Advisory Services

CGIAR Research Program 2020 Reviews: MAIZE Annexes

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Annex 1: Terms of Reference for the CRP2020 Review, Addendum

Links to CRP 20202 Reviews TOR and Addendum[1].

Annex 1.1: Call for Expressions of Interest CRP 2020 Reviews of Quality and Effectiveness

Deliverables and consultation for the CRP Review (pp.9-10 of the ToR attached)

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.

[1] Accessed September 25, 2020

Annex 1.2: Addendum to the Terms of Reference & Call for Expressions of Interest, June 2020

The CAS Secretariat has made the following modifications to the Terms of Reference (TOR) and Call for Expressions of Interest, for the CRP 2020 Reviews of Quality of Science (QoS) and Effectiveness.

Please note: (i) the independent reviewers for CRP reviews that will begin in August (see Annex I for the working schedule) will be selected by the first week of July, and (ii) the overall deadline is 15 July 2020 for submission of expressions of interest for the CRP 2020 Review.

Methods. The proposed surveys of CRP researchers, partners, and donors have been removed from the CRP 2020 Reviews. The sample frame of respondents for these surveys was considered to be smaller than anticipated, thereby limiting the value of quantitative data collected from the surveys. Given the extensive qualitative methods (primarily key informant interviews) already applied to the same pool of respondents, the value of the surveys was determined to be questionable. Further, the burden on respondents was considered excessive, and a higher value is placed on the in-depth qualitative interviews. Considering the limited value addition of the proposed surveys and the burden on respondents, CAS has removed the surveys as a method for the reviews.

Establishing contributions to Intermediate Development Outcomes (IDOs). Links between the outcomes (documented as milestones) from the CRPs and the CGIAR Strategic Results Framework will be examined at the sub-IDO level, not the IDOs themselves.

Data sources. CRP performance data will be drawn from the Plans of Work and Budget (POWBs) and Annual Reports for the period under review, with supplementary information from the CGIAR result dashboard. The CAS Secretariat supports the reviews by providing to the review teams dashboard data pre-analyzed by CAS, the CRP internal monitoring, and the POWB and annual reports, to allow the review team to make quantitative assessments of performance. The dashboard data will also be used in conducting a 'deep dive' of selected CRP outcomes (OICRs).

Knowledge management. The review team will be responsible for uploading and storing its original data, analysis, and drafts on the secure online content site (SharePoint) provided by the CAS Secretariat, as a basic step in knowledge management for the review.

Analytics support. The team will also need to adhere to timelines for accessing technical consultants made available by the CAS Secretariat, e.g., for quantitative analysis of performance data.

Distribution of effort within team. The two members of each review team (subject matter expert and senior evaluator) are each allocated 39 days for execution of the work, over the 11-week period. An additional two days are allocated to the team member who takes on the team leadership role. The team leader will also commit to responding to any questions or need for clarifications that arise from copy editing of the final report.

Further notes to interested consultants:

Consultants who have already submitted their expressions of interest have been logged in the CAS consultant database and do not need to re-submit their documents. Short-listed candidates will be contacted as preparations for the CRP reviews are made.

Consultants who wish to apply should indicate their expertise and availability in relation to the nine CRPs that are scheduled to be reviewed between August and December 2020. The reviews of three CRPs (A4NH, GLDC, and Wheat) have already started.

Annex I: Working schedule of CRP 2020 reviews

CGIAR Research Program (CRP)	Type	Review period
Grain, Legumes and Dryland Cereals (GLDC)	Agri-Food System	Apr-Jun
Wheat	Agri-Food System	Apr-Jun
Agriculture for Nutrition and Health (A4NH)	Global Integrated Program	Apr-Jun
Forests, Trees and Agroforestry (FTA)	Agri-Food System	Aug-Oct
Livestock	Agri-Food System	Aug-Oct
Climate Change, Agriculture and Food Security	Global Integrated Program	Aug-Oct
Fish	Agri-Food System	Sep-Nov
Maize	Agri-Food System	Sep-Nov
Water, Land and Ecosystems (WLE)	Global Integrated Program	Sep-Nov
Rice	Agri-Food System	Sep-Dec
Roots, Tubers and Bananas (RTB)	Agri-Food System	Sep-Dec
Policies, Institutions, and Markets (PIM)	Global Integrated Program	Sep-Dec

Note: this working schedule may be modified. When submitting an Expression of Interest, consultants are advised to indicate a range of dates for which they are available for conducting the reviews. The schedule for all 12 reviews spans April to December 2020, with an anticipated during of 11 weeks for each review. The final three reviews will begin in late September, to conclude by mid-December.

Annex 2: Approaches, Principles, and Data Collection and Analysis Tools.

Annex 2.1: Approaches and Principles

For this review the team followed a mixed-methods approach, combining quantitative and qualitative evaluation approaches. This allowed for triangulation and ensured rigor. A utilization-focused approach was also taken in which the CRP Program Manager and/or the CRP MEL unit lead joined many of the interviews. This allowed for co-learning for all concerned. review/evaluation. The team operated in a consultative manner (both within and beyond the review team), was respectful of stakeholders' wishes and their time constraints, and maintained independence.

Annex 2.2: Data Collection and Analysis Methods and Tools

Qualitative Methods

a) *Document review***.** Key documents that were reviewed included the Phase II CRP Proposal and annexes such as the Gender, Youth and Capacity Development Strategies therein, the ISPC response to this, the MAIZE Management Handbook, the MAIZE Results-Based Framework, ARs, POWBs, M-MC minutes, ISC minutes, policies and processes for QA of science, selected project documents, and selected outputs for the 2017-2019 period. In addition, the team reviewed the cross-cutting IEA evaluations of gender in CGIAR research, and of capacity building. The full list of documents reviewed is in Annex 2.

b) *Semi-structured interviews (SSIs).* Following the initial document review, the team proceeded to arrange for (with the help of the CRP PMU), and run a number of SSIs. The purpose of these was to gain greater understanding of processes, outputs, and outcomes and to cross-check our findings from the review of documents and data. We interviewed the following categories of stakeholders: From within the CGIAR: CRP management including members of the M-MC and FP leads from both CIMMYT and IITA. From within and beyond the CRP we interviewed ISC leadership and project leads for OICRs/projects for which we conducted focused reviews. In relation to these, we also interviewed selected donors, partners, and a range of next-users e.g. from the public sector, private sector, and civil society. Annex 4 provides the full list of those interviewed and in which capacity. The review team shared the topics they planned to cover in each interview with the interviewee in advance, along with an explanation of how the findings would be used and the interviewee's right not to respond if they did not wish to. In practice, all interviewees cooperated. Below is an example of the introduction provided and an outline of topics the team hoped to cover (from an interview about STMA with Mwansa Kabamba, maize breeder and maize breeding program coordinator at Zambia's ARI).

Figure 1. Example of introductory note and questions shared in advance with an interviewee

Introductory note and outline of areas we hope to cover during our interview

Interviewee: Mwansa Kabamba

Interviewers: Michel Ragot and Rachel Percy (Review team for MAIZE CRP review)

Date:

We (Michel Ragot – team leader and subject matter expert, and Rachel Percy – evaluation specialist) have been contracted to carry out a "light touch" review of the MAIZE CRP for the CGIAR Advisory Services (CAS) through Biodiversity. The review is focusing on the Quality of Science and the Effectiveness of the CRP. We started on this contract in early September with orientation by the CAS and the CRP and since then have been carrying out document review and interviews and have selected a few projects which we are exploring in a little more depth. One of these is STMA.

To this end we would like to thank you for making time to speak with us, we very much appreciate it and look forward to our discussions. Please note that the interview is entirely voluntary. You can choose to stop at any time or to skip any questions that you do not want to answer. Your interview responses are confidential and will only be shared among ourselves (Michel - team Leader and Quality of Science expert, and Rachel - evaluation expert) for analysis. If there is anything you prefer for us not to note down, then just say so as we go along.

While we aim to use information and perspectives that you provide, in the report we will not link these to your name. Your name will only be listed as a person that we interviewed, in the report annex. At the start of our interview please indicate if you are OK with the above and consent to the interview.

Questions we hope to cover

1. How did your ARI engage in STMA?
2. What national partnerships did you have?
3. Did the performance level of the varieties released by the project meet expectations in terms of stress tolerance, yield, farmer preference? Did you receive enough and adequate information about released varieties?
4. How did you ensure that the new stress-tolerant maize varieties reached farmers?
5. Can you comment on the product profiling process? Were you involved in designing specifications of how improved varieties should look like (product profiles)? If so, how (workshops, written input, objectives validation)?
6. Did you take into account any gender considerations when developing and promoting new varieties? If so, can you elaborate?
7. Is there anything that your ARI learned from its engagement in STMA that has been applied in other work the ARI is doing?
8. Did you receive any capacity building from STMA, if so, please elaborate? And did your ARI provide any capacity building or awareness raising e.g. for extension and or for seed companies (if so, please elaborate)
9. Are you familiar with the gender-responsive tools, frameworks, and manuals developed by STMA? If so which ones and how have they helped you/how have you used them?
10. Are there any points you would like to raise about STMA with us that we have not covered?

The timeframe allocated by CAS to the review team was limited. The review team decided to start interviews only after having acquired sufficient understanding of the CRP in order to be in a position to conduct the most relevant possible interviews and in the most informed manner. The team felt that this was particularly important when interviewing non-CRP team members. Input about the CRP's relationship with next-stage users was obtained from a limited number of such next-stage users and from independent externals with a deep and long-term understanding of the CRP, such as ISC members and donors. The review team felt that these individuals could provide a good overall understanding of the CRP's relationship with next-stage users, more so than very few next-stage users sampled based on time constraints.

c) "*Deep Dive" case study method to be applied to OICRs and large projects***.** Whilst the TORs called for such "deep dives" in practice the team, rather, carried out **focused reviews** of three CRP projects: STMA, MasAgro, and those related to MLN. The first two of these are OICRs no's 3332 and 3321 and MLN is not yet an OICR. Criteria that were used to select the two OICRs included: Level of maturity, focus, geographical spread, availability of partners. The team chose to also review MAIZE's response to the MLN threat as an example of how the CRP was able to respond quickly and effectively to address an emerging threat. The focused reviews were carried out in a similar way to the wider review process involving document review and interviews, but they allowed for exploration of review questions at the project rather than FP and CRP level. The team also "observed" the participation of the CRP Director in a USAID Agrilinks Webinar on 21.10.20 in which he made a presentation and answered questions on MAIZE's actions on MLN.

Quantitative Methods

The review team used data from bibliometric and Altmetric analyses of journal publications, technical publications, germplasm or digital outputs, ARs, POWBs, and Dashboard data pre-analyzed by CAS to conduct limited quantitative analysis. Whenever relevant, results were used to establish findings, analyze them, and draw conclusions. Quantitative analyses, however, were generally less informative than qualitative analyses and have therefore only been of secondary importance when establishing findings and drawing conclusions.

Data Analysis

The team devised a data management tool. Based in excel it allowed for sorting and recording of findings from all documents and all interviews against the evaluation questions, sub-questions, and areas to cover as outlined in the Review Guidelines. This provided a good foundation for subsequent reviewing all the findings around each specific area, and for identifying gaps in findings so that these could be subsequently explored through further document review and interviews where possible.

