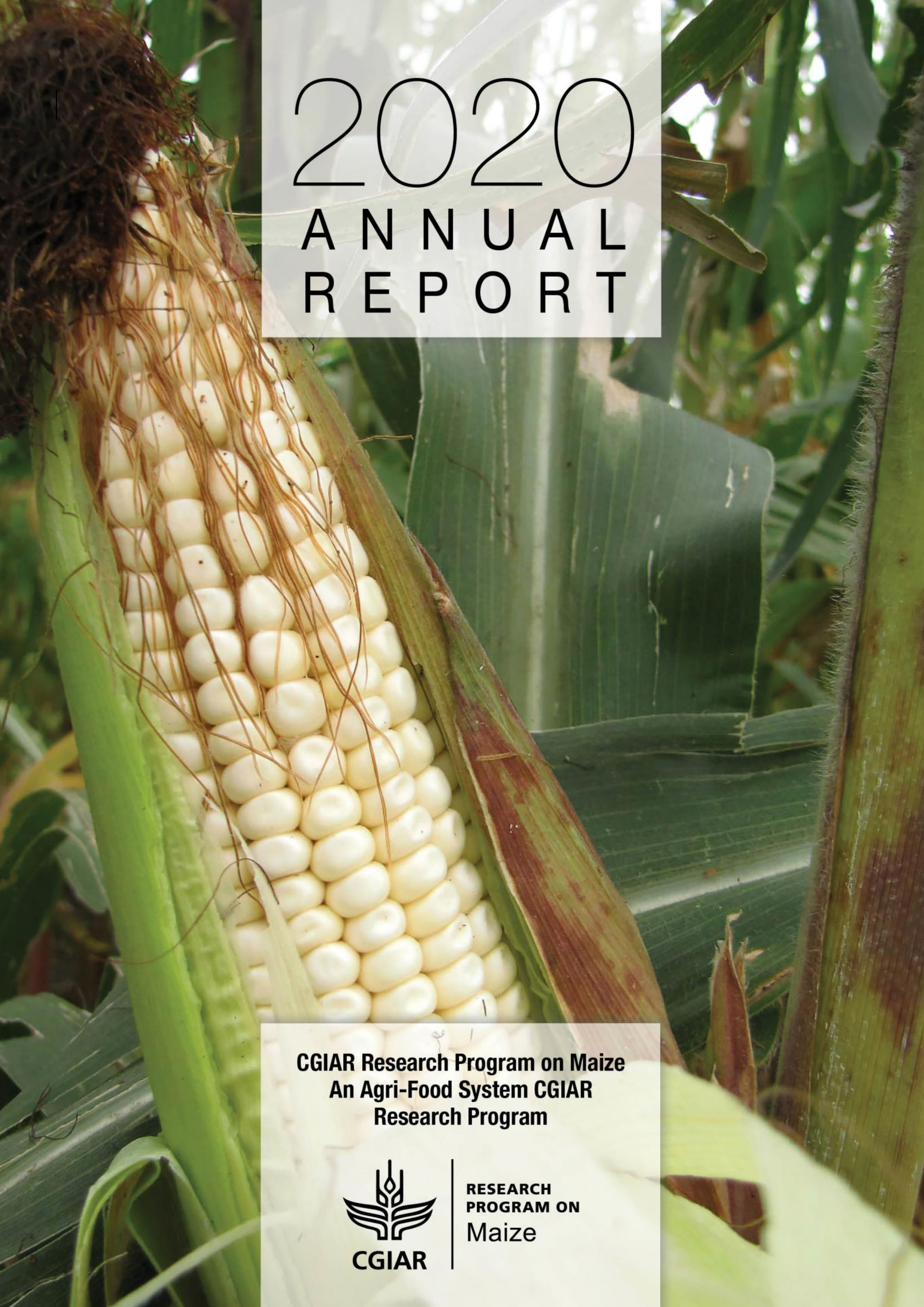

2020 ANNUAL REPORT

CGIAR Research Program on Maize
An Agri-Food System CGIAR Research Program

CGIAR

RESEARCH PROGRAM ON Maize

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Acronym list

CGIAR System Institutions and Processes

AFS	Agri-food systems
A4NH	CGIAR Research Program on Agriculture for Nutrition and Health
ARI	Advanced Research Institute
Buena Milpa Project	Feed the Future Buena Milpa Guatemala Project
CASI	Conservation Agriculture for Sustainable Intensification
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CGIAR	CGIAR, a global research partnership for a food-secure future
CIMMYT	International Maize and Wheat Improvement Center
CSISA	Cereal Systems Initiative for South Asia
CRP	CGIAR Research Program
EiB Platform	Excellence in Breeding Platform
FACASI	Farm Mechanization and Conservation Agriculture for Sustainable Intensification
FAW Consortium	Fall Armyworm R4D International Consortium
FP	Flagship project
GENNOVATE	Global Comparative Gender Norms Research Initiative
Harvest Plus	A program that is part of the CGIAR Research Program on Agriculture for Nutrition and Health
IA	Impact Assessment or Intellectual Asset
IDO	CGIAR Intermediate development outcome
IEA	Independent Evaluation Arrangement
IITA	International Institute of Tropical Agriculture
IMIC-Africa	International Maize Improvement Consortium in Africa
IMIC-Asia	International Maize Improvement Consortium in Asia
IMIC-LATAM	International Maize Improvement Consortium in Latin America
ISC	Independent Steering Committee
LMS	Learning Management System
MAIZE	CGIAR Research Program on Maize Agri-food Systems
MARLO	Managing Agricultural Research for Learning and Outcomes
MC	Management Committee
MEL	Monitoring, Evaluation & Learning
MEL CoP	Monitoring, Evaluation and Learning Community of Practice
MELIA	Monitoring, Evaluation, Learning and Impact Assessment
OICR	Outcome impact case report
POWB	Plan of Work and Budget
R4D	Research-for-Development
SIMLESA	Sustainable Intensification of Maize and Legume Systems for Food Security in Eastern and Southern Africa
SLO	System Level Outcome
SMB	System Management Board
SMO	System Management Office
SRF	Strategy and Results Framework
STMA	Stress Tolerant Maize for Africa
TAMASA	Taking Maize Agronomy to Scale in Africa
W1, W2, W3/bilateral	CGIAR Windows 1, 2 and 3/bilateral
WHEAT	CGIAR Research Program on Wheat Agri-food Systems

Research and Development Partners

BARI	Bangladesh Agricultural Research Institute
DArT	Diversity Arrays Technology, Australia
DFID	Department for International Development, UK
ICAR	Indian Council of Agricultural Research
EIAR	Ethiopian Institute of Agricultural Research
ICTA	Agricultural Science and Technology Institute
IDS	Institute of Development Studies, University of Sussex, Brighton, UK
JHI	James Hutton Institute, UK
INIFAP	Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias (Mexico)
KALRO	Kenya Agricultural & Livestock Research Organization
KIT	Royal Tropical Institute, the Netherlands
NARC	Nepal Agricultural Research Council
NARO	National Agricultural Research Organisation, Uganda
USAID	United States Agency for International Development
WUR	Wageningen University, the Netherlands
YPARD	Young Professionals for Agricultural Development

Miscellaneous

AIPs	Agricultural Innovation Platforms
CA	Conservation agriculture
CSA or CSAPs	Climate smart agricultural practices
DH	Double haploid
DOI	Digital Object Identifier
DT	Drought tolerant
FAW	Fall armyworm
GS	Genomic Selection
IP	Intellectual Property
ISI	International scientific indexing
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MLN	Maize lethal necrosis
M&E	Monitoring and Evaluation
NARS	National agricultural research system(s)
SSA	Sub-Saharan Africa
SDGs	Sustainable Development Goals
WTP	Willingness to pay
Zn	Zinc

Statistical analysis applications

CERES-Maize	Crop model. Part of the Decision Support System for Agro technology Transfer

COVER PAGE

Name of the CRP: MAIZE
Name of the Lead CGIAR Center: International Maize and Wheat Improvement Center (CIMMYT)
Flagship lead institutions (CGIAR Centers or lead partners)
Flagship 1: CIMMYT & IITA
Flagship 2: CIMMYT & IITA
Flagship 3: CIMMYT & IITA
Flagship 4: CIMMYT & IITA

Other participating CGIAR Centers: IITA, plus key partners: **ICAR (India), IDS (UK), KIT (NL), DArT (AU), JHI (UK), Bayer, Corteva Agriscience, Syngenta, KALRO (Kenya), NARO (Uganda), EIAR (Ethiopia), DR&SS (Zimbabwe), NARC (Nepal), BARI (Bangladesh), INIFAP (Mexico), African Seed Trade Association (ASTA) and WUR (NL). Top ten list/map of project partners (2020) is accessible** here.

Acknowledging our funders:
In 2020, Australia (ACIAR) and UK (DFID) supported the CGIAR Agrifood-Systems Research Program on Maize (MAIZE) with Window 2 funding ($2.1M) and 12 funders supported this CRP with Window 1 funds ($6.43M) through the CGIAR Fund. Bilateral funders supported projects matched to MAIZE Flagship Projects (FPs) and Clusters of Activity (CoAs) totaling US$39.12 million.

EXECUTIVE SUMMARY

Part A: NARRATIVE SECTION

The world faced unprecedented disruptions and change in 2020. Agricultural systems and research-for-development (R4D) were no exception. Nevertheless, the CGIAR Research Program on Maize (MAIZE) made great advances in ongoing research initiatives. It was also able to respond to unique circumstances and challenges posed by the Covid-19 pandemic that engulfed the world in 2020, such as major agricultural labor shortages induced by mobility restrictions.

From research on value chains and improved nutrition to conservation agriculture and scale appropriate mechanization, researchers delivered outcomes and impacts relating to SLO targets 1.1, 1.2, 2.1 and 2.2. MAIZE researchers also made great strides in the development and deployment of elite stress-tolerant and nutritionally enriched maize varieties with enhanced genetic gain, using novel genetic diversity and tools. Adoption and impact assessments of drought-tolerant maize in sub-Saharan Africa (SSA) show much promise for further scaling. In South Asia, W1&2-funded climate-resilient maize breeding and bilaterally-funded sustainable intensification-related outputs and outcomes provide the basis for expanded new partnerships for scaling. Most maize innovations stood at Stage 1 or 2, and half of them were genetics-related --- *see Table 4.*

Impacts of CGIAR Maize Improvement in sub-Saharan Africa 1995-2015, a comprehensive review, documents the adoption and impacts of CGIAR-related maize varieties in 18 major maize-producing countries in SSA over the course of two decades. Of the 1,345 maize varieties released in this timeframe, approximately 60% had known or reported CGIAR parentage. In 2015, the aggregate yearly economic benefits of using newer CGIAR-related maize varieties (released after 1994) were estimated to be between US$ 0.66-1.05 billion, whilst global investment in CGIAR maize improvement was modest at up to US$ 30M p.a. - *see SLO 1.1, Table 1.*

Focusing on Ethiopia, a SPIA study investigated the impacts of the maize breeding program started in 1988 (CIMMYT and EIAR). Of the 54 maize varieties released since 1990, 34 are considered to contain CIMMYT-derived germplasm. In the past 20 years, 10 drought-tolerant and 8 Quality Protein Maize (QPM) varieties have been released.

Together with researchers from the CGIAR Research Program on Rice (RICE), the CGIAR Research Program on Policies, Institutions, and Markets (PIM), and the CGIAR Research Program on Wheat (WHEAT), MAIZE researchers found that the cereal-based food security system has been evolving due to rural transformations. With global population expected to reach 10.6 billion by 2050, the total demand for cereals will rise to provide the caloric base for diets worldwide, posing important challenges to the productive capacity of rural areas. It is therefore imperative to understand these transformations.

Researchers found that cereal-based food system will remain dominant but will face major challenges. Principally: how to support rural and agricultural transformation (e.g. poverty alleviation, employment creation) while maintaining agricultural diversity; and meeting increased demand for cereals without displacing other nutritious crops and livestock from rural landscapes. To date, global agricultural assessment models are unable to adequately address these concerns. Separately, MAIZE partner scientists argue that cereals, including maize, could be an important source of nutrients known to enhance health and prevent diseases.

The 20 foresight, ex-ante and evaluation and learning products cut across all MAIZE Flagships - *see Table 10.*

Part A: Covid-19

Scientists were part of a multi-center initiative in Bangladesh and provided recommendations for policy action to the Secretary of Agriculture and Ministry line agencies. This positioned the CGIAR as a "go-to" for advice on COVID response in Bangladesh. With other partners, WHEAT and MAIZE scientists provided ex-ante, foresight and prioritization advice to decision-makers (see OICR4025/MAIZE and 3988/WHEAT for details). In "Fixing our global agricultural system to prevent the next COVID-19," CIMMYT and partner scientists identified biodiversity stress/loss as a leading factor in the emergence of infectious diseases. Promoting landscapes that work for nature and people requires removing policies such as subsidies and distortion. Separately, ICRAF & CIMMYT scientists gathered evidence about value chain fractures and identified three priorities for further research. MAIZE and WHEAT scientists engaged in three of four Covid-19 Hub workgroups - see Tables 3 and 10.

CIMMYT implemented its Business Continuity Plan to protect the continuity of critical operations, steered by a Crisis Management Team that managed CIMMYT's contingency plan. Monitoring tools and traffic light reports were also implemented to track projects deliverables from all funding sources affected by Covid-19.

1. Key Results

1.1 Progress Towards SDGs and SLOs

Sustainable intensification: In an ex-post study, scientists examined the farm-level yield and income effects in Ethiopia of adopting a set of agronomic practices focused on productivity—i.e. fertilizer alone—versus Natural Resource Management (NRM)—i.e. a combination of measures. Fertilizer use alone was associated with a 29.5% yield gain (827 kg/ha) and a net maize income gain of about 1423 *birr*/ha (6.3%). The yield impact of a combination of measures (fertilizer, maize-legume diversification, and soil and water conservation measures) was around 1748 kg/ha (87.5%), with a net income impact of 9461 *birr*/ha (63.8%). This analysis is important; farmers adopt sustainable intensification practices only when they can observe yield and income effects under their specific circumstances. *See table 1, SLO 1.1*

Yield gap components in Ethiopia: An ex-ante study argues that Ethiopian farmers' maize yields could be up to five times higher if four different drivers of yield gap were addressed simultaneously. Considering all climate zones, MAIZE and partner scientists found that the technology gap makes up the largest component of the yield gap (41%), followed by the allocative yield gap (26%) and economic and technical efficiency gaps. Closing the technology gap requires the diffusion of advanced technologies (e.g. precision agriculture, improved protection against weeds, pests, and diseases) and an increase in the use of improved varieties tailored to Ethiopian agro-ecological conditions. The researchers' sample estimated only 26% of Ethiopian smallholders use improved seeds.

Rapid response to MLN (FP3): Maize lethal necrosis has had a devastating effect on the livelihoods of resource-poor maize farmers and other value chain actors in eastern Africa, including Small- and Medium-Enterprise (SME) seed companies and processors. In 2013, Kenya lost an estimated 0.5 million tons, valued at US$ 180 million. MLN was poised to spread to other countries in SSA. A MAIZE-supported multi-disciplinary and multi-institutional strategy, launched in 2012, curbed the spread and mitigated its impact in SSA. The strategy revolved around a) fast-tracked development and deployment of MLN-tolerant/resistant maize hybrids; b) virus diagnostics; c) MLN monitoring and surveillance across Africa; and d) production and exchange of MLN pathogen-free commercial maize seed. Key results to date include 19 MLN-tolerant/resistant hybrids released in eastern Africa; converting 52 elite—but MLN-susceptible—inbred lines into MLN-resistant versions; optimized diagnostic protocols and NARES partner training. Building on this success, MAIZE and partner scientists developed a CERES-Maize model to measure MLN damage on selected maize hybrids with different levels of MLN tolerance, and to develop genetic coefficients for 17 selected maize hybrids. These findings will enable breeders to quantify the bioeconomic impact of breeding for resistance to MLN.

Drought tolerant maize adoption for improved yields and livelihoods:

Stress Tolerant Maize for Africa (STMA): The STMA project, a partnership with 13 countries' NARES partners and the International Institute of Tropical Agriculture (IITA), exceeded its objectives. STMA-derived drought-tolerant maize varieties have benefited more than 8 million households and were grown on 5 million hectares in 13 target countries in eastern, southern and west Africa in 2020. These varieties demonstrate at least 25-30% grain yield advantage under drought stress at flowering. This translates into at least a one ton per hectare enhanced grain yield, stabilizing income and food insecurity. The varieties are also more resistant to major diseases (MLN) and parasitic weeds (Striga), and some offer enhanced protein quality and provitamin A. STMA closed in 2020, but its legacy has been celebrated, including by Bill Gates, and has been incorporated into the Accelerating Genetic Gains in Maize and Wheat for Improved Livelihoods (AGG) project.

