Advisory Services

CGIAR

CGIAR Research Program 2020 Reviews: Grain Legumes and Dryland Cereals (GLDC) - List of Annexes

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Annex 1: Terms of Reference for the CRP 2020 Review

TERMS OF REFERENCE & CALL FOR EXPRESSIONS OF INTEREST

CRP 2020 Independent Reviews of Quality of Science and Effectiveness

Background

In 2020, the CGIAR Advisory Services Shared Secretariat (CAS Secretariat[1]), through its evaluation function, is planning independent reviews of the twelve CGIAR research programs (CRPs[2]). The reviews, commissioned by the CGIAR System, will provide information on Quality of Science and Effectiveness in each CRP. The CAS Secretariat has been mandated to undertake this work as part of its role in providing independent evaluation and assessments to the CGIAR System[3]. The reviews are designed to be rapid (completed within 11 weeks) and produce top-level findings, but not to generate the range of in-depth information as would be obtained from an evaluation. Further, the reviews are entirely desk-based, and no travel is planned.

Between April and December 2020, teams of two external expert consultants will each review one CRP, relying on its documentation and a limited number of virtual (telephone or online) interviews with the CRP Program Leader, staff and key external stakeholders. An internet-based survey will also be conducted for CGIAR researchers and CRP donors and partners. Bibliometric analysis conducted by the CAS Secretariat will supplement the information available to the expert reviewers.

The CRPs were designed to run for six years, from 2017 to 2022, but have been curtailed by one year and are now scheduled to conclude in 2021. Each CRP is composed of 3 to 5 Flagship Programs (see Annex 1), which in turn operate clusters of activities for research. The CRP reviews will rely on data and information available for the period 2017-2019, and will inform future research modalities to be developed in 2021.

A key document for the CRP review is the program Theory of Change, which in many cases may be the version developed in the CRP proposal or its updates. In some programs the Theory of Change may be implicit or not completely documented. The external experts who will conduct the reviews will rely on additional sources (annual planning documents or interviews) to understand the Theory of Change in use by the CRP, which will be the basis against which the program will be reviewed. The Flagship Programs within the CRP each have their own Theories of Change, which are nested under the CRP Theory of Change. Together, the hierarchy of the CRP and Flagship Theories of Change form the key reference documents for the CRP 2020 Review.

As a desk-based review, this effort will attempt to minimize the burden on CRPs. In advance of the reviews, CRPs will prepare the set of reference documents for the review. At the start of each review, the CAS Secretariat will organize an initial briefing involving the team of expert reviewers and the respective CRP Lead and staff .During the data collection phase, the review team will conduct an interview with the CRP Leader and a focus group discussion (FGD) with other members of the CRP management. The review team will provide a debrief discussing the preliminary findings with the CRP management and the CAS Secretariat, for validation and feedback. The draft report will be shared with the CRP Leader and staff for factual correction and final feedback. CRPs may choose to provide a formal management response to the review, though this is not a requirement.

[1] See Annex 4 for a list of acronyms used in this Terms of Reference
[2] See Annex 1 for a list of the twelve CRPs and their associated Flagship Programs.
[3] The CAS Secretariat/Evaluation 2021 workplan will propose a similar review or evaluation of the CGIAR Platforms, creating a harmonized Terms of Reference that has been adjusted to Platform's characteristics and function. The Platforms are considered separately from CRPs in order to address aspects of their work that differ substantially from the CRPs.

In July 2020, the CAS Secretariat also will conduct an after-action review with the Program Leader and staff from the first three CRPs reviewed, to ensure that the approaches used to pursue the review questions are as streamlined and appropriate as feasible.

Purpose of the review

The primary purpose of the CRP 2020 review is to assess the extent to which CGIAR research programs are delivering Quality of Science and demonstrating effectiveness in relation to their own Theories of Change (or other planning documents stemming from the Theory of Change set forth at program inception, in the event that the original Theory of Change has not been updated to reflect the current thinking behind the CRP's work). Within that primary purpose, the objectives of the independent CRP reviews are captioned below:

1. To fulfil CGIAR's obligations around accountability regarding the use of public funds and donor support for international agricultural research;
2. To assess the effectiveness and evolution of research programs' work under CRP 2017-2021;
3. To provide an opportunity for programs under review to generate insights about their research contexts and programs of work, including lessons for future CGIAR research modalities.

Expected uses and users of the CRP 2020 reviews

The CRP 2020 reviews are a key step in the CGIAR System's demonstration of accountability. Accordingly, the primary users of the reviews will be the CGIAR System Council, with insights and lessons developed from the reviews for use by the programs themselves.

Recognizing the potential of these reviews to support Program Leaders and their teams, the CAS Secretariat will engage the expert review team to work with each Program Leader in defining any supplementary questions of specific interest to their CRP, which will be included in the scope of work for the respective CRP review, subject to the limitations of time and resources for the review. Interested consultants should keep in mind that the final scope of work follows the structure and process laid out in this Terms of Reference and for some CRPs may include 1-2 well-defined additional question(s) from the CRP under review.

Further, the CRP reviews may provide lessons that inform the transition to One CGIAR in 2022, based on the program-level findings and a synthesis of system-level findings in 2021; to that extent, the reviews will be a future reference for system management in the change process.

In the final report, the expert review teams are expected to identify findings, conclusions and recommendations that apply to CRPs for use in refining the 2021 Plans of Work and Budget (POWB) to the extent feasible in the remaining program year, and lessons to inform future research modalities.

Scope of the CRP 2020 review

The CRP reviews will cover 12 CGIAR research programs from the proposal acceptance date in 2017 through 2019, making use of all the reporting and monitoring information available to date. The first three reviews will rely on the CRP's 2019 draft annual reports, prior to their vetting and quality assurance by the CGIAR System Management Office, and the other nine reviews will use the finalized CRP annual reports. The scope will include the program of work of each CRP and its Flagship Programs, with the reviews guided by the CGIAR's Quality of Science and Effectiveness criteria, and the Theories of Change for the CRP and its Flagship Programs. The reviews will not assess individuals, teams, or institutes in which programs reside. Emphasis will be on the CRP's Sphere of Control, that is, the quality of inputs, activities and outputs, and Influence, that is, short and intermediate outcomes that are expected to lead to a development impact.

The CGIAR System defines outcome-level changes as Intermediate Development Outcomes (IDO) and System Level Outcomes (SLO), as described in detail on the CGIAR website[4]. The CRP 2020 Reviews will focus on the IDOs, including sub-IDOs, given the short span of time (three years) for the current phase of CRPs. Expectations of documented outcomes will be informed by (a) the amount of time the research

4 https://cas.cgiar.org/sites/default/files/ISPC_WhitePaper_SLOsIPs.pdf

has been conducted under the CGIAR and its centers, including research prior to the CRP in the case of legacy programs, and (b) whether the CRP's targeted first users of research outputs are within the research community or closer to market adoption. It is not expected that all planned outcomes will have been achieved by the CRPs at the time of its review, because the present reviews are to be conducted after three years of operation on five-year research programs (originally planned for six years). Where data on impacts have been reported in an Outcome and Impact Case study Report (OICR) these will be included in the review. To the extent feasible, the review of CRP effectiveness should assess the likelihood for achieving IDOs and/or sub-IDOs, based on the CRP's and its Flagship Program's documented performance in relation to their Theories of Change.

Review Criteria

The CRP 2020 Review will be based on two of the six CGIAR evaluation criteria as defined in the CGIAR Evaluation Policy[5], which comprise relevance, quality of science, efficiency, effectiveness, impact, and sustainability. Because the CAS Secretariat/Evaluation Function has been directed to execute the external reviews in a compressed timeframe, the two criteria for assessing the CRPs that have been agreed with the System Council committee that is concerned with evaluation are Quality of Science and Effectiveness.

Quality of Science in the CGIAR is defined as the ways by which research is designed, conducted, documented and managed, in terms of the processes, inputs and outputs. The CGIAR's definition of Effectiveness aligns with that of OECD-DAC and other international bodies as the extent to which objectives have been achieved. An element of effectiveness present in the definition of impact is "a chain of events to which research outputs and related activities have contributed that are likely to contribute to impacts."[6] The application of these criteria in the CRP 2020 Review is further elaborated, below.

Review of Quality of Science

The CRP 2020 Review will examine quality of science and looks both at the conditions that are in place for assuring high quality of science, and the conduct and outputs of research. A systematic and consistent review of science quality across research programs and program components has three dimensions:

- Processes for assuring and enhancing science quality (staff recruitment, performance management and incentives; review processes used; codes of conduct; monitoring, evaluation and oversight for enhancing science quality);
- Inputs (quality of staff and research leaders, facilities and equipment, data management, research design);
- Outputs (volume and quality of publications, genetic materials, etc.).

The above dimensions are captured and elaborated in the review questions, below.

Review of Effectiveness

Assessing effectiveness of a CRP includes documenting the achievement of outputs and outcomes based on program reports and interviews and surveys of people involved or in a position to observe these. Outcomes or impacts will be included when those have been reported in an OICR. The CGIAR reporting definitions of these terms, and a modification made in the definition of outcome for these reviews, are as follows:

- *Outputs:* Knowledge, technical or institutional advancement produced by CGIAR research, engagement and/or capacity development activities. Examples of outputs include new research methods, policy analyses, gene maps, new crop varieties and breeds, institutional innovations or other products of research work.
- *Outcome:* A change in knowledge, skills, attitudes and/or relationships, manifested as a change in behavior, to which research outputs and related activities have contributed.

5 https://cgspace.cgiar.org/handle/10947/2762
6 https://marlo.cgiar.org/glossary.do

For the CRP 2020 reviews, the definition of outcome will be expanded to include innovations[7] that have entered into use. CGIAR defines innovation as follows: "development innovations are new or significantly improved (adaptive) outputs or groups of outputs - including management practices, knowledge or technologies. This could also refer to a significant research finding, method or tool. A significant improvement is one that allows the management practice, knowledge or technology to serve a new purpose or a new class of users to employ it … ."[8]

- *Impact:* A change in state resulting from a chain of events to which research outputs and related activities have contributed. Some examples: crop yield, farm productivity, household wealth (state) income (flow), quality of water (state), water flow (flow).

The CRP 2020 Reviews will assess CRP effectiveness from two perspectives. The first will compare planned versus completed outputs and outcomes as provided by the programs in annual Plans of Work and Budget and Annual Reports for 2017, 2018 and 2019. The second perspective is to assess reported achievements against the CRP's and its Flagship Programs' Theories of Change, which articulates the pathways from outputs to a sequence of outcomes and impact, to be tested in the course of program implementation. As noted earlier, the CRP's Theory of Change is either the original version from its proposal with any updated documentation or, if that Theory of Change has not been followed, an implicit theory in the CRPs annual work plans (POWB). The Flagship Programs' theories of change supplement the CRP Theory of Change as additional reference documentation.

The likelihood of future progress is a further aspect of effectiveness to be examined in the 2020 reviews**.** Whether or not there is a pipeline of innovations, which are reported by stage such as "ready for take up" and policies influenced by sphere of influence, will be determined. Reports of capacities developed, environment enabled, and key partnerships in place for development will also be considered as will opinions of research managers and key partners. Another important factor in future effectiveness, and a common question asked in CGIAR external evaluations, is about the management and governance that is in place in the CRP. Evidence gathered will include presence of a learning environment, addressed and unaddressed challenges to success, and integration across other CRPs' work.

Questions for the CRP 2020 Review

Cross Referencing to the CGIAR Quality of Research for Development Frame of Reference

The CRP 2020 review will cross-reference and map Effectiveness and Quality of Science to the CGIAR's broader Quality of Research for Development (QoR4D) frame of reference. The QoR4D frame of reference encompasses all review criteria and indicators, albeit organized in a different fashion and with a stronger emphasis on how each CRP positions its research and outputs for development outcomes and impact. In deploying two out of six of the evaluation criteria (i.e., as defined in CGIAR's 2012 Evaluation Policy and its accompanying Guidelines), while also bridging with the QoR4D frame of reference adopted by CGIAR in 2017, the review will overtly map the query areas and indicators to the QoR4D frame of reference so that the CRP 2020 Reviews speak to the QoR4D frame of reference. For more information, refer to the QoR4D brief on the CGIAR website: https://cas.cgiar.org/isdc/publications/quality-research-development-cgiar-context

To guide the planning and implementation by the expert review teams contracted to complete the CRP 2020 Reviews, questions for the review have been provided below. These questions were developed based on the definitions of the two review criteria (Quality of Science and Effectiveness), existing self-reported program data and internally funded studies by external experts. This set of review questions will be applied in each CRP review. As noted earlier, the CAS Secretariat will arrange for an initial briefing between the expert review team and the CRP under review, which will include a discussion to define 1-2 supplementary questions of interest to the CRP itself, if any.

[7] CGIAR glossary (https://marlo.cgiar.org/glossary.do) defines an innovation as an output while most research evaluation defines an innovation as a new or improved technology, product, process, or business model that has been put into use (OECD/Eurostat 2005).
[8] https://marlo.cgiar.org/glossary.do

Quality of Science

1. To what extent does the CRP deliver Quality of Science, based on its work from 2017 through 2019?

1.1. To what extent does the CRP benefit from sufficient high-quality inputs (with reference to the research environment and project designs)?

The review should look at productivity and engagement of scientists; diversity of teams and partnerships, in relation to planned outcomes; quality of facilities, equipment and other tools for research; and the level and predictability of CRP funding during the review period.

1.2. To what extent do the CRP management processes ensure the quality of science, including credibility, legitimacy, relevance to next stage users, and potential effectiveness, of the research and operations?

The review will consider the CRP's periodic re-assessment of the demand and quality of research; the research work environment as enabling QoR4D; research ethics, transparency and procedures for conflict of interest; and use of learning mechanisms to inform current and future research, for ultimate users of the research.

1.3. In what ways are the research outputs, such as germplasm, knowledge tools and publications, of high quality?

The review will assess external recognition of CRP outputs as high quality; collaboration for innovation with next stage users and/or beneficiaries; value of outputs in developing capacities for researchers, next stage users and partners.

Effectiveness

2. What outputs and outcomes have been achieved and what is the importance of those identified results?

2.1. To what extent have planned outputs and outcomes been achieved by 2019?

The review should examine the CRP's own targets and deliverables (outputs, milestones, and outcomes) as listed in the program's Plan of Work and Budget (POWB) and annual reports or in the OICRs; as well as contributions to cross-cutting issues, and integrated work with other CRPs.

2.2. What is the importance of achieved outcomes, with reference to CGIAR intermediate development outcomes (IDOs) and sub-IDOs, cross-cutting issues (Capacity Development, Climate Change, Gender and Youth), and partners' objectives, with consideration for predictability of funding and legacy time frame for the CRP?

The review will focus on IDOs and sub-IDOs and other unanticipated outcomes reported by the CRP, whether positive or negative; the program's engagement with cross-cutting issues, namely gender, capacity development, innovation and partnerships; the program's age and maturation (with research in some cases preceding the current CRP cycle) and the context of its work; and achievements in relation to partners' expressed needs.

2.3. How have the program's management and governance supported the CRP's effectiveness in research?

The review will consider changes and adaptations in the program's activities, objectives, and strategy based on lessons learned; unaddressed changes in context or other challenges; and risk management planning and mitigations by the CRP.

2.4. To what extent has the CRP and its Flagship Programs made progress along their Theories of Change?

The review will assess how the program has used its TOC, if at all, or developed an alternative program logic; progressed along the defined impact pathways; and adapted its TOC (explicit or implicit) based on learning and evidence.

Future orientation

3. To what extent is the CRP positioned to be effective in the future, seen from the perspectives of scientists and of the end users of agricultural research (such as policy-makers, practitioners or market actors)?

3.1. What programmatic evidence exists for future effectiveness within the life of the program (through 2021), considering the comparative advantages of the CRP and its Flagship Programs and drawing on the CRP's and its Flagship Programs' progression according to their Theories of Change?

The review will assess the readiness for adoption of the program's deliverables at the IDO and sub-IDO levels; and changes in the program's enabling environment, capacities and partnerships that prepare its research outputs for successful use by next users and beneficiaries.

As noted, 1-2 supplemental questions may be developed by the expert review team and senior scientists and leadership from the CRP under review, with guidance from the CAS Secretariat. These limited questions will align within the three primary review questions as shown above, and will not constitute additional, stand-alone review questions.

Methods and data sources

The reviews will rely extensively on CRP documentation and interviews with Program Leaders and external groups including research partners, national policy-makers and donors, and FGDs with CRP staff. Additionally, bibliometric analysis of CRP research products (publications) will be conducted by the CAS Secretariat and provided to the expert review team. The primary sources of data and information for the reviews comprise the following:

*Documents from the CRP***:** These include CRP proposals (2016-2018) including the CRP's Theory of Change as well as any documented updates or revisions, the CRP's Flagship Program Theories of Change, program independent steering committee reviews, CRP Plans of Work and Budget (POWB), Annual Reports for 2017 through 2019 (the 2019 annual report will be drafted by April and finalized by July 2020), the internal program MARLO data system or the Measurement, Evaluation and Learning Platform of the CGIAR MEL organization, the most recent CRP independent, external evaluation report (for CRPs that had such an evaluation), impact studies from the past five years (for CRPs that have had such a study) and other relevant program documents.

CGIAR Results Dashboard: The results dashboard is an online portal that summarizes each CRP's reported results, including innovations, capacity development, policies and partnerships, as a quantitative supplement to the CRP annual report.

CGIAR database of Output Impact Case Reports (OICRs): OICRs are short reports describing and documenting the contribution of CGIAR research to development outcomes and impact, searchable by geographic location, level of maturity along the impact pathway, or by their contribution to CGIAR's IDOs. The benefit of the OICR analyses is its critical review of the development effectiveness of the CRP's work, in generating lessons learned based on concrete cases, for the design of future research arrangements.

Interviews with CRP Leaders, donors and partners, including CRP Program Directors and levels of management above them. Their wide perspective will be particularly helpful for key accomplishments now and projected for the future and challenges faced. The expert review team will conduct these short (approximately one hour) interviews by phone or video conference call.

Focus group discussion (FGD) with CRP management, to assess aspects of quality of science and the research environment, and to obtain broader views on management and governance. The expert review team will conduct FGDs through a virtual (webinar with video) setting.

External Expert Studies: Any outcome and impact assessment studies conducted or commissioned by the CRP itself, as well as external assessments on other subjects including those that cross-cut programs, are also available.

The CAS Secretariat will conduct pre-analysis on the datasets captioned below, and provide the outputs to the review team for inclusion in the analysis of the CRP. The review team does not need to access these data sources directly. These include data and information from the sources below.

Bibliometric and Altmetric and Other Studies of CRP Publications and Other Outputs: These studies are done mostly by CRP or CGIAR staff. Sources of information about outputs such as datasets, innovations, contributions to policy-making and decision support tools include literature and website reviews.

Survey of Researchers in CGIAR and research partners. To avoid researchers receiving multiple surveys, a master list will be compiled of researchers and the programs/flagships each is involved with. Individual

programs could add a few program-specific questions to the general battery of general interest questions such as opinions of the research environment.

Survey of Partners, defined as a relationship with CGIAR with specific objectives (fund, joint planning or implementation). To avoid partners receiving multiple surveys, a master list will be compiled of partners and the programs/flagships each is involved with. Individual programs could add a few program-specific questions to the battery of general interest questions such as satisfaction with joint efforts with CGIAR.

Overview of Methods and Analysis

These reviews will use mixed methods, quantitative and qualitative, so that analysts can triangulate perspectives, both internal (CRP) and external (partners, next users, etc.) in analysis. When assessing a CRP's quality of science, the expert review team will derive findings from existing CRP documents, bibliometric analysis and reports of any external expert reviews, and from primary data collection from questions on surveys of researchers and partners, interviews with CRP leader (also Principal Investigator) and external stakeholders, and focus group discussions with others in the CRP management.

Publication data collection, bibliometric and Altmetric analyses, and a set of analyses of CRP results are done internally by the CAS Secretariat and CRPs. Analysis of the quantity and quality of research outputs, the number of publications in peer-reviewed journals and other outlets, and the citation of those publications by other scientists will be provided to the expert review team for triangulation of findings.

Three general methods will be utilized in assessing programs on both effectiveness and quality of science: content analysis, descriptive and statistical analysis, and synthesis of existing external evaluations. More information on each of these follows.

- Content Analysis. Quantitative and narrative descriptions of achievements and programmatic actions are found in the CRP documents for the review, particularly the proposal, annual plans, annual reports and selected OICRs. Content analysis of individual reports and cross-report analysis can summarize findings for many of the review questions, including production and utilization of non-publication outputs such as datasets and training events. This could include preliminary analysis of trends observed, given the low number of available data points in the period under review.
- Surveys and Interviews with Statistical and Content Analysis. Representative samples of both researchers and partners will be developed for surveys. Interviews will be done with the CRP manager and selected partners, and an FGD will be conducted with the CRP management and staff. Qualitative analysis will be done on open-ended questions. As with any survey, statistical analysis will be completed with survey responses where that is feasible.
- Synthesis. The content of existing external studies will be aligned with stated objectives of the program and findings in these studies summarized. In a few cases, the studies themselves provide a synthesis across studies to draw more general conclusions.

Methods for documenting the CRP's effectiveness and responses to challenges rely on examining the Theories of Change or alternative program logic at the program and flagship levels in relation to the CRP's reported results from monitoring data (reported on CGIAR's MARLO and/or MEL platforms) and outcome/impact case reports (i.e., OICRs).

- *Comparison of achieved results versus proposed objectives/milestones*. Because each CRP uses annual work plans (POWB) and produces annual reports, it will be relatively straightforward to compare planned outputs against reported completed deliverables (some CRPs may also use milestones, along with or instead of deliverables). The reports also record when deliverable deadlines slip, with explanations for that lack of expected progress. Tagging innovations by stages will also help with year to year comparisons.
- *Comparison of operational or proposed theories of change with reported achievements:* As programs are not asked to report progress along their specific theories of change, the expert review teams will map reported achievements against the expected sequence of achievements along the elements of the CRP and Flagship theories of change (or alternative program logic models). With that, the review team will be able describe what and where progress has been made toward reaching stated objectives and link these to learnings about the theory to change and influencing factors. The benefit of this approach is that it describes the program progress toward objectives more clearly than counts or lists of deliverables, providing a better understanding of (a)

the plausibility of cause-effect linkages within the program logic and (b) the contribution of the CRP to development outcomes.

- *In-depth analysis of selected outcomes and impacts*. The expert review team will select one or two Outcome and Impact Case Reports (OICRs) for each CRP, in consultation with CRP leadership. The review will analyse the selected OICR(s) in greater depth, looking at the contribution of the CRP's research in successfully addressing a given development objective, mapping the reported outcome or impact within the Theory of Change at the Programme and Flagship level. This work will be done through analysis of documents from the CRP and from next users of the research, such as national government policies, and interviews with key informants (both within the CRP and equally importantly the next users of the research, e.g., external stakeholders in NARS and national policy-makers) who may assist in better understanding the nature and importance of the CRP's contribution, as reported in the OICR. A specific reporting template for the OICRs analysis will be provided to the review team.
- *Contextual analysis*. For many reasons related to context within the program or the context of those who would move the research forward to development and scale up, research for development projects and programs may progress at a different pace. At a minimum, context of a program will be characterized by the age of the program including all earlier phases of similar research, total amount of budget, quality of funding, and the CRP's typology as a Global Integrating Program or Agri-food System Program.
- *Analysis of management and governance*. There are several sections in the Annual Reports in which CRPs report aspects related to learning lessons as the research evolved and challenges that arose and how those were handled. The annual POWB discusses changes, if any, in the theories of change. The review team will supplement these sources with responses from surveys, interviews and focus group discussions. The analysis will triangulate information from these sources to identify how the CRP has managed and governed its research program in the context of the challenges faced over the period of review.

Deliverables and consultation for the CRP Review

The review team is expected to produce the following deliverables:

1. A preliminary findings matrix, for discussion midway through the review process, to check the progress of the review and to provide a basis for early course correction if required. The CAS Secretariat will provide the review team with a template for the preliminary findings matrix.
2. A brief presentation of preliminary findings, for the debrief with the CRP management and the CAS Secretariat for validation, factual corrections, and feedback.
3. A draft report of the CRP review, for review by the CRP management and the CAS Secretariat for final feedback. The CAS Secretariat will provide a template for the draft and final reports.
4. A final report of the CRP review, following the report template with a maximum of 20 pages, a 2-3 page executive summary, and a set of annexes with additional information apart from the main body of the report.
5. A PowerPoint presentation covering the main points of the review, including purpose, methods, findings, conclusions, recommendations and additional notes relevant to the review. The CAS Secretariat will provide a template for this presentation.