Quality Assurance

The team had an internal process whereby we commented on and reviewed findings related to specific areas and ensured that there were no contradictions or any points that any one of us did not agree with. CAS ensured further quality assurance through joint review/team CAS use of the CAS quality assurance template at the mid-point check-in and at the point of submitting the draft and final reports. CAS also secured an external reviewer, Rodomiro Ortiz (Faculty Professor and Chair of Genetics & Plant Breeding, VF Plant Breeding Division Manager; Swedish University of Agricultural Sciences (SLU), Department of Plant Breeding) to provide valuable feedback to the review team.

Annex 3: List of Documents Reviewed

Annex 3.1: General Documents

Beyene T. Mainstreaming DNA FP for varietal tracking in Ethiopia. Technical, financial, and institutional feasibility assessment. Commissioned by CIMMYT

BMGF (2016) Stress Tolerant Maize for Africa (STMA). Grant Proposal Narrative

BMGF (2020) Stress Tolerant Maize for Africa (STMA). Final Project Narrative

BMGF (2016) Understanding and preventing seed transmission of maize lethal necrosis (MLN) in Africa. Grant Proposal Narrative

BMGF (2020) Understanding and Preventing Seed Transmission of Maize Lethal Necrosis (MLN) in Africa. Final Project Narrative

CGIAR Research Program 2020 Reviews: A4NH

CGIAR Research Program 2020 Reviews: GLDC

CGIAR Research Program 2020 Reviews: WHEAT

CGIAR-IEA (2017) Evaluation of Gender in CGIAR – Volume I, Evaluation of Gender in Research. Rome, Italy: Independent Evaluation Arrangement (IEA) of CGIAR

Chassaigne A (2016) Programa MasAgro en México: Éxito en Asociaciones Público-Privadas. Presentation to "VII Congreso Venezolano de Mejoramiento Genético y Biotecnología Agrícola" – Maracay, Venezuela; July 13-15, 2016

Child K (2019) Review of sustainable intensification monitoring and evaluation and inventory of associated indicators and data. Commissioned by CIMMYT

CIMMYT Agenda Global Maize Program Workshop on Maize Product Profile-based Breeding and Varietal Turnover in Eastern Africa - ICRAF Campus, Nairobi; August 29-30, 2019

CIMMYT Agenda Global Maize Program Workshop on Maize Product Profile-based Breeding and Varietal Turnover in Southern Africa - Cresta Lodge, Harare, Zimbabwe; October 21-22, 2019

CIMMYT Agenda Global Maize Program Workshop on Maize Product Profile-based Breeding and Varietal Turnover in Latin America - El Batán, Mexico; Oct 30-31, 2019

CIMMYT Annual Reports 2018, 2019

CIMMYT Diagnostics and management of MLN, Project Brief

CIMMYT Global Maize Breeding Program, CIMMYT: Current Status and Vision to Continually Improve Genetic Gains

CIMMYT Global Priority Market Segments - CIMMYT Maize Breeding Program

CIMMYT Informe sobre el consorcio de semillas de MasAgro Maíz 2019

CIMMYT Maize Product Profiles: Eastern Africa (EA-PP1, EA-PP2, EA-PP3), Southern Africa (SA-PP1, SA-PP2), Latam (LatAMML, LatAMTL), Asia (SAHDT, SAWLDT, SADT), Nutritious Maize (NuM)

CIMMYT Report on 2019 maize product profile workshops in Eastern and Southern Africa

CIMMYT Stress Tolerant Maize for Africa. Project Brief

CIMMYT & Gobierno de México (2019) Maíz para México - Plan Estratégico 2030. https://repository.cimmyt.org/bitstream/handle/10883/20219/60937.pdf?sequence=1&isAllowed=y

IEA (2015) Evaluation of the CGIAR Research Program on MAIZE

IEA (2017) Evaluation of Gender in CGIAR Research

IEA (2017) Evaluation of Capacity Development Activities of CGIAR

IFAD (2019) Creating opportunities for rural youth. 2019 Rural Development Report

ISPC (2016) Assessment of the Maize Agri-Food System (MAIZE) CRP-II revised proposal (2017-2022)

Krishna VV, Feleke S, Marenya PP, Abdoulaye T, Erenstein O (2019) A Strategic Framework for Adoption and Impact CGIAR Research Program on Maize: CIMMYT: IITA

MAIZE Annual Reports (2017, 2018, 2019)

MAIZE Plan of Work and Budget (POWB) (2017, 2018, 2019)

MAIZE CRP Phase II Proposal

MAIZE management committee meeting minutes (eight sets of minutes between June 2017 and November 2019)

MAIZE independent steering committee meeting minutes (four sets of minutes between September 2016 and October 2019)

MAIZE, WHEAT, and YPARD (2016) Concept Paper. Youth in the Wheat and Maize CRPs – A collaboration with YPARD

MAIZE Youth Task Force TOR

MAIZE Youth Task Force meeting minutes July 2020

MAIZE Outcome impact case report (OICR) (2019) no 3321: Over 5 million sub-Saharan African households benefit from improved drought-tolerant maize varieties

MAIZE Outcome impact case report (OICR) (2019) no 3322: MasAgro project in Mexico: 500,000 farmers improve yields, incomes, and food security by growing improved maize varieties and practicing conservation agriculture on 1.3 million hectares

Management response to Child, K (2019) Review of sustainable intensification monitoring and evaluation and inventory of associated indicators and data

MasAgro report: Theory of Change workshop

MasAgro (2019) Monitoring, evaluation, accountability, and learning (MEAL) strategy

Pixley K (2016) MasAgro Biodiversidad: A learning model towards effective and equitable use of genetic resources. Presentation to COP13, Cancún, México; December 5, 2016

Prasanna BM (2019) CIMMYT Global Maize Program - Continuous Improvement & Change Management. Presentation to EiB; October 30, 2019

Prasanna BM (2020) CIMMYT Maize Program: Product Profile-based Breeding, Stage Gate Advancement Process and Criteria, and Product Life Cycle Management. Presentation to USAID; August 27, 2020

Results-Based Management Framework for the MAIZE CRP, 2017

STMA Project Bulletin. January to April 2020

Storr S (2020) Development of the Enterprise Breeding System well underway. https://www.cimmyt.org/news/development-of-the-enterprise-breeding-system-well-underway/

The MAIZE Handbook: How MAIZE is run, funded, governed and more, 2018

USAID MLN Diagnostics and Management Project. Final Project Technical Report

Yasabu S (2019) Ethiopian policymakers consider wider use of DNA fingerprinting. https://www.cimmyt.org/news/ethiopian-policymakers-consider-wider-use-of-dna-fingerprinting/

Annex 3.2: Scientific Publications

Abdoulaye T, Wossen T, Awotide B (2018) Impacts of improved maize varieties in Nigeria: ex-post assessment of productivity and welfare outcomes. Food Sec. 10:369-379. https://doi.org/10.1007/s12571-018-0772-9

Ali A, Erenstein O (2017) Assessing farmer use of climate change adaptation practices and impacts on food security and poverty in Pakistan. Climate Risk Management 16:183-194. https://doi.org/10.1016/j.crm.2016.12.001

Almekinders CJM, Beumer K, Hauser M, Misiko M, Gatto M, Nkurumwa AO, Erenstein O (2019) Understanding the relations between farmers’ seed demand and research methods: The challenge to do better. Outlook on Agriculture 48(1):16-21. https://doi.org/10.1177%2F0030727019827028

Alwang J, Gotor E, Thiele G, Hareau G, Jaleta M, Chamberlin J (2019) Pathways from research on improved staple crop germplasm to poverty reduction for smallholder farmers. Agricultural Systems 172:16-27. https://doi.org/10.1016/j.agsy.2017.10.005

Amondo E, Simtowe F, Rahut DB, Erenstein O (2019) Productivity and production risk effects of adopting drought-tolerant maize varieties in Zambia. International Journal of Climate Change Strategies and Management 11(4):570-591. https://doi.org/10.1108/IJCCSM-03-2018-0024

Araus JL, Kefauver SC, Zaman-Allah M, Olsen MS, Cairns JE (2018) Translating high-throughput phenotyping into genetic gain. Trends Plant Sci. 23(5):451-466. https://doi.org/10.1016/j.tplants.2018.02.001

Atlin GN, Cairns JE, Das B (2017) Rapid breeding and varietal replacement are critical to adaptation of cropping systems in the developing world to climate change. Global Food Security 12:31-37. https://doi.org/10.1016/j.gfs.2017.01.008

Awata LAO, Beyene Y, Gowda M, Suresh LM, Jumbo MB, Tongoona P, Danquah E, Ifie BE, Marchelo-Dragga PW, Olsen M, Ogugo V, Mugo S, Prasanna BM (2020) Genetic analysis of QTL for resistance to maize lethal necrosis in multiple mapping populations. Genes 11(1):32. https://doi.org/10.3390/genes11010032

Ayinde OE, Daramola OC, Adenuga AH, Tahirou A (2019) Estimating farmers’ willingness to pay for stress-tolerant maize (STM) in Nigeria: A Heckman model approach. Pertanika Journal of Social Sciences and Humanities 27(2):1159-1174. http://www.pertanika.upm.edu.my/Pertanika%20PAPERS/JSSH%20Vol.%2027%20(2)%20Jun.%202019/28%20JSSH-2541-2017.pdf

Badu-Apraku B, Talabi AO, Ifie BE, Chabi YC, Obeng-Antwi K, Haruna A, Asiedu R (2018) Gains in grain yield of extra-early maize during three breeding periods under drought and rainfed conditions. Crop Sci. 58:2399-2412. https://doi.org/10.2135/cropsci2018.03.0168

Baudron F, Zaman-Allah MA, Chaipa I, Chari N, Chinwada P (2019) Understanding the factors influencing fall armyworm (Spodoptera frugiperda J.E. Smith) damage in African smallholder maize fields and quantifying its impact on yield. A case study in Eastern Zimbabwe. Crop Protection 120:141-150. https://doi.org/10.1016/j.cropro.2019.01.028

Beyene Y, Gowda M, Olsen M, Robbins KR, Pérez-Rodríguez P, Alvarado G, Dreher K, Gao SY, Mugo S, Prasanna BM, Crossa J (2019) Empirical comparison of tropical maize hybrids selected through genomic and phenotypic selections. Front. Plant Sci. 10:1502. https://doi.org/10.3389/fpls.2019.01502

Beyene Y, Gowda M, Suresh LM, Mugo S, Olsen M, Oikeh SO, Juma C, Tarekegne A, Prasanna BM (2017) Genetic analysis of tropical maize inbred lines for resistance to maize lethal necrosis disease. Euphytica 213:224. https://doi.org/10.1007/s10681-017-2012-3

Bukowski R, Guo X, Lu Y, Zou C, He B, Rong Z, Wang B, Xu D, Yang B, Xie C, Fan L, Gao S, Xu X, Zhang G, Li Y, Jiao Y, Doebley JF, Ross-Ibarra J, Lorant A, Buffalo V, Romay MC, Buckler ES, Ware D, Lai J, Sun Q, Xu Y (2018) Construction of the third-generation Zea mays haplotype map. GigaScience 7(4)1-12. https://doi.org/10.1093/gigascience/gix134

Cadena-Iñiguez P, Rendón-Medel R, Rodríguez-Vázquez H, Camacho-Villa C, Santellano-Estrada E, Guevara-Hernández F, Govaerts B (2018). Propuesta metodológica-interinstitucional para un nuevo extensionismo en México. Revista mexicana de ciencias agrícolas, 9(8):1777-1785. https://doi.org/10.29312/remexca.v9i8.826