Determinants of climate-resilient crop adoption: A scoping review examined the conditions that led to the adoption of climate-resilient crops over the past 30 years in lower- and middle-income countries struggling with climate-related impacts (e.g. the 45 indicators established by the Notre Dame Global Adaptation Initiative). Small-scale producers adopted climate-resilient crops and varieties to cope with abiotic stresses such as drought, heat, flooding and salinity. The most prevalent trait in the study dataset was drought tolerance, followed by water-use efficiency. The most important determinants of adoption were 1) the availability and effectiveness of extension services and outreach, 2) the education levels of heads of households, 3) farmers' access to inputs, especially seeds and fertilizers, and 4) the socio-economic status of farming families. Farmers adopting multiple complementary strategies contribute to building highly resilient and sustainable agriculture systems that can respond to shocks. The authors recommend a multiple-interventions approach, if countries want to promote adoption of climate-resilient crops.

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

1.2.1 Overall CRP progress

During 2020, MAIZE made strong progress on both of its research strategies: stress resilient and nutritious maize, and sustainable intensification of maize-based systems. In total, 48 improved maize varieties derived from germplasm from CIMMYT and IITA were released through MAIZE partners in 2020. These include 28 in sub-Saharan Africa, 10 in Latin America and 10 in Asia. Besides high and stable yield potential, some of the special traits stacked in these varieties include drought tolerance, Nitrogen Use Efficiency (NUE), Tar Spot Complex (TSC) resistance, Quality Protein Maize (QPM), increased provitamin A content (in partnership with A4NH), ear rot or mycotoxin resistance and Turcicum leaf blight resistance.

MAIZE's Sustainable Intensification impact pathway, led by FP4, can point to progress on policy (in Ethiopia and India), landscape level ex-ante learning, and second user outcomes in Sub-Saharan Africa, Latin America, and South Asia, as documented in Outcome and Impact Case Reports 2701, 3930, 4042 and 4043 - *see Table 5.*

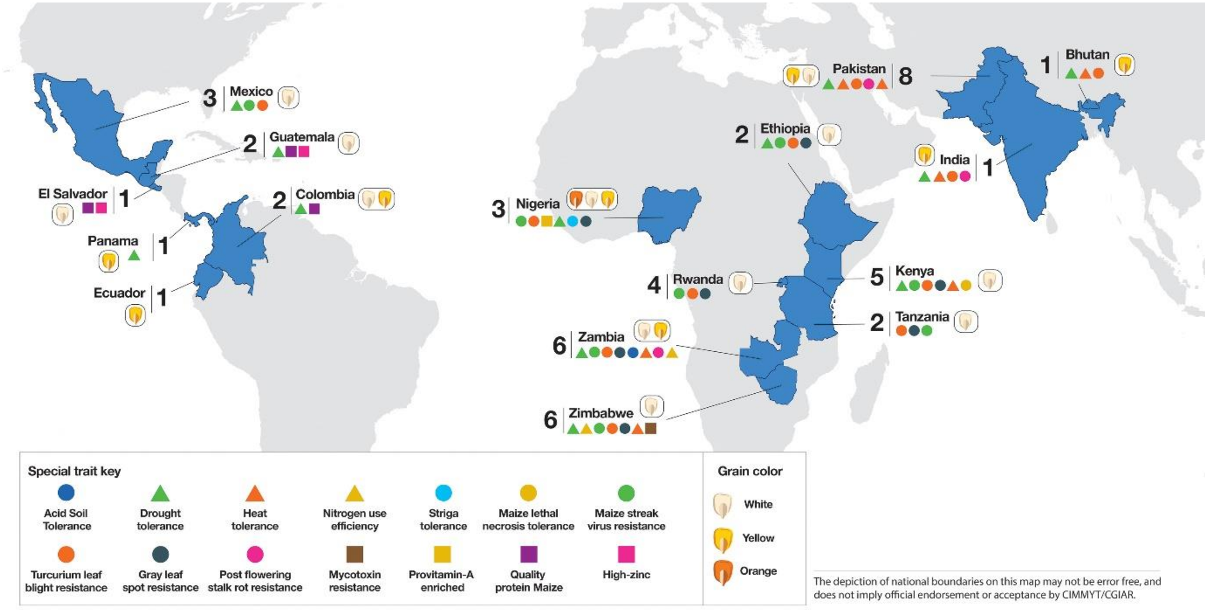


Figure 1: Elite maize varieties released by MAIZE CRP partners in 2020, with depiction of key traits.

1.2.2 Progress by flagships

FP 1 Enhancing MAIZE's R4D Strategy for Impact

Biofortified crops have tremendous potential to improve child nutrition in Ethiopia (Oromia). Scientists tested whether complementing the distribution of Quality Protein Maize (QPM) with a package of interventions informed by behavioral insights could increase young children's consumption and translate into improved growth. Results suggest that it is **possible to elicit changes in behaviors that can help translate adoption of biofortified crop varieties into child consumption**. Impacts were substantial: the intervention increased QPM consumption for young children by nearly 25% and more than doubled the probability that the caregiver cooked a QPM food specifically for young children. While behavioral changes attenuated over time, statistically significant changes in behaviors persisted.

The current agricultural extension system in Ethiopia emphasizes intensification of maize production using external inputs (improved seed and chemical fertilizer) among smallholders (Source: panel data from 2,887 and 2,853 maize plots operated by a sample of 1,751 and 1,774 farm households surveyed in 2010 and 2013). Applying the full package of external input use, combined with diversification, provided the highest maize yield and lowest downside risk. Policies should therefore support and encourage the use of the full package, using those farmers already implementing it as exemplars for their peers. Policies should also support non-users to apply the missing components, to generate additional yield and income benefits at a reduced downside risk.

An examination of the impact of cooperative membership on the rate and speed of technology adoption in Zambia showed that cooperative membership increased the probability of technology adoption by 11-24 percentage points. Cooperative membership increased the speed of adoption of improved maize by 1.6-4.3 years. Results point to the need for policies and strategies that promote and strengthen farmer associations such as cooperatives, which play multiple roles, such as marketing, input distribution, credit and information provision—especially in the presence of market failures.

Despite hybrids being grown on 30-40% of the maize area in Pakistan, the seed retail price is high compared to neighboring countries. MAIZE scientists analyzed the adoption and impact of hybrid maize on livelihoods among 822 maize growers (e.g. adopters and nonadopters in four major provinces). Hybrid maize adopters enjoyed higher grain yields (94-124 kg per ha), higher household income levels (Pakistani rupees 2,176-3,518), and lower poverty levels (by 2-3%). The authors propose scaling adoption through policies to enhance supply and lower the seed cost of hybrid maize varieties.

A MAIZE study of maize growers, seed producers and retailers, service providers, and end-use industries in Nepal found that seed companies' lack of production, business operations, and marketing capacity is pushing agro-dealers and farmers to turn to imported varieties. To upgrade Nepal's hybrid maize value chain, authors recommend improving seed company access to parental lines and increasing their capacity to build demand for new hybrids in a competitive marketplace.

Limited seed company and farmer engagement with agro-dealers was found to be one reason for low maize yields and disappointing uptake of new, stress-tolerant varieties in Kenya. MAIZE scientists suggested exploring seed company engagement with agro-dealers and in-store promotions to improve returns on investments in seed systems.

An innovative platform approach improved women's participation in the maize value chain in rural Congo in a 2015-2017 study. Average individual income from platform participation increased from US$100 to $300 per cropping season, and average earnings were higher in a platform composed of only women. However, to be most effective for rural women, an innovation platform should avoid wide social disparity among members and diversify the sources of income by including livestock and other off-farm activities.

FP 2 Novel diversity and tools for improving genetic gains

Make use of genetic diversity in African maize gene pools. A wide range of genetic variability was observed among the West and Central African inbred lines, indicating that they are an **invaluable resource for breeding for heat and drought tolerance** in maize breeding programs. The study identified valuable landraces that have not served as sources of improved germplasm. Another study assessed the genetic diversity and population structure of a Sahel/Coastal Western Africa maize panel of 208 accessions. Authors found that **this gene pool could be a source for novel genetic variation** for maize improvement. Separately, researchers used a large set of lines together comprising 1,400 inbreds to understand and validate the genetic architecture of MLN resistance and identified 32 SNPs significantly associated with MLN resistance. A set of **candidate genes associated with the significant markers were shown to be directly or indirectly involved in plant defense responses. MLN is a complex trait** controlled by few major and many minor effect genes.

Scientists expanded Environmental GWAS (EnvGWAS) from a defined panel of germplasm to a **set of maize germplasm bank holdings with collection site-specific environmental characterization data**. This panel of over C.17,000 landraces associated genotypes with nine environmental variables, ranging from precipitation to heat to soil pH. This analysis relied on the gold standard reference genome B73 as a framework. Eight CIMMYT Maize Lines (CML) tropical genome references were newly released. Analyses will be validated in 2021, when suitable phenotypic data is available.

New lines developed through pre-breeding released. Nine new sources of variation for drought tolerance and resistance to Tar Spot Disease Complex were released by CIMMYT. The new category of maize inbred lines called CIMMYT Maize Genetic Resource Lines (CMGRL) are derived from crosses between elite CIMMYT lines and landrace accessions, populations or synthetics from the CIMMYT Germplasm Bank. These well characterized lines bring novel variation to breeders in an easy to use genetic background.

Characterizing Striga Resistance Mechanisms in Maize: 24 maize inbred lines with varying levels of field resistance to two ecotypes of S. hermonthica were screened for pre- and post-attachment resistance mechanisms. Several maize inbred lines demonstrated a good level of resistance to both S. hermonthica ecotypes in rhizotrons in controlled environments, consistent with the results from field studies in Nigeria. In addition, quantification of the amounts of strigolactone germination stimulants in the root exudates of these lines and analyses of their biological activity on parasite seed germination found some lines that produced very small amounts of strigolactones, triggering the least or no germination of Striga seeds. The presence of lines combining good levels of post-attachment resistance with low infection levels allows strategic stacking of different resistance mechanisms in a single maize genotype.

FP 3 Stress tolerant and nutritious maize

MAIZE and partner scientists demonstrated ***successful breeding program scale use of genomic selection (GS) in Africa*** and Latin America, reducing the operational cost of Stage 1 field testing by 40%. CIMMYT and national agricultural research breeding programs throughout eastern and southern Africa are scaling up this method - *see OICR Table 3.*

The STMA project came to an end in March 2020, after having ***successfully developed and deployed multiple stress tolerant maize varieties adapted to eastern, southern and West Africa***. 110,000 tons of certified seed (2019) for over 100 stress-tolerant improved maize varieties, produced by seed company partners, reached more than 8 million households in 2020. Accelerating Genetic Gains in Maize and Wheat for Improved Livelihoods (AGG) was launched in August 2020, which aims to reduce the breeding cycle to 3-4 years and produce 150,000 tons of certified seed reaching 10 million households by 2024.

Host plant resistance is an important component of Integrated Pest Management (IPM) of fall armyworm (FAW), because it is compatible with other control methods and exhibits synergistic effects with natural enemies, good agronomic practices and environmentally safer pesticides. Starting in 2017, the MAIZE breeding program in Kenya developed elite maize germplasm with tolerance/resistance to FAW. To date, over 6000 maize genotypes from diverse sources were screened under artificial FAW infestation. Based on the results of the different trials, three FAW tolerant hybrids were announced to partners for further evaluation under NPTs, varietal release and commercialization in East and Southern Africa.

Four major approaches have been used in the identification and development of germplasm resistant/tolerant to FAW. These include (a) screening CIMMYT and exotic germplasm to identify resistant/tolerant inbred lines, (b) formulating, testing and identifying hybrids combining high yield potential, good agronomic and adaptive traits, and resistance to FAW, and (c) development of new FAW tolerant lines from different source populations using Doubled Haploid (DH) method. Several crosses were made among resistant lines and progenies were selected and intercrossed to increase the frequency of favorable resistance alleles. In 2019/2020 a total of 2,733 DH lines were produced from different source populations. In 2020, a total of 1,400 DH lines were screened for FAW under artificial infestation. Several promising lines with resistance to FAW for both foliar and ear damage have been identified. The best lines will be used to make new single cross and three-way hybrids to be evaluated in 2021.

IITA, together with national partners in Cameroon, Benin and DR Congo, has carried out field research since 2019 to identify FAW natural enemies in farmers' fields. Collected specimens were sent to the Natural History Museum in the UK for species identification and their parasitism rate on eggs and larvae were evaluated in the IITA laboratory on lab-reared FAW colonies and other Spodopterans. Laboratory studies of the egg parasitoid *T. remus* revealed high field parasitism rates of 52 to 100% as well as the induction of significant non-reproductive mortalities in FAW.

IITA scientists also carried out laboratory and field efficacy studies of 27 products designed to kill FAW, including chemical pesticides, biopesticides and botanicals, as well as local farmer practices. Six chemicals pesticides were tested in the IITA laboratory in Cameroon and were found to kill FAW even if applied at half the recommended dosage. On-farm testing of 22 products in Benin, Cameroon, Ghana and DRC revealed, among other findings, several botanicals and two parasitoids with high potential. Several varieties of maize grown across 12 sampled sites under good agronomic practices recovered from the initial attack and had less than 30% damage severity and 0% yield loss *- see OICR Table 3.*

FP 4 Sustainable intensification of maize-based systems for improved smallholder livelihoods

***Synthesis of Conservation Agriculture (CA) systems' maize yield merits* in eastern and southern Africa (ESA).** MAIZE scientists analyzed CA in maize systems relative to conventional farmer practices and the contribution of agro-ecological zones, seasonal rainfall regimes and soil characteristics in five ESA countries over a seven-year period. They found that CA reduced yield variability by 11% points (from 67% under conventional tillage to 56%). Across all ESA environments, and relative to conventional tillage with a mean of 2,401 kg/ha, CA-rotation had the highest maize yield increase (35%) compared with CA-sole (29%) and CA-intercrops (15%) systems. Smallholder farmers realized the highest returns (90–95%) on CA investments under low rainfall conditions (<700 mm), providing clear evidence of the climate-smartness of CA systems under soil moisture-stressed conditions - *see Table 1 SLO 2.1.*

Agriculture in rural Bihar can maintain productivity while enhancing its biophysical sustainability (ex-ante modeling, based on on-station trials). To sustainably intensify the predominant rice-wheat systems, alternative cropping patterns with short duration legumes in fallow summer season were developed. On-station experiments previously demonstrated the agronomical feasibility of the alternative cropping patterns. This study addresses the implications of such field-level changes at the farm-level. Scientists found diverse farm performances, indicating a heterogenous farming community. Rearranging current cropping patterns gave all farms possibilities to save water, increase soil organic matter content and decrease nitrogen losses, but showed trade-offs with operating profit. More highly resource-endowed farms had the most potential to improve upon multiple performance indicators. Two out of five farms assessed did not benefit from including the alternative cropping patterns. Researchers conclude that the impact of innovations greatly depends on farm type and current farm features and performance (farm typology).

Efforts in Latin America, sub-Saharan Africa and South Asia to expand appropriate agricultural mechanization solutions geared towards positive transformations in rural communities continued in 2020. Exacerbated by COVID-19, which put further pressure on rural labor, mechanization R4D focused on how to mitigate labor shortages and strengthen capacity for delivery and support systems. Research revealed much higher demand for mechanization than previously found by macroeconomic analyses (eastern and southern Africa), pointing to a problem of access rather than demand - *see OICRs Table 3 and section FP4.*

Mexican maize seed sector scaling. The rapid growth of private investment in the maize seed sector poses challenges for public breeding organizations and smaller seed companies that have decreasing access to technologies and markets. The International Maize Improvement Consortium (IMIC-LAC), created in Mexico in 2011, seeks to increase the size and competitiveness of the seed sector through access to germplasm and breeding tools. Evaluation results showed a larger and more competitive seed sector after 25 years, especially in the most recent years, when the rapid increase in volume and the share of sales of the national business sub-sector stands out. The broad participation of seed companies in IMIC-LA and the development and commercialization of new seed varieties suggest a positive impact and a role of the consortium in the growth and competitiveness of the national subsector. To evaluate impact, the authors combined and triangulated data on farmers' seed usage with data on the differences between seeds in terms of yield, aptitude for various uses, and profitability compared to other seed options. The strengthening of the seed sector must finally be shown via growth in agricultural productivity. To move forward there is a need to evaluate how improved seeds help farmers and to combine seed sector indicators with indicators pertaining to seeds' on-farm performance and development outcomes.