Templates for the preliminary findings matrix, draft and final report, and the presentations will be provided to the review team in the first week of the review.

The review team will engage with the CAS Secretariat and the CRP under review at the following key points:

- Initial discussion with the CAS Secretariat to start the review and clarify questions from the review team;
- Briefing at the start of the review between the review team and CRP management, facilitated by the CAS Secretariat;
- Interview with the CRP Leader and a focus group discussion (FGD) with other members of the CRP management during data collection;

- Debrief presentation of the preliminary findings led by the review team, for validation, clarifications and feedback by the CRP management and the CAS Secretariat;
- The draft report will be shared with the CRP Leader and staff for factual correction and final feedback.

Additional discussions between the review team, the CRP management and the CAS Secretariat may be scheduled based as needed during the course of the review.

Schedule of the reviews

The reviews will be conducted in a phased, stepwise manner, so as to enable due support from CAS Secretariat throughout the review process. The first three reviews will take place between April and June 2020. Thereafter, in late June, CAS Secretariat will conduct an 'after-action review' involving the Program Leaders from the first three CRPs reviewed, for fine-tuning of the review process in enhancing learning and minimizing the burden on CRPs. While refinements to the review process may be made, the fundamental review parameters will remain harmonized for all CRP reviews through the year. Substantive changes on questions and sub-questions are not foreseen from the after-action review. The subsequent nine CRP reviews will be conducted in the second half of the year, commencing in August 2020.

The first set of reviews, scheduled for April through June 2020, includes three CRPs - one global integrated program and two agri-food system programs. This initial selection of CRPs for review is based on (a) two Agri-Food Systems and one Global Integrated Program, (b) the length of time since the last independent evaluation conducted for the CRP and (c) CRPs with and without substantial changes in program and/or structure from Phase I to Phase II. CRPs that had requested to be included in the first set of reviews were prioritized, within the above criteria. The working schedule of CRP reviews is attached as Annex 2. For each review, an indicative time frame of deliverables and milestones for the review is provided in Annex 3.

Qualifications for the expert review team

Each review team is anticipated to include (1) a senior subject matter expert with in-depth subject matter expertise related to the CRP under review, and (2) a senior evaluator with experience in agriculture, natural resources management, food systems or nutrition. Of the two team members, one must serve as the team leader, who will bring relevant experience in that evaluation leadership and be the lead author for the report and accountable for the review team performance.

The estimated number of days of effort for each role in the review is provided below:

- Senior Subject Matter Expert: 40 days;
- Senior Evaluator: 30 days;
- Team Leader (additional to one of the above roles): 10 days.

The qualifications for each role are outlined below. **This is a desk-based review and no travel is envisaged.**

Qualifications for the senior subject matter expert include the following:

- Excellent understanding and knowledge of the key issues in agriculture, natural resources management, food systems and/or nutrition, as related to the CRP to be reviewed;
- 15 or more years (preferably, over 20 years) of work experience in the domain(s) related to the CRP to be reviewed;
- Strong knowledge of the main international institutions and mechanisms involved in the areas of research and development that are the focus of the CRP to be reviewed;
- Academic background relevant to the CRP's areas of research;
- Excellent understanding and knowledge of the international debate on the key issues related to the CRP to be reviewed;
- Depth of knowledge of areas of research and development that are the focus of the CRP to be reviewed;
- Knowledge of the CGIAR and/or the CRP to be reviewed.

- Strong English writing and verbal communication skills.

Qualifications for the senior evaluator include the following:

- 8 or more years of experience leading evaluations, preferably including international programs or research on agriculture, natural resources management, food systems and/or nutrition;
- Extensive experience with theory-based evaluations, including analysis of effectiveness in relation to a Theory of Change with potential implicit adaptations;
- Preference for evaluation experience in one or more research areas specific to the CRP;
- Preference for knowledge of the CGIAR and/or the CRP to be reviewed.
- Strong English writing and verbal communication skills.

In addition, the consultant (from one of the above two positions) who will also serve as Team Leader must demonstrate the following:

- Experience leading evaluation of complex programs, preferably in international agricultural research;
- Demonstrated accountability in terms of timeliness and quality of deliverables and responsiveness in communication;
- Academic background or experience in evaluation and/or an area relevant to the CRP's work;
- Strong project management skills;
- Experience working virtually (online) in successfully conducting interviews and facilitating discussions with senior managers, researchers, practitioners and policy-makers;
- Excellent English writing and verbal communication skills.
- Excellent presentation and report writing skills, including for executive and multicultural audiences and remote/virtual presentations.

Alternative team configurations may be considered, and the CAS Secretariat will discuss options presented by the proposed consultants.

Applications are encouraged from teams of two consultants with the qualifications and experience outlined above for the senior subject matter expert and the senior evaluator, clearly indicating which individual is proposed for the team leader role. Individual consultants may also apply for the subject matter expert or evaluator roles, with the intent to be matched with a suitable counterpart from the roster of other applicants.

Application process

Interested teams and individuals should send their CV and a cover letter indicating the role to which s/he is applying and the CRP(s) in which s/he is qualified to serve as a reviewer (see Annex 1 for an overview of the CRPs and their flagships and also the full CRP profiles on the CGIAR website: https://www.cgiar.org/research/research-portfolio/). The CV and cover letter should include information on the applicant's:

- Proposed role (Senior Subject Matter Expert or Senior Evaluator) and intended CRP(s) for the review, with both the role and intended CRP(s) clearly stated in the subject line of the email and the cover letter;
- Demonstrated expertise in the technical research areas relevant to the CRP to be reviewed;
- Experience in evaluation;
- Expected daily fee rate (demonstrable with evidence of rates on previous assignments);
- Location and time zone of her/his work location;
- Email, telephone and Skype contact details of the applicant(s);
- Names and contact information (email, telephone and postal address) for three (3) referees, who will be contacted for short-listed candidates;

- Availability for the CRP review based on the schedule provided in Annex 2, as well as more generally over the period April through December 2020.
- List of publications (including peer reviewed work and past evaluations/reviews authored)

Interested teams or individuals meeting the above criteria should send their application by email to CAS-Evaluation@cgiar.org . Applications are accepted on a rolling basis, and the CAS Secretariat will contact short-listed candidates for follow-up at an early date, for potential scheduling of the relevant CRP review. Regrettably, we are unable to respond to all applicants, but will retain CVs and contact information on file for those who meet the above criteria.

Contract and payment schedule

The CAS Secretariat is hosted at the Alliance of Bioversity International and the International Center for Tropical Agriculture[9], at the offices in Rome, Italy. Consultancy contracts will be issued by the host institute of the CAS Secretariat. The members of the review team are expected to abide by the Conflict of Interest and Safeguarding policies of the CAS Secretariat and its host institutions, and must maintain independence in fact and appearance from the CRP under review throughout the duration of the assignment. Each review team member must sign and return statements indicating their understanding and compliance with the policies of the CAS Secretariat and its host institutions.

Payments under the contract are scheduled as below:

- 25% on signing of the contract;
- 25% after the midterm check-in discussion and delivery of the preliminary findings matrix, subject to satisfactory approval by the CAS Secretariat;
- 50% on delivery of the final review report, subject to satisfactory approval by the CAS Secretariat.

This is a short-term consulting opportunity with the level of effort as indicated for each consultant role. All consultancy fees and conditions will be administered in line with the Alliance for Bioversity International and CIAT's approved policy for consultants.

Contact at the CAS Secretariat for the CRP 2020 Review

The CAS Secretariat has appointed an Evaluation Consultant, Dr. Ravi M. Ram, to manage the CRP review process, along with CAS evaluation staff and a consultant providing senior technical advice, under the overall direction of the CAS Secretariat Director, Allison Grove Smith. Questions regarding this Terms of Reference should be directed to r.ram@cgiar.org .

Who we are

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to reducing poverty, enhancing food and nutrition security, and improving natural resources and ecosystem services. Its research is carried out by 15 CGIAR Centers in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations, and the private sector. These 15 Centers have close to 10,000 staff based in over 50 countries.

Each Center has its own governing instrument, board of trustees, director general, and staff. CGIAR Research Centers are responsible for hands-on research programs and operations.

The CAS Secretariat supports and facilitates the CGIAR's independent advisory services, comprising the Independent Science for Development Council (ISDC), the Standing Panel on Impact Assessment (SPIA) and an independent evaluation workstream.

9 Bioversity International and CIAT are CGIAR Research Centers. For further information consult the websites at https://www.bioversityinternational.org and www.ciat.cgiar.org

In 2020, CGIAR is embarking on an ambitious reform, One CGIAR, to streamline governance and operational structures and processes across CGIAR. More information can be found here[10].

The Alliance of Biodiversity International and CIAT is an equal opportunity employer and strives for diversity.

[10] https://www.cgiar.org/how-we-work/strategy/cgiar-system-reference-group/

Annex 2: List of documents reviewed

CGIAR (2015) CGIAR Strategy and Results Framework 2016-2030: Refining how CGIAR does business until 2030.

EiB (2020) Key actions taken in response to Crops to End Hunger: EiB Special Report to the CGIAR System Management Board, May 2020.

Echeverria, R and Beebe, S (2019). Common Bean Flagship Proposal Final Version. Cali, Colombia: International Center for Tropical Agriculture (CIAT).

GLDC (2017) CRP Grain legumes and dryland cereals agri-food system: demand-driven innovation for the drylands. Full Proposal.

GLDC (2018) Annual Report.

GLDC (2019) Annual Report.

GLDC (2018) Plan of Work and Budget

GLDC (2019) Plan of Work and Budget

GLDC (2020) Plan of Work and Budget

ISPC (2017) ISPC Commentary on the Grain Legumes and Dryland Cereals (GLDC) CRP-II revised proposal (2017-2022). ISPC, Rome, Italy

ISPC (2020) Quality of research for development (Qo4RD) in the CGIAR context

Minutes of meetings of the Independent Advisory Group

Minutes of meetings of the Research Management Committee (Meetings 6-14)

White paper: ICRISAT strategy and operations for crop improvement

Focus traits for improvement of GLDC crops through FP4 and FP5 interventions

Orr et al. (2017a) Assessment of past performances and lessons learned

Orr et al. (2017b) Unpacking demand for GLDC crops

Gaur et al. (2017) Product concept notes of GLDC crops

Midmore et al. (2016) CCEE Report on CRP Grain Legumes

*Does not include publications, technical reports or communication documents listed in Annex 5.

Annex 3: List of persons contacted during the Review

Annex 3. Persons interviewed by Skype or email*

Person	Affiliation	Role in GLDC
Dr Shiv Kumar Agrawal	ICARDA, Morocco	Centre Focal Point
Dr Syed Shakir Ali	KVK-Baramati, India	NGO partner
Dr Arega Alene	IITA, Malawi	FP1 leader
Dr Augustine Ayantunde	ILRI, Burkina Faso	Centre Focal Point
Dr Ian Barker	CIP, Peru	Former IAC Chair
Dr Jules Bayala	ICRAF, Mali	FP3 leader
Professor Ramesh Bhat	UAS-Dharwad, India	NARS partner
Dr Peter Carberry	GRDC, Australia	Former PD of GLDC
Dr Ravindra Chary	ICAR-CRIDA, India	NARS partner
Dr Sigrun Dahlin	SLU, Sweden	ARI partner
Dr Jeffrey Ehlers	B&MGF, USA	Funder
Dr Thomas Falk	ICRISAT, India	Capacity Development Specialist
Dr Rajeev Gupta	ICRISAT, India	FP5 leader
Dr Etienne Hainzelin	CIRAD, France	IAC Chair
Dr Andrew Hall	CSIRO, Australia	MPAB leader/Centre Focal Point
Dr Michael Hauser	ICRISAT, Kenya	Innovation systems
Dr Geoffrey Heinrich	CRS, Zambia	Seed systems/IAC member
Dr Karl Hughes	ICRAF, Kenya	CoA1.4 leader
Dr Jane Ininda	AGRA, Kenya	Seed systems/IAC member
Ms Neena Jacob	ICRISAT	GLDC Program Manager
Dr Mariame Maiga	CORAF, Senegal	Gender specialist/IAC member
Dr Kai Mausch	ICRAF, Kenya	CoA1.2 leader
Dr Eng Hwa Ng	EiB, Philippines	CGIAR Platform partner
Dr Esther Njuguna-Mungai	ICRISAT, Kenya	CoA1.3 leader/Gender specialist
Dr Chris Ojiewo	ICRISAT, Kenya	Seed systems
Dr Lucky Omaigui	IITA, Nigeria	Seed systems
Dr Janila Pasupuleti	ICRISAT, India	FP4 leader
Dr Babu Raman	Corteva Agri-science, USA	Private sector partner
Dr Jean Claude Rubyogo	CIAT/PABRA, Kenya	FP6 leader
Dr Kiran K Sharma	ICRISAT, India	GLDC Director/DDG-R
DR N P Singh	ICAR-IIPR, India	NARS partner

Dr Hanumanthappa Sudhakar	Advanta Seeds, Kenya	Private sector partner
Dr Manuele Tamo	IITA, Benin	Centre Focal Point
Dr Fousseni Traore	INERA, Burkina Faso	NARS partner
Dr Vincent Vadez	IRD, France	CoA4.1 leader/Centre Focal Point
Dr Ronnie Vernooy	Bioversity, Netherlands	Seed systems

*Interviews and group discussions

Annex 4: Data collection tools

These included:

1. Specific interview guides
2. CGIAR Dashboard
3. Publication analysis tools (see Table below)

Interview guide for FP and CoA leaders – personalized depending on FP/CoA

Structure of FP

Brief description of activities

Highlight key outputs in context of quality of science

Strategic issues

Progress to date

Integration within GLDC – FP linkages

Partnerships – types and effectiveness

Direction and management

Future plans

Any deficiencies/gaps/challenges

Interview guide for partners

Description of partnership

Effectiveness of partnership

Own and GLDC's comparative advantage

Benefits of partnership

Management of partnership

Any deficiencies/gaps/challenges

Interview guide for 'deep dive' seed systems

Outcomes

Partnerships

Gender

Capacity development

Tracking outcomes

Enabling environment

Lessons learned

Future research needed

Annex Table 5.3: Significant Journal Article Publications by Bibliometric or Altmetric Scores

Criterion	Assessment approach	
1. Methodological rigor and coherence of data analysis	Rating Scale 1=poor 2=mediocre 3=good 4=excellent	
2. Originality, innovativeness	Rating Scale 0 =not applicable 1 = no originality 2= standard methods, established knowledge 3= rather original 4= very original, new research, analytical or theoretical concepts	
3. Referencing (whether referencing is up to date, balanced across relevant disciplines, indicating that the publication takes account of earlier work)	Rating Scale 1=referencing is poor 2= referencing is limited	
	3. Referencing (whether referencing is up to date, balanced across relevant disciplines, indicating that the publication takes account of earlier work)	Rating Scale 1=referencing is poor 2= referencing is limited 3= referencing is good 4=referencing is excellent
	4. Do the results (knowledge) presented in the paper represent broadly applicable knowledge (International Public Goods) relevant to agriculture and climate change?	Rating Scale 0= results not relevant to agriculture and climate change 1=no broader applicability (local relevance only) 2= potentially broader applicability, but not spelled out 3= broader applicability is presented 4= significant international applicability
	5. Quality (and appropriateness) of publication venue	Observation of low-quality or inappropriate venue relative to subject and quality of paper
	6. Co-authorship	Observation of extent of co-authorship, with whom and is it appropriate?

	7. Overall quality of publication (including additional criteria at evaluator discretion)	Brief overall assessment (around 100-150 words)
	3=referencing is good 4=referencing is excellent	
4. Do the results (knowledge) presented in the paper represent broadly applicable knowledge (International Public Goods) relevant to agriculture and climate change?	Rating Scale 0= results not relevant to agriculture and climate change 1=no broader applicability (local relevance only) 2= potentially broader applicability, but not spelled out 3= broader applicability is presented 4= significant international applicability	
5. Quality (and appropriateness) of publication venue	Observation of low-quality or inappropriate venue relative to subject and quality of paper	
6. Co-authorship	Observation of extent of co-authorship, with whom and is it appropriate?	
7. Overall quality of publication (including additional criteria at evaluator discretion)	Brief overall assessment (around 100-150 words)	

Annexes 5 (a-j): Bibliometric analyses, diversity of teams, assessment of physical outputs, assessment of publications and reports, assessment of milestones

Annex 5a. Diversity of teams according to institute, geographical location and gender*

Flagship	Partner institutes	Countries	Gender
FP1	ICRISAT, IITA, ICRAF, ICARDA, Bioversity, CSIRO	Australia, Egypt, India, Italy, Kenya, Malawi, Mali, Morocco, Tunisia, Zambia, Zimbabwe	Female = 10 Male = 19
FP3	ICRISAT, ICRAF, IITA, ICARDA, CIRAD, CSIRO, SLU, WUR, KALRO, Makere University, INERA, SPGRN and ICAR	Australia, Benin, Burkina Faso, Egypt, France, India, Lebanon, Malawi, Mali, Mozambique, Netherlands, Niger, Nigeria, Senegal, Sweden, Uganda and Zimbabwe	Female = 27 Male = 45
FP4	ICRISAT mainly, ICARDA, ILRI, IITA, Bioversity, IRD, CIRAD, ARI, PAU, IIPR, INERA, IER, MPKV, PPKV, UAS	Burkina Faso, Egypt, Ethiopia, France, Ghana, India, Italy, Kenya, Lebanon, Malawi, Mali, Morocco, Niger, Nigeria, Senegal, Uganda and Zambia	Female = 38 Male = 146
FP5	ICRISAT mainly, IITA, ICARDA, CIMMYT, CIRAD, IRD, JIRCAS, Bayer College, KALRO, PJTSAU, UAS, NRCG and IARI	Egypt, France, India, Japan, Kenya, Mali, Morocco, Nigeria, Senegal, USA and Zambia.	Female = 16 Male = 89

*Extracted from GLDC spreadsheet of collaborating scientists

Annex 5b. Analysis of bibliometric data for GLDC from 2017-2018 using the QoR4D Framework for all publications with 5 or more citations

Author	Institute/Location	Publication	Journal	IF	H-index	Citations/ Altmetric	FP	Partnerships: Institutes/Countries	Significance	IPG value
Varshney R K	ICRISAT, India	Pearl millet genome sequence	Nature Biotechnology	35.7	94	74/336	4, 5	ICRISAT, India = 12 BGI, China = 9 IRD, France = 7 U of Georgia, USA = 5 IPK, Germany = 3 Plus 41 others from USA, India, China, France, Austria, Italy, UK, Niger and Senegal	High	High
Verkaart S	ICRISAT, Kenya	Welfare effects from adoption of chickpea in Ethiopia	Food Policy	3.8	6	60/14	1	ICRISAT, Kenya = 2 ICRISAT, Zimbabwe = 1 WUR, Netherlands = 1 U Illinois, USA = 1	High	High
Pandey M K	ICRISAT, India	High density Axiom Arachis Array	Scientific Reports	4.5	39	59/7	5	ICRISAT, India = 10 U of Georgia, USA = 8 CRI, GAAS, China =2 U of WA, Australia = 1	Good	Good
Pandey M K	ICRISAT, India	QTL sequencing of Arachis for markers for two diseases	Nature Biotechnology Journal	6.3	39	57/3	5	ICRISAT, India = 10 UAS, Dharwad, India = 1 U of Georgia, USA = 1	Good	Good
Varshney R K	ICRISAT, India	Whole genome sequencing of pigeon pea	Nature Genetics	27	94	56/107	5	ICRISAT, India = 6 Macrogen, Korea = 4 SMG, China = 3 PJTSAU, India = 1 UAS, Kanataka = 1 Visva-Bharali, India = 1 U of California, USA = 1 Int. U. Florida, USA = 1	High	High
Clevenger J	University of Georgia, USA	Genome wide SNP genotyping in peanut	Molecular Plant	10.8	14	47/1	5	U of Georgia = 6 ICRISAT, India = 6 U of Brasilia, Brazil = 1 EMBRAPA, Brazil = 1	High	High

								Plus 5 others from USA and Israel		
Gumma M K	ICRISAT, India	Mapping pulse crop areas in Myanmar	International Journal of Digital Earth	4	34	4	3	ICRISAT, India = 4 USGS – Arizona, USA = 4 IPNI,Malaysia = 1	Good	High
Dwivedi S L	ICRISAT, India	Diversifying food systems for sustainable production and healthy diets	Trends in Plant Science	14	?	58	3 and 4	ICRISAT, India = 2 WUR, Netherlands = 1 RSR, Italy = 1 SAS, Alharp, Sweden = 1	Moderate	Moderate
Roorkiwal M	ICRISAT, India	High density Axiom Cicer Array	Plant Biotechnology Journal	4.2	11	25	5	ICRISAT, India = 5	Good	Good
Parankusam S	ICRISAT, India	Plant heat stress tolerance: current knowledge and perspectives	Frontiers in Plant Science	4.3	?	27/3	4 and 5	ICRISAT, India = 4	Good	Moderate
Pandey M K	ICRISAT, India	Novel QTLs for resistance to leaf spot and wilt virus in peanut	Frontiers in Plant Science	4.3	39	21/3	5	ICRISAT, India = 5 U of Georgia, USA = 4 USDA/ARS, USA = 5 SAAS, China = 1	Good	Good
Sathya A	ICRISAT, India	Growth-promoting actinobacteria for production and protection of grain legumes	3 Biotechnology	1.8	?	38	5	ICRISAT, India = 3	Moderate	Moderate
Sharma K K	ICRISAT, India	Peanuts keeping aflatoxin at bay	Plant Biotechnology Journal	4.2	39	29	5	ICRISAT, India = 5 Danforth, USA = 2 USDA/ARS, USA = 2 Louisiana State, USA = 2	High	High