Cairns JE, Prasanna BM (2018) Developing and deploying climate-resilient maize varieties in the developing world. Current Opinion in Plant Biology (45):226-230. https://doi.org/10.1016/j.pbi.2018.05.004

Camacho-Villa TC, Almekinders C, Hellin J, Martinez-Cruz TE, Rendon-Medel R, Guevara-Hernández F, Beuchelt TD, Govaerts B (2016) The evolution of the MasAgro hubs: responsiveness and serendipity as drivers of agricultural innovation in a dynamic and heterogeneous context. The Journal of Agricultural Education and Extension 22(5):455–470. https://doi.org/10.1080/1389224X.2016.1227091

Chaikam V, Gowda M, Nair SK, Melchinger AE, Prasanna BM (2019) Genome-wide association study to identify genomic regions influencing spontaneous fertility in maize haploids. Euphytica 215(8):138. https://doi.org/10.1007/s10681-019-2459-5

Chaikam V, Martinez L, Melchinger AE, Schipprack W, Prasanna BM (2016) Development and validation of red root marker-based haploid inducers in maize. Crop Sci. 56:1678-1688. https://doi.org/10.2135/cropsci2015.10.0653

Chaikam V, Nair SK, Martinez L, Lopez LA, Utz HF, Melchinger AE, Prasanna BM (2018) Marker-assisted breeding of improved maternal haploid inducers in maize for the tropical/subtropical regions. Front. Plant Sci. 9:1527. https://doi.org/10.3389/fpls.2018.01527

Chen J, Zavala C, Ortega N, Petroli C, Franco J, Burgueño J, Costich DE, Hearne SJ (2016) The development of quality control genotyping approaches: A case study using elite maize lines. PLOS One. https://doi.org/10.1371/journal.pone.0157236

Crossa J, Pérez-Rodríguez P, Cuevas J, Montesinos-López O, Jarquín D, de Los Campos G, Burgueño J, González-Camacho JM, Pérez-Elizalde S, Beyene Y, Dreisigacker S, Singh R, Zhang X, Gowda M, Roorkiwal M, Rutkoski J, Varshney RK (2017) Genomic selection in plant breeding: Methods, models, and perspectives. Trends Plant Sci. 22(11):961-975. https://doi.org/10.1016/j.tplants.2017.08.011

Donnet ML (2017) Productivity differences and food security: a metafrontier analysis of rain-fed maize farmers in MasAgro in Mexico. AIMS Agriculture and Food 2(2):129-148. http://dx.doi.org/10.3934/agrfood.2017.2.129

Fonteyne S, Martinez Gamiño M-A, Saldivia Tejeda A, Verhulst N (2019) Conservation agriculture improves long-term yield and soil quality in irrigated maize-oats rotation. Agronomy 9:845. https://doi.org/10.3390/agronomy9120845

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Gracia-Romero A, Kefauver SC, Vergara-Díaz O, Zaman-Allah MA, Prasanna BM, Cairns JE, Araus JL (2017) Comparative performance of ground versus aerially assessed RGB and multispectral indices for early-growth evaluation of maize performance under phosphorus fertilization. Front. Plant Sci. 8:2004. https://doi.org/10.3389/fpls.2017.02004

Hickey J, Chiurugwi T, Mackay I, Powell W, Implementing Genomic Selection in CGIAR Breeding Programs Workshop Participants (2017) Genomic prediction unifies animal and plant breeding programs to form platforms for biological discovery. Nat Genet. 49:1297–1303. https://doi.org/10.1038/ng.3920

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Annex 4: List of Persons Interviewed

Note that all interviews were conducted jointly by the review team. Further, the co-leads for each Flagship program (from each of IITA and CIMMYT) were interviewed together. Some respondents were interviewed several times due to their having several roles. In particular, the CRP Director gave his time to be interviewed as the CRP director, as the FP3 co-lead, and as the Chair of the Maize Management Committee. In some cases, follow-up questions were sent to interviewees where it was not possible to cover all the questions in the interview. All interviewees replied to the follow-up questions.

The review team followed a utilization approach in which members of the CRP management unit were welcome to join interviews so as to enhance co-learning (for the CRP and for the review team). Both the MAZIE CRP Program Manager and the MEL expert joined interviews as far as they could and made useful additional contributions as needed. Of the respondents listed below, three were female (interviewee numbers 1, 4, and 12) the rest were male. Given that B.M Prasanna was interviewed three times, in different capacities, the total number of interviewees was 22 (19 men and 3 women).

Table 1. List of interviewees

Date	Name	Organization	Capacity in which interviewed	Gender
05.10.20	1.Shaylyn Gaffney	MAIZE (CIMMYT)	MEL expert in MAIZE PMU	Female
07.10.20	2.B.M. Prasanna	MAIZE (CIMMYT)	CRP Director	Male
07.10.20	3.Victor Kommerell	MAIZE (CIMMYT)	CRP Program Manager	Male
08.10.20	4.Sarah Hearne	MAIZE (CIMMYT)	FP2 Co-lead	Female
08.10.20	5.Melaku Menkir	MAIZE (IITA)	FP2 Co-lead	Male
09.10.20	6.Tahirou Abdoulaye	MAIZE (IITA)	FP1 Co-lead	Male
09.10.20	7.Olaf Erenstein	MAIZE (CIMMYT)	FP1 Co-lead	Male
12.10.20	8.Bernard Vanlauwe	MAIZE (IITA)	FP4 Co-lead	Male
12.10.20	9.Bruno Gerard	MAIZE (CIMMYT)	FP4 Co-lead	Male
13.10.20	10.Mike Robinson	Syngenta Foundation for Sustainable Agriculture	Chair, ISC	Male
15.10.20	11.Cosmos Magorokosho	CIMMYT (Zimbabwe)	STMA Project Leader	Male
15.10.20	12.Felister Mankini	KALRO	ISC member	Female
16.10.20	13.B.M. Prasanna	MAIZE (CIMMYT)	MMC Chair	Male
16.10.20	14.Kevin Pixley	MAIZE (CIMMYT)	MMC Member (interim DGG CIMMYT)	Male
16.10.20	15.V.R. Kaundinya	Federation of Seed Industry of India	ISC Member	Male
19.10.20	16.B.M. Prasanna	MAIZE (CIMMYT)	FP3 Co-lead	Male
19.10.20	17.Abebe Menkir	MAIZE (IITA)	FP3 Co-lead	Male
20.10.20	18.May-Guri Saethre	NIBIO (ex IITA)	Ex ISC member	Male
22.10.20	19.Nicolai Rodeyns	Naseco, Uganda	Partner (MLN)	Male
23.10.20	20.Bram Goevarts	MAIZE (CIMMYT)	MasAgro Project Leader	Male
26.10.20	21.Gary Atlin	BMGF	Donor (STMA)	Male

Date	Name	Organization	Capacity in which interviewed	Gender
28.10.20	22.Mwansa Kabamba	Zambia ARI	Partner (STMA)	Male
28.10.20	23.Tony Cavalieri	BMGF	Donor (STMA)	Male
29.10.20	24.Luc Dendooven	CINVESTAV	Partner (MasAgro)	Male

Total Females	3
Total Males	21

Annex 5: Bibliometrics and Altmetrics

Bibliometrics and Altmetrics data were provided through dashboard data pre-analyzed by CAS. The analysis of bibliometric and Altmetric data is most relevant for quality of science assessment. Data are however mostly descriptive. Author keyword co-occurrences describe who is working on what. Co-citation network describes who cites who, which essentially groups authors by research area. Country collaboration describes which countries work together, mostly showing that the most productive countries also appear as the most collaborative. Other data provides demographics about publication authors. Altmetrics data represent all forms of mention to publications, including those made through social media. After examination, we believe that Altmetric data do not contribute to the understanding of the scientific quality of publications. Similarly, we also do not believe that descriptive elements such as those illustrated above contribute to the understanding of the scientific quality of publications. Rather, we believe that the most relevant data to assess quality of science are citation data. We have therefore focused our analysis of bibliometric and Altmetric data mostly on citation data.

The total number of publications for the 2017-2019 period amounted to 532, with 458 being ISI publications [2]. Only two of these publications were single-authored, the rest displaying about four co-authors. While single-authored documents clearly reflect the absence of any collaboration in the underlying work (single-authored publications are typically review papers), co-authored documents do not necessarily reflect diverse collaborations, less collaborations across groups or organizations. Indeed, for a significant number of co-authored publications, co-authors belong to the same organization, sometimes the same group.

Overall, publications were, to date, cited an average of 8 times, with a median of 4, for an average age of almost 2 years. The publications released between 2017 and 2019 were, to date, cited an average of 8 times, with an overall median of 4 and 25% quartile of 2 (yearly details are provided in Table 2). These low values, which “persist” through years with a 25% quartile of 5 for 2017, suggest that a large percentage of publications have been published in secondary journals and will likely have only limited impact on any further research. The most-cited publication was cited 187 times. The tenth most-cited publication was cited only 44 times. None of those 10 most-cited publications is first-authored by a NARS scientist.

Table 2: Citation counts of peer-reviewed publications by year of publication

Year	Mean	Median	25% Quartile	75% Quartile
2017	15.5	9	5	18
2018	7.8	5	2	10
2019	3.4	2	1	4
Overall	8.4	4	2	10

During the 2017-2019 period, authors contributed on average to 1.6 publications. The most productive author contributed to 32 publications, the least productive to 1 publication, with a median of 1 publication. Among the 30 most productive authors, who contributed to 8 to 32 publications each, only 4 were not affiliated with CIMMYT or IITA: one was affiliated with the University of Wageningen, one with CAAS, one with ICAR, and one with the Colegio de Postgraduados.

Country publication productivity, which is based on the country affiliation of the first author’s organization, averaged about 10 with a median of 3. However, the 10 most productive countries accounted for almost 80% of all publications (Figure 2). Of these 10 most productive countries, only 3 are countries where the number of publications is not driven by either CIMMYT, IITA, or a higher education organization; these are India, China, and Ethiopia which together only account for 20% of the total publication production of the 10 most-productive countries.

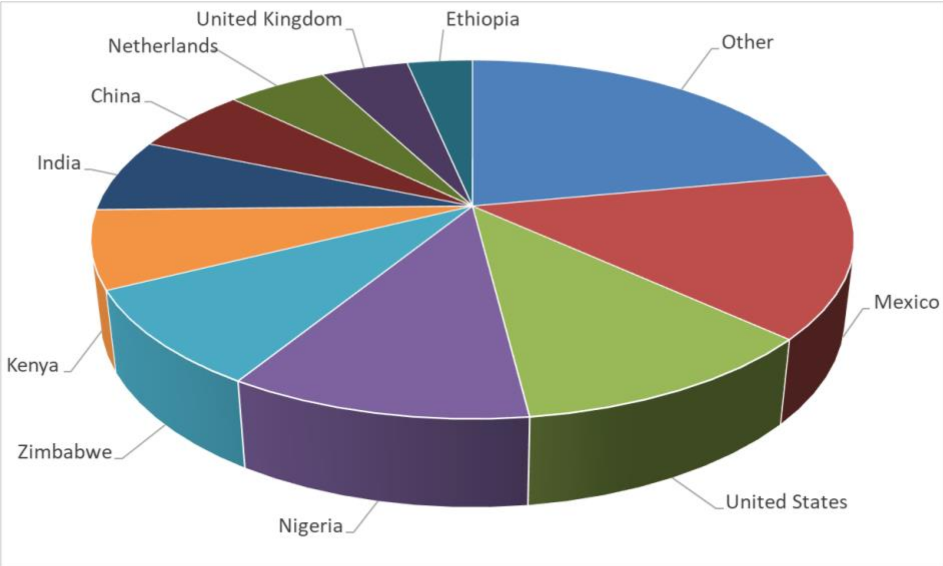
Altmetrics scores show that quite a number of publications are above the 90% percentile for their age. Because Altmetrics is weighted heavily by social media it is hard to distinguish between “external”

[2] Statistics below only concern ISI publications

reactions to the publications and authors or affiliates' "promotion" of their own work. For this reason, we believe that citation frequency s is the best tool to apprehend the value and quality of publications.