To quantify progress toward landscape sustainability and to help users advance toward shared goals, WHEAT, MAIZE and partner scientists developed a structured assessment framework. This *approach* engages stakeholders to identify essential features of the landscape and determine steps to be taken to attain or maintain beneficial conditions. It was applied to determine progress in two situations:

large, high-input, commercial agriculture in northwestern Mexico and small, low-input family farms in the Western Highlands of Guatemala. The focus is on agricultural landscapes, which include farm ecosystems as well as the environmental and socio-economic factors that interact with them. The two case studies show the importance of local champions, stakeholder engagement, transparency and trust, effective communication, timely monitoring, long-term commitment, and continual improvement. Iterative application of the assessment *approach* builds capacity and promotes continual improvements in management practices to achieve locally defined goals for sustainable agricultural landscapes. Application of the *approach* to a new and different system would help confirm or refute these results.

Intercropping maize for yield productivity and weed control in Ghana: Researchers found that intercropping maize with soybean reduced weed biomass relative to the maize sole cropping system This effect might be due to the soybean plants, which reduced the niches available for weed growth. The cropping system had a significant effect on grain yield, Land Equivalent Ratio (LER), weed biomass and weed species count. LER for the intercrops were greater than one, which indicates better yield productivity of the intercrops, compared with the sole crops. Similar approaches has been conducted in Tanzania where results of an assessment made in the Northern Highlands intercropping common bean with maize indicated that continuous intercropping of bean with maize over two cropping seasons increased bean grain yields from 1.5 to 2.3 t ha^{-1} (lower), 2.0 to 2.3 t ha^{-1} (middle), and 1.8 to 2.9 t ha^{-1} in upper altitudes. Land utilization advantage of intercrops over monocultures yielded a total LER of 1.58, whereas the average partial land equivalent ratio (PLER) of individual beans was 1.53. Researchers also explored intercropping strategies for smallholder farmers in Zimbabwe. On-station experiments showed maize/pigeonpea intercropping to be comparable to the sole maize and to be superior in total system yield (108 GJ ha−1 vs. 74 GJ ha−1). Researchers conclude that intercropping is a viable option for smallholder farmers.

1.2.3 Variance from Planned Program for this year

2020 objectives moved forward into 2021: MAIZE-led operations and project implementation remained as planned, with some exceptions due to COVID-19. MAIZE-MC implemented a monitoring tool to assess continuous performance of W1&2-funded projects. Overall 80% of project milestones were reached as planned in 2020. The remainder were delayed until 2021.

W1 & 2 Work Packages	Budget	Deliverables % of completion		Deliverables moved into next year / potential carry over	
Lead Center	$ 5,693,438.00	$ 4,839,422.30	85%	$ 854,015.70	15%
Participant Center	$ 1,783,673.00	$ 1,444,775.13	81%	$ 338,897.87	19%

1.2.4 Altmetric and Publication highlights

MAIZE Facebook saw a 16.5% increase in followers, reaching 8,682 followers by the end of 2020. MAIZE Instagram attracted approximately 600 followers by the end of the year, a 139% increase.

Final website analytics show that the MAIZE Website had well over 25,000 sessions, attracting over 20,000 users. The communications team started to re-think website purpose and design, reflected in a make-over that ensures MAIZE content will be kept online after MAIZE closes down.

The top the Altmetric-scored publications co-funded by MAIZE were:

- 114 Wijk, M.T. et al (2020) The Rural Household Multiple Indicator Survey, data from 13,310 farm households in 21 countries - https://cimmyt.altmetric.com/details/75778587

- 86 Bonilla Cedrez, C.; Chamberlin. et al (2020) Spatial variation in fertilizer prices in Sub-Saharan Africa - https://cimmyt.altmetric.com/details/74022494
- 75 Acevedo, M.; Pixley. et al (2020) A scoping review of adoption of climate-resilient crops by small-scale producers in low- and middle-income countries - https://cimmyt.altmetric.com/details/92237600

1.3 Cross-cutting dimensions (at CRP level)

1.3.1 Gender

Main research outputs:

With data from 386 households in four districts of Zimbabwe, MAIZE scientists investigated current Climate Smart Agriculture (CSA) technology combinations that smallholders practicing integrated crop-livestock farming are adopting. The results highlight that gender of household head, farm characteristics (soil type and labor size), and institutional factors (market access, information access, and access to credit) are the main factors that determine the adoption of various CSA technology combinations. Researchers recommend that the government design policies aimed at improving farmers' knowledge with regards to CSA, including early warning systems and programs that enhance access to information, markets, and credit.

MAIZE improved varieties offer numerous benefits for smallholder farmers in sub-Saharan Africa. Adoption of new varieties is related to decisions at the household level that expose embedded gender norms, which privilege male agency, limiting women's empowerment and their ability to maximize the benefits from improved varieties. Study findings, done as part of Gennovate, explore how women in Nigeria negotiate power dynamics to access and secure the improved maize variety-based benefits. Men accrue more benefits and benefit directly. The authors conclude that development and extension actors should improve their understanding of the complex, relational nature of empowerment, when introducing new agricultural technologies.

The multi-year STMA project has made significant progress in considering the range of traits valued by both men and women farmers in West Africa (Benin, Mali, and Nigeria). Findings do not provide support for a dualistic classification as merely "men versus women"-preferred products. MAIZE scientists also learned about traits that should be considered for gender-focused product pipeline development in the future. They propose to improve partnerships with food scientists, post-harvest specialists and the private seed sector, to better deliver and package technologies to farmers and other value chain actors.

Methods or tools: Evidence from GENNOVATE supported a powerful call for changing the way development researchers work to reach greater gender equity in agricultural innovations, with authors pointing out the need for an invigorated research agenda that emphasizes critical self-reflection and introspection among research institutions about the norms they bring to the research process; partnerships with civil society and other organizations with long-term, trusted local presence; engagement with both women and men from different social groups on the structures and mindsets that hinder and enable equality and empowerment; sufficient time and resources to accompany a process of social change; and mechanisms to scale advances made using gender transformative approaches.

Intra-household gender dynamics affect women's articulation of demand for and adoption of labor-saving technologies. MAIZE researchers engaged with households in maize-based systems in Ethiopia and Kenya and learnt that women are seldom involved in decision-making. Their study contributed a conceptual approach and methodology for the analysis of gender dynamics, in relation to demand articulation and adoption of laborsaving technologies.

Capacity Development: In Bangladesh, women are leaders in Integrated Pest Management (IPM) against fall armyworm, which eats over eight plant species there but threatens maize in particular. One hundred seven female Department of Agricultural Extension (DAE) officials from 25 districts participated in hands-on training about identification, monitoring, and integrated management in Chudanga and Dinajpur, representing key regions for maize growth in southern and northern Bangladesh, respectively. Bangladesh Wheat and Maize Research Institute (BWMRI) and the Cereal Systems Initiative for South Asia (CSISA) co-facilitated the trainings.

1.3.2 Youth and other aspects of Social inclusion / "Leaving No-one Behind[1]"

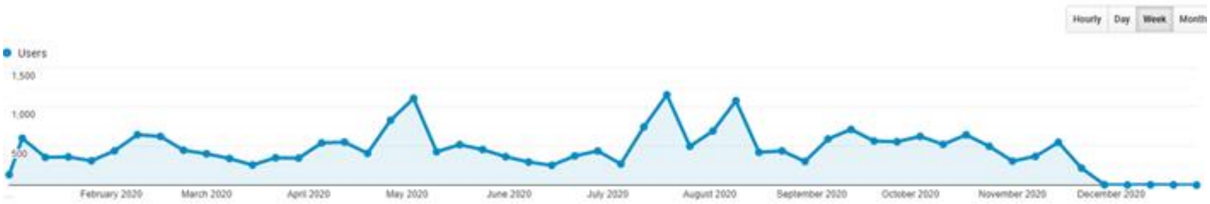
The MasAgro program has increasingly emphasized social inclusion, to respond to overwhelming evidence that makes Mexico one of 25 countries with the highest levels of inequality globally. Inequality is linked to poverty and hunger. Poverty is concentrated in certain population groups, in such a way that seven out of 10 young rural and indigenous women are poor. MasAgro incorporated social inclusion processes that address inequalities associated with gender and ethnicity, resulting in the Technical Guide for Social Inclusion in the Sustainable Development of Agri-food Systems. The guide targets those actors who participate and collaborate with MasAgro Productor (e.g. public officials at different levels, technical advisers to NGOs, researchers), to deepen their understanding of how social inclusion is relevant to achieve MasAgro Productor's objectives.

Empower the excluded (Ceres study) by participating in farmers' organizations. This research showed that agricultural interventions—whether climate-resilient crops, membership in a farmers' organization, or reducing crop losses—have more impact when people have a minimum level of income and education, as well as access to networks and resources. Unless particular care is taken, the poorest do not always see the benefits.

Entrepreneurs in eastern Africa offering mechanization services — often young people who embrace new technologies — can earn a good income while boosting the productivity of local farms.

1.3.3 Capacity Development

MAIZE Lead Center Learning Online Portal " CIMMYT Academy" was further improved by: migrating to a new Learning Management System technology; including content curation; and adding new functionalities and connections to external e-learning providers (e.g. LinkedIn Learning, OpenSesame), the latter to be 100% completed in 2021. CIMMYT Academy had 15,241 unique visitors, of which 43.5% were female (see graph below); 26% more than in 2019. Current CIMMYT Academy users are CIMMYT staff and external users trained by CIMMYT scientists.



Some examples of typical short-term training activities under MAIZE are:

In Bangladesh, CSISA carried out several activities in collaboration with USAID and Michigan State's Borlaug Higher Education for Agricultural Research and Development (BHEARD), including:

- A series of intensive three-day field trainings on integrated FAW management for agricultural extension agents;

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

- A video produced by Michigan State University's Scientific Animations Without Borders (SAWBO), USAID and CIMMYT on FAW management was shown to over 130,000 farmers. It can be viewed here. Two additional Bangla language videos raised awareness about FAW integrated pest management.

In Somalia, an online training on fall armyworm management for sustainable crop protection was conducted as part of the mitigation measures, the training was designed to help the participants to effectively implement Integrated Pest Management practices (IPM), by an early identification, monitoring and implementation of ecological strategies..

In Mexico, training farmers in grain drying and storage techniques has had a significant impact on reducing post-harvest losses. Across a broad range of altitudes and ecologies, MAIZE and partner researchers tested multiple storage technologies, to determine which are most effective at avoiding post-harvest losses, using-real world smallholder practices.

The full annex of MAIZE 2020 Capacity Development Activities can be found here. For references, see table 7 below.

1.3.4 Climate Change

Conservation Agriculture for Sustainable Intensification (CASI) impacts in South Asia. Continued efforts of generating science evidence, innovative partnerships, and enhanced capacity led to policy changes for large scale adoption of low emission risk mitigating practices in smallholder systems. Estimated South Asian farmer adoption of about 2M ha CASI and 20M ha precision nutrient could potentially benefit ~14 million smallholders with ~14 million tons of extra grain production and US$ 1.3 billion additional revenue generation, while reducing ~3.4 million tons of CO2 each year.

MAIZE scientists examined the prospects of smallholder production systems in South Asia (SA; Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka) **in adapting to climatic variability, to minimize negative impacts on food systems**. Researchers also investigated why farmers used few adaptation measures, if any. Adaptation is particularly fundamental to South Asian agriculture. The key challenges are institutional change and flexibility to enable adaptation; the adaptive management approaches are new to the bureaucratic systems. To date, only a few studies have assessed the **overall effectiveness of adaptation actions taken at local, sub-national, and national levels**. Fewer still have focused on the **farmer behavior determinants of adaptation** to climate change. Researchers found that **education and interaction among farmers changed their adaptation behavior; focusing on farmer-to-farmer communication can help improve adaptation** in agriculture. **Economic benefits alone may not explain farmers' adoption. Multiple factors such as gender of the household head, education, and market access** affect adaptation behavior. Policies focusing on adaptation require the flexibility to address these factors adequately. In sum, **though adaptation practices are available to farmers, the institutional set-up to share them widely needs to be strengthened**. Researchers recommend designing dynamic policies for long-term climate change adaptation in agriculture, rather than a mere focus on agricultural technology.

Rural farming households in Malawi face multiple livelihood shocks and risks. A SIMLESA-led study assessed farmers' experiences with different climatic shocks strategies. Scientists examined adoption of different risk management and coping strategies before and after climatic shocks occurred and investigated farmers' adaptation decision making. The study considered long-term shocks evaluated over a ten-year period (e.g. drought, crop pests and diseases, floods) and short-term risks and shocks over a five-year period (e.g. crop and livestock yields, prices, and market fluctuations). Researchers found that before shocks occurred, farmers were likely to adopt off-farm work, early planting, and drought-resistant varieties. After the shocks, farmers planted earlier, did more on-farm work, and changed their eating habits. Key factors influencing those adoption decisions were: limited information, financial constraints, and social networks. Authors propose that marketing, extension and credit services be provided to neglected communities on priority basis, to improve their coping abilities.

Similar results were found by MAIZE scientists investigating how better agronomic management increases maize resilience to drought in Tanzania. They used grid-based crop model (DSSAT) simulations to quantify benefits and risks to regional food security and smallholder farmers' livelihoods.

Crop modeling science has contributed to accelerate maize breeding. This new evidence shows how genotypic adaptation can effectively contribute to climate change adaptation. Modeling of cropping systems and trait-specific responses can also support design of breeding pipelines.

2. Effectiveness and Efficiency

2.1 Management and governance

Starting April 2020, MAIZE held several Managing Committee (MC) meetings focused on current and likely future Covid-19-driven constraints, risks to R4D operations, and projects under MAIZE. The meetings' focus was on W1&2-funded operations and activities and W1&2 (re-)allocation priorities.

By June 2020, MAIZE-PMU Unit developed four likely scenarios for the CRPs' wind-down, and a most-likely scenario for 2020 and 2021 budgets as the ONE CGIAR initiative moves forward.

In July 2020, the most-likely budget scenario was confirmed when USAID W2-funds shifted to W3 and MAIZE W1&2 funding reductions were fully buffered by the Research and Partnerships components of MAIZE's total budget. The PPA Budget component remained unchanged.

By October 2020, MAIZE-MC received confirmation from the System Management Office that 2020 new W1&2 income remained stable at 90% of the System Council-approved FinPlan as supplemental W1 funds were received to complement the original combined Window 1/2 FinPlan target.

In 2020 MAIZE and WHEAT Independent Steering Committees (M-ISC, W-ISC) held a joint session focused on CRPs closure, new One CGIAR modalities (future CRPs 2022+) and the transition. Main follow- up actions were:

- Engage the CGIAR System Board (ex-SMB), EMT and Chair of ISDC;
- Develop a multi-scientist authors' op-ed, highlighting the critical importance of staples-based foods for food and nutritional security in low- and medium-income countries;
- Update and summarize MAIZE-ISC guidance about MAIZE Must-Do R4D during 2022-2030.

2.2 Partnerships

2.2.1. Highlights of External Partnerships

The *Technological Portfolios and Modeling Techniques for Sustainable Intensification* project funded by MAIZE: Upgrading the AgroTutor App, which reaches 150,000 farmers via extension agents, was redesigned during Phase II to allow current users to access benchmarking data faster and more reliably. AgroTutor can now provide agricultural recommendations for planning a cropping season, based on analyses performed by the International Center for Tropical Agriculture (CIAT-Colombia) on data collected by CIMMYT across Mexico. The App can also be used to predict future commodity prices. Th models are run at IIASA and partner institutions in Vienna, Austria. AgroTutor now includes a video-making feature, and visual documentation of all activities for future reference, e.g. when extension services visit the farmer. Included in AgroTutor are locations and information for CIMMYT-MasAgro Hubs, research platforms, and machinery points. AgroTutor is available as an iOS or Android version. All technology is transferred back to CIMMYT with an open GitHub repository and the server functions working on the cloud, via Docker.

CABI launched a new Fall Armyworm Research Collaboration Portal, to facilitate global research collaboration to help fight this devastating crop pest. Developed by CABI in partnership with MAIZE, leading researchers and, institutions, the portal is a free-to-access platform for sharing of research data, insights, and outputs, and includes a range of key features such as identifying collaborators, and posting questions to the community. It is funded by the UK's FCDO (ex-DFID) and DGIS (NL) under the Action on Invasives program. This program encourages researchers to post preprints of research articles to the new agriRxiv, for no-cost, easy access globally. The portal aims to reduce the duplication of research and highlight opportunities for collaboration.

2.2.2. Cross-CGIAR Partnerships

Collaborations with Big Data, CCAFS, WHEAT, PIM, and RICE were maintained.