Mallikarjuna B P	ICRISAT, India	Molecular mapping of flowering time in chickpea	Frontiers in Plant Science	4.3	3	22	5	ICRISAT, India = 7 UAS, Raichur, India = 3 U of WA, Australia = 1	Good	Good
Singh P	ICRISAT, India	Yield gains under climate change for pearl millet	Science of the Total Environment	5.9	?	16	4	ICRISAT, India = 6 U of Florida, USA = 1	Good	Good
Saxena R K	ICRISAT, India	Genotype-by-sequencing of mapping populations of pigeon pea for SM resistance	Scientific Reports	4.5	34	21/9	5	ICRISAT, India = 13 PJTSAU, India = 2	Good	Good
Saxena R K	ICRISAT, India	High density genetic maps and QTLs for FW of pigeon pea	Scientific Reports	4.5	34	24/6	5	ICRISAT, India = 13 PJTSAU, India = 2 Osmania U, India = 1	Good	Good
Huynh, BL	U of California, USA	MAGIC population for genetic analysis and improvement of cowpea	Plant Journal	5.7	17	22	4	U of California, USA = 12 Discovery Sci, USA = 1 IERA, Burkino Faso = 2 IITA, Nigeria = 2 ISRA, Senegal = 1 SARI, Ghana = 1	Good	Good
Anuradha N	ICAR, India	Genomic regions for high grain Fe and ZN in pearl millet	Frontiers in Plant Science	4.3	?	18/2	5	ICAR, India = 8 ICRISAT, India = 1	High	High
Agarwal G	USDA/ARS and U of Georgia, USA/ICRISAT, India	Fine mapping for disease resistance in peanut	Plant Biotechnology Journal	4.2	14	21/7	5	USDA/ARS, USA = 6 U of Georgia, USA = 9 ICRISAT, India = 4 U Laval, Canada = 1 SAAS, China = 1 BGI-Shenzhen, China = 2	High	High
Ye H	U of Missouri, USA	Root system architecture in response to drought stress	Journal of Experimental Botany	5.3	9	18/7	4	U of Missouri, USA = 5 ICRISAT, India = 2	High	High

		in grain legumes								
Fountain J C	U of Georgia	Proteome analysis of A flavus with regard to aflatoxin production	Scientific Reports	4.5	?	18/5	5	U of Georgia, USA = 4 ICRISAT, India = 4 U of Florida, USA = 2 Louisiana State, USA = 1 USDA/ARS, USA = 1	Good	Good
Varshney R K	ICRISAT, India	Understanding drought tolerance from alleles to cropping systems	Journal of Experimental Botany	5.3	94	9	4 and 5	ICRISAT, India = 1 U of Bologna, Italy = 1 U of Montpellier, France = 1	Moderate	Good
Siddaiah C N	U of Mysore, India	Chitosan nanoparticles induce resistance against pearl millet downy mildew	Scientific Reports	4.5	?	23/0	5	U of Mysore, India = 1 CSIR, India = 1 Kanataka St. U, India = 1 Bharathiar U, India = 2 Tallinn U, Estonia = 1 ICAR, India = 1 CAAS, China = 2 University, Romania = 1 Mizoram u, India = 1 ICRISAT, India = 1	Moderate	Good
Milcher J	U Saskatchewan, Canada	Role of yields and profits in technology adoption	American J Agric. Economics	1.8	?	23/74	1	ICRISAT, Kenya = 2 U Saskatchewan, Canada = 1 U Wisconson, USA = 1	Good	Good
Shasidhar Y	ICRISAT and Osmania U, India	Molecular mapping of oil content and fatty acids in peanut	Frontiers in Plant Science	4.3	?	20	5	ICRISAT, India = 8 Osmania U, India = 1 USDA/ARS, USA = 1 U of WA, Australia = 1	High	High
Ramya AR	ANGRAU and ICRISAT, India	Defining heterotic genepools in pearl millet	Frontiers in Plant Science	4.3	?	18/21	5	ICRISAT, India = 6 ANGRAU, India = 2 ICAR, India = 1 AAU, India = 1 Aberystwyth U, UK = 1	Good	Good
Kante AM	U of Hohenheim, Germany	Yield advantage of sorghum hybrids for smallholder	Crop Science	1.6	3	15	4	U of Hohenheim, Germany = 2 U of Wisconsin, USA = 2 IER, Mali = 3 ICRISAT, Mali = 1	Good	Moderate

		farmers in West and Central Africa								
Singh V K	ICRISAT, India	Sequencing genes for resistance to Fusarium wilt in pigeon pea	Plant Biotechnology Journal	4.2	24	50/1	5	ICRISAT, India = 15 PJTSAU, India = 2 UAS – K, India = 1	Good	High
Pashamala L T	ICRISAT, India	Gene expression atlas of pigeon pea for pollen fertility and seed formation	Journal of Experimental Botany	5.3	12	23/10	5	ICRISAT, India = 6 INRA, France = 1	Good	Good
Djanaguiraman M	Kansas State U, USA and TNAU, India	Sensitivity of sorghum pollen to high temperature	Plant Cell & Environment	5.6	24	24/1	4	Kansas State U, USA = 6 TNAU, India = 1	Moderate	Good
Djanaguiraman M	Kansas State U, USA and TNAU, India	Qualifying pearl millet response to high temperature stress	Plant Cell & Environment	5.6	24	15/11	4	Kansas State U, USA = 4 TNAU, India = 1 ICRISAT, India = 1	Good	Good
Huber R	Zurich ETHZ, Switzerland	Decision-making in European agricultural agent models	Agricultural Systems	4.1	18	18	1	Many authors from institutes in Europe (Switzerland, Netherlands, Germany, Belgium and UK) ICARDA, Jordan = 1	Low	Moderate
Varshney R K	ICRISAT, India	Can genomics deliver climate change -ready crops	Current Opinions in Plant Biology	7.5	94	14/54	4 and 5	ICRISAT, India = 1 IRRI, Philippines = 2 SRUC, UK = 1 Cornell U, USA = 1	Good	Moderate
Akinseye F M	FUT, Nigeria and ICRISAT, Mali	Sorghum crop simulation models for crop improvement	Field Crop Research	3.9	?	14	3 and 4	FUT, Nigeria = 2 ICRISAT, Mali = 1 CIRAD, France = 1 UGottingen, Germany = 1 ICRISAT, India = 1	Moderate	Moderate

Kudapa H	ICRISAT, India	RNA gene expression atlas reveals changes associated with growth and development	Plant, Cell & Environment	5.6	22	20	5	ICRISAT, India = 4	Good	Good
Sivasakthi K	ICRISAT, India	Plant vigour and drought tolerance QTLs co-map in chickpea	BMC Plant Biology	3.7	4	14/1	5	ICRISAT, India = 11 Bharathiar U, India = 2 IRD, France	High	High
Seetha A	ICRISAT, India	Management of aflatoxins in cropping systems in Tanzania	Mycotoxin Research	3.7	?	17	3	ICRISAT, Malawi = 2 ICRISAT, India = 1 ARI, Tanzania = 1 SAU, Tanzania = 1	Good	Moderate
Saxena R K	ICRISAT, India	Mapping of Dt1 locus for growth habit in pigeon pea	Theoretical and Applied Genetics	3.9	34	12/4	5	ICRISAT, India = 5 ACCI, South Africa = 1 Moscow S U, Russia = 1	Good	Moderate
Nayak S N	ICRISAT, India	Aspergillus flavus infection triggered immune responses in groundnut	Scientific Reports	4.5	?	12/1	5	ICRISAT, India = 8 UAS, India = 1 USDA/ARS, USA = 2 CAAS, China = 2	Good	Good
Paul PJ	ICRISAT and SHUATS, India	Molecular mapping QTLs for heat tolerance in chickpea	Int. Journal Molecular Science	4.2	?	17	5	ICRISAT, India = 9 SHUATS, India = 2 U of WA, Australia = 1	Good	High
Purushothaman R	ICRISAT and JUNTH, India	Variation in water use and root distrib in chickpea	Functional Plant Biology	2.5	?	14	4	ICRISAT, India = 5 JUNTH, India = 1 Kansas S U, USA = 1 U of WA = 1	Good	Moderate
Ojiewo C	ICRISAT, Kenya	Genomics, genetics and breeding of	Plant Breeding	1.3	?	10/13	4 and 5	36 authors from ICRISAT, Kenya, Mali, India, Ethiopia, Malawi,	Moderate	Moderate

		grain legumes for smallholders						IITA, Nigeria, Zambia, CIAT, Uganda, Tanzania and 13 NARs from Africa		
Guiguitant J	ICARDA, Morocco	Limited transpiration trait in lentil	Field Crops Research	3.9	?	9	4	ICARDA. Morocco = 4 Supagro, France = 2 ICRISAT, India = 1 Gorgan U, Iran = 1 NCSU, USA = 1	High	High
Mbuvi D A	Kenyatta University, Kenya	Novel sources of Striga resistance in wild sorghum	Frontiers in Plant Science	4.3	?	17	4	Kenyatta U, Kenya = 5 TIDI, Uganda = 1 ARC, Sudan = 1 ICRISAT, Kenya = 1 SASK, Sudan = 1 U of Virginia, USA = 1	Good	High
Purushothaman R	ICRISAT and JUNTH, India	Root traits, grain yield and drought in chickpea	Field Crops Research	3.9	?	24	4	ICRISAT, India = 5 JUNTH, India =1	Good	Good
Patil G	U of Missouri, USA	Mapping seed protein, oil and sucrose in soybean	Plant Biotechnology Journal	4.2	16	10	5	U of Missouri = 4 ICRISAT, India = 2 Laval u, Canada = 1 Bayer CropSci, USA = 1 Dow, USA = 1	Moderate	Good
Gayawali S	ICARDA, Morocco and WSU, USA	GWAS for spot blotch resistance in barley	Molecular Breeding	1.9	14	6/1	5	ICARDA, Morocco = 3 WSU, USA = 1 NDUAT, India = 2 BHU, India = 1 USDA/ARS, USA = 1	Moderate	Moderate
Kaashyap M	RMIT, Australia	Regulation of genes associated with salt tolerance in chickpea	Scientific Reports	4.5	?	12/1	5	RMIT, Australia = 2 ICRISAT, India = 2 Griffith U, Australia = 1 NIPGR, India = 1 U of WA, Australia = 1	Good	High
Zhang G	CAS, China	Grassland degradation and desertification in Central Asia	Ecological Applications	4.4	25	12	3	U of Oklahoma, USA = 5 ICARDA, Jordan = 2 CAS, China = 2 Jangxi U, China = 1	Good	Moderate
Lu Q	GAAS, China	Genome sequencing and analysis	Frontiers in Plant Science	4.3	?	10/4	5	GAAS, China = 11 ICRISAT, India = 1 NOCRC, China = 1 U of WA, Australia = 1	Low	Moderate

		of peanut progenitor								
Seetha A	ICRISAT, Malawi	Mitigating child malnutrition in Malawi	Plant Health Nutrition	0.4	?	9/51	1	ICRISAT, Malawi = 6 LUANAR, Malawi = 5	High	High
Seghal A	PAU, India	Drought and heat stress in lentil	Plant, Cell & Environment	5.6	?	10	3	PAU, India = 4 ICARDA = 1 U of WA, Australia = 1 IIPR, India = 1 Kansas State, USA = 1	High	High
Sharma S	ICRISAT, India	Wild species for genetic enhancement of grain legumes	Crop Science	1.6	?	8	5	ICRISAT, India = 1	Moderate	Low
Vadez V	ICRISAT, India	Mapping water stress, plant density and duration for African groundnut enhancement	Frontiers in Plant Science	4.3	67	9	3	ICRISAT, India = 1 ICRISAT, Niger = 1 ICRISAT, Mali = 1 AM U, Niger = 1 CERAAS, Senegal = 1 U of Florida, USA = 1 GUA, Iran = 1	High	High
Venkata S K C	ICRISAT, India	Pigeon pea improvement: breeding and genomics	Plant Breeding	1.3	?	2/2	4 and 5	ICRISAT, India = 15 ICARDA, Tanzania = 1 Plus 13 NARS in Tanzania, Malawi, Uganda, Mozambique, Zambia and India	Moderate	Moderate
Mausch K	ICRISAT, Kenya	Household aspirations for rural development through agriculture	Outlook on Agriculture	1	10	6/73	1 and 3	ICRISAT, Kenya = 2 ICRAF, Kenya = 1 Bangor U, UK = 3 Ogilvy Change, UK = 1 BOKU, Austria = 1	Good	Good
Bohra A	ICAR-IIPR, India	SSR markers for diversity analysis, purity testing and trait mapping in pigeon pea	Frontiers in Plant Science	4.3	?	21/3	5	ICAR-IIPR, India = 9 ICRISAT, India = 2 ICAR-IISRI, India = 1	Low	Moderate

Sita K	Punjab U, India	Seed filling heat stress on seed quality and yield in lentil	Journal of the Science of Food and Agriculture	2.4	?	8	4	Punjab U, India = 2 IIPR, India = 1 ICARDA, Morocco = 1 U of WA, Australia = 1	Good	Good
Verkaart s	ICRISAT, Kenya	Rural farmer aspirations and reality in Kenya	Development in Practice	0.8	6	8/67	1	ICRISAT, Kenya = 2 ICRAF, Kenya = 1 WUR, Netherlands = 1	Good	Good
Islam M S	USDA/ARS, USA	A. flavus resident in Kenya: diversity of populations	Fungal Ecology	2.9	?	12	3	USDA/ARS, USA = 3 IITA, Nigeria = 1 IITA, Kenya = 1	Moderate	Moderate
Amezrou R	INRAE, France	Genome wide studies net blotch resistance in barley	Molecular Breeding	2.3	?	6	5	INRAE, France = 1 ICARDA, Lebanon = 1 WSU, USA = 1 USDA/ARS, USA = 1	Moderate	Moderate
Roorkiwal M	ICRISAT, India	Genome enable prediction models GXE interaction in chickpea	Scientific Reports	4.5	11	15	5	ICRISAT, India = 10 U of Neb-Lin, USA = 2 IARA, India = 1 IPKGateslb, Germany = 1 Cornell, USA = 2 CIMMYT, Mexico = 1	High	High
Vishwakarma M K	ICRISAT, India	Genome-wide studies and markers for understanding genetic relationships in Arachis genus	Frontiers in Plant Science	4.3	12	9/6	5	ICRISAT, India = 8	High	High
Parankusam S	ICRISAT, India	Molecular mechanisms underlying heat tolerance in chickpea	Environmental and Experimental Botany	4.5	?	9	5	ICRISAT, India = 3	High	High

Verkaart S	ICRISAT, Kenya	Learning from rapid adoption of chickpea in Ethiopia	Int. Journal Agricultural Sustainability	1.4	6	7/5	1	ICRISAT, Kenya = 2 IITA, Tanzania = 1 ICRAF, Kenya = 1 Wageningen = 3	High	Good

*If a paper cannot attract at least 5 citations within 2 years of publication, experience shows that it is unlikely to be cited in future. Generally those publications with the lowest citations (>5) tend to be in journals with lower IFs.

Using the QoR4D Framework: Scientific credibility – journal IF, citations, h-index and altmetrics; Legitimacy – co-authors as partnerships; Relevance – significance of research and IPGs

Relevance and IPGs were assessed subjectively: good to high = broader to significant applicability demonstrated; moderate = potential for broader applicability; low = less broad applicability.

Annex 5c. Analysis of bibliometric data for GLDC from 2019 using the QoR4D Framework including those from FP6

Author	Institute/Location	Publication	Journal	IF	H-index	Citations /Altmetrics	FP	Partnerships: Institutes/Countries	Significance	IPG value
Bertioli D	University of Georgia	Genome sequence Arachis hypogea	Nature Genetics	27	?	45/290	5	U of Georgia, USA = 16 ICRISAT, India = 3 Iowa State, USA = 6 Plus 25 others from USA, India, China, France, Korea, Japan, Argentina, Brazil	High	High
Varshney R	ICRISAT, India	Sequencing chickpea from 45 countries	Nature Genetics	27	94	13/184	5	ICRISAT, India = 14 BGI, China = 5 U of WA = 3 IRD = 3 Plus others from India, USA, Korea, Kenya and CIMMYT	High	High
Gassner A	ICRAF, Kenya	Poverty eradication and food security through agriculture in Africa	Outlook on Agriculture	1	11	2/146	1	ICRAF, Kenya = 4 ICRAF, Indonesia = 1 ICRISAT, Kenya = 1 Bangor U, UK = 1 Oxford-Martin, UK = 1	High	High
Zhuang W	Fujian Agric For Institute, China	Genome cultivated peanut and crop domestications	Nature Genetics	27	?	39/116	5	FAFI, China = 31 NBI, China = 6 ICRISAT, India = 5 U of Georgia, USA = 2 Plus 32 others from China, Taiwan, USA, India	High	High
Nay M	MPBI, Switzerland	Genomics Angular Leaf Spot in bean	Frontiers Plant Science	4.3	?	0/68	6	MPBI, Switzerland = 2 IITA, Uganda = 1 CIAT, Colombia = 1	Moderate	High
Anitha, S	ICRISAT, Malawi	Ability of Malawian farmers to mitigate aflatoxin contamination	Toxins	3.3	?	1/30	3	ICRISAT, Malawi = 9 IFPRI, Malawi = 1 CRS, Malawi = 2 ICRISAT, Kenya = 1	Good	Moderate
Perez, L	CIAT, Colombia	Vulnerability bean households to	Climate and Development	2.4	?	0/28	6	CIAT, Colombia = 6 CIRAD, France = 1	High	Moderate

		climate variability in Colombia								
Pandey A K	ICRISAT, India	Peanut phenotyping allergies food safety	Frontiers Plant Science	4.3	6	3/26	4	ICRISAT, India = 5	High	Good
Godwin I	U of Queensland, Australia	Technology perspectives plant breeding	Ther. Appl. Genetics	3.9	39	2/25	4, 5	U of Queensland, Australia = 2 ICRISAT, India = 1 IRRI, Philippines = 1	Good	Good
Gumma	ICRISAT, India	Satellite imaging monitoring changes in cultivation legumes Malawi	Remote Sensing	4.1	34	2/20	3	ICRISAT, India = 4 ICRISAT, Malawi = 5 U of Malawi = 1	High	Good
Varshney R	ICRISAT, India	Tropical legume development in SSA and SA	Plant Breeding	3.0	94	0/18	4	ICRISAT, Kenya = 2 ICRISAT, India = 1	Good	Moderate
Tufa A H	IITA, Malawi	Productivity and income adoption improved soybean	World Development	3.9	9	2/28	1	IITA, Malawi = 4 IITA, Tanzania = 2 IITA, Zambia = 1 IITA, Kenya = 1	Good	Good
Basu U	NIPGR, India	ABC-mediator transporter transport seed yield quality chickpea	Plant Physiology	5.9	?	1/19	5	NIPGR, India = 11 IARI, India = 3 ICRISAT, India = 1 NAFBI, India = 1	Moderate	Good
Kumar R	ICRISAT, India	Whole genome sequencing QTLs fresh seed dormancy groundnut	Plant Biotechnology J	4.2	?	2/18	5	ICRISAT, India = 9 CIMMYT, India = 1	High	Good
Baatz B	CIAT, Colombia	SNPs for bean diversity	Genetic Resources	1.2	?	4/17	6	CIAT, Colombia = 2 CIAT, Uganda = 2 CIAT, Malawi = 2 CIMMYT, Mexico = 1 Plus NARs: Ethiopia, Tanzania, Uganda, Zambia, Zimbabwe, South Africa,	Good	Moderate
Govindaraj M	ICRISAT, India	Biofortified millet varieties and	Agriculture	2.0	19	3/16	4	ICRISAT, India = 5	High	High

		hybrids for markets and nutrition						Harvest Plus-CIAT, Colombia = 1		
Joe-Nikamyoke U	IFAD, Nigeria	Gender gap in legume production in Malawi	Rev. Agric. Food and Environ. Studies	?	?	0/14	1	IFAD, Nigeria = 1 ABI, UK = 1 ICRISAT, Kenya = 1 ICRAF, Kenya = 1	Good	Good
Maredia M	MSU, USA	Farmer perception and evaluation of seed quality: bean and cowpea	Agricultural Economics	2.5	23	2/13	3, 6	MSA, USA = 3 SUA, Tanzania = 2 CIAT, Nicaragua = 1	Moderate	Moderate
Gangurde S	ICRISAT, India	NAM-based genetic dissection: genes for seed and pod weight in peanut	Plant Biotechnology J	4.2	3	0/12	5	U of Georgia, USA = 7 ICRISAT, India = 4 NCSU, USA = 1 Corteva, USA = 1	Good	High
Oliphant A J	USGS, USA	Mapping cropland in Asia with Landsat	Int J Appl Earth Obs and Geoinformation	4.0	11	13/11	3	USGS, USA = 4 ICRISAT, India = 1 U New Hampsh, USA = 1	Moderate	Good
Jain A	ICRISAT, India	InDel markers for molecular breeding in chickpea	Plos One	2.8	41	1/11	5	ICRISAT, India = 6	Good	High
Smith M	U of Sydney, Australia	Drought impacts yield not nutritional quality in bean	Plos One	2.8	15	3/8	6	CIAT, Colombia = 3 U of Sydney, Australia = 2 U of WA, Australia = 1	High	Good
Kumar S	AAU, India	Crop biofortification (Fe, Zn, Vit A) transgenically	Heliyon	1.7	?	3/8	5	AAU, India = 4 ICRISAT, India = 1	Good	Good
Mugisha J	Makere U, Uganda	Gender yield gaps in groundnut production	Gender, Technology Development	1.3	41	1/7	1	Makere U, Uganda = 3 ICRISAT, Kenya = 1 ICRAF, Kenya = 1 NaSARRI, Uganda = 1	Good	Moderate
Kumar S	ICRISAT, India	Farm typology analysis and technology assessment	Land Use Policy	3.6	15	0/7	3	ICRISAT, India = 3 IMWIC, Nepal IWMI, Ethiopia = 1 Massey U, New Zealand = 1	Good	Good
Upadhyaya H	ICRISAT, India	Multi-trait diverse germplasm	Agriculture	2.0	43	0/7	4	ICRISAT, India = 5 KAUJ, Saudi = 2 U of WA, Australia = 1	Good	Good

		resources in sorghum						UHF, India U of Louisiana, USA = 1		
Luo H	CAAS, China	Sequencing diagnostic markers groundnut resistance to bacterial wilt	Plant Biotechnology J	4.2	?	5/7	5	CAAS, China = 12 ICRISAT, India = 3	Good	High
Finkelstein J	Cornell, USA	Feeding Fe-biofortified beans to school children Mexico	Nutrients	4.2	21	4/7	6	Cornell, USA = 5 INSP, Mexico = 3 CIAT, Colombia = 1	Moderate	Moderate
Berney Meir Teran J	U of California-Davis, USA	Drought stress and photosynthate remobilisation in beans	BMC Plant Biology	3.7	?	6/7	6	U of California-Davis, USA = 4 CIAT, Colombia = 2 CENA, Brazil = 1	Good	Good
Zwart R	U of S Queensland, Australia	Resistance to nematodes chickpea	Frontiers in Plant Science	4.3	8	6/6	4	U of S Queensland, Australia = 4 ICRISAT, India = 3	Good	Good
Luo H	CAAS, China	Genomic regions and genes shelling % peanut	Plant Biotechnology J	4.2	?	7/5	5	CAAS, China = 12 ICRISAT, India = 3	Good	Good
Saxena K B	ICRISAT, India	Early maturing pigeonpea germplasm impact on adaptation	Plant Breeding	1.3	?	3/4	4	ICRISAT, India = 4 ICAR, India = 2	Good	Good
Muoni T	SLU, Sweden/ILRI, Kenya	Farmers perceptions of legumes and role in smallholder systems	Int. J. Agric. Sustainability	1.3	?	4/3	3	SLU, Sweden = 4 ILRI, Kenya = 2 SRC, UK = 2 ICRAF, Kenya = 1 KALRO, Kenya = 1	Good	Moderate
Manda J	IITA, Malawi	Poverty impacts of improved cowpea in Nigeria	World Development	3.9	6	2/2	1	IITA, Malawi = 3 IITA, Nigeria = 1 IITA, Zambia = 1 IITA, Kenya = 1	Good	Good
Strock C	Penn State, USA	Seedling architecture, seed yield in Phaseolus vulgaris	Field Crops Research	3.9	?	2/2	6	Penn State, USA = 4 CIAT, Colombia = 2 ARI, Mozambique = 3 SUA, Tanzania = 2 USDA-ARS, USA = 3 ARC, South Africa = 1	Good	High

								O Puerto Rico = 1		
Sou A	CIRAD, Senegal	Deciphering host-parasitoid interactions of crop pests	Scientific Reports	4.2	?	5/2	5	CIRAD, France = 5 CIRAD, Senegal = 3	Good	Good
Yadav P	RVSKVV, India	Axiom Cajanus SNP array in pigeon pea	BMC Genomics	3.7	2	5/1	1	ICRISAT, India = 5 RVSKVV, India = 2	Good	Good
Assefa T	USDA-ARS, USA	Review breeding and genomics in Phaseolus vulgaris	Molecular Breeding	1.9	?	2/1	6	USDA-ARS, USA = 2 Iowa State, USA = 2 Tennessee State, USA = 2 CIAT, Tanzania = 1 CIAT, Colombia = 1	Good	Good
Pandey M K	ICRISAT, India	Mitigating aflatoxin contamination in groundnut	Toxins	3.3	39	11/1	3,4	ICRISAT, India = 7 ICRISAT, Malawi = 3 ICRISAT, Niger = 1 USDA-ARS = 2 CAAS, China = 3	High	High
Kumar J	IIPR, India	Exploitation of adaptive traits for climate smart pulses	Int. J. Molecular Sciences	4.2	24	3/1	4	IIPR, India = 2 ICARDA, Morocco = 1 ICAR, India = 1	Good	Good
Almekinders, C	WUR, Netherlands	Understanding relations between farmers' seed demand and research methods	Outlook on Agriculture	1	27	7/0	1	WUR, Netherlands = 1 CIMMYT, Mexico = 2 ICRISAT, Kenya = 1 CIP, Peru, = 1 Egerton U, Kenya = 1 Utrecht U, Netherlands = 1	High	Good

*Sample only based on altmetrics and citations – many papers had not yet been cited due to the short time frame; not included: publications with in journal with low IFs and few citations/altmetrics

Using the QoR4D Framework: Scientific credibility – journal IF, citations, h-index and altmetrics; Legitimacy – co-authors as partnerships; Relevance – significance of research and IPGs; Relevance and IPGs were assessed subjectively: good to high = broader to significant applicability demonstrated; moderate = potential for broader applicability; low = less broad applicability

Annex 5d. Most productive authors by institute, FP and h-index

Author	Articles No.	Institute	Flagship	h-index
Varshney R K	53	ICRISAT, India	5	94
Pandey M K	16	ICRISAT, India	5	39
Saxena R K	14	ICRISAT, India	5	34
Thudi M	13	ICRISAT, India	5	31
Rathore A	12	ICRISAT, India	4/5	34
Garg V	11	ICRISAT, India	5	18
Upadyaya H D	11	ICRISAT, India	5	45
Vadez V	11	IRD, France	4	67
Chitikineni A	10	ICRISAT, India	5	2
Gaur P M	9	ICRISAT, India	4	54
Gupta S K	8	ICRISAT, India	4	27
Kale S M	8	ICRISAT, India	5	15
Kumar S	8	ICRISAT, India	3	15
Srivastava R K	8	ICRISAT, India	5	?
Saxena K B	7	ICRISAT, India	4	?
Sharma K K	7	ICRISAT, India	5	39
Bhatnagar-Mathur P	6	ICRISAT, India	5	27
Khan A W	6	ICRISAT, India	5	17
Kumar C V S	6	ICRISAT, India	5	?