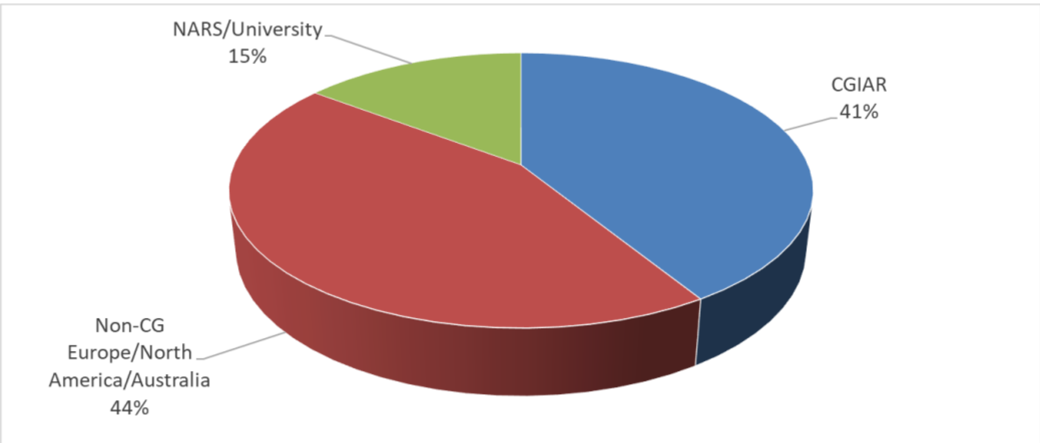
A qualitative analysis of some publications shows the existence of frequently cited work published in prestigious peer-reviewed journals. This constitutes undeniable evidence of work of high scientific quality. A large number of publications, however, do not fall in this group. This may be for reasons of quality or scope. There is undoubtedly work of high scientific quality that is not fit for publication in prestigious scientific journals because of a narrow scope (geography, technologies, applied science). In such cases, one may wonder whether publications in peer-reviewed journals is the best approach to reach the desired audience, compared to extension-type communication.

Figure 2. Country counts of peer-reviewed publications for the 2017-2019 period and the 10 most productive countries



Last, there is a very pronounced gap between CG centers and their partners, in particular, NARS and academic research organizations in Africa, Asia, or Latin America, in the publication landscape, as described above and illustrated in Figure 3. While a perfect balance may not be desirable, it is expected that capacity development and technology transfer efforts should at least partially fill that gap in the near future.

Figure 3. Organization affiliation of first authors of the 10% most cited peer-reviewed publications for the 2017-2019 period.



Note: NARS/University are meant as located in Africa, Asia, or Latin America; Non-CG Europe/North America/Australia are non-CGIAR organizations (public or private) located in Europe, North America (United States or Canada), and Australia

Annex 6: OICR Templates

Annex 6.1: OICR 3321 (STMA) Analysis template

OICR Number & Title: 3321: Over 5 million sub-Saharan African households benefit from improved drought-tolerant maize varieties

Phases of report (new/updated same level/updated new level of maturity): Updated Outcome/Impact case at same level of maturity (Level 3). Note, this OICR relates to the Stress Tolerant Maize for Africa (STMA) project which built on the achievements of the preceding Drought Tolerant Maize for Africa (DTMA) project and the Improved Maize for African Soils (IMAS) project

Year reported: 2019	Maturity level: 3	Years of programmatic work: 4

Geographic location(s): Regional, covering Western, Southern, and Eastern Africa

Populations covered, estimated size and socio-demographic categories (e.g., subsistence farmers, women, adolescents, etc.) Target populations were 5.2 million households or well over 49 million people in 12 countries. In practice, the target population was exceeded by the project, which recorded adoption by 6.5 million households

Key contributors to the outcome
Contributing CRPs/Platforms: <Not Defined>
Contributing Flagships:
- FP2: Novel Diversity and Tools for increasing Genetic Gains
- FP1: Enhancing Maize's R4D Strategy for Impact
- FP3: Stress Tolerant and Nutritious Maize

Contributing Regional programs: <Not Defined>
Contributing external partners:
- CSIR - Council for Scientific and Industrial Research
- BMGF - Bill & Melinda Gates Foundation
- ZARI - Zambia Agriculture Research Institute
- IER - Institut d'Economie Rurale (Mali)
- EIAR - Ethiopian Institute of Agricultural Research
- SARI - Selian Agricultural Research Institute
- NAERLS - National Agricultural Extension and Research Liaison Services
- ARC - Agricultural Research Council
- INRAB - Institut National de Recherche Agricole du Benin
- DARS - Department of Agricultural Research Services
- KALRO - Kenya Agricultural and Livestock Research Organization
- NARO - National Agricultural Research Organization (Uganda)
- DR&SS - Department of Research and Specialist Services
- USAID - U.S. Agency for International Development

Links to the CGIAR Strategic Results Framework: (IDOs and sub-IDOs)
Sub-IDOs:
- Increase capacity of beneficiaries to adopt research outputs

SRF 2022/2030 targets:
- # of more people, of which 50% are women, meeting minimum dietary energy requirements
- # of more farm households have adopted improved varieties, breeds, or trees

[CRP] contributions to the outcome *(list any of the following)*

Innovations: The OICR states not defined but it also states: In 2019, over 87,000 metric tons of improved stress-tolerant maize varieties were produced for smallholder farmers.

Policies: Not defined

Key CRP publications supporting the OICR: (Note that the publications listed below are taken from the OICR document)
2018:
1. Cairns, J.E. & Prasanna, B.M. (2018) Developing and deploying climate-resilient maize varieties in the developing world. Current Opinion in Plant Biology (45): 226-230. https://doi.org/10.1016/j.pbi.2018.05.004
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3. Tesfaye, K., Kruseman, G., Cairns, J.E., Zaman-Allah, M., Wegary, D., Zaidi, P.H., Boote, K.J., Rahut, D., Erenstein, O., 2018. Potential benefits of drought and heat tolerance for adapting maize to

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OICR relationship with CGIAR cross-cutting issues (YES/NO)
Capacity development: 0 not targeted (but see analysis of OICR in annex and main report, CD was key)
Climate change: 1 significant
Gender: 0 not targeted (but see analysis of OICR in annex and main report, gender was a key component)
Youth: 0 not targeted
Organization responsible for OICR (CGIAR/not CGIAR): CGIAR
Partnerships STMA involved about 50 downstream partners (NARS and seed companies), and a handful of upstream partners (research institutes or technology companies). Upstream partnerships were limited to the provision of tools, methods, services, or scientific guidance. They usually delivered exactly what was expected. Downstream partnerships were also generally satisfactory although more alike to supplier/user relationships than to full partnerships. Because products released to downstream partners are unfinished in the sense that their performance in the very specific agro-ecologies of the partners has not been fully demonstrated, it appears that true partnerships, i.e. peer-to-peer relationships, where the downstream partner can influence the work of its upstream one would be beneficial to all.
Brief reviewer's description of the outcome (based on OICR report, documents cited, original data collected/interviews, and other references) STMA exceeded its targets. Actual targets for the project period of 2016-2020 were to produce and ensure use of 54,000 metric tons of seed to reach 5.4 million households with adequate improved seed varieties covering at best 2.2. million hectares. In practice, 97,000 MT were produced, 6.5 million households adopted over 3.8 million hectares. Objectives relating to the development of innovative breeding tools and techniques were also generally met. In particular, very significant progress was made in the use of DH lines, resulting in increased rate of genetic gain. Progress was also made in phenotyping of both abiotic and biotic traits. Early efforts towards marker-assisted selection were successful for resistance to diseases, leading to significant marker-based selection implementation in line development or conversion (particularly productive and effective for the deployment of MLN resistance). Marker-assisted efforts were however abandoned and replaced with genomic selection for more complex biotic tolerance traits such as drought tolerance.
Analysis

STMA was generally based on very sound science and strong partnerships. This is well illustrated from the work on doubled-haploids where STMA partnered with the most advanced group in terms of maize DH inducers, the University of Hohenheim, and further built on that starting point to develop tropical inducers with very high induction rates, now available to public and private organizations across East Africa for a fee. Efforts in marker-assisted selection or backcrossing were also well-conducted, at least for pest resistances. The QTLs identified allowed to implement effective marker-assisted selection and backcrossing, with rather spectacular outcomes in the case of resistance to MLN. Similar efforts also targeted more complex traits such as tolerance to nitrogen or water stresses. These efforts ended-up being abandoned due to insufficient numbers of large QTLs identified or inability to validate QTLs. The high risks associated with such projects should have been anticipated before launching them given the general state of knowledge at the time. Genomic selection was subsequently selected as the approach of choice to tackle those more complex traits. High quality work was conducted by highly qualified scientists to identify the most effective GS approach given the genetic diversity to which models are to be applied. The outcomes of STMA map very well with FP2 and FP3 of MAIZE. STMAs Primary Outcome 1: “Innovative breeding tools and techniques applied for increasing the rate of genetic gain in the maize breeding pipeline” is very clearly aligned with FP2. Meanwhile Primary Outcome 2: “Increased commercialization of improved multiple-stress-tolerant maize varieties with gender-preferred traits by the sub-Saharan African seed sector” and Primary Outcome 3: “Increased seed availability and farmer uptake of stress-tolerant maize varieties in target countries” are aligned with FP3. STMA benefitted from a strong foundation of germplasm going back decades and from the success (and successful relations built through) previous projects such as DTMA.
Conclusions The OICR does represent the application of MAIZE’s research to developmental outcomes. Whilst STMA did not have its own ToC, assumptions were clear in the problem statement of the project proposal. Assumptions related to engagement of women may not have been correct and would need further consideration, for example in the present Accelerated Genetic Gains project which follows on from STMA. Lessons that emerge for the CRP and indeed the CGIAR more generally relate to how STMA engaged with partners, where having annual review meetings bringing together staff and partners from all 12 countries involved, and drawing on existing long-term collaborative arrangements with NARS and some seed companies, aided effectiveness. The value of the varieties that were developed through STMA and the tools and methods that have been transferred to partners should help strengthen the relationship between CIMMYT-IITA and NARS or seed companies, and eventually the value of outcomes that could emerge from future collaborative work.

Annex 6.2: OICR 3322 (MasAgro) Analysis Template

OICR Number & Title: 3322: MasAgro project in Mexico: 500,000 farmers improve yields, incomes, and food security by growing improved maize varieties and practicing conservation agriculture on 1.3 million hectares.