MAIZE, RICE, PIM, WHEAT foresight collaboration. The cereal-based food security system has been evolving due to rural transformations. With global population at 10.6 billion by 2050, total demand for cereals will rise, to assure the caloric base of diets worldwide. IMPACT modeling pointed to the following trends. Rural transformation in Asia is diversifying out of rice production into high value commodities and non-farm employment. In Africa, smallholder rice production has growth potential as part of the rural transformation process. In Africa, besides rural transformation factors, the production and supply of major crops such as maize is influenced by environmental factors. Rain-fed maize systems in Africa will be hit hardest by climate change. To off-set these pressures, with rural transformation ongoing, investments are needed that allow farmers to take advantage of unexploited agricultural potential in maize-based systems. Rural transformation in MENA will certainly result in more pressure on the wheat sector, but investments in productivity enhancement could result in significant increase of wheat supply. More value chain opportunities would also be expected, with growing urbanization, markets and diversification.

MAIZE collaborates with many other CRPs and with all the CGIAR Platforms, such as in Nepal, on the digital ground water monitoring piloting project, to test a potential groundwater monitoring system that could be scaled out. Collaborations with RICE, WHEAT, and South Asian national partners, such as CSISA Phase III, generate on-farm performance data to support potential innovations in agronomic practices. Trials were conducted at 42 sites. Hybrid rice varieties and DSR establishment methods have also been evaluated. Long-term trials (started in 2010) at the CSISA Patna platform are also important sources of knowledge. MAIZE and Big Data continue to build synergies that facilitate OA/OD compliance. This includes the set-up and maintenance of free, open access, repository for research software, studies, and datasets produced and developed by MAIZE lead center and its partners.

2.3 Intellectual Assets

MAIZE co-funded the International MAIZE Improvement Consortia (IMIC-LAC, IMIC-Africa, IMIC-Asia), which offer early access to elite germplasm based on an annual fee.

CIMMYT and IITA maintained their relevant policies to support greater transparency including in partnerships and results dissemination, in line with CGIAR Principles.

MAIZE is not a legal MAIZE co-funded entity. The management of legal assets relevant to the CRP is managed by MAIZE Lead and participant centers, both of which annually submit a detailed and confidential intellectual asset report to the System Board and the information contained therein is not repeated here. Flagship projects, MAIZE and CIMMYT-PMU do not, on their own, manage intellectual assets without consulting with the Lead Center's legal department; the same applies to IITA.

CIMMYT and IITA have not filed, nor has any CIMMYT partner informed CIMMYT, of any application for patent or plant variety protection associated with intellectual assets (IA) developed under MAIZE. Critical issues and challenges that remain relevant:

- Ensure sufficient funding and adequate human resources to implement on a timely basis all actions needed for a proper Intellectual Asset (IA) management. During 2020, Covid-19 made replacing of specialist legal staff difficult.
- Lack of IP policies in some NARS; lack of knowledge among NARS of IA management practices at CGIAR Centers and/or insufficient capacity to conduct adequate IA management; in certain CGIAR donor country NARS, reluctance to apply ITPGRFA standards (STMA).
- Collecting, exporting, and licensing seed in view of the ITPGRFA and the Nagoya Protocol.
- Some intellectual property policies or practices from certain MAIZE/WHEAT partners are not aligned with CGIAR IA management policies;
- Harmonization of licensing practices to disseminate digital sequence data with the Open Access obligation, in light of concerns raised among some ITPGRFA stakeholders in relation to the use of such datasets;
- The rising bar for centers' privacy protection and accountability in the context of dealing with datasets, wherein such data include personal information that carry with them accompanying dissemination obligations under Open Access.

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

The 20 foresight, ex-ante, and evaluation and learning products cut across the MAIZE Flagships. In view of ONE CGIAR Change, several MELIA studies focus on changes to impact assessment approaches (3984), improved germplasm impact assessment (e.g. DNA fingerprinting) and on farmer/social adoption dynamics, mostly linked to Climate-Smart Agriculture/CASI practices (3983, 4012, 4013, 4059). Others generated learning related to value chains (4009, 4060).

MAIZE participated in the Monitoring, Evaluation and Learning Community of Practice (MEL CoP) Steering Committee and contributed to advancing several methodology inquiries related to the CGIAR annual reporting process. It also continued to enhance MARLO, positioning the platform as a reporting tool for the upcoming One CGIAR Initiatives. MAIZE/WHEAT co-hosted the first virtual MEL CoP meeting, replacing the CoP's annual face-to-face meeting given COVID-19.

MAIZE's lead center continued building project management capacity, collecting data from previous CRP evaluations, and converting them as institutional knowledge useful for future project development. Collected evaluations, impact assessments, mid-term reviews, adoption studies, and synthesis studies were stored in CIMMYT's Project Management databases; MEL translated relevant recommendations into project management best practices.

MAIZE was part of the CGIAR light touch reviews in 2020, focusing on effectiveness and quality of science and supported the MAIZE review conducted by CGIAR Advisory Services. A series of recommendations and learnings resulting from the review were shared with CGIAR Science Leaders, to shape the development of CGIAR Initiatives.

MAIZE released a new comprehensive review of two decades of longstanding CGIAR-led work on improved maize for Africa: "Impacts of CGIAR MAIZE Improvement in Sub- Saharan Africa, 1995- 2015" - *see SLO 1.1, Table 1*.

2.5 Efficiency

For improved efficiencies related to breeding research, see reporting under FP2 and FP3. CRP administration and management achieved no further efficiency gains since 2019.

2.6 Management of Risks to Your CRP

The greatest risks in 2020 again were uncertainty and budget reductions which, in the end, did not materialize, but by then cost-cutting/adjustment measures had been implemented. MAIZE Lead and Participant centers responded by restricting fund flow to competitive partner grants. The USAID shift from W2 to W3 adversely affected a few W1&2 work packages. Another perceived risk was the anticipated reorganization of CIMMYT and IITA's research functions to fit into the new ONE CGIAR operational structure and the associated transitioning. In the end, this process did not start in earnest during 2020. MAIZE-MC managed this risk by engaging in TCF/TAGs and offering to participate in new initiatives design.

2.7 Use of W1-2 Funding

CIMMYT and IITA Flagship Leaders develop W1&2-funded work plans every year, which are reviewed and signed off by the MAIZE-MC. Budget per work package ranges between US$ 25,000-60,000.

Most 2020 W1&2 funds were used to support a) proof-of-concept R4D activities; b) seed investment on emerging research priorities leading to funding of W3/bilateral projects; c) cross-project learning and building new strategic partnerships for scaling; and d) MAIZE management functions, inclluding open access and open data management, communications and knowledge management. See Table 12 below.

3. Financial Summary

In 2020, MAIZE received US$2.1M W2 support from Australia (ACIAR), UK (DFID) and USA (USAID) and $6.4M W1 funding from Australia, Belgium, Canada, France, India, Japan, Korea, Netherlands, New Zealand, Norway, Mexico, Sweden, Switzerland, UK and the World Bank. Bilateral funder support is documented in the MAIZE Annual Financial Report and in the CGIAR Financial Dashboards. Initial CGIAR Financial Plan 2020 was set at $10.4, then lowered to $9.5M. See Table 13 below

During 2020:

- As per SMO FinPlan guidance, MAIZE-MC agreed to work with 2020 new income $9.673M (90% of W1 + 100% W2) plus carry-over of ca. $2.16M, of which $1.46M was allocated to running partner grants.
- MAIZE & WHEAT-MC decided at meeting M-MC200416 decision to postpone investment in new partner grants until the W1 &2 CGIAR financial situation became clearer. Competitive Grants ideas by MC members were kept on hold in case that COVID-19 impacts in MAIZE target countries might require new priorities.
- MAIZE-MC (M-MC200128) decided to allocate $716k to ongoing and new MAIZE partner grants. Total investment in 2020 in ongoing and new partner grants added up to $1.6M, which represents 17% of 2020 W1&2 income received.
- MAIZE-MC noted with satisfaction that 2020 actual new W1&2 income ($9.673) equaled 98% of System Council-approved (net of CSP) and that CGIAR-SMO income and cashflow predictions continued to be more accurate.

Part B. TABLES

Table 1: Evidence on Progress towards SRF targets

(Sphere of interest)

SLO Target (2022)	Brief summary of new evidence of CGIAR contribution	Expected additional contribution before end of 2022	Geographic Scope
100 million more farm households have adopted improved varieties, breeds, trees, and/or improved management practices.	Ex post (2020 publication delayed to 2021): Impacts of CGIAR Maize Improvement in Sub-Saharan Africa 1995-2015 reports on adoption and impacts of CGIAR-related maize varieties in 18 major maize-producing countries in sub-Saharan Africa for 1995-2015. Of 1,345 maize varieties released in the study countries, approximately 60% had a known or reported CGIAR parentage. In 2015, about 34% of total maize area in those countries (9.5 million ha) was cultivated with CGIAR-related maize varieties released between 1995-2015. Another 13% of the total maize area was cultivated with CGIAR-related maize varieties released before 1995. In 2015, aggregate yearly economic benefits of using newer CGIAR-related maize varieties (released after 1994) were estimated to be between US$ 0.66-1.05 billion, whilst global investment in CGIAR maize improvement was modest, about US$ 30 million p.a. Potential economic impacts of CGIAR investment on risk reduction (e.g. losses avoided) and nutritional enhancement in maize are not accounted for.	NA	•Geographic Scope: Global.
	In Kenya, maize accounts for 40% of the crop area, yet yield remains low (poor soil-fertility; frequent droughts). Drought-tolerant varieties (DTMVs) developed by CIMMYT, KALRO and seed companies, also offer resistance to major biotic stresses and nitrogen use efficiency and can out-yield commercial checks by 50% (on-farm). DTMV adoption in Kenya is far from universal. DTMV adoption amounted to 26% of our sample (2018 survey of households in 8 counties). 37% of the households were aware of DTMV's. 36% reported having physical access to the seeds. Authors conclude that DTMVs in Kenya could be scaled up to 52% of the farming population, if the whole population was exposed to them – double the observed adoption rate - and to 60% if seed were also made available at an affordable price. Using electronic media appears to have a positive impact on DTMV awareness, but over-reliance may exclude more marginalized groups.	NA	•Geographic Scope: National. •Countries: Kenya.

	Focusing on Ethiopia, a SPIA study investigated the impacts of the maize breeding program started in 1988 (CIMMYT and EIAR). Of the 54 maize varieties released since 1990, 34 are considered to contain CIMMYT-derived germplasm. In the past twenty years, 10 drought-tolerant and 8 Quality Protein Maize (QPM) varieties have been released. For context: A recent DNA fingerprinting study in Ethiopia highlighted that maize CGIAR-related germplasm was grown by 63% of maize-growing households in 2019, translating into 4.1 million adopters in Ethiopia alone.	NA	•Geographic Scope: National. •Countries: Ethiopia.
30 million people, of which 50% are women, assisted to exit poverty	Ex post. Ethiopia: Scientists examined farm level yield and income effects of adopting a practice or set of practices: Pillar 1 (productivity = fertilizer alone) and pillar 2 (combination of agronomic/NRM measures). Yield impacts of fertilizer alone was associated with a 29.5% yield gain (827 kg/ha), compared to the counterfactual. Net maize income gain was about 1423birr/ha (6.3%). Yield impact of a combination of measures (fertilizer, maize-legume diversification, and soil and water conservation measures) was ca. 1748 kg/ha (87.5%) and net income impact of 63.8% (9461birr/ha). Previous study identified 128,000 SIMLESA project direct beneficiaries , which were the basis for this study's sample. Analyzing performance of Sustainable Intensification packages based on farmers' data is important: Farmers adopt them only when they can observe yield and income effects for themselves. Researchers identified other marginal effects (e.g. male-headed farm households more likely to adopt maize-legume diversification and fertilizer).	NA	•Geographic Scope: National. •Countries: Ethiopia.
Improve the rate of yield increase for major food staples from current < 1% to 1.2-1.5% per year	(Ex post) 15-20% of global maize production p.a. is lost due to heat and drought. South Asian farmers are particularly impacted. MAIZE-led regional collaborative research projects (2013-2020) developed maize hybrids with improved resilience to sub-optimal conditions, without comprising on yield potential under optimal conditions, thanks to systematic integration of novel breeding tools (e.g. GWAS, RC-GS), supported by managed stress phenotyping and double haploid technology. Heat-tolerant maize can reduce yield losses due to climate change by 36% and 93% (rainfed/irrigated conditions). By 2018, 68 heat stress tolerant, CGIAR-derived hybrids were licensed to public and private sector partners, who released 16 of them, made available to farmers in stress-vulnerable ecologies, Post-project impact studies showed that farmers received 0.96 tons/ha of additional yields and $179.45/ha additional net income under stressed climatic conditions. Under unstressed conditions, adopters received about US$1.0/kg more than from conventional hybrids. Stay-green trait provided additional green-fodder income of $550/ha.	NA	•Geographic Scope: Regional. •Regions: Southern Asia.

	(Ex post) Synthesis of Conservation Agriculture (CA) systems' maize yield merits in Eastern and Southern Africa (ESA): MAIZE scientists analyzed CA in maize systems relative to conventional farmer practices and the contribution of agro-ecological zones, seasonal rainfall regimes and soil characteristics in five ESA countries over a seven-year period, by compiling agronomic data generated from 287 smallholder on-farm trials (total 4976 observations). CA reduced yield variability by 11% (from 67% under conventional tillage to 56%). Across all ESA environments and relative to conventional tillage with a mean of 2401 kg/ha, CA-rotation had the highest maize yield increase (35%) compared with CA-sole (29%) and CA-intercrops (15 %) systems - offering the best opportunity for improved maize productivity. Smallholder farmers realized the highest returns (90–95%) to CA investments under low rainfall conditions (<700 mm), providing clear evidence of the climate smartness of CA systems under soil moisture stressed conditions. See OICR4043.	NA	•Geographic Scope: Regional. •Regions: Eastern Africa, Southern Africa.
	On-farm trial, to study genetic gains under farmers' conditions : Scientists monitored the efficiency of varietal turnover and refinement of product development and deployment strategies. Experience has shown that breeding programs can benefit from participatory approaches. New stress-tolerant maize hybrids were tested in four East African countries (12 early-to-intermediate- & 13 intermediate-to-late maturing hybrids, including popular, farmer-selected commercial checks). They were evaluated by 2,025 farmers (55% women) at 27 sites in Kenya and Rwanda. New hybrids had 18% higher yields than commercial checks under farmers' conditions (e.g. stressed); yields were similar to those of commercial checks under optimal conditions. This participatory approach to breeding profile development should support greater farmer adoption of stress-resilient maize, beyond STMA and SIMLESA projects achievements (see OICR4003 & 4043).	NA	•Geographic Scope: Regional, National. •Regions: Eastern Africa, Southern Africa. •Countries: Rwanda.
30 million more people, of which 50% are women, meeting minimum dietary energy requirements			

150 million more people, of which 50% are women, w/o deficiencies of one or more essential micronutrients: iron, zinc, iodine, vitamin A, folate, and vitamin B12	Biofortified crops have tremendous potential to improve child nutrition (Ethiopia, Oromia). Scientists tested whether complementing the distribution of quality protein maize (QPM) with interventions informed by behavioural insights could support young children's's' greater consumption, translating into improved growth. Results suggest it is possible to elicit behaviour changes that lead to children consuming more biofortified crop-based food. Impacts were substantial: Young children's' increased QPM consumption by nearly 25%; probability that the caregiver cooked a QPM food specifically for young children. Increased consumption of QPM did not translate into significant improvements in growth, perhaps because QPM consumption increase, or duration, were not (long) enough to lead to meaningful changes. Future research should further investigate the relationship between QPM consumption and child growth in uncontrolled settings and realized impacts (see p.19). Ethiopia had adopted a 2014-2017 QPM scaling plan; Seqota Declaration). 738,000 beneficiaries (see p.14) benefitted from drought-tolerant or QPM maize by mid-2019.	NA	•Geographic Scope: National, Regional. •Regions: Eastern Africa. •Countries: Ethiopia.
10% reduction in women of reproductive age consuming less than the adequate number of food groups			
5% increase in water and nutrient use efficiency in agro-ecosystems, including through recycling, reuse			
Reduce agriculturally-related greenhouse gas emissions by 0.2 Gt CO2-e yr–1 (5%) compared with business-as-usual scenario in 2022			
55 million hectares (ha) degraded land area restored			
2.5 million ha of forest saved from deforestation			

Table 2: Condensed list of policy contributions in this reporting year
(Sphere of Influence)