? – h-indices not found in Google Scholar

Annex 5e. Assessment of the quality of ad hoc selected GLDC research publications*

Journal article	Rigor	Originality	Referencing	IPGs	Journal IF	Co-authorship	Overall quality summary (including metrics – Cit./Alt.)**
Peanuts that keep aflatoxin at bay: a threshold matters ***Plant Biotech. J.* 16: 1024-1033 (2018)**	4	4 (original research)	4	4	4.2	Appropriate – 5 authors from ICRISAT, India, 3 from USDA-ARS, USA, 1 from Danforth, USA, 1 from Louisiana State U, USA	Aflatoxin contamination in peanuts poses major health challenges for vulnerable populations of sub-Saharan Africa and South Asia. Identification of resistance to the fungal causal agent and to inhibition of toxin production is novel and offers a potential solution for serious food safety, health and trade issues in the semi-arid regions. Overall quality – high; (Cit. 30/Alt. 153)
The genome sequence of segmental allotetraploid peanut *Arachis hypogaea*. ***Nature Genetics* 51: 877-884 (2019)**	4	4 (original research)	4	4	27	Appropriate - 50 authors from 29 institutes including ICRISAT, India + ARIs from USA, China, France, Korea, Argentina, Brazil	Uniformity of patterns of homeologous recombination at the ends of chromosomes favours a single origin for cultivated peanut and its wild counterpart *A. monticola*. However homeologous recombination has created diversity which can generate phenotypic changes, of use in breeding for target traits to improve peanut for farming in semi-arid areas. Overall quality – high; (Cit. 48/Alt. 290)
The genome of cultivated peanut provides insight into legume karyotypes, polyploid evolution and crop domestications ***Nature Genetics* 51: 865-876 (2019)**	4	4 (original research)	4	4	27	Appropriate – 78 authors from 24 institutes including China, ICRISAT, India, USA, Taiwan, India	The polyploid genome provided insights into the evolution of *Arachis hypogaea* and other legume chromosomes. Resequencing of 52 accessions suggests that independent domestications formed peanut ecotypes. Whereas 0.42–0.47 million years ago (Ma) polyploidy constrained genetic variation, the peanut genome sequence aids mapping and candidate-gene discovery for traits such as seed size and color, foliar disease resistance and others, also providing a cornerstone for functional genomics and peanut improvement. Overall quality – high; (Cit. 39/Alt. 123)

Crop biofortification for Fe, Zn and Vitamin A with transgenic approaches ***Heliyon* 5: e01914 (2019)**	3	2 (review)	3	3	1.7	Lacks recognition of partners - 5 authors from ICRISAT, India	Supplementation and food fortification of staple food with minerals and vitamins can address the issue of adequate nutrition security. But supplementation and fortification is neither feasible for each nutrient specially iron nor viable due to recurrent cost. Genetic engineering based food biofortification is promising way to address the hidden hunger especially, where breeding is not rewarding due to lack of genetic variability and is a swift and accurate method to develop nutrient denser crops without any recurrent investment as compared to different strategies. Overall quality – moderate; (Cit. 3/Alt. 0)
Breeding biofortified pearl millet varieties and hybrids to enhance millet markets for human nutrition ***Agriculture* 9: 106 (11 pgs) (2019)**	3	2 (review)	3	3	2	Lacks recognition of partners – 5 authors from ICRISAT, India	The review provides the current biofortification breeding status and future directions of the pearl millet for growing nutrition markets. Research on the pearl millet has shown that a large genetic variability (30–140 mg kg −1 Fe and 20–90 mg kg −1 Zn) available in this crop can be effectively utilized to develop high-yielding cultivars with high iron and zinc densities. Open-pollinated varieties (Dhanashakti) and hybrids (ICMH 1202, ICMH 1203 and ICMH 1301) of pearl millet with a high grain yield and high levels of iron (70–75 mg kg −1) and zinc (35–40 mg kg −1) densities have been developed and released first in India. Currently, India is growing > 70,000 ha of biofortified pearl millet, and furthermore more pipeline cultivars are under various stages of testing at the national (India) and international (west Africa) trials for a possible release. Overall quality – moderate; (Cit. 3/Alt. 0)
Rapid generation advance (RGA) in chickpea to produce up to seven	4	4 (original research)	4	4	3.4	Appropriate – 4 authors from ICRISAT, India but partners not	This study was aimed at developing a protocol for increasing the number of generation cycles per year in chickpea (*Cicer arietinum* L.). Six accessions, two

generations per year and enable speed breeding ***The Crop Journal* 8: 164-169 (2020)**						needed to develop the protocol	each from early (JG 11 and JG 14), medium (ICCV 10 and JG 16), and late (CDC-Frontier and C 235) maturity groups, were used. The mean total number of generations produced per year was respectively 7, 6.2, and 6 in early-, medium-, and late-maturing accessions. These results have encouraging implications for breeding programs: rapid progression toward homozygosity, development of mapping populations, and reduction in time, space and resources in cultivar development (speed breeding). Overall quality – high; (Cit. 2/Alt. 0)
Characterization of main chickpea cropping systems in India using a yield gap analysis approach *Field Crops Research* 223: 91-104 (2018)	4	4 (original research)	4	3	3.9	Appropriate – Two authors from Iran, 6 from ICRISAT, India, 1 from ICRISAT, Mali	This study used a modelling approach to quantify the region-specific constraints and yield gaps limiting chickpea productivity and evaluates the potential for boosting production in the major chickpea growing regions of India. Information on bio-geo-physical properties (weather, soil, crop, management) of these regions was collated and the SSM-iLegume model used to reproduce seasonal variability and potential yield for the major chickpea producing districts to estimate the yield gap. The results showed that India has the capacity to produce 40% more chickpea (i.e. 80% of the achievable yield) than is the current production status under the standard crop management practices. The identified HSUs, each with a well-defined set of yield-limiting constraints, are proposed as authentic breeding units in crop improvement programs ("target population of environments") for developing a breeding strategy to enhance chickpea production in India. Overall quality – high; (Cit. 7/Alt. 0)
Welfare impacts of improved chickpea adoption: a pathway for rural development in Ethiopia	4	4 (original research)	3	3	3.5	Appropriate – 3 authors from ICRISAT, Kenya, 1 from U of Illinois,	Improved chickpea adoption significantly increased household income while also reducing household poverty. Disaggregated results by landholding showed that adoption

***Food Policy* 56: 50-61 (2017)**						1 from ICRISAT, Zimbabwe	favoured all but the largest landholders, for whom the new technology did not have a significant impact on income. Overall, increasing access to improved chickpea appears a promising pathway for rural development in Ethiopia's chickpea growing regions. Overall quality – high; (Cit. 60/Alt. 14)
Climbing bean as a solution to increase productivity in land-constrained environments: Evidence from Rwanda ***Outlook on Agriculture* 48: 28-36 (2019)**	3	2 (established knowledge)	3	3	1	Appropriate – authors from Rwandan NAR, PABRA, CIAT, Uganda, USA	Climbing bean is a potential solution to increase the agricultural sector productivity and sustainability. About 50% of bean-producing households surveyed in Rwanda grow climbing bean, a substantial increase over the past 15 years. Elevation, population pressure, and drought shocks are important drivers of climbing bean adoption. Adoption of climbing bean increases yield by 23% among adopters and has the potential to increase yield by 48% for non-adopters. Overall quality – moderate; (Cit. 0/Alt. 0)
Adoption and ex post impacts of improved cowpea varieties on productivity and net returns in Nigeria ***J. Agric. Economics* 71: 165-183**	3	2.5 (extended established knowledge	3	2	2.5	Greater recognition of partners needed – 7 authors from IITA (various locations), 1 NAR, Nigeria	Adoption and impacts of improved cowpea varieties on yield, net return and production costs of 1,525 cowpea-growing households in northern Nigeria cultivating over 2,500 cowpea plots were assessed. The results showed that 38% of the cowpea plots were planted with improved varieties, and cowpea yields, net returns and production costs increase significantly with the adoption of improved cowpea varieties. Adoption of improved cowpea varieties is associated on average with 26% yield gains, 61% increase in net returns and 14% increase in production costs. Overall quality – moderate; (Cit. 0/Alt. 2)

The poverty impacts of improved cowpea varieties in Nigeria: A counterfactual analysis ***World Development* 122: 261-271 (2019)**	3	3 (original aspects)	3	2	3.9	Lack of recognition of partners – 7 authors from IITA (various locations)	Using a nationally representative survey data from a sample of over 1500 households in Nigeria, the impacts of adoption of improved cowpea varieties on income and asset poverty reduction were assessed. Adoption of improved cowpea varieties increased per capita household income and asset ownership by 17 and 24 percentage points, respectively. The results further showed that adoption reduced both income poverty and asset poverty by 5 percentage points. The paper concludes with a discussion of the policy options for increasing adoption and impacts of improved cowpea varieties in Nigeria. Overall quality – moderate; (Cit. 5/Alt. 0)
The productivity and income effects of adoption of improved soybean varieties and agronomic practices in Malawi ***World Development* 124: 104361 (2019)**	3	3 (original aspects)	3	2	3.9	Lack of recognition of partners – 8 authors from IITA (various locations)	This paper assesses the productivity and income effects of adopting ISVAPs using plot level data collected from a nationally representative sample of 1237 soybean growing households in Malawi. Soybean yields and net crop incomes for adopters are significantly higher than those of non-adopters over the entire probability distribution of ISVAPs adoption. Adoption of ISVAPs is associated with an average of 61% yield gain and 53% income gain for adopters. Overall, the results point to the need for further scaling of ISVAPs for greater adoption and impact on the livelihoods of smallholder farmers in Malawi. Overall quality – moderate; (Cit. 3/Alt. 0)
Poverty eradication and food security through agriculture in Africa: rethinking objectives and entry points ***Outlook on Agriculture* 48: 309-315 (2019)**	3	4 (novel, innovative perspective)	4	3	1	Appropriate – 3 authors from ICRAF, 1 from ICRISAT + U Bangor and U Oxford, UK	The expectation is that if the gap between actual and potential yields can be closed, smallholders will grow sufficient crops to feed their families, with a surplus to sell, thus meeting food security needs and bringing in an income to move them out of poverty. While technologies already exist

							that can raise smallholder farmers' yields 3 or 4 times, even under rainfed conditions, the small size of land available to them limits how much can be grown and the per capita income from agriculture is insufficient to allow people to move above the poverty line. It is important to understand where and for whom agriculture will have the main purpose of ensuring food and nutritional security and where and for whom there is the potential for significant increases in incomes and a contribution to wider economic growth. Overall quality – high; (Cit. 2/Alt. 147).
Household aspirations through rural development in Africa ***Outlook on Agriculture* 47: 108-115 (2018)**	3	4 (novel, innovative perspective)	4	3	1	Appropriate – ICRISAT, ICRAF, U Bangor + Ogilvy Change, UK + BOKU, Austria	Understanding farming households' technology choices remains one of the most critical aspects of agricultural research in rural areas. However, many technologies that are known to be effective and potentially highly beneficial have remained widely unused. We suggest that human aspirations have a much greater influence on technology choices than hitherto believed. Better understanding of aspirations will improve the targeting of technology development by researchers and better research priority setting as well as more effective rural development strategies in general. Overall quality – high; (Cit. 11/Alt. 73)
Money matters: the role of yields and profits in agricultural technology adoption ***Amer. J. Agric. Economics* doi: 10.1093/ajae/aay050 (2018)**	3	4 (original research)	4	3	1.8	Appropriate – U Saskatchewan, Canada, U Wisconsin, USA, WUR, Netherlands, ICRISAT, Kenya	Despite the growing attention to technology adoption in the economics literature, knowledge gaps remain regarding why some valuable technologies are rapidly adopted, while others are not. This paper contributes to our understanding of agricultural technology adoption by showing that a focus on yield gains may, in some contexts, be misguided. Our results suggest economic measures of returns may be more relevant than increases in yields in

							explaining technology adoption decisions. Overall quality – high; (Cit. 24/Alt. 75)
Who are these people we call farmers? Rural Kenyan aspirations and realities ***Development in practice* 28: 468-479 (2018)**	3	3 (original aspects)	3	3	0.8	WUR, Netherlands, ICRISAT, Kenya	Rural Kenyan households have different aspirations and income portfolio strategies, including agricultural intensification and income diversification. Combining aspirations with potential to invest, the article provides suggestions for targeting agricultural interventions. We need to start listening better to those people we call "farmers" to develop and offer innovations that meet their realities. Overall quality – good; (Cit. 8/Alt. 67)
How immediate and significant is the outcome on training on diversified diets, hygiene and food safety: an effort to mitigate child undernutrition in Malawi ***Public Health Nutrition* 21: 1156-1166 (2018)**	3	3 (original aspects)	3	3	2.4	Appropriate – 6 authors from ICRISAT, Malawi, 4 from LUANAR, Malawi	The study clearly suggests that comprehensive training immediately guides mothers into improved dietary and hygiene practices, and that improved practices take immediate and progressive effects in ameliorating children's undernutrition. Overall quality – good (Cit. 9/Alt. 0)

Note: Criteria for assessment can be found in Annex 4 *Non-open access publications could not be included as they were behind pay walls **Citations/Altmetrics

Annex 5f. Assessment of selected technical publications* both referenced in OICRS and generated by Flagships

Technical publications	Quality	Relevance to next stage users**	Potential for capacity development
Efficient Legume Seed Systems for Better Smallholder Farmers' Livelihoods in the Semi-Arid Tropics - OIRC			
1. Tropical Legumes III - Improving Livelihoods for Smallholder Farmers: Enhanced Grain Legume Productivity and Production in Sub-Saharan Africa and South Asia (project report)	High	Comprehensive and usable by project collaborators	Substantial embedded capacity building of partner breeders and seed producers
3. Sowing legume seeds and reaping cash – Springer published e-compilation of tropical legumes projects led by ICRISAT	High	Valuable compilation for use in target countries	N/A
High oleic groundnut varieties commercialized in India meet the enhanced shelf-life needs of food industry and consumer health benefits OICR.			
1. High oleic peanuts for Asia and Africa to meet the needs of the food processing industries – paper presented at the 2018 Science Forum, South Africa	High	Clear and usable by private sector	N/A
698 tons of Quality Declared Seed (QDS) produced by a network of seed producers, potentially reaching over 230,000 households in Ethiopia, Tanzania, Uganda, Burkina Faso, Mali and Nigeria - OICR.			
1. Harnessing Opportunities for Productivity Enhancement (HOPE) of Sorghum and Millets in sub-Saharan Africa-Phase 2	High	Comprehensive and usable by project collaborators	Substantial embedded capacity building of breeders and seed producers
Biofortified Cultivars of Grain Legumes and Dryland Cereals Development, Mainstreamed and Adopted in India Improving Food Security and Wellness – OICR			
1. Enhancing Food and Nutritional Security and Improving Livelihoods through Intensification of Rice-Fallow Systems for Pulse Crops in South Asia (Bangladesh, India and Nepal)	Good	**IFAD-ICARDA Project to improve the household nutritional security in India, Nepal and Bangladesh, establishing and integrated pulse production system in rice fallows.**	Embedded capacity development
2. Development of Lentil Cultivar with High Concentration of Iron and Zinc	Good	**HarvestPlus funded Program; nutrition breakthrough and usable by farmers and consumers**	Embedded capacity development

Impact of ICRISAT Pearl Millet Hybrid Parents Research Consortium (PMHPRC) on the Livelihoods of Farmers in India - OICR.			
1. Impact of ICRISAT Pearl Millet Hybrid Parents Research Consortium (PMHPRC) on the Livelihoods of Farmers in India. Research Report 75.	High	The study covered 563 pearl millet farmers from Rajasthan, Gujarat and Uttar Pradesh. HPRC hybrids covered about 60% of pearl millet hybrid area during 2013-14. HPRC hybrids have provided at least 20% higher grain and fodder than the varieties/other hybrids they replaced. Total benefits accrued due to HPRC hybrids added up to US$133.7 million per year. Benefits could surpass US$150 million per year at country level if we include the contribution of HPRC hybrids in other states of India.	N/A
Bhoosamrudhi: Improving Rural Livelihoods through Innovative Scaling-up of Science-led Participatory Research for Development – OICR			
1. Bhoosamrudhi: Improving Rural Livelihoods through Innovative Scaling-up of Science-led Participatory Research for Development Progress Report, 2016-2017 (last one of four)	Good	A consortium of national and international research institutes was formed to scale up various Natural Resources Management (NRM) technologies. Best management practices along with improved cultivars increased crop yield by 15-40%.	Significant embedded capacity development
***ICRAF Working Paper No. 295* - What do we really know about the impacts of improved grain legumes and dryland cereals? A critical review of 18 impact studies – FP1**	High – critical baseline study necessary for the approval of GLDC	Five reasonably well-identified adoption studies estimated significant, positive effects of improved GLDC adoption on yields, profits, or household welfare. Recommendations offered to improve methodological approaches	Two PhDs

		in future impact assessments of GLDC crops.	
ICRISAT Research Report No. 76 – Impact assessment of village seed bank program for chickpea, groundnut and pigeonpea in CDZ, Myanmar – FP4	High – established a successful model for seed multiplication and distribution of improved varieties	Grain yields from improved VSB cultivars were 34% and 43% higher for sole and intercropped pigeonpea, respectively, 55% higher for groundnut and 52% higher for chickpea. The yield benefits translated into reduced unit (basket) costs and improved net margins by 86,314 Kyats/acre and 84,625 Kyats/acre for sole and intercropped pigeonpea respectively; 177,000 Kyats/acre for groundnut and 264,125 Kyats/acre for chickpea. Lack of seed storage was seen as one of the major issues by most farmers. Nonetheless, 87% of the VSB farmers indicated their willingness to continue in the program.	Significant embedded capacity building
Book chapter - Climate-Smart Groundnuts for Achieving High Productivity and Improved Quality: Current Status, Challenges, and Opportunities. *In: Genomic Designing of Climate-Smart Oilseed Crops. Springer International Publishing – FP5*	High	The novel promising technologies such as genomic selection and genome editing need to be tested for their potential utility in developing climate-smart groundnut varieties. System modelling may further improve the understanding and characterization of the problems of target ecologies for devising strategies to overcome the problem. The combination of conventional breeding techniques with genomics and system modelling approaches will lead to a new era of system biology assisted breeding for	N/A

		sustainable agricultural production to feed the ever-growing population.	
Book chapter - Genomic Approaches to Enhance Stress Tolerance for Productivity Improvements in Pearl Millet. In: Biotechnologies of Crop Improvement, Volume 3: Genomic Approaches. Springer International Publishing – FP5	High	Genomic research has resulted in the generation of large amounts of genomic resources and information including recently published sequence of the reference genome and re-sequencing of almost 1000 lines representing the global diversity. This chapter reviews the advances made in generating the genetic and genomics resources in pearl millet and their interventions in improving the stress tolerance to improve the productivity of this very important climate-smart nutri-cereal.	N/A
Leaflet: The potential of systems modelling to inform farm decisions for higher resilience and profit ICAR-ICRISAT Systems Modelling Project – FP3	High – well-presented and illustrated	The project parameterizes an integrated systems model for local situations which include a suite of tools such as farm systems models and economic model to capture the benefits of soil, water and fertilizer management and integrates Climate Risk Analysis (CRA) as well as market-led interventions over time using climate data from study locations.	Significant embedded capacity building

*Technical publications include: working papers, project reports and book chapters **Clarity, simplicity, usability

Annex 5g. Assessment of newsletters, manuals and digital innovations* both referenced in OICRS and generated by Flagships

Communication products	Quality	Relevance to next stage users**	Potential for capacity development
Efficient Legume Seed Systems for Better Smallholder Farmers' Livelihoods in the Semi-Arid Tropics - OIRC			
1. Digital Seed Roadmap	High	Clear and usable by breeders	N/A
Rapid generation advancement platforms, and crop-specific rapid cycle breeding methods enabling speed breeding in chickpea, lentil, sorghum, pearl millet, and groundnut - OICR			
1. New chickpea breeding protocol promises to shorten varietal development from 12 to 6 years – article in ICRISAT Happenings	Good	Communication product useful to promote efficiency in breeding programs	N/A
High oleic groundnut varieties commercialized in India meet the enhanced shelf-life needs of food industry and consumer health benefits -OICR.			
1. India's first 'high oleic' groundnut varieties ready to go commercial – article in ICRISAT Happenings	Good	Communication product useful to reach a wider audience	N/A
Bringing the Arbuscular Mycorrhiza (AM) Biofertilizer in Uganda - OICR			
1. Manual of the AMF inoculum production training course held at Makere University, Uganda	High	Detailed and useful report – well-illustrated	The capacity of 11 participants from several African countries was developed through a 5 day course
Standard Operating Procedure Manual			
SoP for Lentil Breeding and Testing	High	Comprehensive and well-illustrated instruction manual for breeding pipelines, PVS, naming and record keeping – excellent feedback from NARS breeders	By design, it builds capacity

Standard Operating Procedure Manual SoP for Groundnut Breeding and Testing	High	Comprehensive and well-illustrated instruction manual for breeding pipelines, PVS, naming and record keeping – excellent feedback from NARS breeders	By design, it builds capacity
Access to improved chickpea as pathway for rural development - OICR *1. New research shows adopting improved chickpea increases farmer livelihoods in Ethiopia – article in ICRISAT Happenings* *2. Adopting improved chickpea improves farmer livelihoods in Ethiopia*	Good Good	Communication product useful to reach a wider audience Communication product useful to reach a wider audience	N/A N/A
Policy favours biofortified pearl millet in India to combat Fe and Zn deficiencies - OICR *1. Biofortified pearl millet varieties to fight iron and zinc deficiencies in India – article in ICRISAT Happenings* *2. Investment in advocacy and institutional commitments on mainstreaming nutrition can be the game changer for pearl millet – article in ICRISAT Happenings*	Good Good	Communication product useful to reach a wider audience Communication product useful to reach a wider audience	N/A N/A
Newsletter *Indian groundnut farmers' seed businesses debut yields big profits – article in ICRISAT Happenings*	Good	Communication product useful to reach a wider audience	N/A
Newsletter *First public research facility to put agriculture on fast-forward launched – article in ICRISAT Happenings (RapidGen reduces breeding cycle by 40%)*	Good	Communication product useful to reach a wider audience	N/A
Newsletter *New multi-purpose sorghum variety captures attention in Burkina Faso*	Good	Communication product useful to reach a wider audience	N/A
Blogposts			

https://theconversation.com/can-african-smallholders-farm-themselves-out-of-poverty-126692	Insightful and novel thinking	Integrated investments that affect both on- and off-farm livelihood choices and outcomes will produce better welfare than a narrow focus on production technologies in smallholder dominated systems. Production technology research for development will remain important. But to reach the smallest of Africa's smallholders will require focus on what's happening off the farm.	N/A
https://theconversation.com/not-just-farmers-understanding-rural-aspirations-is-key-to-kenyas-future-129909	Insightful and novel thinking	Capturing what drives the decision-making and aspirations of rural households will help design more effective policies and development initiatives that trigger positive, lasting change within the community.	N/A

Because of nature of this FP5, there are few non-peer reviewed brochures, working papers, leaflets etc.