Phases of report (new/updated same level/updated new level of maturity):
New outcome/impact case

If for Innovations at Level 4 or Policies at Levels 2 and 3

Year reported: 2019 | Maturity level: 3 | # Years of programmatic work: Since 2012

Geographic location(s): Mexico

Populations covered, estimated size and socio-demographic categories (e.g., subsistence farmers, women, adolescents, etc.) 500,000 farmers

Key contributors to the outcome
Contributing CRPs/Platforms: <Not Defined>
Contributing Flagships:
- FP4: Sustainable intensification of maize-based systems for improved smallholder livelihoods
- FP1: Enhancing Maize's R4D Strategy for Impact
- FP3: Stress Tolerant and Nutritious Maize

Contributing Regional programs: <Not Defined>
Contributing external partners:
- SADER - Secretaria de Agricultura y Desarrollo Rural (México)

Links to the CGIAR Strategic Results Framework: (IDOs and sub-IDOs)
Sub-IDOs:
- Adoption of CGIAR materials with enhanced genetic gains
- Agricultural systems diversified and intensified in ways that protect soils and water
- Increase capacity of beneficiaries to adopt research outputs

SRF 2022/2030 targets:
- # of more people, of which 50% are women, meeting minimum dietary energy requirements
- # of more farm households which have adopted improved varieties, breeds, or trees

[CRP] contributions to the outcome *(list any of the following)*

Innovations
- 1404 - 60 hybrids selected to be evaluated in the 2019 collaborative evaluation network of MasAgro
- 252 - Five hybrids with high yield potential selected for the seed sector of Mexico
- 251 - 47 hybrids (with high yield potential) selected for the three agricultural environments of Mexico: lowlands, mid-altitudes, and highlands
- 1405 - CIM17MMT04: A new maize hybrid with high yield potential released in Mexico
- 1403 - Maize hybrids with high yield potential for lowlands, mid-altitudes, and highlands
- 253 - Four new hybrids with high yield potential incorporated into the Mexican seed market

Policies N/A

Key CRP publications supporting the OICR:
1.) Fonteyne S, Martinez Gamiño M-A, Saldivia Tejeda A, Verhulst N (2019) Conservation agriculture improves long-term yield and soil quality in irrigated maize-oats rotation. Agronomy 9:845. https://doi.org/10.3390/agronomy9120845
2.) Donnet ML (2017) Productivity differences and food security: a metafrontier analysis of rain-fed maize farmers in MasAgro in Mexico. AIMS Agriculture and Food 2(2):129-148. http://dx.doi.org/10.3934/agrfood.2017.2.129
3.) MasAgro Case Study, 2018
4.) Chassaigne A (2016) Programa MasAgro en México: Éxito en Asociaciones Público-Privadas. Presentation to "VII Congreso Venezolano de Mejoramiento Genético y Biotecnología Agrícola" – Maracay, Venezuela; July 13-15, 2016
5.) Pixley K (2016) MasAgro Biodiversidad: A learning model towards effective and equitable use of genetic resources. Presentation to COP13, Cancún, México; December 5, 2016

OICR relationship with CGIAR cross-cutting issues (YES/NO)

Capacity development 0 not targeted

Climate change 1 significant

Gender 0 not targeted

Youth 0 not targeted

Organization responsible for OICR (CGIAR/not CGIAR) CGIAR

Partnerships

MasAgro has partnered with an increasing number of Mexican actors in the seed sector since its launch in 2011. In 2019 it totaled 71 partner seed companies, an increase of 9 compared to the previous year. Micro and small seed companies rely more heavily on MasAgro's support that comes in addition to making new and improved varieties available. Seed sales of MasAgro Consortium member companies have almost doubled since 2011, from 600 thousand bags to 1,100 thousand. Partner companies have generally grown in terms of seed sales. All these facts demonstrate a very favorable partnership environment creating value for all partners as well as for smallholder farmers.
Brief reviewer's description of the outcome (based on OICR report, documents cited, original data collected/interviews, and other references) On average, farmers participating in the MasAgro project in Mexico had 20.5 percent higher maize yields than the average yields achieved in the region where they live, and 23 percent higher average net income. In rain-fed conditions specifically, MasAgro helped participant farmers achieve yields and income gains that were 92 percent and 105 percent higher, respectively. As noted above, seed sales of MasAgro Consortium member companies have almost doubled since 2011, from 600 thousand bags to 1,100 thousand. Most of the increase, however, took place between 2011 and 2015, after which sales dipped and rose back to their 2015 level. MasAgro has had a positive impact on the lives of more than 500,000 farmers who have adopted conservation agriculture and sustainable farming technologies on more than 1.3 million hectares across Mexico. The innovation hub model it uses has become increasingly demand-led, and the project has deployed cutting-edge tools and technologies for farm analysis, farmer support, and MEL.
Analysis MasAgro has been running for almost a decade now, and from 2013 covered the whole country. Whilst it focuses on both maize and wheat, a larger percentage (around 70%) of the focus is on maize. It has recorded large increases in both yields and incomes, through its promotion of sustainable intensification practices. These increases are highest for farmers in rain-fed areas than those growing maize under irrigation. The system of innovation hubs around the country allows for MasAgro to provide appropriate technologies and advice for the widely varying agroecological systems in the country. However, the review team notes that there are other approaches in Mexico that may have had more success than MasAgro. Still, the ever-increasing number of partners, in particular, seed companies that join MasAgro is a clear demonstration of both its scientific legitimacy and credibility.
Conclusions MasAgro's work and, for this review, three of its four components (Biodiversity, Maize, and Farmer) embody MAIZEs research to development outcomes. It has been very successful in increasing sales of improved varieties through seed companies since its beginning in 2011, and logically, planting of the same improved varieties by Mexican smallholder farmers. The progression, however, has been slower since 2015. MasAgro grew and evolved over time. For example, an early assumption may have been that scientists "knew the answers" and just had to extend technologies and varieties to the farmers. But over time the project moved away from a technology transfer approach to a participatory innovation hub approach which could then better understand demand, including market demand, and respond to that. It is worth noting here that MasAgro has for example been drawing from ICRISAT to respond to farmer demand for legume crops as well Lessons are still being learned about the efficacy of the various conservation agriculture and sustainable intensification measures that MasAgro have been availing to farmers. In particular, MasAgro remains essentially a single commodity endeavor in Mexico (even though MasAgro is a maize and wheat endeavor, maize and wheat production areas in Mexico barely intersect). As such, there is probably a limit to what MasAgro can achieve in terms of increasing total agricultural production, sustainability, and income of smallholder farmers, through increasing their maize production only.

Annex 7: Focused Review of OICRs/Projects

Annex 7.1: Review of OICR 3321 (STMA)

OICR title: Over 5 million sub-Saharan African households benefit from improved drought-tolerant maize varieties.

Overview of Case

This OICR relates to the BMGF funded Stress Tolerant Maize for Africa (STMA) project which ran from 2016 through to early 2020. The STMA followed on from several projects including the Drought Tolerant Maize for Africa (DTMA) which was also funded by BMGF and ran from 2012-2016. In turn, DTMA and other projects were building on decades of drought-tolerant maize research conducted by both IITA and CIMMYT.

As noted in the 2017, 2018, and 2019 STMA project summaries, the STMA project aimed to develop improved multiple stress-tolerant varieties that effectively addressed emerging and future production challenges, while increasing genetic gains and scaling-up and scaling-out products developed, and knowledge gained. STMA aimed to facilitate the production and use of 54,000 metric tons (MT) seed of multiple stress-tolerant maize to cover nearly 2.2 million ha, benefiting more than 5 million households or well over 49 million people in 12 target countries in Africa by 2020. To achieve this, STMA organized its work along four Primary Outcomes. These were: a) innovative breeding tools and techniques to increase the rate of genetic gain in the maize breeding pipeline; b) increased commercialization of improved multiple-stress-tolerant maize varieties with gender-preferred traits; c) increased seed availability and farmer uptake of stress-tolerant maize varieties in target countries; and d) optimized investment impact through effective project oversight and communication.

STMA operating in 12 countries across West, East, and Southern Africa. These were Benin, Ghana, Mali, and Nigeria in West Africa, Ethiopia, Kenya, Tanzania and Uganda in East Africa, and Malawi, South Africa, Zambia, and Zimbabwe in Southern Africa.

The STMA website, https://stma.cimmyt.org/ notes that STMA would prioritize the replacement of obsolete varieties that were more than 15 years old with new, improved, stress-tolerant varieties to change the current low use of modern varieties, which stood at the time at 58% in all the maize growing areas in SSA. The executive summary of the project proposal anticipates that "the transition to privately funded maize improvements will continue to focus on high productivity pockets of Africa in the near term, and that the development of multiple-stress tolerant variety development for low impact farming systems will not be a primary target of private maize breeding programs". To this end, it is understood that there was a clear space for MAIZE to serve smallholder farmers through the NARS and seed companies through the project period.

Partnerships

STMA targeted 12 countries across West, East, and Southern Africa, as noted above, where it supported close to 50 downstream public and private partners, releasing 218 new stress-tolerant varieties. STMA also established upstream partnerships to develop methods and tools for subsequent implementation in CIMMYT's or IITA's breeding programs. No specific issues were reported with any of the partners.

With respect to delivery of varieties to downstream partners, it appears that the relationship between CIMMYT and IITA on one hand and NARS and seed companies on the other is more one of supplier/user than one of peer-to-peer partnership. For example, there seems to be little or no one-to-one interaction between CIMMYT or IITA and NARS or seed companies to identify, based on the latest performance data, which varieties should be released to whom. Similarly, once varieties have been taken up by downstream partners, there is little evidence of any feed-back to CIMMYT or IITA about the performance of these varieties and resulting adjustments in the breeding objectives or selection decisions.

Upstream partnerships were limited to the provision of tools, methods, services, and/or scientific guidance. STMA generally made good use of these partnerships as illustrated by the very successful development and deployment of tropical haploid inducers, and by the thorough investigation into the most effective predictive models for genomic selection.

Outcomes and Contribution to SRF and IDOs

As noted in the OICR document and in the last STMA bulletin (January to April 2020), STMA exceeded its targets. Actual targets were to produce and ensure use of 54,000 metric tons of seed to reach 5.4 million households with adequate improved seed varieties covering at best 2.2. million hectares. In practice, 97,000 MT were produced, 6.5 million households adopted over 3.8 million hectares.

The final project narrative noted that the following conditions enabled success:

- Collaborative work with key partners NARS and seed companies. Seed companies are the main channel to take improved varieties to the farmers' field. In the long term, this will contribute to the increase of maize productivity and production in the region. In Ethiopia, collaboration with AMSAP (advanced maize seed adoption program), a local NGO helped to undertake many and geographically wider demos and helped a lot the scaling
- Timely and impactful delivery of improved germplasm, information, and services from the breeding and molecular breeding teams
- Adequate budget through different projects for seed system work over the years
- Complementarity of projects within CIMMYT ensured project activities were beneficial across the board. Dedication of technical, management, and supporting staff to the project ensured efficient delivery of project outputs

Reasons for success were also explored in interviews and include the following:

- Buy-in to STMA (and prior projects) by governments
- Increased presence of seed companies at least in East and Southern Africa
- Good (and long term) relationships between MAIZE and partners
- Focus on small and mid-sized farmers who are resource-constrained and operating in drought-prone environments
- Support given to seed companies by the project
- The solid foundation of germplasm going back decades
- Promotion of the new varieties by the NARS and seed companies

Both the final project narrative and interview responses also referred to challenges. The final project narrative noted:

- Maize Lethal Necrosis and Fall Armyworm continue to be challenges for seed production in ESA
- Most of the local seed companies in Eastern Africa are newly emerging and they needed capacity building (financial, physical, technical, etc.) over the years to deliver quality seeds to the farmers
- The investment in EGS production from private seed companies, especially for the small and emerging companies was still in its developing stage and offered limited support to existing seed companies
- Relatively low investment levels of African governments in agriculture, in particular, non-existent extension systems in most SSA was a major bottleneck to promotion of new varieties to small scale farmers
- Extremes weather patterns were a major bottleneck for breeding and seed systems work, for example, uneven distribution of rain, drought and heat stress in Zimbabwe, excessive rains (hurricanes in Mozambique) adversely affected some trials and nurseries
- Unstable agricultural policies such as ban on intercountry movement of maize grain and seed affected seed companies that ended up with huge carryover stocks that could not be sold due to ensuing gluts and shortages (e.g. Tanzania 2016-17 ban on grain sales to Kenya, grain shortages in Zimbabwe 2019)

Interview findings regarding challenges included the cost to seed companies to change products and the need for these seed companies to be convinced, by numbers of on-farm trials, that new replacement varieties will really perform sufficiently better for them to feel confident to market them. The review team notes that studies that report on yield performance show advantage of newly developed stress-tolerant (ST) varieties over cultivated (commercial) varieties ranging from 4% to 150% across on-farm, research, drought-stressed, well-watered, or rainfed trials across Eastern, Western, and Southern Africa (Amondo et al., 2019; Lunduka et al., 2017; Martey et al., 2020; Rezende et al., 2020; Setimela et al., 2017; Worku et al., 2020). Unless data is available for their specific target agro-ecologies, such a range of variation in relative performance makes it very challenging for small, local seed companies, to select new candidate varieties for further investment into development.