Title of policy, legal instrument, investment or curriculum to which CGIAR contributed (max 30 words)	Description of policy, legal instrument, investment or curriculum to which CGIAR contributed (30 words). See guidance for what to cover.	Level of Maturity	Link to sub-IDOs (max. 2)	CGIAR cross-cutting marker score				Link to OICR (obligatory if Level of Maturity is 2 or 3) or link to evidence (e.g. PDF generated from MIS)
				Gender	Youth	Capdev	Climate Change	
683 - Ethiopian Government scales up conservation agriculture-based sustainable intensification systems (CASI) via extension policy	The Ethiopian Ministry of Agriculture adopted CASI as part of its extension package, focused on maize-based systems, and cascaded it to regional agriculture bureaus for implementation in 2019.	Level 2	• Agricultural systems diversified and intensified in ways that protect soils and water	1 - Significant	1 - Significant	1 - Significant	1 - Significant	OICR2701

684 - Improve Nepalese mechanization policy: Focus on appropriate-scale and gender equality	MAIZE scientists recommend 3 strategies to promote responsible agricultural mechanization - and that policymakers implement female-targeted farm mechanization programs, to enhance the level of small-scale mechanization in Nepal's hilly regions	Level 1	• Closed yield gaps through improved agronomic and animal husbandry practices	1 - Significant	0 - Not Targeted	0 - Not Targeted	1 - Significant	https://doi.org/10.3390/su12010374. Agricultural mechanization in developing countries has taken at least two contested innovation pathways—the "incumbent trajectory" that promotes industrial agriculture, and an "alternative pathway" that supports small-scale mechanization. Authors examine the case of Nepal's first Agricultural Mechanization Promotion Policy 2014 (AMPP) using a conceptual framework of what will be defined as "responsible innovation". They make 3 recommendations (consider smallholder land fragmentation; reflexivity and innovation champions; domestic machinery production). https://doi.org/10.1016/j.techsoc.2020.101250 : Scientists show there are substantial differences in the adoption of small-scale farm mechanization between male-headed (MH-HHs) and female-headed households (FH-HHs). These differences are larger when we compared with food-secure and food-insecure FH-HHs. The prospect of adopting mini-tillers for female-headed households would remain lower even after having the same level of attributes for the MH-HHs and FH-HHs.
685 Reducing Poverty in South Asia by accelerating irrigation Intensification by influencing groundwater pricing policy in Bangladesh, East India and Nepal	Groundwater irrigation plays a critical role in supporting food security, in Eastern Indo-Gangetic Plains region , many farmers lack access to affordable groundwater supply.	Level 1	• Appropriate regulatory environment for food safety	1 - Significant	0 - Not Targeted	0 - Not Targeted	1 - Significant	Cereal Systems Initiative for South Asia (CSISA) is helping to support uptake and dissemination of market research findings on the ground, working with local partners in government, donor agencies and the private sector at all stages of the pump set supply chain to provide targeted advisories and policy recommendations to facilitate behavioral change at the landscape level. https://www.agrilinks.org/post/reducing-poverty-south-asia-through-accelerating-irrigation-intensification

Table 3: List of Outcome/ Impact Case Reports from this reporting year

(Sphere of Influence)

Title of Outcome/ Impact Case Report (OICR)	Link to full OICR	Maturity level
OICR2701 - Ethiopian Government incorporates scaling sustainable intensification of maize-based systems (agronomy at scale) into its extension system	Link	Level 2
OICR3062 - Synthesis and learning products with regard to maize germplasm adoption and impact assessment	Link	Level 1
OICR4003 - Improved drought tolerant maize improved farmer yields and livelihoods benefiting 5.4 million households in eastern, western & southern Africa (DTMA, STMA)	Link	Level 2
OICR4025 - CGIAR Centers' rapid assessment of food and nutrition security in the context of COVID-19 guides Bangladesh Government action	Link	Level 1
OICR4037 - Gender norms, agency, power relations research developed by MAIZE and WHEAT guides other CGIAR and partner researchers impact pathway and scaling interventions	Link	Level 1
OICR4043 - Smallholder farmers use conservation agriculture-based technologies and sustainable intensification practices adapted to climate change on 627,000 ha in southern Africa	Link	Level 2
OICR4044 - Farmers plant Heat Tolerant Maize varieties to improve their food security and livelihood in climate-vulnerable areas of South Asia, on over 20,000 ha	Link	Level 2
OICR4046 - Guidance and management techniques help to combat and recover from Fall Armyworm in West and Central Africa	Link	Level 1
OICR4048 - Accelerating the rate of genetic value creation for East and South African smallholder maize farmers	Link	Level 1

Table 4: Condensed list of innovations by stage for this reporting year

Title of innovation with link	Innovation Type	Stage of innovation	Geographic scope (with location)
1951 - Development of Maize Seed Production Technology	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Latin America & the Caribbean
1999 - remote sensing-based tool to assess nitrogen levels in farmers' fields, to support farmers' Stover + fertilizer use/management	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
2003 - Development of 9 (Nine) synthetic varieties for the tropical lowlands of Mexico	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	National, Mexico
2004 - Development of 9 (Nine) maize hybrids with high yield potential and competitive agronomic characteristics for the highlands, mid-altitudes and lowlands of Mexico.	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Sub-national, Mexico
2005 - Development of 72 maize hybrids with high yield potential and competitive agronomic characteristics for the highlands, mid-altitudes and lowlands of Mexico	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Mexico

2006 - Development of 23 maize hybrids with high yield potential and competitive agronomic characteristics for the highlands, mid-altitudes and lowlands of Mexico.	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	National, Mexico
2007 - 48 CGIAR-derived elite maize varieties released by MAIZE national partners globally in 2020	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	Global
2034 - New value-chain approaches for food supply- transformation and the future of cereal-based agri-food systems	Social Science	Stage 3: available/ ready for uptake (AV)	Global
2035 - Improved forecasting of impacts of climate change and targeted technology development	Biophysical Research	Stage 3: available/ ready for uptake (AV)	Global
2050 - Agroecological management Practices against Fall Armyworm for cereal systems in Bangladesh	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Bangladesh
2101 - Establishment of the first public DH facility - Maize Doubled Haploid Facility	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, South-Eastern Asia
2108 - Satellite monitoring to prevent impact of drought on crop production: meteorological drought	Other	Stage 2: successful piloting (PIL - end of piloting phase)	Global

2148 - Development of maize pre- breeding lines for climate change adaptation in Mexico.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Mexico
2149 - Development of Climate Change adaptation Open pollinated varieties in Mexico	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Mexico
2173 - Agricultural information videos to increase women's empowerment in agriculture in Uganda	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Sub-national: Uganda
2332 - Willingness-to-pay stress tolerant maize as an agricultural insurance product informing a strategy for mitigating production risk in Nigeria	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Nigeria

Table 5: Summary of status of Planned Outcomes and Milestones

(Sphere of Influence-Control)

FP	FP Outcomes 2022	Sub-IDOs	Summary narrative on progress against each FP outcome this year.	Milestone	2020 milestones status	Brief Explanation Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed	Link to evidence
FP1	FP1 Outcome: 1.10 Farmers have greater awareness and access to, and increased adoption and adaptation of improved technologies	• Increase capacity of beneficiaries to adopt research outputs	Highlights to enhance adoption/impacts: - adoption/impact reviews: Instrumental variables (11); remote-sensing (12); no-tillage (19) - adapting to climate change: Malawi (1); Ghana (16); Zimbabwe (17); Pakistan (3;4) - adoption/impact studies: Pakistan (2;13), Ethiopia (8; 15); ESA (5); Tanzania (9) - biotic-stress impact studies (FAW): Kenya (6); Ethiopia (10) - institutional innovations: community-based-seed-production Nepal (7); cooperatives Zambia (14); repatriation landraces Mexico (18) Highlights to enhance gender/social-inclusiveness:	2020 - Adoption and impact studies on technologies rolling plan based on progress of technologies along the theory of change	Complete	Adoption/impact 19 publications: 18 papers, 1 book-chapter 1. Climate Risk Management 27,100200 2. Scientifica 2020,5959868 3. Hydrology 7(1),2 4. Arabian Journal of Geosciences 13,1025 5. Environment, Development and Sustainability 22,3159-3177 6. Agriculture, Ecosystems & Environment 292,106804 7. Experimental Agriculture 56,884-900 8. African Journal of Agricultural and Resource Economics 15,95-110 9. Sustainability 12,998 10. European Review of Agricultural Economics 47,1473–1501 11. Global Food Security 26,100383 12. Agronomy for Sustainable Development 40,16 13. Journal of Animal and Plant Sciences 30,175-184 14. Technological Forecasting and Social Change 158,120160 15. Food Policy 95,101941 16. Land Use Policy 95,104622 17. African Journal of Science, Technology, Innovation and Development12,735-746 18. Food Security 12,945-958	1.https://doi.org/10.1016/j.crm.2019.100200 2. https://doi.org/10.1155/2020/5959868 3.https://doi.org/10.3390/hydrology7010002 4.https://doi.org/10.1007/s12517-020-06019-w 5.https://doi.org/10.1007/s10668-019-00340-5 6.https://doi.org/10.1016/j.agee.2019.106804 7.https://doi.org/10.1017/S0014479720000381 8.https://www.dropbox.com/s/ysjx2qe6c4bjpqb/62669.pdf?dl=0 9.https://doi.org/10.3390/su12030998 10.https://doi.org/10.1093/erae/jbz048 11.https://doi.org/10.1016/j.gfs.2020.100383 12.https://doi.org/10.1007/s13593-020-0610-2 13.http://www.thejaps.org.pk/Volume/2020/30-01/20.php 14.https://doi.org/10.1016/j.techfore.2020.120160 15.https://doi.org/10.1016/j.foodpol.2020.101941 16.https://doi.org/10.1016/j.landusepol.2020.104622 17.https://doi.org/10.1080/20421338.2019.1694780 18.https://doi.org/10.1007/s12571-020-01054-7 19.https://doi.org/10.1007/978-3-030-46409-7_23 20.https://doi.org/10.1177/0030727019888661

			- country case gender--maize studies: Ethiopia(23); Nigeria(24); Bangladesh(25); Mexico(30) - multi-country gender--maize comparative studies: ESA (21;29) - GENNOVATE knowledge products (22;33;35) - quantitative gender-studies: Kenya(26), Nepal(27) -gender trait-preferences: West-Africa(28); ESA (31) -gender-in-value-chains: Mozambique(20); Kenya(34); Uganda(32)			19. book-chapter-23, pp.395-412 Gender/social-inclusiveness 16 publications: 11papers; 4reports/briefs; 1 book-chapter 20. Outlook on Agriculture 49, 133-144 21. Gender, Technology and Development 24, 341-361 22. Development in Practice 30, 541-547 23. Sustainability 12, 9847 24. Gender, Technology and Development 24, 271-296 25. Canadian Journal of Development Studies 41, 20-39 26. Women's Studies International Forum 83, 102419 27. Technology in Society 61, 101250 28. World Development Perspectives 20, 100268 29. World Development Perspectives 18, 100206 30. Tropical and Subtropical Agroecosystems 23, 40 31. Discussion Paper 32. 33. 34. Brief 35. book-chapter-15	21.https://doi.org/10.1080/09718524.2020.1830339 22.https://doi.org/10.1080/09614524.2020.1757624 23.https://doi.org/10.3390/su12239847 24.https://doi.org/10.1080/09718524.2020.1794607 25.https://doi.org/10.1080/02255189.2019.1650332 26.https://doi.org/10.1016/j.wsif.2020.102419 27.https://doi.org/10.1016/j.techsoc.2020.101250 28.https://doi.org/10.1016/j.wdp.2020.100268 29.https://doi.org/10.1016/j.wdp.2020.100206 30.http://www.revista.ccba.uady.mx/ojs/index.php/TSA/article/view/3043 31. https://hdl.handle.net/10883/20926 32.https://hdl.handle.net/10883/20927 33.https://repository.cimmyt.org/handle/10883/20934 34.https://hdl.handle.net/10883/20928 35. https://doi.org/10.4060/cb1331en
	FP1 Outcome: 1.9 Last mile provider (extension partners, farmer organization, community-based organizations, private sector) increased access and promotion of		Highlights of markets/value-chain studies to enhance last mile linkages: -seed-sector-analysis: Mexico(9); Kenya(11;12); Nepal(5;16) -specialty maize: Mexico (4) -technological--institutional innovations: Bundling Drought-Tolerant Index-Insurance(2); price-	2020 - Benchmarking information of maize value chain collected in selected countries to support identified priorities and effective interventions	Complete	Mkt/VC 21 publications: 14 papers, 1 book, 1 report, 5 book-chapters 1. Cogent Environmental Science 6 2. Journal of Agricultural Economics 71, 239-259 3. Agricultural Economics 51, 793-807 4. Journal of Food Products Marketing 26, 564-579 5. Enterprise Development-&-Microfinance 31, 92-112 6. Agrekon 59, 202-217	1. http://doi.org/10.1080/23311843.2020.1813451 2. https://doi.org/10.1111/1477-9552.12344 3. https://doi.org/10.1111/agec.12592 4. https://doi.org/10.1080/10454446.2020.1832637 5. http://dx.doi.org/10.3362/1755-1986.19-00012 6. https://doi.org/10.1080/03031853.2019.1703769

	technologies to farmers		information, Ethiopia(3); Digital-Agricultural-Extension, Nigeria(10); Fertilizer, Nepal(13); metal-silos, Zimbabwe(6); Lupin, Ethiopia(1) -Agri-nutrition research: human-nutrition--health contributions (14 – published online, visiting-fellow); QPM RCT, Ethiopia(8); Food-Fortification, Kenya(7) -Value-Chain-Development Poverty: edited book(15), chapters: Introduction(17); Nicaragua(18); review(19); gender(20); poverty-reduction(21) Highlights of foresight/targeting studies to inform policy: -Covid-19: monitoring food-system disruptions(23); Rapid-Assessment Food--Nutrition-Security Bangladesh(32) -Climate-change analysis: adaptation Ethiopia(22); mitigation SSA(35) -Yield-gap analysis Ethiopia(24;31) -Spatial-price-variation SSA: fertilizers(25;29); cereals(26)			7. Food and Nutrition Bulletin 41, 224–243 8. BMJ Global Health 5, e002705 9. Agronomia Mesoamericana 31, 367-383 10. Journal of Agricultural Economics 71, 798-815 11. Journal of Crop Improvement 34, 486-504. 12. Outlook on Agriculture 49, 39–49 13. Food Policy 90, 101809. 14. Food Policy, 101976 15. Book 16. Report 17. Book-chapter-0(intro) 18. Book-chapter-8 19. Book-chapter-1 20. Book-chapter-6 21. Book-chapter-12 Foresight/targeting 15 publications: 10 papers; 4 reports; 1 book-chapter 22. Weather and Climate Extremes 29, 100263 23. Food Security 12, 761-768 24. Food Security 12, 83-103 25. PLOS ONE 15, e0227764 26. Global Food Security 26, 100438 27. Food Policy 90, 101805 28. Global Food Security 26, 100441 29. PLOS ONE 15, e0239149 30. Land 9, 68 31. Agricultural Systems 183, 102828 32. Covid-19 Report 33. Trinity-Economics-Papers 620 34. Regional-Agronomy handbook 35. World Bank report 36. Book-chapter-3, pp.67-104	7. https://doi.org/10.1177/0379572119876848 8. http://dx.doi.org/10.1136/bmjgh-2020-002705 9. http://doi.org/10.15517/am.v31i2.34894 10. https://doi.org/10.1111/1477-9552.12371 11. https://doi.org/10.1080/15427528.2020.1737296 12. https://doi.org/10.1177/0030727019900520 13. https://doi.org/10.1016/j.foodpol.2019.101809 14. https://doi.org/10.1016/j.foodpol.2020.101976 15. http://dx.doi.org/10.3362/9781788530576 16. https://repository.cimmyt.org/handle/10883/21242 17. http://dx.doi.org/10.3362/9781788530576 18.http://dx.doi.org/10.3362/9781788530576 19. http://dx.doi.org/10.3362/9781788530576 20. http://dx.doi.org/10.3362/9781788530576 21. http://dx.doi.org/10.3362/9781788530576 22. https://doi.org/10.1016/j.wace.2020.100263 23. https://doi.org/10.1007/s12571-020-01083-2 24. https://doi.org/10.1007/s12571-019-00981-4 25. https://doi.org/10.1371/journal.pone.0227764 26. https://doi.org/10.1016/j.gfs.2020.100438 27. https://doi.org/10.1016/j.foodpol.2019.101805 28. https://doi.org/10.1016/j.gfs.2020.100441 29. https://doi.org/10.1371/journal.pone.0239149 30. https://doi.org/10.3390/land9030068 31. https://doi.org/10.1016/j.agsy.2020.102828 32. https://knowledgecenter.cimmyt.org/cgi-bin/koha/opac-detail.pl?biblionumber=62500 33.