* Newsletters (e.g. ICRISAT Happenings), digital outputs, manuals, blogs **Clarity, simplicity, usability

Annex 5h. Assessment of physical outputs including varieties, digital innovations, methodologies, tools, services etc. for IPG value

Flagship/cross-cutting theme - objective	Physical products - examples	IPG assessment*
FP1 - To enhance the relevance and impact of GLDC research through improved targeting and priority setting, learning and adoption studies, strategic gender research, and supporting scaling efforts	1. Expert commissioned studies laid baseline for approval and implementation of GLDC	3
	2. Updated IMPACT model for foresight modelling and ex ante analysis for priority setting	3
	3. Product profiles: early maturing and drought tolerant varieties and hybrids with resistance to pests and diseases – defined priorities and targets	3
	4. Ex ante nutritional and poverty impact assessments of GLDC research and technology options to identify priorities and targets	3
	5. Framework developed and tested for integrating gender into breeding decisions and insights gained on developing gender relevant product profiles	2
	6. Scaling framework reviewed against 4 GLDC case studies to strengthen scaling approaches	2
FP2 - To strengthen agri-food systems mechanisms to respond to the needs of farmers and value chain and governance actors	FP2 was not approved or funded through W1/W2 in 2018. In 2019, W1/W2 funds were allocated to the cross-cutting theme MPAB to cover a small part of the planned activities	
FP3 - To improve the profitability, productivity and sustainability of smallholder farming systems and in-household innovation for nutritional security and enhanced income generation through integrated crop, tree and livestock production systems	1. Biocontrol agents were developed for Fusarium wilt of chickpea and cowpea pests	2
	2. Mapping diseases of chickpea and pigeonpea for risk area maps	2
	3. Efficiency of resources use and soil management options such as compost developed	2
	4. Mycorrhizal fungi and Bradyrhizobium for managing Striga in several cropping systems	2
	5. Modelling frameworks to assess trade-offs and co-design farming systems for resilience and income generation	2
	6. Crop system modelling tools as a decision support tool to optimize GxExM for integration in breeding programs in India	2
	7. Field testing of improved systems for integrated crop, composting and animal feeding systems in Mali	3
	8. Developed and used 115 sustainable intensification indicators, a platform and a framework in India, Niger and Burkina Faso (other CRPs are adapting it for their use)	2
	9. Trade-off analysis and household modelling in Niger and Burkino Faso in USAID funded Crop-Livestock Value Chain project with Livestock/ILRI	

FP4 - To develop high-yielding, nutrient dense and market-preferred GLDC varieties and hybrids available and utilized by farmers and value chains	1. Multi-locational and national testing for commercialization of 99 improved varieties of sorghum, pearl millet, finger millet, chickpea, pigeonpea, groundnut, lentil and cowpea in 16 countries in SSA and SA including the first molecular bred varieties	3
	2. Characterized Target Population Environments to deliver products in target agroecologies	3
	3. Biofortification of pearl millet, sorghum and groundnut mainstreamed as must-have traits based on Product Profiles developed by FP1 and in collaboration with Harvest Plus and GoI/Mars	3
	4. Phenotyping tools (NIRS [systematically deploying fodder quality testing in breeding and testing pipelines of sorghum, pearl millet, finger millet and groundnut] and XRF) optimized to enhance selection for grain quality	3
	5. Host-resistance and tolerance to diseases and pests mainstreamed as must-have traits based on Product Profiles developed by FP1	
	6. Climate resilience (drought, heat and cold) mainstreamed as must-have traits based on Product Profiles developed by FP1	3
	7. SNP markers developed by FP5 deployed for early generation selection through the HTPG	3
	8. Speed breeding protocols have been deployed in chickpea (publication), lentil and groundnut to enhance the rate of genetic gain by increasing the number of cycles per year.	3
	9. Significant efforts on modernization crop breeding approaches and methods with EiB platform	3
	10. Significant impact through successful development of functional seed systems in several countries as described in 5 OICRS (covered in more detail under Q 2.2 Deep Dive).	3
	11. Development of mechanized chickpea harvesting in Ethiopia	4
	12. Crop Network Groups (CNGs) established for 5 GLDC crops (covering product design, development, testing, advancement and delivery) with small and medium seed companies and private sector	3
	13. Successful model of the Hybrid Parents Research Consortium (HPRC) in Asia was expanded to deliver the improved cultivars of sorghum in ESA region	3
	14. Gender issues well-integrated in priority trait targets and seed systems (cross-reference to gender input)	3
FP5 - To widen the genetic base of GLDC crops and provide an extensive tool kit of modern genomics,	*The focus of FP5 is 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,*	

genetic enhancement and breeding tools and high precision phenotyping for efficient breeding	*and breeding tools for accelerated, precise, cost-effective and efficient breeding of new varieties. Many physical outputs are highlighted in the 2018-2019 Annual Reports – examples only are given.*	
	1. Tolerance to BGM in chickpea and heat tolerance in pearl millet lines introgressed from wild germplasm	3
	2. Transgenic events for insect resistance in chickpea, pigeon pea and cowpea and aflatoxin resistance in groundnut characterized and advanced	3
	3. Novel genes for priority traits identified in cowpea and finger millet	
	4. Previously introgressed lines advanced in groundnut, pearl millet (drought, blast) and pigeonpea (podborer)	3
	5. Donors and markers developed for pigeon pea, groundnut and chickpea	3
	6. High oleic acid in groundnut and stay-green in sorghum mapped	
	7. Genomic selection models developed in chickpea	3
	8. Marker development/deployment resulted in the generation of more than 700K marker data points combined in all GLDC crops through the HTPG platform for identifying QTLs for the breeding activities (FP4)	3 3 3
	9. SNP panels for quality control developed and partially validated in pearl millet, groundnut and chickpea (for use by FP4)	
	10. Standardizing protocols, establishing proof-of-concept in genome editing, second generation transformation achieved (QuickCrop from Corteva Agriscience)	3
	11. Systematic mutant population and rapid generation advancement (RGA) developed with ARIs	
	13. Significant effort in modernizing pre-breeding and trait discovery approaches and methods with EiB platform	3
	14. Development of demand-led breeding approaches to generate varieties with better attributes reflecting the needs of end users, especially women.	3
		3
		3
		3
		3
Gender and youth – Unique to each FP with 5 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 (labour, decision-making,	1. Development of gender-responsive product and consumer profiling tools with other CRPs	2 2
	2. On-going activities in mainstreaming gender analysis across GLDC research activities	2

knowledge access, yield, participation) and nutrition (FP3); (iv) gendered value chain development, learning and impacts (MPAB) and (v) social norms and behaviour change for men and women to support women empowerment and impacts on delivery of GLDC research outputs (FP1).	3. Partnered with GREAT for training in theory and practise of gender responsive research	2
	4. Initiated a Gender Internship Program for mentoring young researchers in gender responsive research	2
	5. Initiated development of a strategy for Youth Research in the Drylands in 2018; further developed in 2019	2
	6. Framework on gender responsive breeding programs (PPB) developed in WCA, contributing to gender sensitive Product Profiling	2
	7. Generated primary data, analysis and documentation on gender dynamics aspects in seed systems in Mozambique and Uganda	2
	8. Primary data sets generated on youth realities, aspirations, transitions and opportunity structures in Tanzania, Uganda and Ethiopia	2
	9. Explored gender dynamics issues in non-hybrid cereal and legume seed systems in Uganda through workshops	2
Capacity development – To raise awareness of capacity development interventions and to facilitate the identification of opportunities for capacity development and of the capacity building required	1. Formation of a Capacity Development Task Force (ICRISAT and ICARDA) to service GLDC to improve the capabilities of GLDC staff and their key partners to implement capacity development	3
	2. Facilitated 15 training courses and programs with NARs and private sector covering breeding technologies, seed systems, farming practices, modelling and research methods (noteworthy in FP3: 1198 men and 941 women trained in improved agronomic practices related to GLDC technologies) in 2018	2
	3. Supported the growth of future researchers through 10 PhD and 8 MSc students in 2018	
	4. With funds from GLDC Innovation Fund, partnered with Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) to support the involvement of students from Kenya, Uganda and Nigeria in GLDC activities	2
	5. Developed the technical foundation for a GLDC E-Learning Platform - operationalized in 2019 (portal (https://gldc.codeobia.com/)	2
	6. Facilitated 3000 beneficiaries in training courses and programs with NARs and private sector covering breeding technologies, farming practices and field days in 2019	
	7. Supported the growth of future researchers through 30 PhD in 2019	2
		2
		2
MPAB – To design principles on effective interventions to develop market opportunities for GLDC crops and	Study on how to analyse value chains and to look at mechanisms to engage more effectively with markets completed	2

learning and support to develop market opportunities that increase adoption of outputs	Pilot study on sorghum fodder enterprises in the Karimnagar district of Telangana state in India were surveyed to capture feed and fodder transaction patterns	2
Climate change	Physical products are reported above in FP3 and FP4 – many linked to CCAFS although this is not made clear in ARs	

*Annex A. IPG rating: 0=not relevant to agriculture; 1=no broader applicability; 2=potentially broader applicability; 3=broader applicability demonstrated; 4=significant international applicability

Annex 5i. 2020 Reviewer's examination of CRP's targets and deliverables

1. P	FP outcomes 2022	Sub-IDOs	Summary narrative on progress against each FP outcome this year	2019 Milestone	2019 Milestone status	Provide evidence for completed milestones *Max 50 words/milestone*	2020 CRP reviewers comments
2.	3. FP1.01. 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	4. Increased resilience of agro-ecosystems and communities, especially those including smallholders	5. With the priority GLDC crops, countries and lines of research identified based largely on the initial foresight and ex-ante impact evaluation work, the subsequent multi-criteria ex-ante impact evaluations are providing a sound decision support to enhance the targeting, responsiveness and impacts of GLDC research.	6. Ex-ante evaluation of GLDC research and technology options completed and working papers published on the potential poverty and nutrition security impacts to guide priority setting. 7. THIS IS THE ORIGINAL 2019 WP MILESTONE	8. Complete	9. Reports on ex-ante (1) poverty, and (2) nutrition security impacts of Research and Technology Options for Grain Legumes and Dryland Cereals in Sub-Saharan Africa and South Asia.	10. PROGRESS AS REPORTED 11. The outputs are important ex ante evaluations of economic aspects of GLCL crops extended to include poverty and nutritional factors. Such work is vital for future planning on GLDC crops but each report does come with health warnings on the limitations of the modeling approach. There are also interesting results concerning assumptions that increase crop yields necessarily lead to eg better nutrition. 12.
13.	14. FP1.02. Market and household demand identified, and trade-offs assessed for more inclusive value chains that improve income and nutrition status in target regions	15. Increased livelihood opportunities	16. The different needs and wants of households based on various circumstances like aspirations and farm size among others, has been outlined in various studies and shared widely through scientific publications, blogs and magazine contributions.	17. Diversity of farm household preferences vis-a-vis market demand by context outlined in view of research in GLDC. 18. THIS IS AN ADDITIONAL MILESTONE NOT IN THE 2019 WP	19. Complete	20. Insights shared on farming household diversity and entry points for technology development and dissemination outlined and shared in GLDC meetings.	21. PROGRESS AS REPORTED 22. Studies on "farmer's aspirations" and "drivers" behind "farmers" strategies for improved livelihoods are very relevant and useful. The premise that "not all farmers are the same" and that "farmers spend a lot of time doing non-farm activities" is of course, not new. But feeding these elaborations of earlier thinking into the "product profiles of GLDC crops would be very useful. 23.
24.	25. FP1.02. Market and household demand identified, and trade-offs assessed for more inclusive value chains that improve income and nutrition status in target regions	26. Increased livelihood opportunities	27. The work on household aspirations is helping to better identify end-user demands and profiles and build on what has been documented in several market and value chain	28. Shared learning across GLDC stakeholders and FPs on implications of diverse target aspirations and	30. Complete	31. Report on diversity of target group preferences and match and mismatch of GLDC research targets based on	

			studies in terms of market and household demands and preferences.	future scenarios leading to strategic adjustments. 29. THIS IS THE ORIGINAL 2019 WP MILESTONE		meetings and workshops across GLDC.	
32.	33. FP1.03. Inclusive and equitable technologies and innovation systems and broadened impact across the agri-food system	34. Improved capacity of women and young people to established for accelerated participate in decision-making	35. N/A	36. Inclusive and equitable innovation system tested and adjusted to different biophysical and socioeconomic contexts including policy interactions. 37. THIS IS THE ORIGINAL 2019 WP MILESTONE	38. Cancelled	39. Reasons for cancelling: 7. Others- This milestone is duplicating the milestone "Inclusive and equitable innovation system for accelerating impacts for women and young people designed and piloted including policy interactions". The retained duplicate was edited to make it more inclusive of the gender and youth work.	40. NO PROGRESS HAS BEEN REPORTED AGAINST THIS MILESTONE. 41. This FP1 Outcome (No 3) was designed (and remains) an important part of the "new" thinking in GLDC CRP. It is not clear, however, why this outcome/milestone receives two entries here in this table. The changes in the milestone status (effectively to delay the activity until 2020) seems to be related to the non-funding of FP2 .
42.	43. FP1.03. Inclusive and equitable technologies and innovation systems established for accelerated and broadened impact across the agri-food system	44. Improved capacity of women and young people to participate in decision-making	45. The ongoing strategic youth research work involving cross-country surveys in Tanzania, Ethiopia and Uganda is enhancing our understanding of the potential nodes for participation of youth in GLDC value chains. Ongoing work on women participation in cowpea and chickpea seed value	47. Inclusive and equitable innovation system for accelerating impacts for women and young people designed and piloted including policy interactions. 48. THIS IS THE ORIGINAL	49. Changed	50. Reasons for extending: 7. Others- There was a delay in the youth study partnerships` establishment in 2019, but data collection was initiated in 2019 and will proceed for analysis and stakeholder	51. (SEE ABOVE)

			chains in Ethiopia, Zambia and Mozambique gives insights on inclusive and equitable technologies, innovation systems and policy recommendations. 46.	2019 WP MILESTONE		meetings in 2020.	
52.	53. FP1.04. Strong project design, execution, monitoring and evaluation systems and tools consistently applied in GLDC scaling projects, with demonstrable progress on enhanced adoption and impact	54. Conducive agricultural policy environment	55. The review of scaling approaches has generated useful lessons for increased technology adoption and impact through the identification of successful approaches to technology scaling and the underlying institutional and policy contexts.	56. Evaluation designed and implementation underway to evaluate current GLDC scaling approaches & associated impact evidence. 57. THIS IS THE ORIGINAL 2019 WP MILESTONE	58. Complete	59. The review of scaling approaches was designed and already implemented by the team.	60. PROGRESS AS REPORTED *61.* Developmental impacts at scale, are at the heart of the GLDC CRP. Historically, low adoption rates of new technologies by smallholders Sub Saharan Africa, is a major challenge to the relevance of the work of the CGIAR. This output concerns a review of an existing GLDC scaling framework which is found to be useful but not a practical guide to the realities of scaling with relevance beyond the GLDC CRP. It proposes that an approach that takes a wider perspective with more emphasis, for example, on gender and partnerships, should be adopted. Also, that there is a need for a more nuanced understanding of how a new technology fits into the agri-food system and the concept that "subsistence farmers are all small scale commercial farmers in the making" is not the only paradigm.
62.	63. FP1.04. Strong project design, execution, monitoring and evaluation systems and tools consistently applied in GLDC scaling projects, with demonstrable progress on enhanced adoption and impact	64. Conducive agricultural policy environment	65. The review of impact studies of GLDC innovations has identified major gaps in terms of crops, countries and types of impact and offered recommendations for future impact assessments of GLDC technologies to expand crop and country coverage; to assess environmental, nutritional or social	66. Joint systematic review of impact studies with CoA 1.2. 67. 68. THIS IS AN ADDITIONAL MILESTONE NOT IN THE 2019 WP	69. Complete	70. A working paper has been published on the review of impact studies of GLDC technologies.	71. PROGRESS AS REPORTED 72. Interesting paper reviewing 18 previously published impact studies of GLDC crops. Conclusion is broadly that the empirical evidence base for the wider claims that increased yield in GLDC crops has a positive impact on improved livelihoods, nutrition etc is poorly identified and incomplete. It is not clear how these findings impact on the outcomes 01 and 02 of FP1 or are being assimilated in the wider CRP. An interesting concluding statement is as follows: The objective of impact

			impacts in addition to economic impacts; and to improve on methodological approaches.				assessment should be to establish an evidenced base that informs policymaking - not to confirm or legitimize favoured programmes.
73.	74. FP1.04. Strong project design, execution, monitoring and evaluation systems and tools consistently applied in GLDC scaling projects, with demonstrable progress on enhanced adoption and impact	75. Con ducive agricultural policy environment	76. The ongoing review of scaling approaches is generating useful lessons for increased technology adoption and impact through identification of successful approaches to technology scaling and the underlying institutional and policy contexts.	77. Scaling toolkit for Design, Execution, Monitoring, and Evaluation (DEME) content agreed to support improved horizontal and vertical scaling of GLDC commodities and management practices. 78. THIS IS AN ADDITIONAL MILESTONE NOT IN THE 2019 WP	79. E xtended	80. Reason for extending: 4. Internal resources - key staff, infrastructure or equipment was not available at the time needed.	81. NO PROGRESS HAS BEEN REPORTED AGAINST THIS MILESTONE. 82.
83.	84. FP1.04. Strong project design, execution, monitoring and evaluation systems and tools consistently applied in GLDC scaling projects, with demonstrable progress on enhanced adoption and impact	85. Con ducive agricultural policy environment	86. The ongoing review of scaling approaches is generating useful lessons for increased technology adoption and impact through identification of successful approaches to technology scaling and the underlying institutional and policy contexts.	87. Evaluatio n documenting the strengths, shortcomings and key lessons learned on GLDC scaling approaches and impacts. 88. THIS IS THE ORIGINAL 2019 WP MILESTONE	89. E xtended	90. Reason for extending: 7. Other, please state: A scaling framework was developed that encapsulates key elements considered important in promoting the large-scale adoption and impacts of GLDC technologies. Following an internal review, it was decided to expand the framework to make it more comprehensive for supporting	91. NO PROGRESS HAS BEEN REPORTED AGAINST THIS MILESTONE. 92. It is not clear how the work listed to be undertaken here (and extended) relates to similar work undertaken, completed and reported in the first section of this FP1 4 report above. There is a clear synergy.

						and enhancing GLDC's scaling approaches and impact.	
93.	94. FP1.04. Strong project design, execution, monitoring and evaluation systems and tools consistently applied in GLDC scaling projects, with demonstrable progress on enhanced adoption and impact	95. Conducive agricultural policy environment	96. The impact evidencing strategy that has been developed is expected to facilitate monitoring and evaluation and impact assessment systems for greater accountability and enhanced adoption and impacts of GLDC innovations.	97. Working strategy for evidencing the outcomes and impacts of GLDC. 98. ADDITIONAL MILESTONE NOT IN THE 2019 WP	99. Complete	100. Strategy note.	101. PROGRESS AS REPORTED 102. The CRP in its proposal has committed itself to achieving an ambitious set of impact targets contributing to the CGIAR SRF. In this activity a CRP wide Impact evidencing working strategy has been developed. This strategy seeks to set in train a means of credibly and practically evidencing the extent to which it has or will meet the GLDC CRP targets. One recommendation is that GLDC requires senior champions to push the impact evidencing strategy within GLDC. 103.
104.	105. FP3.O1. Cropping systems sustainably intensified and diversified	106. Increased resilience of agro-ecosystems and communities, especially those including smallholders	107. N/A	108. Participatory field trials under smallholder conditions in different cropping systems and environments evaluated. 109. THIS IS THE ORIGINAL 2019 WP MILESTONE	110. Cancelled	111. Reason for cancelling: 7. Others. This milestone was merged with the milestone: 3,000 farmers are trained in the use of crop mixes and sequences in which they have jointly identified with researcher for better water and soil management.	112. N/A
113.	114. FP3.O1. Cropping systems sustainably intensified and diversified	115. Increased resilience of agro-ecosystems and communities, especially	116. Research and training of farmers, extension agents and students on legume systems and crop mixes for better water and soil management for increased productivity.	117. 3,000 farmers are trained in the use of crop mixes and sequences in which they have jointly identified with researcher	119. Complete	120. Research and evaluation reports, training manuals.	121. PROGRESS AS REPORTED 122. A range of different studies and activities have been undertaken in various countries. Each study is worthy and useful in its own right and adds to knowledge in this area. It is not clear, however, what or whether there is a

		those including smallholders		for better water and soil management. 118. THIS IS THE ORIGINAL 2019 WP MILESTONE			coordinated theme and whether the sum is greater than the parts.
123.	124. FP3.O1. Cropping systems sustainably intensified and diversified	125. Increased resilience of agro-ecosystems and communities, especially those including smallholders	126. Surveys have been completed for impacts of legume-based technological interventions on smallholder production and livelihood performance in Burkina Faso and Ethiopia.	127. Ex-post impacts of innovation practices on crop production efficiency and household livelihoods measured. 128. THIS IS THE ORIGINAL 2019 WP MILESTONE	129. Complete	130. Reports and publications on ex-post impact assessment with an efficiency focus.	131. PROGRESS AS REPORTED 132. This is essentially the same activity as above but with a different milestone. Hence the comments are the same :- A range of different studies and activities have been undertaken in various countries. Each study is worthy and useful in its own right and adds to knowledge in this area. It is not clear, however, what or whether there is a coordinated theme and whether the sum is greater than the parts.
133.	134. FP3.O1. Cropping systems sustainably intensified and diversified	135. Increased resilience of agro-ecosystems and communities, especially those including smallholders	136. Surveys have been completed for farm-household livelihood typologies in Burkina Faso and Ethiopia.	137. Farm-household typologies characterized and participatory field trials under smallholder conditions in different cropping systems evaluated for common and type-specific determinants of adoption of innovations, intensification and diversification 138. options. 139. THIS IS THE ORIGINAL 2019 WP MILESTONE	140. Complete	141. Research reports, training manuals and other IEC materials.	142. PROGRESS AS REPORTED 143. Studies completed as stated but the context and development strategy (ie significance of the work in the programme ToC) not clear. How will these results be used?