The OICR indicates that STMA contributed to the following SRF targets: more people, 50% women, meeting minimum dietary requirements, and more farm households who have adopted improved varieties. Sub-IDO: increase capacity of beneficiaries to adopt research outputs. The review team cannot confirm these but it is likely they were met (other than the 50% women target as that is unknown) given the fact that the project exceeded its targets. The review team considers that IDOs 1.3 (increased income and employment), 1.4 (increased productivity) and 2.1 (improved diets for poor and vulnerable people) will have been met and all four of the cross-cutting IDOs to some extent.

Cross-cutting Issues

In the OICR only **CC** is rated as significant. This is clear given the focus of the project. However, even though the other cross-cutting issues (gender, youth, and CD) were said not to be targeted, STMA did have a focus on both gender and CD.

The proposal for STMA paid significant attention to **gender** and once the project started it employed a full-time gender expert. Under primary objective 3 of STMA there were ten intermediate outcomes and of these four related to gender:

- Intermediate Outcome 3.5 Enhanced capacity of seed companies and agrodealers to reach women and other socially disadvantaged groups with improved seed
- Intermediate Outcome 3.6 Increased awareness and access among women on improved seed varieties and agronomic practices through alternative approaches such as NGOs, CBOs, and local Extension
- Intermediate Outcome 3.7 Improved Knowledge and Capacity on Gender in Seed Value Chains
- Intermediate Outcome 3.8 Improved institutional framework for integrating gender into the STMA Project

Having these gender-related intermediate outcomes and a full-time gender expert-led not only to a number of publications in journals but also the production of several gender-responsive frameworks and tools for use with farmers, farmer organizations, extension systems, breeders, technicians, agro-dealers, and seed companies. However, the extent to which these frameworks and manuals were deployed and subsequently made a difference was not clear. STMA did give recognition to women entrepreneurs with awards being given to two seed companies being run by women. This was seen as a particular achievement in that women farmers may well be more likely to buy from a female-run seed company. Nevertheless, the percentage of women amongst the staff and partners of STMA was low.

The product profiling carried out by STMA gradually began to consider women's interests and requirements. These included women's preferences for flint/semi flint maize, for early maturing varieties to fill the rainy season hunger gap, for taste, and for sweeter maize suitable for weaning foods and sweet beverages as then there are natural sugars from the maize to mention just a few.

Turning to **CD**, the project's final narrative states that the project supported close to 50 NARS and seed companies through more than 100 technical backstopping visits by STMA scientists, to discuss and address producibility issues and other technical challenges faced by partners. CD of NARS scientists and technicians, and of small and medium seed companies was particularly noted in interviews. Annual review meetings (see below) were also opportunities for CD.

Relevance of the Outcomes to the CRP and FP ToC

Being a BMGF funded project, STMA was not required to develop a ToC as such. However, the review team observed what was also pointed out by the Project lead, that STMAs Primary Outcome 1: "Innovative breeding tools and techniques applied for increasing the rate of genetic gain in the maize breeding pipeline" is very clearly aligned with FP2. Meanwhile Primary Outcome 2: "Increased commercialization of improved multiple-stress-tolerant maize varieties with gender-preferred traits by the sub-Saharan African seed sector" and Primary Outcome 3: "Increased seed availability and farmer uptake of stress-tolerant maize varieties in target countries" are aligned with FP3. Primary Outcome 4: "Investment impact optimized through effective project oversight, monitoring, and evaluation, and communication" is cross-cutting and contains elements such as MEL that are reflected in the cross-cutting FP1.

FP/CRP/Partner Learning from the Reported Outcomes

STMA had annual review meetings to which staff and partners came from all the STMA countries across West, East, and Southern Africa. These provide good opportunities for exchanging of experience and for learning from the experiences of the host country in terms of breeding and partner (NARS and seed companies) engagement in STMA.

Given that STMA was a large project, building on a solid foundation, it is likely that the CRP and FPs learned from approaches, technologies, and outputs of the project and applied them in other MAIZE work. This will particularly have been the case given the close similarities between STMA'S primary outcomes and the FPs of the CRP.

Annex 7.2: Review of OICR 3322 (MasAgro)

OICR 3322: MasAgro project in Mexico: 500,000 farmers improve yields, incomes, and food security by growing improved maize varieties and practicing conservation agriculture on 1.3 million hectares.

Overview of Case

Drawing on the OICR document, the Sustainable Modernization of Traditional Agriculture (MasAgro) project, a joint initiative between CIMMYT and Mexico's Secretary of Agriculture and Rural Development (SADER), has worked since 2012 to help address maize production, biodiversity conservation, food security, and rural development challenges. Improved maize varieties and conservation agriculture techniques reach farmers across Mexico. MasAgro is a collaborative effort with 150+ partners, including Mexico's agricultural research system (INIFAP and universities), local seed companies, multinational agri-food companies, farmer associations, local machinery workshops, and several non-governmental organizations (NGOs). MasAgro has developed 58 new maize hybrids specifically adapted for smallholder farmers in Mexico so far, which are distributed in partnership with local seed companies.

MasAgro has four components (www.cimmyt.org/projects/masagro/):

- **MasAgro Productor (Farmer)** develops a sustainable intensification strategy for maize, wheat, and similar grains by building hubs based on research platforms, demonstration modules, and extension areas where sustainable farming practices and technologies are tested, improved, and adapted.
- **MasAgro Biodiversidad (Biodiversity)** studies and characterizes maize and wheat genetic diversity for use in breeding programs, which develop wheat varieties and maize hybrids improved through conventional technologies. These hybrids are better adapted to climate change, more resistant to pests and diseases, and have higher yield potential.
- **MasAgro Maize** promotes the sustainable development of both maize grain and seed producers by breeding maize hybrids with conventional technologies and improving native maize seed in collaborative breeding projects with participant farmers. MasAgro's improved maize seeds are tested in collaboration with the local seed sector that, in turn, commercializes the best-adapted materials in Mexico's growing regions.
- **MasAgro Wheat** conducts research on wheat genetics and physiology to improve plant structure, increase the resilience and disease resistance of wheat, and its yield potential in Mexico and abroad.

Donnet et al (2017) note that the focus of MasAgro is the traditional farmers who can transition to a more commercial and profitable maize production via the use of modern practices. These include high yielding maize varieties, integral soil fertilization, improved tillage methods, and integration into remunerative markets.

Camacho-Villa et al (2016) provide a good background on the start-up of MasAgro by the Mexican government, drawing on CIMMYT's innovation hub model used in wheat production in Asia. CIMMYT initially collaborated in the establishment of four innovation hubs. In 2013 with a new government that wanted to reach poor farmers in marginal areas, MasAgro established hubs across the country in the differing agro-ecological zones. As noted by Camacho-Villa et al (2016), an innovation hub is seen as a network of value chain actors from a particular agro-ecological region who work together on sustainable solutions in maize- and wheat-based farming systems. The hub envisions the fostering of innovation processes at regional level, taking into account the different contexts. MasAgro farmer (or Productor), works through this network of innovation hubs. As noted in Camacho-Villa et al (2016)'s conclusion: "In the case of MasAgro, an initiative of public national and international partners, there were no standard proto-types or recipes for supporting the process, but there was a continuous thread of strategic analysis and decision-making with opportunistic alliances made and new directions taken. It has transformed the program from a technology transfer-oriented one to a program with a participatory innovation approach, covering the heterogeneity of the Mexican agricultural sector. It is this same heterogeneity that drove the transformation."

Due no doubt to the length of time that MasAgro has been running, the OICR is rated at level 3 in terms of maturity. As understood from CRP staff and partners, of late MasAgro has run into challenges in terms of funding, with just 60% of the required funding being made available this year, as priorities shift towards investing in the petroleum sector.

Partnerships

MasAgro has partnered with many Mexican actors since its launch in 2011. In 2019, 71 seed companies were partners in the project, 9 more than in 2018. These companies were located in 19 of 32 Mexican states and sold varieties developed with the support of MasAgro in 28 states. These seed companies can be classified into three groups according to their volume of maize seed sales: micro (less than 10,000 bags sold); small (between 10,000 and 50,000 bags sold); and medium (between 50,000 and 250,000 bags sold). Over the years, the relative sales of micro-companies have remained fairly stable whereas sales of small companies have declined to the benefit of medium companies, some of it being the result of the growth of small companies into medium ones. In addition to delivering varieties to its partners, MasAgro also provides support in the production and marketing of new and improved varieties. Small and micro seed companies are the most dependent on such support from MasAgro and really welcome it.

Outcomes and Contribution to SRF and IDOs

As noted in the OICR, on average, farmers participating in the MasAgro project in Mexico had 20.5 percent higher maize yields than the average yields achieved in the region where they live, and 23 percent higher average net income. In rain-fed conditions alone, MasAgro helped participant farmers achieve yields and income gains that were 92 percent and 105 percent higher, respectively (note that these much higher yields in rain-fed conditions than under irrigation are due to the difference that conservation agriculture and other sustainable intensification practices make to rain-fed maize production which is much more susceptible to climatic variations than maize under irrigation). On average, rain-fed plots managed with MasAgro's sustainable intensification practices yielded 25 percent more grain and revenue to maize farmers than plots managed with conventional practices, on the same farm. Similarly, Mexican seed companies increased their sales of improved seed by 55 percent from 2011 to 2018, as a direct result of the project's efforts. MasAgro has had a positive impact on the lives of more than 500,000 farmers who have adopted conservation agriculture and sustainable farming technologies on more than 1.3 million hectares across Mexico.