			-Site-Specific Agronomy: Ethiopia (33); Regional-Agronomy handbook (34) -Rural transformation: agri-food-systems(28); farm-structure Tanzania(27); area-expansion SSA(30); Mixed-farming-system SSA(36)				https://ideas.repec.org/p/tcd/tcduee/tep0620.html 34. https://reagro.org/ 35. http://hdl.handle.net/10986/33677 36. https://www.crcpress.com/Farming-Systems-and-Food-Security-in-Africa-Priorities-for-Science-and/Dixon-Garrity-Boffa-Williams-Amede-Auricht-Lott-Mburathi/p/book/9781138963351
FP2	FP2 Outcome: 2.4 Crop researchers world-wide increased use of novel germplasm and tools for validation, refinement and development of products	• Adoption of CGIAR materials with enhanced genetic gains	In 2020 MAIZE publicly released the first bridging germplasm in the form of CMGRLs, the releases targeting the broadening the diversity of breeding germplasm specifically for drought resistance and tar spot disease complex tolerance. The adoption and deployment of new tools and resources to enhance maize breeding has continued despite challenges of COVID-19 and resourcing. Some reprioritization of interventions has occurred to focus on those with greater potential to enhance, in the longer-term, the effective and comprehensive implementation of new breeding tools, methods and approaches to improve delivery of genetic gain.	2020 - Strategy for effective integration of validated breeder-ready markers/haplotypes for at least 4 priority traits with DH and seed chipping technology in forward breeding designed (in FP2; linkage with Genetic Gains Platform) and implemented in MAIZE breeding programs (through FP3).	Changed	The strategies for implementation of validated breeder-ready markers/haplotypes for at least 4 priority traits is well advanced, with validated production markers and genotyping available through a high throughput service provider. Together with the Excellence in Breeding Platform clear steps to modify breeding program structure to facilitate routine implementation have been conducted with more outlined.Seed chipping requires access to proprietary technology in order to effectively leverage the value of application. We have discussed opportunities for access with IP holders. To effectively deploy the technology requires further breeding program operational restructuring. To date we have focused on higher priority and higher return interventions and changes. Application of seed chipping is still a potential in the future but is not currently a high priority.	https://excellenceinbreeding.org/module3/kasp
					Extended		

				2020 extended to 2022 - Recommendations for genomic prediction in pre-breeding for at least 4 priority polygenic traits developed and at least one under validation.		Broad recommendations for genomic prediction in pre-breeding have been made exploring the breeding strategy and targeting of exotic allelic variation. Validation experiments in three traits are ongoing; drought, salinity tolerance and MLN tolerance. These efforts have been impacted by COVID-19 and work to complete validation has been extended to provide the needed evidence to further inform the recommendations	http://www.biomedcentral.com/1471-2164/17/30 https://www.g3journal.org/content10/7/2445 https://www.g3journal.org/content/7/7/2315
				2020 extended to 2022 - Genomic selection enabled for four or more priority polygenic traits with five or more FP3 applied maize breeding programs actively using GS.	Extended	The use of genomic estimations of breeding value in selection is implemented in three breeding programs with further roll out planned. The availability of affordable, fast and effective mid/high-density genotyping services and pipelined analysis and interpretation has impacted further roll out as current implementation involves a lot of manual processing. These bottlenecks are being addressed through engagement with Excellence in Breeding and broader roll out will be conducted as soon as effective solutions are available to breeders	https://link.springer.com/article/10.1007/s00122-020-03696-9
				2020 extended to 2021 - Bridging germplasm carrying favorable novel alleles for Tar Spot Complex (TSC) disease, drought tolerance and maize lethal necrosis (MLN) tolerance released to public.	Extended	Bridging germplasm carrying favorable variation for TSC and drought tolerance has been released as newly defined pre-breeding lines called CIMMYT Maize Genetic Resource Lines (CMGRL). Work has advanced on the development of bridging germplasm for MLN tolerance however COVID-19 related challenges have delayed the development and release processes in this area.	https://www.cimmyt.org/news/cimmyt-releases-its-first-ever-maize-genetic-resource-lines/ https://data.cimmyt.org/dataset.xhtml?persistentId=hdl:11529/10548528

				2020 - Molecular characterization used by more MAIZE breeders to investigate uncharacterized germplasm	Complete	Breeders are adopting molecular characterization more routinely to assess the genomic composition and potential complementarity of germplasm introduced into their programs in addition to assessing for uniformity and homozygosity in the case of line introductions	https://repository.cimmyt.org/handle/10883/21272 https://excellenceinbreeding.org/module3/kasp https://repository.cimmyt.org/handle/10883/17063?show=full https://repository.cimmyt.org/bitstream/handle/10883/19046/58899.pdf?sequence=1&isAllowed=y
				2020 extended to 2022 - At least 15 additional early generation pre-bred lines available, incorporating novel genetic diversity for key traits (MLN, drought, heat) from exotic germplasm sources into elite or semi-elite backgrounds.	Extended	9 pre-breeding lines released as CIMMYT Maize Genetic Resource Lines (CMGRL). Work has advanced on the development of bridging germplasm for MLN tolerance however COVID-19 related challenges have delayed the development and release processes in this area. Additionally, resourcing limitations from bi-lateral projects resulted in a scale back of activities impacting the needed testing for release.	https://www.cimmyt.org/news/cimmyt-releases-its-first-ever-maize-genetic-resource-lines/ https://data.cimmyt.org/dataset.xhtml?persistentId=hdl:11529/10548528
	FP2 Outcome: 2.5 Breeders develop improved varieties more efficiently through greater access and use of documented	• Adoption of CGIAR materials with enhanced genetic gains	The refinement of a framework and development of resources to enable more efficient and effective storage and use of data for the purpose of varietal development has advanced comprehensively in 2020. This in spite of a number of challenges related not only to	2020 extended to 2021 - Centralized breeding data management system and associated tools deployed to provide breeders with better access to germplasm, genealogical, and phenotypic data	Extended	EBS v1.0 and v2.1 have been deployed to specific breeding team members at CIMMYT for the purpose of testing and training. Based on their specific feedback development sprints have been formulated and have and will be conducted to develop the next version for broader release to the MAIZE breeding community.	For limited distribution: https://ebs-staging-maize.cimmyt.org/ https://www.youtube.com/watch?v=L_TVMYpYMdg https://ebsproject.atlassian.net/ wiki/spaces/EBS/pages/10880646663/2020+EBS-B4R+Release

	germplasm and tools		the COVID-19 pandemic but also to a change in the structure and oversight of the EBS development. The work delivered moves MAIZE closer to comprehensive, efficient and effective breeding data management.				
				2020 extended to 2022 - Centralized genotypic data management system deployed to provide breeders with better access to genotypic data	Extended	The GOBii project developed a centralized database for genotypic data. Breeding team members can access it though functionality is limited for direct breeding application. Breeders need to be able to select both genotypic data and phenotypic data for relevant germplasm entities (seed lots) to conduct needed analyses and select and advance germplasm. To facilitate this in a more integrated manner the genotypic data management system is being incorporated into the EBS. While GOBii delivered a system the uplift into EBS is needed to enable broad use of data by breeding teams.	https://excellenceinbreeding.org/toolbox/tools/gobii-genomic-data-management-system-gobii-gdm http://gdm-demo.gobii.org:8081/gobii-portal/
				2020 - Data model developed to link breeding data to target product profiles that incorporate gender, youth, and market-based preferences.	Cancelled	The responsibility for product profile definition and formulation of metrics defining performance needs of germplasm under development is the responsibility of individual breeding teams (comprising market specialists, gender and youth specialists, breeders, trait specialists etc.). The EBS is designed to handle any kind of trait that can be measured and include defined thresholds for traits in particular pipelines. In the future, trait metrics of germplasm within a particular product profile, including those relevant for gender, youth, and market-based preferences, will be summarized and viewed using business	https://www.youtube.com/watch?v=L_TVMYpYMdg https://ebsproject.atlassian.net/wiki/spaces/EBS/pages/11046682216/Traits+20.05

						intelligence tools through a dashboard. Through the ability to handle a diverse portfolio of traits EBS accomplishes the desired goal without requiring a separate and tailored data model.	
				2020 extended to 2022 - New approaches for data capture, curation and analysis piloted and implementation guidelines developed	Extended	Work has been started to enable transfer of data between Maize Field book and KSU Field Book as a stepping stone for using KSU Field Book across CGIAR maize breeding (the EBS chosen data capture application). Additionally, work has been ongoing to ensure all traits required for data capture are included in EBS. . R scripts and protocols for checking and curating genotypic data for upload to standalone GOBii have been enhanced. These base scripts can be repurposed into pre-loading validation processes in the EBS. Efforts have ensued to update pedigree curation processes to incorporate new nomenclature rules, e.g. new backcross nomenclature and to enhance the efficiency of the curation process to help load more current and historic germplasm faster in preparation for EBS rollout.	https://data.cimmyt.org/dataset.xhtml?persistentId=hdl:11529/10548370 https://excellenceinbreeding.org/toolbox/tools/field-book
FP3	FP3 Outcome: 3.1 Improved exchange and utilization of germplasm and data by MAIZE partner breeding teams	• Increased capacity for innovations in partner research organizations	In 2020, CIMMYT licensed a total of 37 improved maize hybrids (19 in Africa, 16 in Asia, and 2 in Latin America) to 27 public/private sector partners (12 in Africa, 13 in Asia, and 2 in Latin America) for varietal release and	2020 - New MAIZE hybrids advanced through stage-gate advancement after Regional Trials announced through CIMMYT website (along with the data), and allocated to public/private sector partners in Africa, Asia and LatAm for	Complete	Licensing of new MAIZE hybrids from different maize breeding hubs to a wide array of public and private sector partners in Africa, Asia and Latin America for varietal release and commercialization.	information about CIMMYT's maize product allocations can be found on CIMMYT's Public Disclosures page. see annual reporting: Innovations and CGIAR-derived varieties released in 2020 https://maize.org/26-new-cimmyt-maize-lines-released/ https://www.cimmyt.org/news/delivering-improved-maize-seed-against-all-odds/

			commercialization in 15 countries (10 in Africa, 3 in Asia and 2 in Latin America) after stage-gate advancement and product announcement in the last quarter of 2019.	varietal release and commercialization			https://www.iita.org/wp-content/uploads/2020/07/Guide-to-Maize-Production-in-Northern-Nigeria.pdf https://www.iita.org/quality-seed-production/ https://www.cimmyt.org/news/announcing-cimmyt-derived-fall-armyworm-tolerant-elite-maize-hybrids-for-eastern-and-southern-africa/
	FP3 Outcome: 3.2 Effective pest/disease surveillance, monitoring and diagnostics protocols/procedures for controlling the spread and impact of existing/emerging threats	• Reduce pre- and post-harvest losses, including those caused by climate change	Maintained standards and practices in all intervention areas. Published innovations or improvements in practices/protocols. A comprehensive review on MLN management in Africa was published in 2020. Technical manuals on MLN management and IPM based FAW management in Asia are in preparation and will be released by first half of 2021.	2020 extended to 2021 - Technical manuals on MLN disease management and IPM for Fall Armyworm (FAW) management published and disseminated, and awareness created among relevant stakeholders on tools / technologies for effective and sustainable management of the transboundary diseases/insect-pests on maize, especially in Africa and Asia	Extended	A comprehensive review on MLN management was published in the journal Virus Research; Prasanna et al. (2020) Maize lethal necrosis (MLN): Efforts toward containing the spread and impact of a devastating transboundary disease in sub-Saharan Africa. Virus Research 282: 197943. Due to Covid19-related pressures, some of the partners involved in development of the MLN and FAW manuals could not contribute their chapters in 2020.	https://doi.org/10.1016/j.virusres.2020.197943 https://doi.org/10.1002/csc2.20317 https://marlo.cgiar.org/projects/Maize/studySummary.do?studyID=4046&cycle=Reporting&year=2020
	FP3 Outcome: 3.3 Partner breeding teams' access and adopt improved breeding processes,	• Increased capacity for innovations in partner research	See annual reporting under SLO Table 1, innovations, FP2 and FP3 a) In 2020,9 NARS partners in	2020 - NARS and seed company partners trained for enhanced use of validated protocols for high-throughput field-based phenotyping	Complete	AGG Annual Report for 2020. (not available at this stage, recently presented to the donor- USAID- for review) https://cgiar-my.sharepoint.com/:w:/g/personal/l_train_cgiar_org/EQPD8_PEa6RAg5EV-WNtX1UBWL4T_5pgxivKKkjZStZvzA?e=9DMCVG	See relevant training activities in 2020: MAIZE_CapDev_2020 under https://maize.org/maize-documents/ See OICR4048: https://marlo.cgiar.org/projects/Maize/study.do?expectedID=4048&edit=true&phaseID=153 See training activities reporting: https://maize.org/maize-lethal-necrosis-

	including new technologies, methodologies, approaches and genetic resources	organizations	Africa utilized doubled haploidy line development service offered by CIMMYT-Kenya. Over 100 maize populations were submitted for DH development at CIMMYT-Kenya DH facility by NARS breeders in Africa from which over 15,00 DH lines were produced and delivered back to the breeders. b) Digitization equipment distributed to maize programs in KALRO, NARO and CSIR-Ghana. This enabled NARS to collect data digitally, print plot tags, and save time in seed counting. c) QA/QC using molecular markers adopted by four seed company partners in ESA.	and molecular breeding for increasing genetic gains in stress-prone tropical maize environments			screening-cycle-to-begin-in-kenya-in-january-2021/ https://maize.org/faster-results-at-a-lower-cost/ https://www.cimmyt.org/events/genomic-assisted-maize-breeding-status-and-opportunities/ See peer-reviewed publications to disseminate molecular breeding innovations: https://www.frontiersin.org/articles/10.3389/fgene.2019.01392/full https://cgiar-my.sharepoint.com/:w:/g/personal/l_train_cgiar_org/EQPD8_PEa6RAg5EV-WNtX1UBWL4T_5pgxivKKkjZStZvzA?e=9DMCVG
	FP3 Outcome: 3.4 Increased deployment of improved MAIZE varieties by seed companies in target agro-ecologies	• Closed yield gaps through improved agronomic and animal husbandry practices	a) A total of 48 improved MAIZE varieties with farmer-preferred traits have been released by public/private sector partners in sub-Saharan Africa (28), Asia (10) and Latin America (10). b) Three FAW-tolerant improved maize hybrids developed by	2020 - Elite, multiple stress tolerant maize varieties with combinations of traits relevant for the smallholders developed and deployed through NARS and seed companies in Africa, Asia and LatAm	Complete	a) MAIZE Varietal Release Map for 2020, presented in the Annual Report. b) Announcement on the CIMMYT website of FAW-tolerant maize hybrids; c) AGG Annual Report for 2020.	a) https://maize.org/wp-content/uploads/sites/60/2021/04/MaizeVARIETIES_MOS-scaled.jpg b) https://www.cimmyt.org/news/announcing-cimmyt-derived-fall-armyworm-tolerant-elite-maize-hybrids-for-eastern-and-southern-africa/ c) https://cgiar-my.sharepoint.com/:w:/g/personal/l_train_cgiar_org/EQPD8_PEa6RAg5EV-WNtX1UBWL4T_5pgxivKKkjZStZvzA?e=9DMCVG