144.	145. FP3.O2. Cropping systems sustainably intensified and diversified	146. Increased resilience of agro-ecosystems and communities, especially those including smallholders	147. This milestone was merged with the milestone: 3,000 farmers are trained in the use of crop mixes and sequences in which they have jointly identified with researcher for better water and soil management.	148. Map out areas suitable for crop diversification using GIS. Participatory field trials under smallholder conditions to evaluate the different cropping systems under different environments in different countries for farmers with landholdings less than 1 ha. 149.	150. Cancelled	151. Reasons for cancelling: 1. Research/science - inherent risk in unknown cutting-edge research or science. 152. 2. Financial - funding delayed and/or cut. 153. 6. External environment (political, economic, legal, market) - e.g. conflict, economic/market changes.	154. N/A
155.	156. FP3.O2. Cropping systems sustainably intensified and diversified	157. Increased resilience of agro-ecosystems and communities, especially those including smallholders	158. At least two intercropping systems tested in India, Mozambique, Malawi, Uganda, Burkina Faso and Senegal.	159. At least two options per site per country to promote diversified, profitable and sustainable crop-livestock systems discussed and agreed upon with local communities and researchers. 160. ADDITIONAL MILESTONE NOT IN THE 2019 WP	161. Complete	162. Research reports and economic evaluation reports.	163. PROGRESS AS REPORTED 164. A significant range of well-designed studies have been completed as stated but the context and development strategy (ie significance of the work in the programme ToC) not clear. How do the findings come together and have developmental impact at scale?
165.	166. FP3.O2. Pest and diseases controlled safely and with reduced agro-chemical inputs	167. Reduced production risk	168. Five strains each of *Streptomyces* and *Bacillus* were evaluated as biocontrol agents against *Fusarium* wilt and PGP agents in chickpea under both	171. 1) Pest and diseases management components for the target pests and 2) resource and soil	173. Extended	174. Reason for extending: 3. Partnership - partners were not able to	175. N/A

			greenhouse and field conditions and they reduced disease incidence. 169. Sweet sorghum bagasse was found to decompose fast and its compost prepared with microbes successfully promoted plant growth and significantly enhanced yields. 170. Five indigenous *Bradyrhizobium* strains were evaluated on soybean and showed promising results with decreasing *Striga* population and increasing biomass and grain yields in Mozambique.	management options in different regions fine-tuned. 172. ADDITIONAL MILESTONE NOT IN THE 2019 WP		deliver a key piece on time.	
176.	177. FP3.O2. Pest and diseases controlled safely and with reduced agro-chemical inputs	178. Reduced production risk	The spatial and temporal distribution of emerging diseases of chickpea and pigeonpea in India were assessed and risk areas mapped. In a large-scale application of biocontrol agents in Benin and Burkina Faso, adults of *Therophilus javanus* were recovered from parasitized *Maruca vitrata* caterpillars. Cowpea pods were collected 3 years after the release and the borer populations remains reduced by 86.3%. Plant growth promotion products like AMF	179. Efficacy of 1) selected pest and diseases management options and 2) resource and soil management options confirmed at pilot scale. 180. ADDITIONAL MILESTONE NOT IN THE 2019 WP	181. Extended	182. Reasons for extending: 1. Research/science - inherent risk in unknown cutting-edge research or science. 183. 2. Financial - funding delayed and/or cut. 184. 6. External environment (political, economic, legal, market) - e.g. conflict, economic/market changes.	185. N/A

			inoculation proved to be effective on *Striga* infection and yield of sole-cropped maize and maize-bean intercrops in Uganda.				
186.	187. FP3.O3. Tested, adapted and validated options applied for sustainable intensification and livelihood diversification by farmers	188. Increased resilience of agro-ecosystems and communities, especially those including smallholders	189. Comprehensive framework for farming systems sustainability with 5 domains and 115 indicators in India. A multi-dimensional analysis was undertaken to explore the near-future effects of different scenarios on food security dimensions of SI in southern Mali._A remote sensing-based model has been calibrated for millet yield estimates allowing to account for parkland effects (R^2=0.70) in Senegal.	190. Suite of systems modelling tools/framework for co-designing resilient farming systems in GLDC regions. 191. THIS IS THE ORIGINAL 2019 WP MILESTONE	192. Complete	193. Publications.	194. PROGRESS AS REPORTED 195. Two studies completed in South Asia and West Africa. These add to the knowledge in this area but as noted above, how do the findings come together and have developmental impact at scale?
196.	197. FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilize food supply	198. Enhanced genetic gains	199. TPE characterization in Asia and WCA is completed for groundnut, sorghum and chickpea and this activity is prioritized under CoA 4.1 and has received co-investment from AVISA and other bilateral projects. See link in evidence.	200. Initial analysis of stress patterns in target populations of environments (TPE) on few crops are available to better decide on breeding target. 201. THIS IS THE ORIGINAL 2019 WP MILESTONE	202. Extended	203. Reason for extending: 1. Research/science - inherent risk in unknown cutting-edge research or science.	204. ONGOING 205. An ongoing (rather traditional) study of bio-geo-physical factors affecting yield of ground nuts in India.
206.	207. FP4.O2. Robust and responsive global to national breeding systems produce and deliver novel varieties and allied innovations at appropriate scale and scope	208. Increased capacity for innovation in partner	209. The GLDC crop product profiles have been developed and uploaded on the EiB platform. NARS were also trained on development of PPs at	210. Develop product profiles for crops X regions with NARS.	212. Complete	213. Blog, product profile reports.	214. PROGRESS AS REPORTED 215. The GLDC crop product profiles are a significant step towards establishing that GLDC crops can play diverse roles in contributing to the CGIAR SLOs. A training course with African NARS to

		research organizations	the second training course organized by FP4.	211. THIS IS THE ORIGINAL 2019 WP MILESTONE			disseminate information on this approach has also been completed as a useful way of disseminating this approach.
216.	217. FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilize food supply	218. Closed yield gaps through improved agronomic and animal husbandry practices	219. The simultaneous improvement of both production and market traits through partnership with NARS under FP4 resulted in the commercialization of 26 GLDC crop cultivars: chickpea (6), lentil (5), groundnut (8), pigeonpea (2), sorghum (1), pearl millet (3), and finger millet (1) in Africa and Asia.	220. New suite of resilient varieties released by NARS partners. (Phase 1 investments start being released). 221. THIS IS THE ORIGINAL 2019 WP MILESTONE	222. Complete	223. Varietal profile.	224. PROGRESS AS REPORTED 225. Good collaboration with NARS resulted in a suite of resilient varieties released as planned. A good and significant outcome.
226.	227. FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilize food supply	228. Increased availability of diverse nutrient-rich foods	229. The first high oleic groundnut varieties that confer consumer health benefits are commercialized in India. Bio-fortified lentil and pearl millet cultivars commercialized are important to reduce the burden of micro-nutrient malnutrition.	230. New varieties with enhanced nutrient levels (Fe, Zn, oil, protein, high oleic) developed. 231. THIS IS THE ORIGINAL 2019 WP MILESTONE	232. Complete	233. Varietal profile.	234. PROGRESS AS REPORTED 235. High oleic groundnut commercialized and details of the success story issued as a 2019 AR GLDC OICR at level 2 of maturity. No evidence available in this table on the bio-fortified lentil and pearl millet cultivars but again a 2018 AR GLDC OICR at level 1 of maturity has been issued on this.
236.	237. FP4.O1. New varieties & allied innovations improving productivity & production potential, agribusiness opportunity & stabilize food supply	238. Enhanced genetic gains	239. Rapid generation advancement (RGA) that enhances rate of genetic gain is used to develop and commercialize high oleic varieties, and protocols were standardized and deployed in lentil and chickpea. New genetic material of GLDC crops was shared with NARS partners in Africa and Asia and multi-location testing is established jointly with NARS to	240. Phase I genetic materials deployed in GLDC crop improvement by CGIAR centers - annually 8 crops X 3 trait clusters X 2 regions tested by NARS. 241. THIS IS THE ORIGINAL 2019 WP MILESTONE	242. Extended	243. Reason for extending: 7. Others. Deployment of innovations including RGA requires logistic adjustment.	244. PROGRESS AS REPORTED / EXTENDED 245. See above and also 2019 AR GLDC OICR at level 1 for progress on rapid generation advancement in lentil, sorghum, chickpea and pearl millet. 246.

			identify new cultivars for the target-agroecologies. Report				
247.	248. FP5.O1. Pre-breeding products through use of genebanks and other sources and modern tools to increase genetic diversity in breeding programs globally	249. Increased conservation and use of genetic resources	250. Advanced the work related to Botrytis grey mold in chickpea, blast/heat tolerance in pearl millet and drought tolerance in cowpea by using wild germplasm.	251. Development/refinement of technologies for overcoming barriers to wide crosses for 1 crop. 252. THIS IS THE ORIGINAL 2019 WP MILESTONE	253. Complete	254. Publications, reports, technical bulletins.	255. PROGRESS AS REPORTED 256. Excellent scientific research work published in worthy journals.
257.	258. FP5.O2. Trait discovery and development based on genomics and phenomics to generate new markers to support trait integration through use of modern enabling technologies and forward breeding	259. Enhanced genetic gains	260. Molecular breeding products (2 in groundnut, 3 in chickpea) released in India and Ethiopia. Markers deployed in breeding program in groundnut, sorghum and cowpea resulting in more than 700K marker data points generated in 2019. QC panels developed and initially validated in groundnut and pearl millet. Germplasm reference sets, other germplasm sets, mapping populations assembled, and traits prioritized for discovery research in 4 legumes (groundnut, chickpea, pigeonpea, cowpea) and 3 cereals (sorghum, pearl millet, finger millet).	261. Precision phenotyping for key traits for these collections and genotyping to identify novel alleles for 2 traits in 2 crops that have limited variability in breeding populations. 262. THIS IS THE ORIGINAL 2019 WP MILESTONE	263. Complete	264. Publications, reports, technical bulletins.	265. PROGRESS AS REPORTED Excellent scientific research work published in worthy journals. Interesting research on physical and hydration properties of chick peas. One wonders whether any thought had been given to how this feeds through to the functional / cooking properties of such seeds? 266.
267.	268. FP5.O3. National researchers able to apply the acquired skills in other pre-breeding programs. Development of enabling technologies	270. Enhanced genetic gains	271. Public-private partnerships to accelerate the development and deployment of modern	272. Network of precision phenotyping sites is established across GLDC	275. Complete	276. Publications, reports, technical bulletins.	277. PROGRESS AS REPORTED 278. Important new tools and platform established. Possibility of transgenic approaches to bio fortification

	platforms to be used for rapid trait discovery, trait validation, trait development and trait introgression 269. *This milestone was planned under FP5.2 in the POWB 2019, but was corrected, and now reported under FP5.3 in this Annual Report 2019.*		enabling tools and technologies. Data management in at least 3 of the GLDC crops digitalized. RapidGen (RGT) platform established in pearl millet and chickpea. Quickcrop nextgen transformation established in sorghum and pearl millet. Genome editing, platform established in sorghum.	crops to provide unique and relevant testing locations for key traits (FP4.1). 273. Gain-of-function or loss-of-function platform in 1 cereal and 2 legumes established. 274. THIS IS THE ORIGINAL 2019 WP MILESTONE			noted. It would, however, be important to ensure that consideration is given to breeding for positive functional properties in tandem with micro nutrients.
279.	280. General	281. Sub-IDO 1.4.3: Adoption of CGIAR materials with enhanced genetic gains	282. Six product profiles have been defined with current traits and traits to add: red mottled, cream mottled, yellow, small white, small red and small black. This process was initiated under the Tropical Legumes III project, and also benefits from on-going consultations in business platforms within bean corridors where commercial interests and gender considerations are taken into account. A foresight exercise will contribute to an evolving set of profiles over time.	283. Researchers created and shared draft product profiles with partners. 284. Flagship Programme 6 not in original 2019 WP	285. Complete	286. EiB website.	287. NOT POsSIBLE TO COMMENT 288. The link provided does not seem to relate directly to the milestone.
289.	290. Outcome 1: Livelihoods	291. Sub-IDO 1.3.2: Increased livelihood opportunities	292. The impact model as developed jointly by IFPRI and collaborating CGIAR centers was applied to beans on a country by country basis. As	293. Researchers wrote a report on foresight analysis that predicts demand for bean based on CIAT research.	295. Extended	296. Reason for extending: 1. Research/ Science. Delays in contracting a post-doc	298. PROGRESS ON FLAGSHIP PROGRAMME COMMON BEANS FOR MARKETS AND NUTRITION 299. This flagship programme on beans was added to the GLDC CRP in 2019. There is little explanation for this in the 2019 AR..The main source of

			expected, the model predicts significant growth in bean productivity, although it underestimates realized gain in Ethiopia where government support attained the predicted gains in 10 years instead of 30 years. Unfortunately, the model does not permit experimenting with theoretical changes, for example, in annual genetic gain under different breeding innovations, or improved markets that incentivize use of inputs. Such innovations must be explored independently.	294. Flagship Programme 6 not in original 2019 WP		required extension. 297. Progress evidence: 2019 Report to Government of Canada.	evidence cited in this table for completion of milestones is the April to September 2019 Report to Government of Canada. This is a very well written and coherent report and provides a comprehensive overview of the important work the FP has undertaken. The report summarizes the work by 5 Outputs whereas the current table reports activities by outcomes. The information is thus not detailed enough to provide a commentary outcome by outcome.
300.	301. Outcome 3: Less yield losses	302. Sub-IDO 1.3.2: Increased livelihood opportunities	303. The large seeded Mesoamerican bean lines' drought-tolerance was tested against drought checks for two years. They also present excellent combining ability. The parentage of these lines does not reveal the source of their traits, with the exception of one parental line with superior low fertility tolerance. These lines illustrate the importance of maintaining a large number of crosses in a breeding program, to identify serendipitous combinations.	304. Researchers collected agronomic data on large- seeded Mesoamerican beans to indicate their potential as a breeding class. 305. Flagship Programme 6 not in original 2019 WP	306. Complete	307. Data for experimental bean lines selected for tolerance to drought.	308.
309.	310. Outcome 4: Enhanced genetic gain	311. Sub-IDO 1.3.2: Increased	A series of greenhouse experiments was performed to establish a	312. Researchers advanced and established RGA-	314. Extended	315. While partially met for bush beans,	317.

		livelihood opportunities	rapid generation advance (RGA) protocol. We tested soil types, light regimes, pod sizes, watering regimes, fertilizer applications and hormone applications, as well as harvest and post-harvest factors such as early harvesting and seed drying regimes. More experiments are ongoing. A field RGA protocol was developed, inspired by work at IRRI to advance single plants one generation for about USD 0.0 9 per plant, with additional savings in seed handling. A recent population was advanced 3 generations by RGA and is entering yield trials now. The protocol will be applied more broadly in several more populations.	rapid generation for climbing beans. 313. Flagship Programme 6 not in original 2019 WP		climbing beans represent a greater challenge as they are inherently late to flower and mature. 316. Progres s evidence: 2019 PABRA Report to Government of Canada.	
318.	319. Outcome 1: Livelihoods	320. Sub-IDO 1.3.2: Increased livelihood opportunities	321. A breeding population for early cooking time was developed using sources described in a recent publication with ABC breeding material. A bush breeding diversity panel was evaluated for cooking time (CKT) and well performing lines were used in the described crosses. This population is now to be sown in F3. A climbing bean panel has also been evaluated for CKT,	322. Research ers developed and shared first crosses specifically for fast cooking time. 323. Flagship Programme 6 not in original 2019 WP	324. E xtended	325. Reason for extending: 1. Research/ Science. Interpreted literally, the first crosses were indeed created, but have not yet been shared with partners. 326. Progres s evidence: 2019 Report to	327.

			in order to use the data in upcoming crosses. A publication on evaluations of CKT in 4 populations is being developed. ACIAR-Australia is funding a genomic selection project on cooking time.			Government of Canada.	
328.	329. Outcome 1: Livelihoods	330. Sub-IDO 1.3.2: Increased livelihood opportunities	331. Platforms focus on product profiles that have established consumer/buyer demand. Business platforms have been established in the red mottled bean corridor in Uganda (with 2 lead firms), Tanzania, Rwanda (3 lead firms) and Burundi (1 lead firm). One platform was established in the yellow bean corridor in Tanzania in the Kagera region (1 lead firm). In Southern Tanzania, in the sugar bean corridor, another platform has been set up (1 lead firm). The Ethiopian platforms are established for the white pea bean corridor with a series of cooperatives and private sector off-takers.	332. Researchers developed four multi-stakeholder bean business platforms with partners using the corridor model to support trade. 333. Flagship Programme 6 not in original 2019 WP	334. Complete	335. Evidence: 2019 Report to Government of Canada.	336.
337.	338. Outcome 1: Livelihoods	339. Sub-IDO 1.3.2: Increased livelihood opportunities	340. One of the key areas supported by ABC is scaling up value added bean products via micro and small-scale entrepreneurs in a number of countries. Producer groups have also been trained within	341. Capacity training completed with partners with 750 male and female entrepreneurs and farmers. 342. Flagship Programme 6 not	343. Complete	344. Evidence: 2019 Report to Government of Canada.	345.

			the framework of business platforms, where some of the training areas include collective production and marketing, management of finances, quality control and gender empowerment among others. In total, 1500 entrepreneurs were trained, about 30% women.	in original 2019 WP			
346.	347. Outcome 1: Livelihoods	348. Sub-IDO 1.3.2: Increased livelihood opportunities	349. ABC supported small-scale entrepreneurs to develop six bean composite flour products in Burundi, Uganda, Rwanda, Tanzania, Kenya, Madagascar, Zambia, Malawi and Zimbabwe. The products are principally nutrient-dense porridges targeting children and women. CIAT supported studies in i) establishing willingness to consume and pay; ii) linking farmers to processors via bean platforms, iii) trainings with grain processors and bean off-takers on how to get certification from governments, iv) nutrient analysis of bean-based flours and v) supporting women entrepreneurs in value addition of bean products. These efforts will be scaled in several countries including	350. Two bean-based products developed with partners through private sector engagement. 351. Flagship Programme 6 not in original 2019 WP	352. Complete	353. Evidence: 2019 Report to Government of Canada.	354.

			Ghana, Cameroon, Lesotho and Eswatini.				
355.	356. Outcome 3: Less yield losses	357. Sub-IDO 1.3.4: More efficient use of inputs	Some 123 Mesoamerican lines were developed in the drought tolerance breeding program with disease resistance and promising levels of Fe in red, black and yellow grain color classes. In the Andean program, 200 lines from a population developed for drought and BCMV resistance were evaluated in a drought and irrigated trial. Thirty-eight lines from a population developed for heat tolerance were evaluated in drought and irrigated conditions. Data needs to be analyzed to code new lines (~70) for multi-location testing.	358. Researchers developed 100 new lines with increased performance for abiotic and biotic stress tolerance. 359. Flagship Programme 6 not in original 2019 WP	360. Complete	361. Data for bean experimental lines selected for tolerance to drought, high temperatures, low P in the soil, high aluminum in the soil and high content of Fe / Zn in grain.	362.
363.	364. Outcome 3: Less yield losses	365. Sub-IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	366. An initial evaluation of wild *P. acutifolius* under a GCDT project revealed 2 accessions (G40287 and G40056) that could withstand night temperatures of 28°C and still produce seed. Families developed from these accessions were evaluated in the greenhouse under 25°C nights, with some 30 families presenting good pod formation. Further evaluation will support the search for QTL for	367. Researchers confirmed ten heat-tolerant lines selected from interspecific populations. 368. Flagship Programme 6 not in original 2019 WP	369. Extended	370.	371.

			heat tolerance. These lines complement other interspecific lines developed in previous years, of which the line SEF 16 emerged as the best in field trials on the north coast of Colombia.				
372.	373. Outcome 3: Less yield losses	374. IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	375. Greenhouse screening using breeding lines for ALS using aggressive strains identified MAB349 and MAB359 as promising resistant genotypes. Other genotypes such as NUA184, SMN184 and NXB080 showed acceptable levels of resistance.	376. Researchers confirmed resistance to root (Pythium) and foliar (ALS, web blight) pathogens derived from *P. coccineus* / *P. dumosus*. 377. Flagship Programme 6 not in original 2019 WP	378. Changed	379. Reason for changing: 4. Internal Resources. Personnel of the pathology section were overstretched on other objectives. 380. Progress evidence: 2019 Report to Government of Canada.	381.
382.	383. Outcome 3: Less yield losses	384. Sub-IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	385. Resistance to BLCrV was identified in Mesoamerican lines; so a population was developed to backcross this trait into Andean germplasm. The population was advanced under disease pressure, evaluated in two seasons, and is now entering yield trials.	386. Researchers introgressed Mesoamerican genes to Andeans for disease and heat resistance. 387. Flagship Programme 6 not in original 2019 WP	388. Extended	389. Reasons for extending: 1. Research/Science; 3. Partnership. Field phenotyping for virus resistance and for heat tolerance has been delayed, the latter by administrative steps in establishing a partnership. 390. Progress evidence: 2019 Report to Government of Canada.	391.

392.	393. losses	Outcome 3: Less yield	394. Sub-IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	395. More than 70 families have been developed for heat tolerance. Several were evaluated under heat in the Caribia Research Station of AgroSavia, the Colombian national program. Other populations presented modest resistance to leafhoppers. Entomological studies demonstrate resistance or tolerance to leaf miners and white flies. Initial data on Fe concentration in some lines exhibit as much as 20 ppm above the baseline. These early results highlight the great value of tapping the tertiary gene pool.	396. Researchers developed new populations with *P. acutifolius* using bridging genotype. 397. Flagship Programme 6 not in original 2019 WP	398. Complete	399. Evidence: CRP-GLDC FP6 Report 2019, 2019 Report to Government of Canada.	400.
401.	402. losses	Outcome 3: Less yield	403. Sub-IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	404. This was adopted as a PhD research topic, and thus was not pursued within the program.	405. Researchers analyzed sequence of bridging genotype between tepary and common bean. 406. Flagship Programme 6 not in original 2019 WP	407. Changed	408. Reason for changing: 3. Partnership. A PhD student has included this in his dissertation research, leading us to leave this objective to him.	409.
410.	411. losses	Outcome 3: Less yield	412. Sub-IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	413. No new markers for BGMV have been tried this year. The MAGIC population needs to be evaluated for this trait in LAC, or the BASE needs to be re-evaluated in replicated trials.	414. Improved markers for BGYMV resistance availed, in collaboration with USDA. 415. Flagship Programme 6 not in original 2019 WP	416. Extended	417. Reasons for extending: 1. Research/ Science; 3. Partnership. Development of collaboration with USDA is pending.	419.

						418. Progress evidence: 2019 Report to Government of Canada.	
420.	421. Outcome 3: Less yield losses	422. IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	423. An R programme facilitates data processing from MSPQ tool for heat-related photosynthate transport, performing basic statistics, reflecting behavior under heat and identifying the best 10% genotypes. MPSQ seeks multidimensional evaluation of data to understand tolerance. Artificial intelligence to evaluate seed filling in scanning bleached bean pods is in final evaluation. We also verified that tolerant genotypes under heat elongate pods rapidly and consistently during pod elongation and later in seed-filling stage. An approach to evaluate abortion with and without heat shock is being developed in growth chambers.	424. Researchers characterized limits on photosynthate transport under heat. 425. Flagship Programme 6 not in original 2019 WP	426. Extended	427. Reason for extending: 1. Research/ Science. Data analysis is progressing but is complex. This is a true example of the challenges of BIG DATA. 428. Progress evidence: 2019 Report to Government of Canada.	429.
430.	431. Outcome 3: Less yield losses	432. Sub-IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	433. ABC research teams in Tanzania have shown that the use of micronutrients based fertilizers increase agricultural productivity by at least 25% across crops and geographies. Beyond phosphorus, research is needed on bean response to	434. One climate-smart and environmentally friendly pre-and post-harvest integrated crop management (ICM) practice developed and recommended to partners.	436. Extended	437. Reason for extending: 1. Research/ Science. ABC is pursuing collaboration with private companies such as OCP (Morocco), Toyota Kyushu	439.

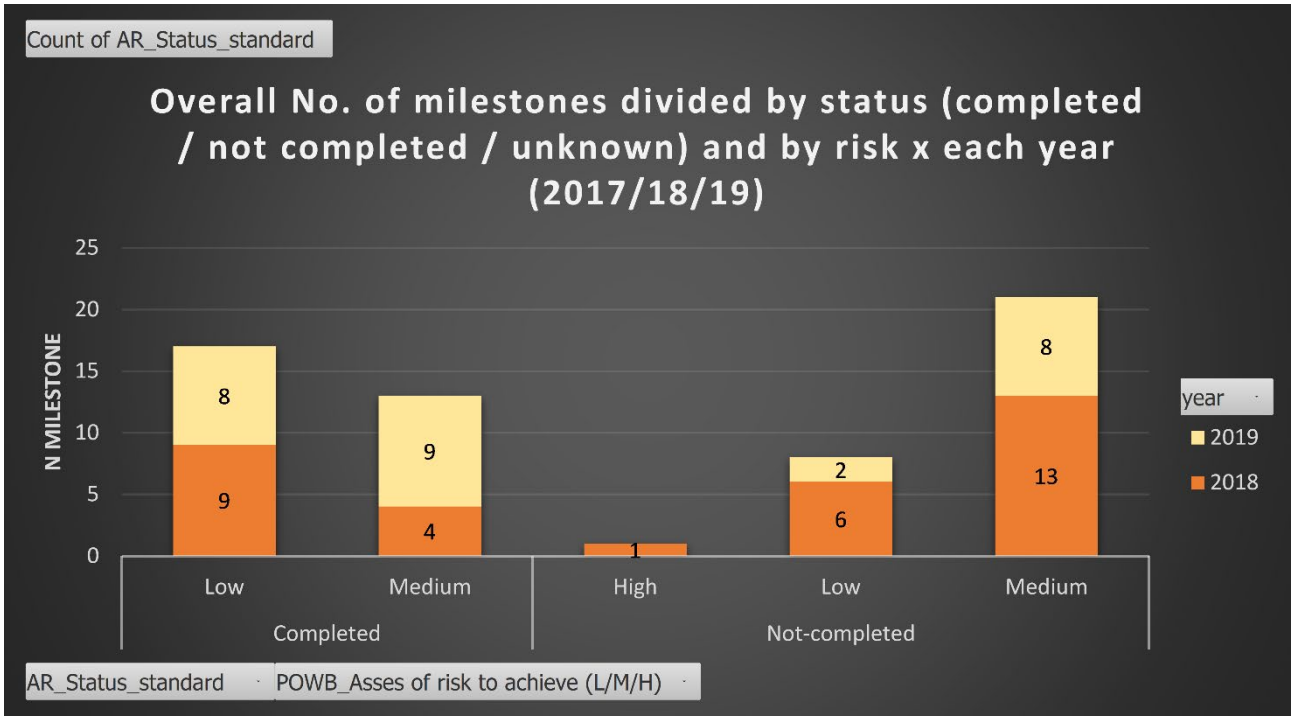
			molybdenum, zinc, boron, manganese and copper.	435. Flagship Programme 6 not in original 2019 WP		(Kenya) to advance research on use of micronutrient fertilizer blends. 438. Progress evidence: 2019 Report to Government of Canada.	
440.	441. Outcome 3: Less yield losses	442. Sub-IDO 1.4.1: Reduce pre- and post-harvest losses, including those caused by climate change	443. 11,885 tons produced in 7 countries. Increased utilization of quality seed of improved varieties. Reduced time between the release and use. Increased number of seed producers engaged and increased seed business volume. Increased linkages between seed and grain production.	444. 9,000 tons of seed of climate-resilient bean varieties produced and disseminated by partners. 445. Flagship Programme 6 not in original 2019 WP	446. Complete	447. Evidence: 2019 Report to Government of Canada	448.
449.	450. Outcome 5: Nutrient-rich food	451. Sub-IDO 2.1.1: Increased availability of diverse nutrient-rich foods	452. Biofortified crops formed part of four strategies of Malawi's nutrition policy (see reported policies table 2). Outcomes: Increased number of seed companies producing biofortified seeds including high Fe and Zn beans. Biofortified crops form part of most of Malawi government's agriculture projects such as AFIKEPO, KULIMA and Adolescent Nutrition Sensitive Agriculture Project (ANSA).	453. Partners jointly developed two policy tools based on ABC research and made them widely available. 454. Flagship Programme 6 not in original 2019 WP	455. Complete	456. Development of the 2nd Uganda Nutrition Action Plan (2020-2025) - See table 2 policies.	457.
458.	459. Outcome 4: Enhanced genetic gain	460. Sub-IDO 1.4.3: Adoption of	461. Marker assisted selection (MAS) is increasingly used in the	462. Researchers and partners evaluated ~	464. Complete	465. SNP genotyping results from	466.