Whilst the OICR records the outcomes as of 2019, the 2018 CIMMYT annual report provides some more specific outcomes:

- CIMMYT bred 64 maize hybrids adapted to the tropical, subtropical, and temperate regions of Mexico
- In 2018, 62 of the small and medium-sized local companies received training from CIMMYT and sold 1 million bags of improved maize seed (and, since 2011, their combined sales had increased by 55%)

The CIMMYT 2019 AR highlights some of the "frontier technologies" and tools developed under MasAgro that can produce predictive and prescriptive site-specific analytics for the benefit of resource-constrained farmers. Some of the innovative technologies which can support more precise diagnostics and provision of extension advice to farmers are:

- The MasAgro electronic field book
- CIMMYT trained extension agents and field technicians loading geographical information onto an open data collection system called ODK Collect or GeoODK
- An interactive on-line Agrotutor system
- Other tools such as on-line interactive dashboards and GIS

It is worth noting, though, that some studies which compared MasAgro with other approaches have identified what could be shortcomings in the MasAgro approach

Turrent Fernández et al. (2017) compare the MasAgro proposal to a traditional milpa system intercalated with fruit trees. Their analysis concluded that the intercalated milpa system is a is superior to the MasAgro proposal to sustainably intensify small-scale agriculture in Mexico due to biodiversity-supported resilience; higher relative land efficiency; and diminution of soil erosion. The milpa is a traditional agricultural system which originated in Mexico, essentially configured around polyculture. Milpas most often consist of a mixture of maize, beans, and pumpkins, but can include other crops such as melons or peppers. Intercalated milpas is a milpa-based system where milpas are grown in long stripes intercalated with rows of fruit trees.

In another study, Huesca-Mariño et al. (2019) compared the extension components of the "Plan Puebla" which operated between 1960 and 1992 in the State of Puebla and was based on the provision of very tailored farming advice to individual farmers, to MasAgro and its hub approach, through a survey of farmers from the State of Puebla. Their results show that farmers perceived communication from the Plan Puebla to be more relevant and aligned with their cultural or community preferences such as the traditional milpa, than the MasAgro approach. Much of that perception could be linked to the frequency and quality of contacts between extension technicians and farmers. The same farmers also felt that services and technologies recommended by the Plan Puebla were more easily accessible and implementable than those recommended by Mas Agro.

Both studies acknowledge the need for traditional Mexican agriculture to profoundly change. Both point, however, to the MasAgro approach as being appropriate for farmers of a certain size with easy access to a number of technologies such as irrigation. They argue that the MasAgro proposal is not viable for the very small Mexican farmers.

Considering effectiveness more generally, the attention to two major crops (wheat and maize) by MasAgro, drawing on the MAIZE and WHEAT CRPs and the presence of the CGIAR Centre covering both these crops – CIMMYT – in the country, is viewed by the review team as a way of creating synergy and added value as well as efficiencies. Interviews indicated that given the different agro-ecologies across the country and the nature of wheat and maize farming in the north of Mexico where it is more commercial and intensive as compared with smallholder low-input often rain-fed farming in the South, there is an advantage to MasAgro of working with both crops. It further helps that both WHEAT and MAIZE CRPs are supported by the same Program Manager.

In terms of the contribution of MasAgro to the CRP SLO's and IDOs, the OICR document indicates that the OICR is linked to:

- # of more people, of which 50% are women, meeting minimum dietary energy requirements
- # of more farm households have adopted improved varieties, breeds, or trees

It further indicates that the OICR is linked to the following sub-IDOs:

- Adoption of CGIAR materials with enhanced genetic gains
- Agricultural systems diversified and intensified in ways that protect soils and water
- Increase capacity of beneficiaries to adopt research outputs

Cross-cutting Issues

Like OICR 3321 (STMA) the MasAgro OICR indicates that **CC** relevance was significant, with gender, youth, and capacity development not targeted. Given that MasAgro is largely concerned with sustainable intensification and conservation agriculture it is understandable that CC was rated as significant. However, this does not mean that the other cross-cutting targets were not addressed at all as a review of documents, as well as interviews, did reveal some focus on gender and the disadvantaged, and on CD.

Firstly, with regard to **gender and social inclusion**, from the end of 2018 MasAgro worked on developing a social inclusion strategy. In 2019 there were workshops and talks to raise awareness and understand lived experience (drawn from documents shared by the MasAgro project leader). Whilst this development only took place in 2018, MasAgro did focus on social inclusion in practice since 2013 when Presidential elections brought a new political party to power which required MasAgro to align with a new governmental program "Cruzada contra el Hambre" (Camacho-Villa et al, 2016). This program focused on reducing hunger in the most marginalized parts of Mexico, so MasAgro reoriented its activities to include marginal parts of the country and the poorest farmers.

Turning to **CD**, the CIMMYT 2018 AR notes that over 34,000 farmers from 16 states of Mexico participated in 2,074 workshops and 1,941 field events in 2018. CIMMYT estimates that these activities had beneficial spillovers in adjacent farms covering a total area of 390,000 hectares.. In addition, as noted above, during 2018 62 small and medium-sized local companies received training from CIMMYT. The 2019 CIMMYT Annual Report, referring to some of the new tools and technologies developed by MasAgro, notes that data collectors were trained to load data variables from plots onto the MasAgro electronic field book. Also, CIMMYT trained extension agents and field technicians loading geographical information onto an open data collection system called ODK Collect.

Project documents indicate that MasAgro conducted different types of CD, including a one-year intensive certified training course in sustainable agriculture, specialized training; training of trainers, engagement in CIMMYT's learning management system, and international course.

Relevance of the Outcomes to the CRP and FP ToC

MasAgro Productor has a ToC which on first impression reads like a cut and paste of the CRP's FP4 sustainable intensification ToC. However, it is understood that the ToC was prepared through a facilitated participatory process. This is in fact evidenced by the fact that the activities and interventions, and the risks and assumptions, differ from those for FP4 of the CRP and are in fact the result of a brainstorming process within MasAgro during the ToC workshop. This is referred to in Childs (2020) in his review of Sustainable intensification MEL practices commissioned by FP1 of the MAIZE and WHEAT CRPs. Childs notes that "One of the reasons the MasAgro ToC appears to be widely appreciated and used is because it was produced through a participatory process. This is an important point because a ToC is both an output that can be used as a tool for multiple purposes, but it is also a process that plays an equally important function in building consensus around the vision of a project and the expected impact pathways and changes that are needed to achieve it —as such, building a ToC through stakeholder participation is a crucial change process in itself." Childs however also notes that staff noted that it was conceived at a high level of abstraction.

Interview findings confirmed that the ToC is interesting as a "thinking element", it is "more of a conversation around that is visible and it is useful to communicate and converse with the government, where they can see individual activities and where they are placed in the ToC".

The reviewers' assessment, confirmed through interviews, was that the ToC was more useful in the upstream components of MasAgro (Biodiversity, Maize, Wheat) than the downstream MasAgro farmer component. Here, as noted also by Childs (2020), the ToC is in practice not as linear as for the other components given the shift, referred to above, away from technology transfer models to a participatory innovation approach. Camacho-Villa et al. (2016) note that "In the case of MasAgro, an initiative of public national and international partners, there were no standard proto-types or recipes for supporting the process, but there was a continuous thread of strategic analysis and decision-making with opportunistic alliances made and new directions taken. It has transformed the program from a technology transfer-oriented one to a program with a participatory innovation approach, covering the heterogeneity of the Mexican agricultural sector. In these contexts, adaptive management shapes agricultural innovations processes resembling more a 'muddling through' to meet and accommodate macro and micro level requirements and negotiate institutional change to be able to embed demand-driven and flexible innovation support arrangements". With regard to the relevance of the ToC for MasAgro farmer, Childs noted that "in trying to strike a balance between the complex systems approach of MasAgro's hub model and presenting a ToC that can be understood by a wide audience, that the ToC leans too far toward simplistic, linear thinking".

FP/CRP/Partner Learning from the Reported Outcomes

Publications, such as those quoted above by Donnet et al. (2017) and Camacho-Villa et al (2016) to mention just two of many, allow for others to learn from MasAgro's outcomes.

Further, the technologies developed and being used in MasAgro have been acclaimed further afield as noted in the CIMMYT 2019 report. The report notes that the United Nations (UN)-sponsored Counting on the World to Act report by the Sustainable Development Solutions Network (SDSN) and the Thematic Research Network on Data and Statistics (TReNDS) describes CIMMYT's data management systems and tools as examples of "frontier technologies" that effectively contribute to sustainable farming in Mexico and respond to the Sustainable Development Goals. Interview findings confirmed that MasAgro has had the opportunity to share their experience in these areas, with both Colombia and Ecuador showing an interest in using similar open source systems and tools. Some of the data capturing systems that MasAgro developed are now being used by the state extension systems, NGOs, and banks. This learning and sharing are connected with the CGIAR Big Data Platform.

Lessons learned through experiences of MasAgro that are relevant to others include:

- The need to move from a push (technology and extension driven sharing of "solutions") to a pull (market-driven) approach

- The use of multi-stakeholder planning informed the development of a structured country collaboration approach around agricultural research issues, which in turn led to national Maize for Colombia, Maize for Mexico, etc., projects
- The need for continuous and stable funding streams.

Links/Synergies with other CRPs

MasAgro not only collaborates with the MAIZE and WHEAT CRPs/CIMMYT, but also with the International Centre for Tropical Agriculture (CIAT), the International Institute for Applied Systems Analysis (IIASA), CCAFS, the Big Data Platform, and with ICRISAT.

Annex 7.3: Review of MAIZE's Response to the Rise of MLN

Overview of Case

Whilst this is not (yet) a MAIZE OICR, the review team chose to take a closer look at MAIZE's response to the rise of MLN as part of the focused reviews conducted in relation to evaluation questions 2.2 under Effectiveness and 1.3 under Quality of Science. This case is an example of how MAIZE used small amounts of W1/2 money to raise awareness of the MLN threat within and beyond Africa and generate substantive W3/bilateral project support to respond to the threat. In particular, in 2016 BMGF funded a three-year project on "Understanding and preventing seed transmission of MLN in Africa" and USAID funded a four-year project on "Diagnostics and management of MLN" from 2015-2019.

The description of the context and response below draws from the donor (BMGF and USAID) summaries, project narratives, and briefs, Prasanna et al. (2020) and Wangai et al. (2012).

The emergence of MLN in East Africa dates back to 2011 when the disease was first reported in lower elevations of the Bomet district of Kenya. From that point on, the disease started spreading first within Kenya, then to Tanzania, the Democratic Republic of Congo, Rwanda, Ethiopia, Mozambique, and Uganda. MLN symptoms are quite numerous: shortened stalk internodes, early leaf necrosis, poor seed set, moldy cobs, and eventually plant death. MLN is a viral disease caused by the combined infection of maize with Maize Chlorotic Mottle Virus (MCMV) and any of the cereal-infecting Potyviruses (SCMV, MDMV, or WSMV). MLN is transmitted through insects and seed transmission has been found to be very low. A study conducted by STAK (Seed Trade Association of Kenya) and KARI (Kenyan Agricultural Research Institute) in 2012 found that 117 out of 119 hybrids released in Kenya were highly susceptible to the disease, putting most of Kenya's maize production at high risk.

Agronomic practices aimed at preventing containment of the disease were put in place. These included: and ensuring a maize-free period across fields at a local/regional level; promoting good agricultural practices, including crop rotation with non-cereals (e.g., legumes): ensuring proper treatment of seeds by seed companies; massively driving awareness of farmers and extension agencies, and providing guidance to farmers on MLN management practices including pesticide applications.

Efforts to identify genetic resistance were also quickly launched. MLN artificial inoculation protocols were developed. By the end of 2013 CIMMYT and KALRO has screened more than 1,000 maize materials and found about 10 to 15% displaying moderate to high levels of resistance against MLN. Major genomic regions controlling resistance to MLN were identified and backcrossed into elite parental lines. A number of additional measures were also taken to ensure a continuous flow of MLN resistant elite maize germplasm in Sub-Saharan Africa, including the establishment of an MLN screening facility accessible to all regional research institutes and seed companies for a fee.