			CIMMYT have been announced to the partners in Dec 2020. c) Certified seed production and commercialization of recently released MAIZE varieties in 13 countries across sub-Saharan Africa reached 134,260 metric tons (MT), covering an estimated 5.5 million ha, and benefiting about 9.4 million households (64.8 million people). Increased deployment both in SSA (STMA- and FAW-driven) and S Asia (HTMA-driven).				
				2020 extended to 2021 - Women and youth participation across the maize seed value chain promoted; Information generated and documented on technology adoption patterns and key drivers to design marketing strategies (linkage with FP1).	Extended	a) Tegbaru A et al. (2020). Addressing gendered varietal and trait preferences in West African maize. World Development Perspectives 20, 100268. b) Teklewold et al. (2020) What explains the gender differences in the adoption of multiple maize varieties? Empirical evidence from Uganda and Tanzania. World Development Perspectives, 2020, 18, 100206. Several studies completed, however gender research capacity reduced in 2020.	https://doi.org/10.1016/j.wdp.2020.100268 https://doi.org/10.1016/j.wdp.2020.100206 https://doi.org/10.1016/j.jspr.2020.101734 https://doi.org/10.1111/rode.12670 https://www.tandfonline.com/doi/full/10.1080/9718524.2020.1794607 https://doi.org/10.1080/02255189.2019.1650332
				2020 - Development of maize source populations for male sterility to make seed	Complete	2020 Seed Production Technology for Africa (SPTA) Annual Project Report	INV-006619_2020_SPTA_P4_Progress_Narrative https://www.cimmyt.org/projects/seed-production-technology-for-africa-spta/

				more affordable (by reducing the cost of seed production)			https://www.cimmyt.org/content/uploads/2019/03/CIMMYT-SPTA-seed-production-SMEs-2020-07-web.pdf https://www.mdpi.com/2077-0472/10/7/259
	FP3 Outcome: 3.9 Increased availability of nutritious maize with desirable end use quality traits to farmers, food and feed producers, and processors	• Increased availability of diverse nutrient-rich foods	In 2020, five nutritionally enriched improved maize varieties, developed by the MAIZE team, have been released by partners; these include 1 provitamin A-enriched maize variety in Nigeria, one QPM variety released in Colombia, and three QPM + High Zinc varieties released in Latin America (one in El Salvador and two in Guatemala).	2020 - At least 5-6 new nutritious maize varieties (provitamin A/QPM/high-Zinc) maize varieties released through partners in SSA, LatAm and Asia	Complete	see annual reporting: CGIAR-derived variety releases	https://maize.org/wp-content/uploads/sites/60/2021/04/MaizeVARIETIES_MOS-scaled.jpg https://doi.org/10.1111/1541-4337.12552 https://doi.org/10.3389/fgene.2019.01392
	FP3 Outcome: 3.10 Farmers adopted improved varieties in farming systems	• Reduced smallholders production risk	A total of 18 MLN-tolerant/resistant hybrids have been released in MLN-endemic eastern Africa; of these, four hybrids (e.g., H6506, Bazooka) are in active commercialization by seed companies in Kenya, Uganda and Tanzania, replacing some of the MLN-susceptible maize varieties.	2020 - At least 15-20 new MLN tolerant / resistant hybrids released in eastern Africa, and at least 4-5 hybrids actively commercialized by seed company partners in the MLN-endemic countries in eastern Africa, replacing some of the dominant but 15+ year old maize varieties.	Complete	A comprehensive review was published by Prasanna et al. (2020) in the journal Virus Research.	https://doi.org/10.1016/j.virusres.2020.197943 See annual reporting, CGIAR-derived variety releases: 12 for Eastern Africa and 13 for Southern Africa in 2020. The STMA project ended March 2020, after having successfully developed and deployed multiple stress tolerant maize varieties adapted to Eastern, Southern and West Africa. 110,000 tons of certified seed (2019) for over 100 stress-tolerant improved maize varieties, produced by seed company partners, reached more than 8 million households in 2020. Key results to date include 19 MLN-tolerant/resistant hybrids released in eastern Africa; converting 52 elite, but MLN-susceptible , inbred lines into MLN-resistant versions; optimized diagnostic protocols

							and NARES partner training. https://mln.cimmyt.org/2020-screening-cycle-for-deadly-mln-virus-in-kenya-april-planting/ Example of seed company collaboration 2020: https://www.cimmyt.org/news/delivering-improved-maize-seed-against-all-odds/ Cap Dev: https://www.cimmyt.org/events/increasing-maize-varietal-turnover-in-sub%E2%80%90saharan-africa/ Value chain, marketing challenges: https://doi.org/10.1080/15427528.2020.1737296
FP4	FP4 Outcome: 4.4 NARS increased use of participatory approach in system research	• Enhanced institutional capacity of partner research organizations	Prior to the COVID19 pandemic, CSISA organized a national level consultation workshop on integrated weed management on 10 October 2020 in Dhaka, Bangladesh. National agricultural research and extension systems (NARES) partners, NGOs, herbicide companies, input dealers and private entrepreneurs participated in the workshop, which focused on presenting CSISA's research results and coordinating participants to identify and build business models that can assist in expanded use of appropriate weed control predicts. CSISA also launched first-of-a-kind research trials with the Bangladesh Rice Research	2020 extended to 2021 - Multi-criteria assessments, taking into account environmental and social acceptability aspects, based on standardized protocols for multi-criteria assessments of advanced crop management packages (not individual technologies)	Extended	Noticeable achievements are documented in Farm Mechanization and conservation agriculture for sustainable intensification (FACASI), Taking Maize Agronomy to Scale in Africa (TAMASA) final reports and on progress reports of Cereal Systems Initiative for South Asia (CSISA Nepal, CSISA MEA, CSISA-BD), MAsAgro.	www.csisa.org http://facasi.act-africa.org/library.php?com=4&com2=12&com3=11&com4=CSISA Nepal https://csisa.org/wp-content/uploads/sites/2/2020/11/201102-FINAL-CSISA-PIII-FY-2019-20-ANNUAL-REPORT_BD-NEPAL_web.pdf

			Institute (BRRI) on weed competitive rice cultivars in Bangladesh. All activities related to integrated weed management, exempting field trials located on research stations. During the reporting period, and despite challenges caused by the COVID-19 Pandemic, CSISA assisted 185 farmers of the Susheli Dairy Cooperative Ltd. to develop business models for expansion of their dairy sales business.				
				2020 - better understand and model farmer perception, farmer diversity, and farm-level integration of technologies	Complete	Wealth of knowledge have been generated and published for the reporting period (see publication list)	Peer reviewed publications
	FP4 Outcome: 4.8 Actors in SI increased consideration and integration of gender and social inclusion into policies, processes and practices	• Technologies that reduce women`s labor and energy expenditure adopted	Gender and social inclusions are now imbedded in all mechanization projects in Asia, Africa and Mexico.	2020 - Smart mechanization lessons learnt routinely applied in other FP4 projects. Interventions derived by cross-learning	Complete	Reports of Cereal systems Initiative for South Asia Mechanization and Extension (CSISA-MEA (Bangladesh), German Agency for International Cooperation (GIZ) projects (Ethiopia), Sustainable Intensification of Smallholder Farming Systems in Zambia (SIFAZ (Zambia), MasAgro (Mexico).	Publications and reports www.csisa.org and https://csisa.org/csisa-bangladesh/ http://facasi.act-africa.org/ https://masagro.mx/es/
				2020 extended to 2021 - Adaptive	Extended	Synthesis to be produced in 2021	https://srfsi.cimmyt.org/casi-visual-syllabus/

				research improves understanding of gender, youth and adoption, adaptation and scaling-up processes, with focus on market demand as trigger of innovation			https://maizewheat.teamwork.com/#/files/5224046
	FP4 Outcome: 4.9 Smallholder farmers increased their capacity to adopt and adapt SI practices and products (associated with cross-cutting sub-IDO)	• Increased access to productive assets, including natural resources	By using innovative approaches to transform agronomy. Working with service providers (i.e. input suppliers, government and private research and extension services, agro-dealers, and others) to identify and co-develop systems and applications that transform this data and information to useable products that support their businesses or programs to reach clients more effectively; and Building capacity in national programs to support and sustain these approaches. Nutrient expert benefits assessed for South Asia, Nutrient decision support tools at different levels (field, farms, regions) assessed in Taking Maize Agronomy to Scale in Africa (TAMASA). Global study on contribution of better nitrogen management published. Water management project	2020 - Tools and methods for assessing agricultural systems for sustainable intensification	Complete	Use of tools and data by service providers and research organizations;- an increased or more efficient use of appropriate inputs by smallholder farmers; and- a better understanding of how to increase the effectiveness of delivering agronomic advice at scale.	https://tamasa.cimmyt.org/ https://tamasa.cimmyt.org/resources/publications/ https://www.dropbox.com/scl/fi/pdu27s0ozg9q7lcte1aqj/INV-008260_Renewal_TAMASA_2020_Final-Narrative.docx?dl=0&rlkey=mclklkcgvlk6kw8c2tb06o4sh

			funded by USAID Nepal. Water use efficiency (WUE) research through subsurface drip irrigation.			
				2020 - Decision support tools for nutrient and irrigation management using remote sensing and geo-spatial frameworks	Complete	Water management project funded by USAID Nepal.consolidating and monitoring groundwater information, which highlights the importance of stakeholder engagement when developing pilots of the project, to ensure that when scaling is achieved, it caters to specific needs. Participants also expressed a strong interest in bringing the results of the project within the ambit of national policy, which would achieve the streamlining of data collection protocols for standardized, publicly accessible, data collection mechanisms.	https://doi.org/10.1016/j.gfs.2020.100464 https://www.sciencedirect.com/science/article/pii/S0065211320300638?via%3Dihub https://www.tandfonline.com/doi/full/10.1080/03650340.2019.1708332 https://www.mdpi.com/2072-4292/12/22/3688 https://link.springer.com/article/10.1007/s13593-020-0610-2 https://www.sciencedirect.com/science/article/pii/S2352938519301831?via%3Dihub https://www.cimmyt.org/blogs/digital-groundwater-monitoring/
	FP4 Outcome: 4.10 Smallholder farmers adopted and adapted SI practices and products	• Closed yield gaps through improved agronomic and animal husbandry practices	2020 - Smart mechanization lessons learned routinely applied in other FP4 projects.2020 – (1) Increase resource-use efficiencies (irrigation water, N, P) while maintaining high, stable yields. (2) Extension of crop mgmt. practices that arrest soil degradation. (3) Reduce labor burden and shortages.2020 - Continuous scaling up and out through W3 projects	2020 - Increased adoption of combinations of SI strategies, resource and labor-saving technologies in specific target geographies compared to 2016.	Complete	Farmers have been exposed to and experiment with improved SI and climate-smart practices.The trials and demonstrations carried out have shown that targeted and smart soil nutrient use can substantially improve the nutrient quality and content of crops, with potential enhancement to human nutrition.	https://csisa.org/wp-content/uploads/sites/2/2020/10/201015.1-2019-20-ANNUAL-FIGHTING-FAW-REPORT.pdf
				2020 extended to 2021 - Strengthened ability to synthesize	Extended	improvement of farm power balance by reducing labor drudgery and minimizing biomass trade-offs through accelerated	https://marlo.cgiar.org/projects/Maize/studySummary.do?studyID=4043&cycle=Reporting&year=2020

				and apply available knowledge related to SI oriented research methodologies (multi-criteria assessments), management practices, technologies, machinery, in 10-15 partner orgs		delivery and adoption technologies by smallholders and creating synergies between small-scale-mechanization and conservation agriculture.	https://www.mdpi.com/2071-1050/12/1/374

Table 6: Numbers of peer-reviewed publications from current reporting period

(Sphere of control)

	Number	Percent
Peer-Reviewed publications	251	100.0%
Open Access	199	79.28%
ISI	236	94.02%

Table 7: Participants in Capacity Development Activities

Number of trainees	Female	Male
In short-term programs facilitated by CRP/PTF	1072	4340
In long-term programs facilitated by CRP/PTF	31	51
PhDs	6	13

Evidence Link

Table 8: Key external partnerships

Lead FP	Brief description of partnership aims (30 words)	List of key partners in partnership. Do not use acronyms.	Main area of partnership (may choose multiple)
FP1	Build foresight portfolio; couple biotic stress to crop growth models & analysis of IAR4D investments using real options theory models	WUR - Wageningen University and Research Centre Utrecht University	• Policy • Research
FP1	Update maize mega-environments for the different growing seasons in South Asia	NARC - Nepal Agricultural Research Council BWMRI - Bangladesh Wheat and Maize Research Institute DMR - ICAR-Indian Institute of Maize Research	• Research
FP2	Innovative seed production technology for African SME seed companies; MLN-tolerant hybrids based on gene-editing by 2025;	Corteva AgriScience ARC - Agricultural Research Council KALRO - Kenya Agricultural and Livestock Research Org.	• Capacity Development • Delivery • Research
FP3	New aflatoxin-tolerant & foliar disease-resistant maize varieties (hybrids) for African mid-altitude agro-ecological zones	BecA - Biosciences eastern and central Africa UoN - University of Nairobi	• Research
FP3	new Fall Armyworm Research Collaboration Portal, to facilitate global research collaboration	CABI - Centre for Agriculture and Biosciences International	• Research • Capacity Development
FP4	TAMASA: co-develop systems and applications (nutrient mgmt app) that transform data/information into useable products that support service providers and farmers	IPNI - International Plant Nutrition Institute SAA - Sasakawa Africa Association PAD - Precision Agriculture for Development MoANR - Ministry of Agriculture and Natural Resources	• Research • Delivery
FP4	"Technological Portfolios and Modeling Techniques for Sustainable Intensification" project funded by MAIZE: Upgrading the AgroTutor App, which reaches 150,000 farmers via extension agents. During Phase II, this was redesigned to allow current users to access benchmarking data faster and more reliably.	CIAT (Alliance) - Alliance of Bioversity and CIAT - Regional Hub (Centro Internacional de Agricultura Tropical) IIASA - International Institute for Applied Systems Analysis	• Delivery • Capacity Development

Table 9: Internal Cross-CGIAR Collaborations

Brief description of the collaboration	Name(s) of collaborating CRP(s), Platform(s) or Center(s)	Optional: Value added, in a few words
Synergies re-enforcing role of monitoring and big-data	Big Data	Synergies
Synergies and collaborative work on foresight and targeting (CoA1.1); adoption/impact (CoA1.2); gender/social inclusiveness (CoA1.3) and markets/value chains (CoA1.4)	Wheat	Synergies and collaborative work
Synergies and collaborative work on foresight and targeting (PIM FP1); seed systems (PIM FP1); rural transformation (PIM FP2), markets/value chains (PIM FP3)	PIM	Synergies and collaborative work
Synergies and collaborative work on gender/social inclusiveness	Gender	scientific benefits; resource pooling

Table 10: Monitoring, Evaluation, Learning and Impact Assessment (MELIA)

Studies/learning exercises planned for this year (from POWB)	Status	Type of study or activity	Description of activity / study	Links to MELIA publications
S3939 - Does farm structure affect rural household incomes in Tanzania?	Completed	Ex-ante, baseline and/or foresight study	Study investigated inter-district variation in farm landholding patterns to determine how differences in localized farmland structure affect rural household incomes across 142 districts, Tanzania. Findings: Most indicators of farmland concentration positively associated with rural household incomes; household incomes from farm/non-farm sources positively and significantly associated with share of land in the district controlled by 5–10 and 5–20 ha farms. These positive spillover benefits are smaller and less statistically significant in districts with a high share of farmland controlled by 20 ha+ farms. Poor rural households are least able to capture the positive spillovers generated by medium-scale and big farms.	https://doi.org/10.1016/j.foodpol.2019.101805
S3983 - Long term (10–12 years) maize-based Conservation Agriculture's impact on soil hydraulic conductivity & water retention (Malawi)	Completed	Program/project adoption or impact assessment	Conservation agriculture (CA) is widely promoted across SSA. But impacts on key soil physical properties and functions governing water storage and transmission remain not well understood. On-farm trial results show that maize-based CA systems result in significant changes to soil hydraulic properties that correlate with improved soil structure. No significant build-up in soil organic matter was recorded, which points to need to improve crop residue management. Study indicates CA's potential to store antecedent water and make it available to plants during dry spells. Future studies should assess carbon balance, to identify pathways to avoid soil organic matter loss.	https://doi.org/10.1016/j.still.2020.104639
S3984 - Bringing together separate disciplinary approaches to impact assessment (Conservation Agriculture in Malawi)	Completed	Correlates of adoption/impact study	'What forms of Conservation Agriculture (CA) work, where, and why?' Answers require consideration of CA within complex farming systems and collating and integrating different forms of knowledge. Researchers performed a comparison of disciplinary approaches to evaluating CA in Malawi; identified knowledge gaps that persist at the intersection of these disciplines and made recommendations for interdisciplinary approaches. Researchers show that neither of two distinct approaches (agro-ecological and socio-economic) can address the full scope of this question; the 'why'. They argue for access to compatible, comprehensive data sets, methodological approaches including farmer participation and ethnography, through on-farm trial research.	https://doi.org/10.1007/s13593-020-0608-9