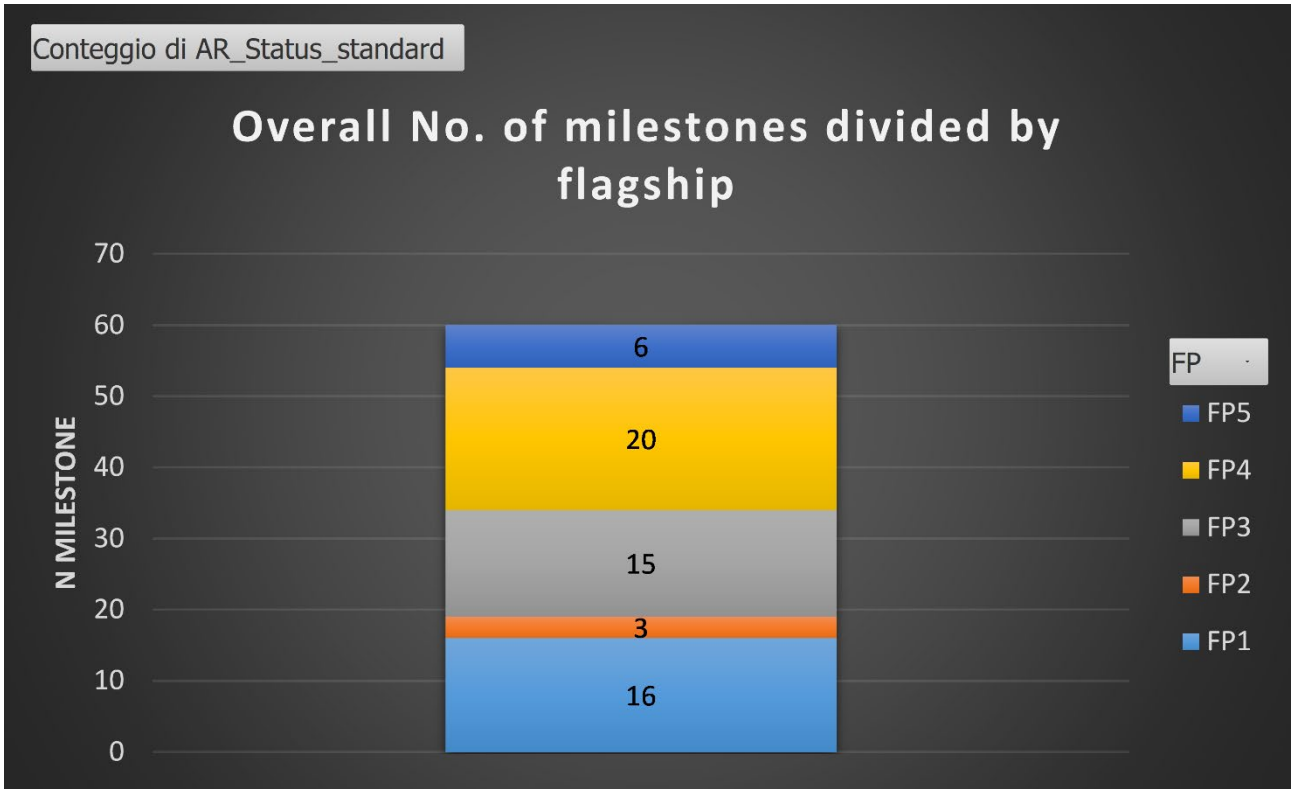
		CGIAR materials with enhanced genetic gains	breeding program. The Mesoamerican program in Cali evaluated 12,000 samples, principally for virus resistance genes (bc-3, bgm-1, I gene), and a small number for angular leaf spot resistance (gene Phg-2) and common blight resistance (SU91 SNP marker). The Andean program used ~6200 samples in 2019, markers for ALS, BCMV, lpa and bruchids, next to QC applications. In total about 200,000 data points generated.	20,000 DNA samples at Intertek. 463. Flagship Programme 6 not in original 2019 WP		Intertek Sweden outsourcing service.	
467.	468. Outcome 4: Enhanced genetic gain	469. Sub-IDO 1.4.3: Adoption of CGIAR materials with enhanced genetic gains	470. The nursery was shipped to Nicaragua, Honduras (2 sites), Guatemala and El Salvador with checks for Fe level and local adaptation.	471. Nurseries of 200 lines established with at least five partners for multi-site evaluation. 472. Flagship Programme 6 not in original 2019 WP	473. Extended	474. Reason for extending: 3. Partnership. In Honduras 46 were selected and 50 in Nicaragua. Evaluations continue in Guatemala and El Salvador. 475. Progress evidence: 2019 Report to Government of Canada.	476.
477.	478. Outcome 4: Enhanced genetic gain	479. Sub-IDO 1.4.3: Adoption of CGIAR materials with enhanced genetic gains	480. While the first evidence of successful gene editing was reported two years ago, this was a random event, and the methodology was far from consistent. Two years were dedicated to creating a system from which a significant	481. Researchers and partners established a gene editing system. 482. Flagship Programme 6 not in original 2019 WP	483. Extended	484.	485.

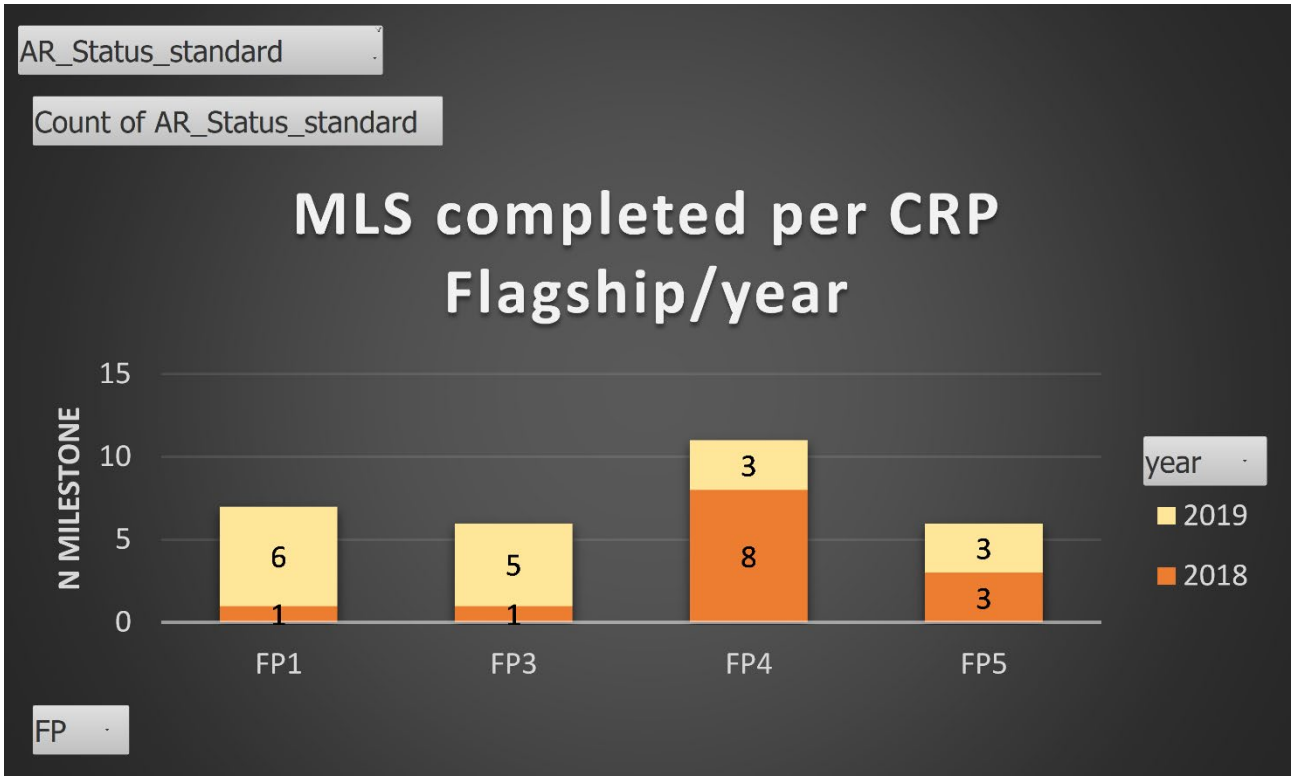
			number of gene editing candidates could be obtained. Plantlets can now be recovered routinely from callus culture with both roots and shoots. In particular, the rooting medium has been improved dramatically.				
486.	487. Outcome 5: Nutrient-rich food	488. Sub-IDO 2.1.1: Increased availability of diverse nutrient-rich foods	489. 6,284 tons of seed produced in 8 countries. Increased investments from other partners as result of information. Good interest by private sector, especially small processors. Increased demand of grain translated into seed demand.	490. 1000 tons of seed of new micro-nutrient bean varieties produced and disseminated by partners. 491. Flagship Programme 6 not in original 2019 WP	492. Complete	493. 2019 Report to Government of Canada.	494.
495.	496. Outcome 5: Nutrient-rich food	497. Sub-IDO 2.1.1: Increased availability of diverse nutrient-rich foods	498. A number of varieties were released: 1 biofortified variety with moderate drought tolerance (line SMR 156) in Nicaragua; 10 varieties, 4 with >20 ppm Fe above the check in the Dominican Republic; 2 varieties - SCR26 = NAROBEAN6 and SCN11 = NAROBEAN7 with drought tolerance, early maturity (68-72 days), relatively high Fe (>70 ppm) and Zn (> 35 ppm) and tolerance to diseases in Uganda; 4 varieties – S CN11 (small black), NUA517 (large red mottled biofortified), SCR15 (small red) and RAZ42	499. Seven consumer-preferred bean varieties including biofortified, that are climate resilient and environmentally friendly developed and released by partners. 500. Flagship Programme 6 not in original 2019 WP	501. Complete	502. 2019 Report to Government of Canada	503.

			(small white) with drought tolerance in Ethiopia; 3 varieties - AFR703 (red kidney) and 2 small white Canpsula (for baked beans industry); and SMC16 (biofortified) in Zimbabwe; 7 bean varieties - CIM-ALS-FeZn08-16-6 (Lusemfwa), CIM-CBB-FeZn08-30-2 (Luswishi), ZMPB-12-61-4 (Lui), SER 124 (Lusitu); Zorro (Lufubu), CIM-SUG05-01-02 (Machili) and MBC 33 (Maninga) in Zambia and NUA45 (Ferrina) in Mauritius.				

Annex 5j. Overview of GLDC Milestone data






AR_Status_standard
Count of AR_Status_standard
MLS completed per CRP Flagship/year
N MILESTONE
15
10
5
0
6
1
5
1
3
8
3
3
FP1
FP3
FP4
FP5
year
2019
2018
FP

Annexes 6 (a, b): Expanded OICR analyses

Annex 6a. Deep Dive 1: Analysis of selected OICRS on seed systems from GLDC Annual Reports 2018 and 2019

OICR title	AR year	Outcomes	Cross-cutting issues	Partnerships	Maturity	Tracking Outcomes	Enabling environment	Funding	Lessons learned
Chickpea in Ethiopia: A Game Changer for Small Farmers.	2018	During 7 years, adoption of improved chickpea varieties rose from 31-80%; share of chickpea growers rose from 65-90%; area sown to chickpea per farm rose from 0.17-0.4 ha; and significantly increased household welfare. Adoption was driven more by profits and disease tolerance than by higher yields. No negative trade-offs: the technology was not overly complex or demanding in terms of labour, inputs or cash investment	*Climate change:* an environmentally friendly technology (drought tolerant and fix nitrogen) for poverty reduction *Gender:* limited input until 2013 *Capacity development:* seed grower associations mainly male	EIAR, Ethiopia ICRISAT, Multi-stakeholder EthioPEA Alliance (chickpea value chain)	Level 3 2006-2014	ICRISAT chickpea varieties released pre-project and added to over years; project reports, meetings, field days; publications	*Institutions:* Seed production and distribution system established seed grower associations; Functional extension services – 70,000 extension agents *Markets:* Good market access for excess seed; Local and export markets *Policies:* GoE very supportive included chickpea in five year strategy and in Ethiopian Commodity Exchange; GoE investing in seed systems and markets	TL II (BMGF)	Investment in small seed packets for distribution to farmers raised awareness of as well as promoted improved varieties; establishment of the multi-stakeholder platform EthioPEA Alliance was crucial in developing the chickpea value chain including farmers, seed producers, extension agents and QC actors, export grain aggregators; demand from both local and export markets drove increased production; conducive policies and support from GoE was crucial

Chickpea in Ethiopia*		Chickpea yields increased >2 t/ha; farmers more receptive to the value of improved varieties; system established for understanding end-user needs (both farmer and market) to inform development of new varieties; quality standards system established for both local and export grain	*Gender:* enhanced involvement of women through widows groups followed by couples to achieve gender equity in developing technologies	Seed companies	2014-present	Project reports; meetings; field days	Seed grower groups developed into seed companies with support from AGRA for sustainable seed systems; established a chickpea corridor	TL III (BMGF)	Scaling-up outputs and outcomes from TL II achieved more impact and built sustainable seed systems for chickpea in Ethiopia
Adoption and Ex-Post Impacts of Improved Cowpea Varieties on Productivity, Income and Poverty in Nigeria	2019	IITA and partners developed and promoted improved cowpea varieties that are high yielding, resistant to striga, alectra, and insect pests, and drought tolerant resulting in the release over 20 improved cowpea varieties in Nigeria since the early 1980's. Access to seed and information on improved cowpea varieties fostered; 42% of	*Climate change:* an environmentally friendly technology (drought tolerant and fix nitrogen) for poverty reduction *Gender:* farmers groups involved in community-based seed production included women *Capacity development:* initially with farmers groups which morphed	IAR & UAM, Nigeria	Level 3 1980's onwards, major effort from 2007	IITA cowpea varieties released pre-project and added to over years; project reports, meetings, field days; publications	*Institutions:* Strengthening of seed systems and involvement of seed companies increased from 50 to >300; *Markets*: Improved grain quality to meet market demands and good country-wide market access as well as export markets *Policies:* Nigerian seed laws revised to allow companies to produce foundation seed for certified seed production;	TL II & III (BMGF)	Investment in small seed packets for distribution to farmers raised awareness of as well as promoted improved varieties; Farmers willing to buy seed of profitable new varieties that meet market demands; GON reclassification of cowpea as a priority crop resulted in nation-wide increase in consumption of cowpea further fostering demand; Scaling-up outputs

		the farmers have adopted improved cowpea varieties resulting into a 26% increase in yields, 14% increase in production costs, 61% increase in net returns per hectare and 5% reduction in poverty incidence, equivalent to 930K people out of poverty.	into seed association, some of which became seed companies				National Seed Regulation body (NASC) concentrates on regulation and quality control; ECOWAS supported sale of cowpea seed between countries; GoN supported increased availability of inputs e.g. pesticides but no specific policies of support of seed systems		and outcomes from TL II achieved more impact and built sustainable seed systems for cowpea in Nigeria
Impacts of early maturing chickpea improved cultivars in Myanmar	2019	Early-maturing varieties enabled higher productivity with two sowing-harvesting cycles per year; production rose 4.8 times from 117,000 to 561,000 tons due to early maturing, disease and pest resistant, drought and heat tolerant and market preferred traits; productivity doubled from 712 kg/ha to 1544 kg/ha, over the	*Climate change:* an environmentally friendly technology (drought tolerant and fix nitrogen) for poverty reduction *Gender:* women participate in chickpea production and agricultural extension but greater male participation *Capacity development:* awareness	DAR & DoA, Myanmar	Level 3 1976-2018	ICRISAT chickpea varieties; project reports, meetings, field days	*Institutions:* Quality seed of high-yielding varieties produced and distributed using 430 Village Seed Banks; farmer to farmer seed exchange responsible for 90% of adoption; *Markets:* strong export market main driver *Policies:* GoM supports export crops such as chickpea; GoM has flexible approach to supporting diverse methods of seed	ICRISAT + link to ACIAR project MyPulses (2015-2018)	Extension service played critical role in creating awareness of improved chickpea varieties; public sector success has stimulated interest by private sector to become involved in chickpea seed production

		last 15 years. ICRISAT-related varieties cover 96% of chickpea area. The introduction and subsequent adoption of ICRISAT sourced early maturing chickpea cultivars generated economic benefits estimated at US$152.8 million.	courses and training in breeding, crop and seed production and IPM				production (Dutch funded project Integrated seed Sector Development – helping to create an enabling environment)		
Efficient Legume Seed Systems for Better Smallholder Farmers' Livelihoods in the Semi-Arid Tropics	2019	Tropical Legumes (TL) Projects together with precursor and complementary projects facilitated the development of 304 nutrient dense, climate-smart, farmer- and market-preferred varieties and the production of 397,050 t (t) of certified and quality declared seeds (QDS). TL III helped to scale out previous projects and seed was planted on about 4.4 million hectares (ha) by more than 22	*Climate change:* an environmentally friendly technology (drought tolerant and fix nitrogen) for poverty reduction *Gender:* gender responsive product profiles, women included in capacity development *Capacity development:* training in breeding, seed production and multiplication as well as 22 next generation	Over 100 public sector institutions and private sector companies	Level 2	ICRISAT groundnut (Tanzania), IITA cowpea (Nigeria) and CIAT common bean varieties; project reports, meetings, field days	*Institutions:* Quality seed of improved varieties fed into a multi-pronged strategy building partnerships between farmers, seed companies, governmental organizations and extension workers; training seed producers, marketers in technology and best practices through participatory varietal selection, on-farm demonstrations and mobile app-based advisories. *Markets:* Creation of market incentives through 55 multi-	TL I, II & III (BMGF)	Value of innovative partnerships linked to seed producer groups; need for quality control systems for development of QDS to attract the private sector; more effort needed to under market preferences

		million smallholder farmers in the 15 target countries and beyond, producing about 4.9 million t of grain worth US$ 2.6 billion. In Tanzania, groundnut area increased from 400 – 1.6 million ha and yields increased from 0.6 – 1.2 t/ha; in Nigeria, yields of cowpea increased from <0.5 to 1.1 t/ha by 2018	scientists (MSc, PhD)				stakeholder platforms *Policies:* GoT established Agricultural Seed Agency (ASA) to support multiplication of early generation seed for foundation seed and the Tanzania Official Seed Certification Institute (TOSCI) for supporting production of QDS; GoT promoted legume crops which were of limited interest to the private sector; Nigerian seed laws revised to allow companies to produce seed from foundation seed; ECOWAS supported sale of cowpea seed between countries; GoN supported increased availability of inputs e.g. pesticides but no specific policies of support of seed systems		
Impact of ICRISAT Pearl Millet Hybrid Parents Research	2018	Study of 563 pearl millet growers in Rajasthan,	*Climate change:* further intensification of farming systems	Public-private partnerships between	Level 3 2000-2010 (study);	Directly or indirectly ICRISAT pearl millet	*Institutions:* Private sector members support public sector members and	ICRISAT, PMHPRC	Private sector is strong in delivery and scaling – fostering rapid

Consortium (PMHPRC) on the Livelihoods of Farmers in India	Gujarat and Uttar Pradesh, India revealed that PMHPRC hybrids covered 60% of the pearl millet area in 2013-2014 providing at least 20% higher yields of grain and fodder. Total accrued benefits for the 3 states were $134 million annually with 1.5 million farm families and millions of consumers benefiting.	*Gender:* gender preferred traits included *Capacity development:* new tools and technologies shared with consortium members	ICRISAT and seed companies	PMHPRC continues past impact assessment and the model is being spilled over to ESA	varieties; meetings; field days; publications	provide funds; Seed availability from seed companies, traders, agro-dealers as well as public sector bodies; cost of seed to farmers reduced *Markets:* Local markets for grain and fodder facilitated by higher quality product *Policies:* GoI seed laws favourable to private seed companies; seed certification regulated and QDS favours seed companies and farmers	adoption; lessons learned have been spilled over to ESA for sorghum and pearl millet; lessons learned have led to the establishment of Crop Network Groups for several GLDC crops and Communities of Practice formed to identify capacity building needs

*Not part of OICR presented in AR **Further findings added beyond OIRC

Outcomes – major achievements; any unanticipated outcomes; Cross-cutting – gender/youth and capacity development; Maturity – time frame of activities (released variety to impact); Tracking outcomes – how were achievements monitored?; Enabling environment – institutions/partners, markets, policies; Funding – predictability of funding during period; Lessons learned – both learned and spilled over to inform other activities

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Annex 6b. "Deep Dive" On the Role Agri-food supply / Value Chains, and Wider Development Issues, play in the GLDC Program

1. INTRODUCTION

The Reviewers are required in their ToRs to conduct "deep dives on selected GLDC OICRs. This should : *focus on IDOs and sub-IDOs reported by the CRP, set in the programme's wider context. It should chronical the programme's engagement with cross-cutting issues, namely gender, youth, capacity development, partnerships and climate change, taking the programme's age and maturation into account.*

The GLDC OICRs for 2018 and 2019 are limited in scope. Almost entirely they focus on the CGIAR's traditional strengths of crop improvement / farming systems – mostly concerned, one way or another, with impact of breeding for improved seed traits, etc. Seed systems are therefore the subject of the first Deep Dive of the Review.

The CGIAR 2016 SRF and the original ToC / Impact pathway described in GLDC proposal (see below) aspired to a rather broader agenda than breeding for improved seed traits, arguing that while crop improvement / farming systems research is necessary, it is insufficient to fully meet the CGIAR higher level developmental outcomes. Thus, it was argued, that in the new generation of CGIAR CRPs it is important, inter alia, to include consideration of:

1. The agri-food-system as a whole and particularly agri-food supply and value chains.
2. Integrating socio-economic science, contemporary development practice and scaling partners.

Thus, for the second Deep Dive, the Reviewers considered the extent to which these (aspirational) issues:

a) were included in the GLDC ***planned*** activities,

b) were undertaken ***in practice*** and

c) ***impacted on the achievement of outputs*** of the programme including the impact on higher level developmental objectives.

2. ORIGINAL THINKING IN THE GLDC PROPOSAL ON THE ROLE AGRI-FOOD SUPPLY / VALUE CHAINS, AND WIDER DEVELOPMENT ISSUES WOULD PLAY IN THE PROGRAMME.

2.1 Theory of Change and Impact Pathways

The ToC as set out in the GLDC proposal, has two distinct impact pathways.

I. **Pathway One**, research will lead to ***household level*** outcomes by developing integrated technological, institutional and policy solutions with key partners. Inter-and transdisciplinary research will connect component solutions; notably improved varieties and hybrids (FP4, FP5), seed delivery systems (FP4), inclusive agribusiness models (FP2), modern agronomic practices (FP3), and policy platforms (FP1).

