operations and Phenotyping	US$ 1,360.00	US$ 2,959.00	US$ 4,319.00	US$ 228.00	US$ 739.00	US$ 967.00	US$ 1,132.00	US$ 2,220.00	US$ 3,352.00	No Comments.
5 - Breeding Bioinformatics and Data Management	US$ 1,555.00	US$ 3,656.00	US$ 5,211.00	US$ 928.00	US$ 701.00	US$ 1,629.00	US$ 627.00	US$ 2,955.00	US$ 3,582.00	No Comments.
Platform Management & Support Cost	US$ 8,281.00	US$ .00	US$ 8,281.00	US$ 492.00	US$ .00	US$ 492.00	US$ 7,789.00	US$ .00	US$ 7,789.00	No Comments.
Platform Total	**US$ 14,714.00**	**US$ 12,851.00**	**US$ 27,565.00**	**US$ 2,560.00**	**US$ 3,609.00**	**US$ 6,169.00**	**US$ 12,154.00**	**US$ 9,242.00**	**US$ 21,396.00**	