S4004 - MAIZE and partner scientists investigated the carbon sequestration potential of conservation agriculture (CA)	Completed	Qualitative Outcome Study: (to substantiate contribution to policy	Factors including climate, crop, soil management and type, can influence agriculture's contribution to global carbon cycle, minimal soil disturbance, maintaining permanent soil cover and crop rotations. Using micrometeorological methods measuring CO_2 flux, researchers compared alternative Conservation Agriculture (CA) in central Zimbabwe +/-3 years. Micrometeorological methods detect differences in total agricultural CO_2 emissions. Analysis: CA produces less CO_2 emissions (for the plot with the most consistent CA practices 0.564 ± 0.0122 g CO_2 m^{-2} h^{-1}) significantly under 0.928 ± 0.00859 g CO_2 m^{-2} h^{-1} for conventional tillage (CT). Overall, no-till CA using cover crops produced (-)CO_2 emissions than CT and fallow.	https://www.tandfonline.com/doi/abs/10.1080/14735903.2020.1750254?journalCode=tags20
S4006 - Adoption-impact studies in maize agri-food systems in the Global South	Completed	Ex-post adoption study	Scoping review of 54 studies found (1) satellite data (SD) successfully used to detect agricultural practices, i.e., cropping intensity and soil/water conservation; (2) few estimated yield impacts, although estimation of crop yields with SD is developed; (3) some explored impact estimation beyond biophysical sphere. Estimation of certain environmental impacts of agricultural practices are possible through SD. SD is rarely used to assess the interventions' economic impacts. Overall SD analysis allows information access with little delay and over longer periods, over wide geographies, reducing measurement error in certain variables. More interdisciplinary research needed to foster uptake of this alternative data source in R4D evaluations.	https://link.springer.com/article/10.1007/s13593-020-0610-2
S4007 - A scoping review of adoption of climate-resilient crops by small-scale producers in low- and middle-income countries	Completed	EPIA: Ex-post Impact Assessment	Review of conditions leading to climate-resilient crops (CRC) adoption (past 30 years) in emerging economies experiencing climate-related impacts; determined by 45 indicators (Notre Dame Global Adaptation Initiative). Cereal predominance in subset of 202 studies on adoption of CRC (67%). Small-scale producers adopted CRC varieties coping with abiotic stresses; mainly drought tolerance, followed by water-use efficiency. Key determinants of adoption: 1) availability/effectiveness of extension services/outreach, 2) household heads' education levels, 3) farmers' inputs' access—seeds/fertilizers— 4) socio-economic status of farming families. Farmers adopting climate-smart agriculture help to build resilient, sustainable agri-systems that better handle shocks associated with climate change & more.	https://www.nature.com/articles/s41477-020-00783-z https://www.cimmyt.org/news/what-can-the-last-30-years-of-research-tell-us/
S4008 - Farmer adoption of sustainable intensification agriculture (SIA)	Completed	Ex-post adoption study	The SIA paradigm includes numerous technologies (chemical fertilizer use, improved crop cultivars, soil/water conservation, intercropping, crop rotations). Understanding what drives SIA technology adoption is applied research that contributes to reaching SDGs. Conventional technology dissemination in the Global South favors large/wealthy farmers and is less effective on needs/preferences of the poor/marginalized. Adoption comprises a range of	https://link.springer.com/article/10.1007%2Fs13593-020-00658-9

technologies in maize systems of the Global South: A review			farmer choices from (a) immediate/continuous full adoption to (b) no adoption at all; only useful for simple impact evaluation, not to generate learning (adoption process/multiple dimensions). Analysis of 137 adoption studies (2007-2018) shows: (1) limited information access/technologies were not suitable; (2) quantitative empirical analysis provides crucial information.	
S4009 - A4NH, MAIZE and partner scientists examined potential public/private sector-driven interventions	Completed	Ex-ante, baseline and/or foresight study	Addresses malnutrition within value-chain interventions by Governments/development partners: Intervention links between value-chains and diets involve direct and indirect actors/effects not well understood. A4NH, MAIZE +partner scientists examined potential public/private sector-driven interventions, which could improve diets of Malawian smallholder farmers. They explored methodological requirements (strategic food-systems-based approach) for undertaking this multisectoral analysis. Consumption is dominated by maize; low-income households have deficits in nutrient intake. From own-production to increasing quantity of nutritious foods, markets fail in their potentially important role to supply safe/nutritious food (hygiene; storage/selling infrastructure; nutrition know-how, stakeholder coordination).	https://www.sciencedirect.com/science/article/pii/S2211912418301081?via%3Dihub
S4011 - Biofortified crops have high potential to improve child nutrition in Ethiopia (Oromia).	Completed	Ex-post adoption study	Complementing the distribution of quality protein maize (QPM) with interventions informed by behavioural insights, to support young children's' consumption for growth. It is possible to elicit behaviour changes for adoption of biofortified crop varieties. This intervention increased QPM consumption for young children by -25% and more than doubled the probability from caregivers cooking QPM food (specifically young children). Behavioural changes attenuated over time, but behaviour changes persisted. Increased QPM consumption did not translate into significant growth improvements, e.g., QPM consumption increase. Possible that the period for children eating QPM was not long enough. Study limitations: Behavioural change self-reported; families-biased. Future research needed in uncontrolled setting to investigate changes in child growth.	https://gh.bmj.com/content/5/12/e002705
S4012 - The current agricultural extension system in Ethiopia emphasizes intensification of maize production using	Completed	Ex-ante, baseline and/or foresight study	Ethiopian agricultural extension system emphasizes smallholder maize production intensification using external inputs (improved seed/chemical fertilizer). Study looked at effect of smallholder farmer training to encourage crop diversification (maize-legume intercropping/crop rotation; panel data = 2.887+2.853 maize plots operated by a sample of 1.751+1.774 farm households, surveyed 2010 and 2013). External input use, combined with diversification, provided highest maize yield and lowest downside risk. Policies must support/encourage adoption of full package, with farmers successfully implementing as	http://afjare.org/wp-content/uploads/2020/07/2.-Jaleta-et-al.pdf

external inputs (improved seed and chemical fertilizer) among smallholders			exemplars. Policies must support non-users applying missing components, to generate additional yield/income benefits at reduced downside risk. Research must explore/promote appropriate package approaches, to avoid focusing on component technologies one at a time.	
S4013 - farmer adoption dynamics learning: African smallholder farmers who have expressed interest in Conservation Agriculture (CA) have generally not implemented on their farms	Completed	Ex-post adoption study	Interest expressed by African smallholder farmers in Conservation Agriculture (CA) generally did not progress towards implementation on farms. Based on in-depth, semi-structured interviews (58 CA-interested farmers), respondents indicated mixed perceptions about CA livelihoods benefits, feasibility and relevance. To improve the CA 'offer', respondents pointed to financial viability, stover competition, small-scale mechanization and informational exchange mechanisms open issues related. Farmer interest in CA should be based on technology-driven benefits, not perverse incentives (e.g. subsidies). Need to fit CA within contextual realities. Survey indicates the way forward is more flexible/transitional CA promotion by components, facilitated through greater community participation in research/extension systems.	https://link.springer.com/article/10.1007%2Fs10668-019-00340-5 https://www.cimmyt.org/projects/sustainable-and-resilient-farming-systems-intensification-in-the-eastern-gangetic-plains-srfsi/ https://link.springer.com/article/10.1007/s10668-019-00340-5 (published online in 2019, in print 2020)
S4014 - MAIZE scientists performed a rigorous economic analysis of the impacts of FAW in Ethiopia	Completed	EPIA: Ex-post Impact Assessment	First comprehensive study undertaken in Ethiopia to evaluate the welfare damage caused by Fall Armyworm (FAW), including pest control strategies and institutions' role in reducing adverse effects. Used Southern-Ethiopian comprehensive household/plot-level collected data. Exposure to FAW had significant negative impact on maize yield (11.5% loss). Reduction in yield did not translate into consumption reduction throughout the study period. Likely that FAW yield loss was not significant enough to affect consumption patterns; or some consumption-smoothing behaviour occurred. Maize supply share much lower amongst FAW-affected households. Minimizing FAW infestation and its impact on maize sales will have food security/poverty reduction impacts in the long-term. Farmer liquidity constraints to investing in productivity-technologies. Study lists 3 limitations, among them: Data not nationally representative.	https://academic.oup.com/erae/article/47/4/1473/5698630
S4023 - Methodology development for innovation processes cross-program (for Crop Country Initiatives)	On Going	Other MELIA activity	Strategies for keep the supply of food flowing across; scale support to the most vulnerable; and invest in sustainable, resilient food systems. This studies also seek to replicate this strategy in other countries and will develop maize varieties adapted to each country's farming conditions and will promote sustainable intensification practices among farmers.	Govaerts, B., et al., 2019. Maíz para México - Plan Estratégico 2030. CIMMYT, México, p. 144: https://repository.cimmyt.org/handle/10883/20219 https://repository.cimmyt.org/handle/10883/20218 https://repository.cimmyt.org/handle/10883/20382

				https://repository.cimmyt.org/bitstream/handle/10883/20219/60937.pdf?sequence=4&isAllowed=y https://www.elfinanciero.com.mx/economia/gobierno-apuesta-por-maiz-por-mexico-para-aumentar-produccion-del-grano https://expansion.mx/economia/2021/01/16/mexico-pretende-reducir-su-dependencia-del-maiz-proveniente-de-eu
S4054 - Mitigating production risk through stress tolerant varieties may be more appealing to farmers in Northern Nigeria compared to index-insurance	On Going	Other MELIA activity	Comparing the price premium that farmers are willing to pay (WTP) for stress tolerant maize varieties, and for index-based insurance products, suggests that the promotion of stress-tolerant (ST) varieties is likely to be more appealing to farmers than insurance. While WTP and hence demand for index-based insurance products is extremely low, WTP for ST varieties is almost twice higher relative to conventional varieties in Northern Nigeria. As such, breeding for ST tolerance may be a near perfect (sufficient) substitute for index insurance.	https://doi.org/10.1080/14693062.2020.1745742 (similar study done for Togo; no publication for Nigeria yet, only workshop report)
S4059 - Conservation agriculture and precision nutrient management in maize-based systems of South-Asia help climate change mitigation coupled with increased food production and economic benefits to smallholders	On Going	Other MELIA activity	Continued efforts to generate science evidence, innovative partnerships and enhanced capacity led to policy changes for large scale adoption of low emission risk mitigating practices in smallholder systems. Farmers adopted CA on 2 million (M) and precision nutrient management on 20M hectares in South Asia. Could potentially benefit ~14 million smallholders with ~14 million tons of extra grain production and US$ 1.3 billion additional revenue generation, whilst reducing ~3.4 million tons of CO_2 each year. Evidences: 1. Chethan, C. R. et al. Crop residue management to reduce GHG emissions and weed infestation in Central India through mechanized farm operations. Carbon Manag. 11, 565–576 (2020). 2. Keil, A. et al. Changing agricultural stubble burning practices in the Indo-Gangetic plains: is the Happy Seeder a profitable alternative? Int. J. Agric. Sustain. 0, 1–24 (2020). 3. Alam, M. K., Bell, R. W. & Biswas, W. K. Increases in soil sequestered carbon under conservation agriculture cropping decrease the estimated greenhouse gas emissions of wetland rice using life cycle assessment. J. Clean. Prod. 224, 72–87 (2019). 4. Gathala, M. K. et al. Enabling smallholder farmers to sustainably improve their food, energy and water nexus while achieving environmental and economic benefits. Renew. Sustain. Energy Rev. 120, 109645 (2020).	Sapkota, T. B. et al. (2021): https://doi.org/10.1038/s41598-020-79883-x https://cgspace.cgiar.org/bitstream/handle/10568/67260/Haryana%20letter.pdf?sequence=1 https://www.cimmyt.org/news/cimmyt-ccafs-initiative-develops-500-new-climatesmart-villages-in-haryana-india/ https://ccafs.cgiar.org/outcomes/scaling-climate-smart-villages-india https://www.ctc-n.org/products/climate-smart-village-haryana-india

S4060 - Cost Advantage of Biofortified Maize for the Poultry Feed Industry and Its Implications for Value Chain Actors in Nepal	On Going	Other MELIA activity	Indicates that a ton of feed produced using QPM, instead of regular maize, reduces feed cost by at least US$7.10 for broilers and at least US$4.71 for layers of different ages. With the cost saving, the feed industry could pay a max 4% price premium for QPM over regular maize. A strong linkage between feed industry and maize value chain actors is required, for the feed industry to benefit sustainably from QPM use.	https://doi.org/10.1080/08974438.2020.1780179
S4213 - Analysis of Kenyan fertilizer markets and smallholder farmer use (1992-2013): Any impact of yields and incomes?	Completed	Ex-post adoption study	Though number of fertilizer users among maize farmers increased slightly and quantity applied per ha increased (from 82 to 100 kg/ha), use remains far below recommended levels. Yields remained stagnant or decreased slightly. Fertilizer use does have a positive impact on both maize yields and household income. Authors conclude that liberalization of fertilizer markets did not have the desired effect, except in high potential maize-growing areas. They recommend targeted extension outreach in less productive regions and policies that incorporate provisions for weather shocks. (Ex post; 4 household surveys 1992 - 2013 in 6 zones; 80% of 6.4M HH produce maize).	https://doi.org/10.1080/14735903.2020.1823699

Table 11: Update on Actions Taken in Response to Relevant Evaluations

Not applicable.

Table 12: Examples of W1/2 Use in this reporting period

	Strategic, longer-term research, seed invests	Rapid response (incl flexibility)	Cross-Portfolio, -CRP learning for impact	CRP Gov. & Mgmt.
Discovery (upstream)	FP1, 4: *ex ante* IA & ex post IA / adoption studies for new knowledge for better targeting, prioritizing; ARI, national partners FP2-4: Generate new knowledge for R-to-D pipeline: New alleles for heat and drought, other climate change-related traits identified; GS models using high throughput phenotyping & environmental data	FP3 new diseases & pests: FAW, MLN, Spittlebug	FP2-3: Germplasm improvement methodologies, methods, data mgmt (e.g. Genetic gain, cross-crops) FP4: Research on scaling out, innovation pathways	MAIZE ISC, MAIZE - MC. SMB Board Member (DG), CRPs Rep in SMB, MEL CoP co-leadership
Validation	FP3: New traits into elite lines: Heat & Drought. Precision Phenotyping Platforms with NARS partners; yield testing FP1: draw lessons from the previous MAIZE years and across MAIZE W3/bilateral studies and geographies to identify implications and priorities for enhancing the impact of MAIZE in Phase-II		FP4: Country coordination, systems research approaches; , strategic support to national research programs, private-sector led scaling FP2: develop decision support tools to enhance genetic gains in breeding programs, in partnership with EiB Platform	
Scaling out (downstream)	FP1, 4: Research on adoption dynamics, scaling out, targeting, prioritizing, M&E approaches FP3: Research on farmer adoption, seed systems innovation	FP3-4: post-conflict emergency support	FP3., FP4: Country coordination, companion crops into maize- based systems, capacity development	
CGIAR-SRF Cross-cutting themes	Gender / social inclusion applied to MAIZE innovations and rapid value chain assessments with proper gender lens		FP1, 4: AFS-CRPs & CCAFS FP3: MAIZE & A4NH on improved nutrition How to improve gender mainstreaming into research	

Table 13: CRP Financial Report

CRP ON MAIZE - CRP14

Rerported Period - 2020	Planned Budget				Actual Expenditures				Difference			
Description	**Windows 1 & 2**	**Window 3**	**Bilateral**	**Total**	**Windows 1 & 2**	**Window 3**	**Bilateral**	**Total**	**Windows 1 & 2**	**Window 3**	**Bilateral**	**Total**
FP1-Enhancing Maize's R4D Strategy for impact	1,352	3,797	1,488	6,637	1,210	2,760	880	4,850	142	1,037	608	1,787
FP2-Novel Diversity and Tools for increasing Genetic Gains	1,419	2,931	1,431	5,781	1,293	2,328	1,274	4,895	126	603	157	886
FP3-Stress Tolerance and Nutritious Maize	3,893	9,547	5,757	19,197	2,757	6,702	3,544	13,003	1,136	2,845	2,213	6,194
FP4-Sustainable Intensification of Maize- Systems for better livelihoods of SH	2,429	6,047	8,126	16,602	2,102	4,060	6,764	12,926	327	1,987	1,362	3,676
Strategic Competitive Research grant				-	-	-	-	-	-	-	-	-
Management and Support Cost	1,385	-	-	1,385	988	-	-	988	397	-	-	397
Total Costs	**10,478**	**22,322**	**16,802**	**49,602**	**8,350**	**15,850**	**12,462**	**36,662**	**2,128**	**6,472**	**4,340**	**12,940**
Note: CGIAR Collaboration Costs breakdown by FP												
FP1-Enhancing Maize's R4D Strategy for impact	250			250	250	97	-	347	-	(97)	-	(97)
FP2-Novel Diversity and Tools for increasing Genetic Gains	332			332	332	-	-	332	-	-	-	-
FP3-Stress Tolerance and Nutritious Maize	442			442	474	-	-	474	(32)	-	-	(32)
FP4-Sustainable Intensification of Maize- Systems for better livelihoods of SH	642			642	642	614	-	1,256	-	(614)	-	(614)
Strategic Competitive Research grant				-	-	-	-	-	-	-	-	-
Management and Support Cost	118			118	158	-	-	158	(40)	-	-	(40)
Total CGIAR Collaboration Costs	**1,784**	**-**	**-**	**1,784**	**1,856**	**711**	**-**	**2,567**	**(72)**	**(711)**	**-**	**(783)**
TOTAL CRP ON MAIZE (Net w/o CGIAR Collaborations)	**8,694**	**22,322**	**16,802**	**47,818**	**6,494**	**15,139**	**12,462**	**34,095**	**2,200**	**7,183**	**4,340**	**13,723**

RESEARCH PROGRAM ON Maize

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