Within that context, the purpose of the BMGF project was: To effectively curb the spread and impact of the maize lethal necrosis (MLN) epidemic in sub-Saharan Africa which was threatening the food security and livelihoods of the smallholder farmers on one hand, and the economic viability of maize-based seed industry on the other. The major aim of the project was to provide the necessary technical foundation, including identification of effective and robust measures to control the spread and impact of MLN through seed, by generating better understanding of the epidemiology of MLN-causing viruses, especially MCMV.

The BMGF project addressed six Primary Outcomes. These were: i) Reliable and cost-effective diagnostic protocols for curbing the spread of MCMV/MLN through seed implemented by NPPOs and commercial seed companies. ii) Mode of MCMV transmission through commercial seed within endemic areas is understood, allowing more effective control iii) Comprehensive knowledge required for development of effective phytosanitary regulations with regard to MLN. iv) Reducing MLN disease pressure in eastern Africa through a comprehensive 'Clean seed, Clean soil' program. v) Preventing the spread of MCMV/MLN from endemic to non-endemic countries (including West Africa and Southern Africa) vi) Project management, M&E&L, and communications.

Meanwhile, the USAID-funded project coordinated regional efforts to strengthen the response to the rapid emergence and spread of MLN. It helped establish a community of practice among national plant protection organizations in eastern Africa for implementing harmonized MLN diagnostic protocols for detecting MLN-causing viruses and enable commercial seed companies to implement necessary standard operational procedures to produce MLN-free clean seed at various points along the maize seed value chain. It also stepped-up MLN surveillance and monitoring in Malawi, Zambia, and Zimbabwe, three of the major commercial maize seed exporting countries in sub-Saharan Africa.

The USAID MLN project was implemented in close partnership with the Alliance for a Green Revolution in Africa (AGRA), the African Agricultural Technology Foundation, national plant protection organizations, and commercial seed companies in eastern Africa. It also pooled expertise from relevant public- and private-sector partners, regional organizations, and seed trade organizations operating in the region. The project was a follow-up step from the May 2015 MLN Diagnostics and Management in Africa conference, which formulated strategies and recommendations to prevent the spread of MLN through seed. The conference was jointly organized by CIMMYT and AGRA in collaboration with the Kenya Agriculture and Livestock Research Organization.

Prasanna et al (2020) provide the following overview of the MAIZE MLN response in the abstract of their paper: "Maize lethal necrosis (MLN), a complex viral disease, emerged as a serious threat to maize production and the livelihoods of smallholders in eastern Africa since 2011, primarily due to the introduction of maize chlorotic mottle virus (MCMV). The International Maize and Wheat Improvement Center (CIMMYT), in close partnership with national and international partners, implemented a multi-disciplinary and multi-institutional strategy to curb the spread of MLN in sub-Saharan Africa and mitigate the impact of the disease. The strategy revolved around a) intensive germplasm screening and fast-tracked development and deployment of MLN-tolerant/resistant maize hybrids in Africa-adapted genetic backgrounds; b) optimizing the diagnostic protocols for MLN causing viruses, especially MCMV, and capacity building of relevant public and private sector institutions on MLN diagnostics and management; c) MLN monitoring and surveillance across sub-Saharan Africa in collaboration with national plant protection organizations (NPPOs); d) partnership with the private seed sector for production and exchange of MLN pathogen-free commercial maize seed; and e) awareness creation among relevant stakeholders about MLN management, including engagement with policymakers".

Partnerships

Response to the appearance and spread of MLN involved a large number of diverse local or international partners covering agriculture and seeds (CGA - Cereal Growers Association; STAK - Seed Trade Association of Kenya), plant health (AAK - Agrochemicals Association of Kenya; ICIPE - International Centre of Insect Physiology and Ecology; KEPHIS - Kenya Plant Health Inspectorate Service; PCPB - Pest Control Products Board), research and technology (AATF - African Agricultural Technology Foundation; BecA - Biosciences Eastern and Central Africa; CIMMYT; FERA - Food and Environment Research Agency, UK; KALRO - Kenya Agriculture and Livestock Research; OARDC - Ohio Agricultural Research and Development Center, USA; University of Minnesota, USA; University of Nairobi), as well as general and policy development support (AGRA - Alliance for a Green Revolution in Africa). This list, which is not exhaustive, illustrates very well the level of network mobilization to contain and mitigate the spread of MLN. The outcome has just been as positive, and very rapid. MLN has been essentially contained to the area of its early years. Screening efforts permitted the identification and launch of hybrids with high enough levels of resistance. Genetic studies have enabled effective breeding for MLN resistance, ensuring a permanent flow of resistant products being released in all relevant geographies. Continued collaborations among partners at the level of quality of the past years should ensure effective containment of the disease while also having mitigation measures in place.

Outcomes and Contribution to SRF and IDOs

During the 21.10.20 USAID Agrilinks webinar in which MAIZE’s response to the MLN threat was presented, it was noted that success was achieved through the integration of the following components: a) Breeding and deploying MLN resistant varieties (CIMMYT, NARS, seed companies), b)MLN diagnostics and epidemiology (CIMMYT, KALRO, USDA/OSU, UMN), c) MLN-free seed production and exchange (NPPOs, Seed companies, AATF, AGRA, CIMMYT), d) rigorous monitoring and surveillance (NPPOs, CIMMYT), e) agronomic management (NARES, Development Partners) and f) capacity building, communication, and outreach (CIMMYT, NARES, ARIs, Development Partners).

In relation to the USAID funded MLN project, the final project report noted that "The project life cycle of four years was completed successfully with the objectives accomplished on time, including those of the final year. The project was implemented in eight countries viz., Kenya, Uganda, Tanzania, Rwanda, Malawi, Zambia, and Zimbabwe with other partners from these countries. Most partners completed their activities in good time with a few exceptions who needed some extension. This was due to extension in planned season activities and others had internal logistics issues."

The conclusion of Prasanna et al (2020) indicates the following outcomes: "MLN management has been effectively addressed through several simultaneously-implemented strategies, including development and deployment of elite MLN tolerant/resistant varieties adapted to Africa; coordinated and synergistic multi-disciplinary efforts of various national and international institutions engaged in maize R&D in Africa; intensive awareness creation among stakeholders, and capacity building of relevant public and private sector institutions on MLN diagnostics and management; devising and implementing a checklist and standard operating procedures for MLN-free commercial seed production and exchange by the commercial seed sector; and strong engagement of the national plant protection organizations (NPPOs) on MLN surveillance across SSA."

Further, the conclusion notes that "Intensive engagement with the NPPOs across sub-Saharan Africa, especially major maize-growing countries in southern Africa and West Africa, have so far been successful in preventing the spread of MLN from the eastern Africa where MLN is widely prevalent. Since 2014, no new country in sub-Saharan Africa has reported incidence of MLN. Among the various interventions implemented by CIMMYT and partners, capacity building of relevant public and private sector institutions on MLN diagnostics and management, intensive awareness creation among the stakeholders, and systematic monitoring and surveillance have been particularly impactful. Despite this, there is no room for complacency because the disease is still prevalent in various countries in eastern Africa, including Ethiopia, Kenya, Rwanda, Tanzania, and Uganda".

Document review findings above were confirmed by an interview respondent who stated that "Because of that early connection with CIMMYT and the quick response the disease has been largely contained in Kenya. Some spread through seeds to other countries but with the early warning system we have been able to control its spread". The respondent was happy with CIMMYT taking early action, noting that CIMMYT (MAIZE) addressed the challenge with the right people and the right resources and timely support from donors and that "If nothing was done it would have been much worse, it would have spread even to West Africa".

In addition to management that has led to containment of the disease, a number of actions have been engaged which resulted in the development and deployment of tools to mitigate the risks of a failure of containment practices. Several studies were conducted to discover or validate genetic elements that control the expression of resistance to MLN (Awata et al., 2020; Beyene et al., 2017; Gowda et al., 2018; Sitonik et al., 2019) or develop predictive models (Nyaga et al., 2020; Sitonik et al., 2019), all with the objective of speeding-up the development of MLN-resistant varieties targeting as many geographies as relevant.

In terms of contribution to MAIZE SLOs and IDOs, the MLN response was proactive and dynamic, rather than something that was planned to fit into any of the CRPs FPs or designed to respond to specific SLOs and IDOs. Nevertheless, the CRPs initial response, which involved identifying the threat MLN posed to maize production in and potentially beyond Africa, and rapidly deploying staff and resources to address it proactively, certainly does respond to the SLOs and IDOs within the CRP's ToC. In particular, it responded to IDOs 1.4 (increased productivity) and 2.1 (improved diets for poor and vulnerable people). It also responded to several of the cross-cutting IDOs including A.1 Mitigation and adaptation achieved, C.1 Enabling environment improved and D.1 National partners and beneficiaries enabled.

Cross-cutting Issues

Of the four cross-cutting areas, the responses to MLN related mostly to CC and CD. They related to CC in that the sudden emergence of cross-boundary diseases and pests is more likely under conditions of climate change. Further MLN resistance was built into new stress-tolerant varieties specifically bred to enhance climate resilience.

Based on the review of CRP and project reports and on interviews, substantial CD was conducted. The 21.10.20 USAID Agrilinks webinar noted that capacity of 574 national plant protection officers was built, 444 seed company personnel, 227 NARES staff, and 2,258 seed growers. The USAID final report notes that seed analysts from eight countries were trained in MLN diagnostics, and training was also provided on surveillance and on MLN free seed production. An MLN Community of Practice was also established which has had a number of both face-to-face and virtual meetings. In addition, an MLN web portal https://mln.cimmyt.org/ was established and officially opened to the public in 2017. A number of clear and simple outreach documents were funded under the USAID project including "12 steps for control of MLN in farmers' fields" and "12 steps to MLN free seed".

The most tangible manifestation of CD is probably the establishment, in 2013, of the KALRO / CIMMYT MLN screening facility, at the KALRO Naivasha research station in Kenya's Rift Valley where MLN incidence is very high. This is the first, and still today, only, dedicated MLN screening facility in East Africa. The facility comprises 17 hectares used for MLN field screening of germplasm, dedicated laboratories, and screen houses. Tens of thousands of accessions are screened each year under artificial inoculation with MLN. The facility operates as a regional resource with both public and private sector partners submitting germplasm for testing. More than ten private seed companies (multi-national and national) and seven public sector partners from 5 East African countries are currently testing materials at Naivasha on a fee-per-use basis. This facility and its regional mission represent a significant step forward in terms of cross-border collaboration and value-creation among national institutes and with the seed industry.

Relevance of the Outcomes to the CRP and FP ToC

The reported outcomes relate to three of the CRP FPs (FP1, FP2, and FP3). The ten outcomes within the FP3 ToC are all ones which the response to the MLN threat undertook (apart perhaps from 3.9 which specifically focuses on increased availability of nutritious maize).

FP/CRP/Partner Learning from the Reported Outcomes

The CRP as a whole learned, both from responding to MLN and their earlier response to FAW, how best to manage staff and resources to be able to respond to urgent emergent threats. Interviews with FP/CRP staff indicate that it would be useful to have a ToC that is itself flexible enough to build in dynamic responses to such threats.

Annex 8: Conflict of Interest Statements by Reviewers

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

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

   No

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

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

   No

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

Name: Dr Rachel B Percy

Signed:

Date: 18.08.20

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 (as far as I know, given the documents I have had access to so far)

    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 (as far as I know, given the documents I have had access to so far)

    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: Michel Ragot

Signed:

Date: 26/08/2020

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