II. **Pathway Two**, GLDC will implement five mechanisms (see below) for ***"working with change agents"*** to address agri-food system-barriers and secure sustainable outcomes.

   a. GLDC informs the work of policy-makers, development NGOs and private sector actors by documenting realized and high-probability impacts from intervention scenarios.

   b. Linkages, partnerships, platforms and relationships across stakeholder groupings will contribute to improved governance arrangements and system capacities. This includes collaboration with multi-lateral organizations, such as the African Union and the Committee of World Food Security (CFS), lobbying and advocacy and engaging in institutional reforms.

   c. Capacity development leads to outcomes that can be repeated and strengthened, contributing to more responsive agri-food systems.

   d. Researchers develop general principles on how to strengthen the capacity of agri-food systems, e.g. through the development of inclusive investment mechanisms which can be applied to other contexts.

   e. Agri-food system change happens through replication of successful initiatives developed under the different FPs. Transformation will take place through incubated initiatives that gradually start changing institutions and discovering new markets.

Thus, in broad terms, the Reviewer's first Deep Dive will consider the GLDC's work that will drive the programme to deliver on impact at ***Household Level, ie Pathway One***, whereas the ***second Deep Dive*** will consider the ***second impact pathway*** which, as defined in the proposal, is dependent on the programme ***delivering outputs concerning agri-food supply / value chains, and wider development issues***.

2.2 Planned activities in original GLDC Flagship Programmes

2.2.1 Overview - Six Flagship GLDC Programmes

FP2 – *Transforming Agri-Food Systems* - was intended as the main instrument in GLDC where research on agri-food supply / value chains, and wider development issues would be undertaken. In addition, a role for work on agri-food supply / value chains, and wider development issues was also envisaged for FP1 - *Priority Setting and Impact Acceleration* – as this FP was designed to ensure **that *GLDC conducts inclusive, demand-driven research that responds to household and smallholder farmer needs, market demand and local and national priorities.*** The results of the activities under FP1 were to inform the activities under FP3, FP4 and FP5, giving them a wider value chain / contemporary development agenda focus. Although not in the original proposal, in 2019 a further FP was added to GLDC - Common Bean Production and Marketing in Africa (IBPMA). Work on this "new" FP in 2019 was to a large extent concerned with agri-food supply / value chains, and wider development issues, and as such it is very interesting to compare and contrast these activities with those planned/actually undertaken by the original GLDC CRP.

2.2.2 Detail - FP2 : Transforming Agri-Food Systems

The original GLDC proposal had very ambitious plans for FP2:

- *FP2 - Transforming Agri-food Systems - focuses on resolving challenges to enable, at scale, step-changes in the off-farm utilization of dryland cereals and grain legumes. FP2 will address these challenges by making use of decision support/modelling tools, big data analytics, business engagement and incubation processes, systems and institutional analysis tools and, in collaboration with FP1, evaluation and learning approaches.*
- *Critical in considering the enabling environment of GLDC agri-food systems, FP2 must partner with businesses, NGOs, civil society and other stakeholders. Gaining mutual ambition and investment of enacting and scaling partners is essential for the realization of crop utilization opportunities and the potential of these to be catalytic in driving wider agri-food systems transformation.*

2.2.3 Detail – FP1 : Priority Setting and Impact Acceleration

This FP, overall, was designed to undertake ex-ante and ex-post analyses to inform and direct the focus of other GLDP FPs. Thus, specifically in the current context, FP1 CoA 1.2 (*Value Chains, Markets and Drivers of Adoption*) focuses on the analysis of:-

a. *local, regional and international market demands for GLDC products and their characteristics;*

b. *input and output value chain effectiveness at national and regional scales; and*

c. *household preferences for new technologies and practices within their wider on- and off-farm livelihood systems. The value chain framework and the structure-conduct-performance approaches were thus designed to be used to identify key constraints and opportunities along the chain aiming for increased competitiveness in production, marketing and processing.*

The key clients for these outputs were FP2 Transforming Agri-food Systems, FP3 Integrated Farm and Household Management and FP4 Variety and Hybrid Development.

In addition to FP1 CoA 1.2 and FP1 CoA 1.4 (*Enabling Environments and Scaling to Accelerate Impact*) was also designed to undertake research relevant to agri-food supply / value chains, and wider development issues based on the premise that:

- *successful scaling of any technology requires a detailed understanding of the drivers of, and constraints to, adoption at the household and farm level.*

Thus, planned under FP1 CoA 1.4 were studies of the often heterogeneous target group(s) for GLDC research outputs, their livelihood systems and the factors impacting on successful scaling of "technologies". This to include:

- *analysis of target group segregation within the continuum of market- and subsistence-oriented farmers,*
- *deepening understanding of the end-user's demands for product and technology attributes and resulting benefits, and*
- *what makes an effective technology an attractive one for rural households and value chain actors.*

2.2.4 Detail – FP3 Integrated Farm and Household Management

In reviewing the FP3 proposal for how the flagship authors took matters related to agri-food systems, value chains, wider development issues, etc into their thinking, the Reviewers found the following (fairly) representative extracts from the text :

- *Smallholder farming systems need to intensify if they are to feed the increasing human population without compromising natural resources.*
- *The FP3 goal is to capacitate stakeholders such that they can improve the productivity, profitability and sustainability of smallholder farming systems using on-farm and in-household innovations to ensure household nutritional security and enhanced income generation through integrated crop, tree and livestock production systems*
- *The purpose of FP3 is to understand and support farming systems transitions to accommodate GLDCs in response to growing market demand.*
- *Capitalizing on existing knowledge on IPM, intra- and intercropping and improved farmer's system management practices, this FP additionally strives toward closing yield gaps and diversifying crop productions for balanced diets through improved agronomic and animal husbandry practices by taking a farming system perspective.*

Market demands are mentioned in these extracts but mostly they refer to a need to focus on reducing yield gaps and increased productivity – all very important targets and essential parts of the CGIAR SRF 2016 – 2030, but as stated in this SRF, they are necessary but likely not to be sufficient if wider contemporary development targets are to be achieved.

2.2.5 Detail - FP4 Variety and Hybrid Development

The proposal for FP4 is perhaps a little ambiguous concerning the appetite within the FP to focus on agri-food supply / value chains, and wider development issues in addition to their more traditional priorities of crop improvement.

The purpose of FP4 as set out in the proposal (*generate crop improvement innovations that catalyse productivity and production increases through modern varieties and functional seed systems, thereby enhancing food and nutrition security, market competitiveness and farming system resilience)* certainly mentions enhancing food and nutrition security and market competitiveness.

And similarly, the FP4 proposal prioritized four trait clusters, (ie *1. productivity improvement that targets genetic gain, grain yield and resilience traits; 2. resource-use efficient and crop architecture traits; 3. traits demanded by markets, focused on user preferences for nutritional quality, post-harvest handling and value addition; and 4. traits that support agri-food system performance, most critically in enhancing the role of GLDC crops as feed/stover/forage for livestock,* two of which focus really clearly on agri-food supply / value chains.

However, in other parts of the proposal text, the thrust is rather back to the more traditional CGIAR approach based more on a linear / increased productivity approach. See for example: *Resilient varieties and hybrids of GLDC crops, it is argued, together with enhanced access through strengthened seed systems will significantly contribute to inclusive livelihood opportunities for smallholder agriculture and improved economies through higher productivity, market-oriented products and entrepreneurship.*

FP4 crop improvement activities (and the FP5 activities that feed into FP4) are also framed by Product Profiles emanating from FP1 CoA 1.2. These Product Profiles are designed to capture key GLDC crop attributes concerning economic returns, poverty reduction and nutrition. They are desk based ex-ante studies.

2.2.6 Detail – FP6 : Improving Bean Production and Marketing in Africa

The rationale behind the inclusion of FP6 on beans into GLDC is complex. It seems that a project entitled "Improving Bean Production and Marketing in Africa" (IBPMA) has been the subject of a successful collaboration between CIAT and Canada for many years. IBPMA is an interesting and well developed programme working with the agri-food-system as a whole and particularly agri-food supply and value chains. In this respect, it has a very different rationale from the rest of the GLDC CRP. It was added to GLDC CRP in 2019 and is being implemented across 31 countries in Africa by members of the Pan Africa Bean Research Alliance (PABRA).

Despite the Improving Bean Production and Marketing in Africa Project (also referred to in GLDC documentation as "Common Beans for Markets and Nutrition") being included in the GLDC AP for 2019, a new and much wider in scope FP proposal, "Strategic and applied research to meet the demand of beans in Africa and Latin America (a Common Bean Flagship)" seems to have been agreed and added to the GLDC CRP in May 2020. The story behind this somewhat confusing state of affairs is given in the Background Chapter of the new Common Bean GLDC FP proposal. The conclusion of this chapter is as follows:

"The System Management Board (after their December, 2017 meeting) requested that CIAT develop a proposal for a common bean flagship research programme and the optimal location of that work. In this context, the Directors of CIAT and GLDC, in consultation with the System Management Office, agreed to a new mode of collaboration. GLDC will host the flagship on common bean, building on residual synergies with other legumes in a relationship of alignment and complementarity to existing flagships, while respecting the dryland systems focus of the CRP GLDC".

3. WHAT ACTUALLY HAPPENED DURING 2018 and 2019 ON THE ROLE AGRI-FOOD SUPPLY / VALUE CHAINS, AND WIDER DEVELOPMENT ISSUES PLAYED IN THE PROGRAMME ACTIVITIES?

3.1 FP2 : Transforming Agri-Food Systems

Despite the best endeavours of the authors of the 2017 GLDC CRP proposal, FP2 was not allotted WI/W2 (ie core CGIAR) funding when the programme was approved. This rather tears the heart out of the right hand side (Pathway 2) of the GLDC Impact Pathway and severely constrains the application of the associated ToC. The consequences of this are discussed in the following sections related to the work of the remaining 5 GLDC FPs.

3.1.1 New cross cutting programme - Markets and Partnerships in Agri-Business (MPAB)

In an attempt to mitigate the consequences of this absence of funding for FP2, a project entitled: Markets and Partnerships in Agri-Business (MPAB) led by the previously designated CSIRO FP2 programme leader, was established as a cross cutting programme. In 2019, MPAB explored emerging market opportunities through a portfolio of scoping studies with stakeholder engagement, as a pathway to develop and pitch for new funding proposals. Underpinning this work appears to be a conceptual framework being developed in collaboration with FP1. This is based on *exploring the narratives and evidences around value chain interventions, forming the basis for a science agenda around markets and partnerships, as well as a way of framing design interventions in this domain*. Progress on the scoping studies to date includes:

- Implications of Kenya's sorghum and millet composite flour policy
- Future studies on GLDC crops as functional foods
- Neighbourhood / food movement effects as a potential mechanism to change food habits
- A pilot study on sorghum fodder enterprises

The funding requested for the original FP2 research for the year 2019 was $12.3 million. The actual spend on MPBA in 2019 was $1.8 million. Thus, this cross-cutting programme only compensates in small part for the absence in the CRP as a whole of FP2.

3.2 FP1 - Priority Setting and Impact Acceleration -CoA 1.2 and CoA 1.4

FP1 CoA 1.2 concerns ***Value Chains, Markets and Drivers of Adoption*** and CoA 1.4 concerns ***Enabling Environments and Scaling to Accelerate Impact.*** As described below, useful and very relevant work for the GLDC overall has been undertaken in both these CoAs. However, the focus and potential usefulness lies more on integrating socio-economic science, contemporary development practice and scaling partners than on agri-food-systems. Although, as noted in Section 2.2.1 of the main report, the findings of the former would be of direct relevance to future work on the latter.

In more detail:

- Research under FP1 CoA 1.2 concerned:
  - "aspirations" and "drivers" behind "farmers" strategies for improved livelihoods.
- Research under FP1 CoA 1.4 concerned:
  - a review of an existing GLDC scaling framework which was found to be useful but not a practical guide to the realities of scaling with relevance beyond the GLDC CRP. Significantly, it proposes that an approach that takes a wider agri -system perspective should be adopted.
  - a review of 18 previously published impact studies of GLDC crops with the conclusion broadly that the empirical evidence base for the wider claims that increased yield in GLDC crops has a positive impact on improved livelihoods, nutrition etc is poorly identified and incomplete.
  - the development of a CRP wide impact evidencing working strategy designed to set in train a means of credibly and practically evidencing the extent to which the GLDC CRP has, or will, meet its stated development targets.

3.3 FP3 : Integrated Farm and Household Management and 4 : FP4 Variety and Hybrid Development

FP3 and FP4 (and by association FP5) crop improvement activities were framed in the original CRP proposal by the notion that through FP2, such activities would be driven by better understandings of the ***"market", "value chain", "customer requirements",*** etc. With the non-funding of FP2, this was not possible to the extent originally envisaged and the very important outputs of these FPs have thus been more focused on more traditional aspects of the CGIAR mandate ie, yields, economic returns, etc. This is not to diminish the important role that the Product Profiles emanating from FP1 CoA 1.2 play in the work of FP3, FP4 and FP5, but these profiles, based on ex-ante studies, starting with economic matters and then expanded to capture key poverty and nutritional attributes of GLDC crops, whilst useful, cannot substitute for a concentrated and dynamic focus on the agri-food system as a whole.

3.4 FP6: Improving Bean Production and Marketing in Africa

The initial bean programme, Improving Bean Production and Marketing in Africa (IBPMA), the progress of which was reported in the GLDC 2019 AR, has a distinctive value chain / bean corridor approach working across Africa. The programme has been running for a considerable time, under one form of governance or another, has worked well and it has been found to have the potential to generate significant economic benefits for poor people. The successful national and regional value chain approach has much in it to commend. This is potentially even more the case for the latest full Common Bean FP proposal added to the GLDC from May 2020. It is much broader in scope than IBPMA including, for example, work in Latin America, but also focuses sharply on post-harvest and value chain issues. In addition, it includes in its ToC an innovation platform approach and has a clear philosophy of subordinating the role of the CIAT (the implementing agency) to that of local partners/NARs. There is considerable potential for cross fertilisation of ideas here between the new Common Beans FP and the rest of the GLDC

4. UNDERSTANDING THE RESEARCH WITHIN THE GLDC PROGRAMME ON ISSUES CONCERNING FARMER ASPIRATIONS, SCALING UP AND MEETING GLDC DEVELOPMENT TARGETS

4.1 Overview

Included in GLDC's 2018/2019 GLDC research outputs under FP1, there are a number of high quality reports of activities designed to help address some fairly fundamental questions concerning the underpinning rationale behind the GLDC CRP and its ToC. These include:

- Does the GLDC approach to design, targeting and dissemination of agricultural research at farmer household level, fully meet their actual aspirations?
    - Historically, most agricultural researchers have implicitly assumed that farming households simply want to maximize returns or outputs from their agricultural activities. This neglects the fact that most "farming" households have in fact multiple income streams which demand their attention. Would properly designed research to understand household aspirations lead to a reassessment?
- Is the GLDC scaling framework a useful and practical guide to the realities of scaling up?
    - Achievement of developmental impacts at scale is at the heart of the GLDC CRP. However, historically, low adoption rates of new technologies by smallholders farmers is a major challenge to the relevance of the work of the GLDC. A GLDC scaling framework currently exists. To what extent is it a useful and practical guide to the realities of scaling with relevance to the CLDC CRP and beyond?
- Does empirical evidence exist on the role that GLDC crops can play in the achievement of sustainable development targets through intensification of smallholder agriculture?
    - Although in experimental settings GLDC crops can be shown to contribute to the sustainable intensification of smallholder agriculture (ie higher yields, increased drought/disease resistance, greater marketability, better nutrition etc) in sub-Saharan Africa and South Asia, does empirical evidence exist to support this finding when the crops are actually grown in farmers' fields?

4.2 Summary of GLDC's 2018/2019 GLDC research outputs on these questions

4.2.1 Farmers Aspirations

In sub-Saharan Africa, rural development and poverty alleviation is the primary focus of policy agendas. One of the main paradigms supporting this trajectory has been to see agriculture in predominantly agrarian societies as a key pathway out of poverty. Rural economies and smallholder farmers typically derive a substantial portion of their livelihoods from this sector. To date, conventional development paradigms have focused on the adoption of profitable farm technologies but adoption rates have been below expectations. This GLDC research suggests that a fundamental reason for this is due to a limited understanding of the varying aspirations amongst different generations of farmers. The results clearly show that there is a strong correlation between aspirations and technology adoption decisions. Potential end-users are more inclined to invest resources into agriculture technologies if their aspirations are aligned with developing farming as their main livelihood strategy. The study also indicates pronounced generational differences in aspirations between elders and youth in the same communities. The findings indicate that the current rural development trajectories strategies founded only on agricultural development need to be revisited, particularly in the context of responding to the aspirations of a growing and increasingly significant young rural population.

4.2.2 GLDC scaling framework

The objective of GLDC is to achieve adoption of it technologies at scale in the semi-arid environment. The programme has developed a scaling framework. The utility of this framework was tested using case studies of four large scaling projects. The study found that the framework was useful because it provided a systematic way to review the design of the projects and their scaling methods but also highlighted potential design flaws as well as opportunities for testing alternative scaling methods. The framework was less useful for evaluating project performance. Although poor performance may be the result of poor design, it may also be the result of factors beyond the project's control. Rather than use the framework to adjudicate 'success' or 'failure' the framework is more useful as a springboard for systematic learning from project experience and ensuring that these lessons are incorporated in the design of future scaling

projects. The case studies exposed some gaps in the framework. One is the need to situate the framework in its wider context, as the product of a theory of change based on the transition from subsistence to commercial agriculture. Another gap is insufficient attention to process, specifically partnerships and gender.

To realise its full potential, however, the framework needs to be developed into a scaling toolkit. This toolkit would set the framework in context, explain the individual components in more detail, suggesting questions to ask about the content of each component, include cross-cutting processes like partnerships and gender. It should also give concrete examples of how the framework might be applied in practice to scaling projects.

4.2.3 Empirical evidence on GLDC crops and sustainable development targets

Although GLDC crops hold potential to intensify smallholder agriculture and improve livelihoods in semi-arid regions of sub-Saharan Africa and South Asia, only 18 previous studies since 2012 were identified to assess the empirical evidence base for these potential benefits. Results from the synthesis revealed that there were only five reasonably well-identified adoption studies and these estimated significant, positive effects of improved GLDC adoption on yields, profits, or household welfare. Another, well-identified study focusing on nutritional impacts of improved GLDC consumption, measured positive effects on iron-deficiency in school children. Macro-level welfare estimates based on economic surplus models (eight of the 18 studies) were largely invalidated because of their dependence on poorly-identified household-level impact estimates. Four additional studies relied only on correlations and expert interviews. Overall, the impact studies focused on chickpea and groundnut, as opposed to other GLDC crops. Studies were geographically concentrated in Ethiopia, India, and Tanzania, and heavily focused on estimating economic impacts, with few studies assessing potential environmental, nutritional or social impacts.

The study concluded therefore that future studies should focused on nutrition and environment issues and may need to borrow methodological approaches from the health and environmental assessment literatures. Assessments of the social impacts of holistic farm- interventions (which may include promotion of improved GLDC crops as a component) should also be undertaken and include analyses of intra-household bargaining, farmers' aspirations and livelihood strategies and migration.

Finally, the researchers offered the following thought:

- *Impact studies that estimate positive results may ensure continued financial support from governments and donors such that researchers may feel significant pressure to arrive at findings favorable to specific programmes or projects. At the same time, the utility of impact assessments arises from their reliable identification of what is working and not working in the field. Thus, it is of the utmost importance that researchers be encouraged and enabled to conduct impact assessments free from internal or external pressures and interests. The objective of impact assessment should be to establish an evidence base that informs policymaking – not to confirm or legitimize favoured programmes.*

4.3 Conclusions

The above studies, undertaken under the auspices of FP1 - Priority Setting and Impact Acceleration – seem to shine a light on the mind-set of earlier, more traditional, crop improvement / farming systems GLDC research. It seems that in addition to a lack of consideration of aspects of the wider agri –food system in previous/current GLDC research, some broader issues such as integrating socio-economic science, contemporary development practice and inclusion of scaling partners, alluded to in section 1 above, are also not prominent.

5. IMPACT ON THE PROGRAMME OF INCLUSION (OR EXCLUSION) OF AGRI-FOOD SUPPLY AND VALUE CHAIN, AND WIDER DEVELOPMENT ISSUES ON SUCCESS OF THE PROGRAMME

Much of the work in FP1 on priority setting and impact acceleration encompasses the spirit of these new paradigms described in Section 1. However, for FP3 and FP4 (and FP5 where it is perhaps rather less relevant) the 2018/2019 ARs and other sources of information analysed often appeared somewhat diffident about agri-food supply/value chains, and wider development issues preferring to fall back on the more general traditional CGIAR strengths of "increased productivity". Undoubtedly, the absence of funding for FP2 has not helped as had GLDC included a vibrant FP enthusiastically advocating for more focus on agri-food systems as originally planned, it would have provided valuable input to FP3 and FP4, extending their involvement with agri-food systems.

What has the impact of this been on the research outputs and developmental impact of GLDC over the last two years? Many useful outputs have been produced by the FPs and these have, and will continue to have, developmental impact. However, would the (long term) developmental impact have been greater if a broader agenda including issues related to agri-food supply and wider development issues, been widely adopted? Of course, it is not possible to tell empirically but current developmental thinking, including that written into the 2016 CGIAR SRF, would seem to suggest it might have done.

The decision not to fund FP2 therefore has had a major impact on the nature of GLDCs research and potentially the nature, and extent, of its developmental impacts. It has resulted in GLDC continuing to perform well, broadly as a conventional CGIAR commodity breeding/farming system programme rather than as a programme serving the agri-food system as a whole and integrating socio-economic science, contemporary development practice and scaling partners into its work.

6. CONCLUSIONS AND LESSONS LEARNED

The 'deep dive' required an assessment of: a) progress along ToC and IP and b) achievement of the CRPs IDOs and sub-IDOs. The concept was that these assessments would relate to selected OICRs at stage 2 or 3 of level of maturity. For reasons explained above, a different approach was agreed for the current "Deep Dive" in that the focus was on how a cluster of issues considered important in the original GLDC proposal and in the 2016 SRF, were followed through in the subsequent programme activities.

The GLDC is only in its third year and still evolving. A new expanded common bean FP has been added. So while accepting that it is still early days for the programme, it seems that the new paradigm for the Phase II CRPs as encapsulated in the original GLDC proposal and in the 2016 SRF, is not yet prominent in FP3, FP4 and FP5. The 2016 SRF said it ***was going to be difficult****,* take more time and need reskilling if the CGIAR was going to move on from its traditional strengths such as commodity breeding programme to adopting a systems-approach. This, indeed, seems to be the case.

Annex 7: Conflict of Interest statements

Annex 1 - Conflict of Interest Statement

1. Main employer and any other organization that provides you with remuneration (which may be named participants in the project/program/proposal you are being asked to review/evaluate)

   Please provide details: None

2. Are you aware whether a relative, close friend, close colleague or someone with whom you have financial ties is receiving funding from or giving advice to a project/program/proposal you are being asked to review/evaluate?

   No

   If Yes, please provide brief details:

3. Does any project/program/proposal you are being asked to review/evaluate cite any of your own current research?

   No

   If Yes, please provide brief details:

4. Does any project/program/proposal you are being asked to review/evaluate name researchers with whom you have active collaborations, recently published joint papers or are in regular email correspondence?

   No

   If Yes, please provide brief details:

5. Does any project/program/proposal you are being asked to review/evaluate name any of your past PhD students are active participants?

   No

   If Yes, please provide brief details:

Declaration: I declare that the information provided on this statement is true and complete.

Name: Jillian Lenné

Signed:

Date: 8th April 2020

v1 dated 13/01/2020 3

CGIAR Advisory Services

Annex 1 - Conflict of Interest Statement

1. Main employer and any other organization that provides you with remuneration (which may be named participants in the project/program/proposal you are being asked to review/evaluate)

   Please provide details: NONE

2. Are you aware whether a relative, close friend, close colleague or someone with whom you have financial ties is receiving funding from or giving advice to a project/program/proposal you are being asked to review/evaluate?

   Yes/(No)

   If Yes, please provide brief details:

3. Does any project/program/proposal you are being asked to review/evaluate cite any of your own current research?

   Yes/(No)

   If Yes, please provide brief details:

4. Does any project/program/proposal you are being asked to review/evaluate name researchers with whom you have active collaborations, recently published joint papers or are in regular email correspondence?

   Yes/(No)

   If Yes, please provide brief details:

5. Does any project/program/proposal you are being asked to review/evaluate name any of your past PhD students are active participants?

   Yes/(No)

   If Yes, please provide brief details:

Declaration: I declare that the information provided on this statement is true and complete.

Name: R. G. POULTER

Signed: R G P

Date: 16/4/20

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