

MAIZE Agri-Food Systems CRP:

Plan of work and budget 2017

RESEARCH PROGRAM ON Maize
CGIAR

CIMMYT

IITA
Research to Nourish Africa

MAIZE Annual Plan of Work and Budget (POWB) – 2017

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List of Acronyms

A4NH	CGIAR Research Program on Agriculture for Nutrition and Health
AATF	African Agricultural Technology Foundation
ACIAR	Australian Centre for International Agricultural Research
AfDB	African Development Bank
AfricaRice	Africa Rice Center
AFS	Agri-Food System
AMEXCID	*Agencia Mexicana de Cooperación Internacional para el Desarrollo*
ARI	Advanced Research Institute
AVRDC	World Vegetable Center
BGLRR	Bayesian Generalized Linear Regression using R
BIO-R	Biodiversity Analysis with R
BMGF	Bill & Melinda Gates Foundation
BSc	Bachelor of Science
CABI	Centre for Agriculture and Biosciences International
CapDev	Capacity Development
CC	Climate Change
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CoA	Cluster of Activity
COGS	Cost of Goods Sold
CRMA	Climate Resilient Maize for Asia
CRP	CGIAR Research Program
CSISA	Cereal Systems Initiative for South Asia
CSISA-MI	CSISA-Mechanization and Irrigation
DG	Director General
DH	Doubled Haploid
DRC	Democratic Republic of the Congo
DSS	Decision Support System
DT	Drought tolerant
DTMASS	Drought Tolerant Maize for Africa Seed Scaling
EiB	Excellence in Breeding
ESA	Eastern and Southern Africa
FACASI	Farm Mechanization and Conservation Agriculture for Sustainable Intensification
FARA	Forum for Agricultural Research in Africa
FP	Flagship Project
FPL	Food Processing Lab
G x E x M	Genotype x Environment x Management
GHG	Greenhouse gas
GLDC	CGIAR Research Program on Grain Legumes and Dryland Cereals
GLS	Gray Leaf Spot
HIR	Haploid Induction Rate
HTMA	Heat Tolerant Maize for Asia
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRAF	World Agroforestry Centre

ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communications Technology
IDO	Intermediate Development Outcome
IFPRI	International Food Policy Research Institute
IIASA	International Institute for applied Systems Analysis
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IMAS	Improved Maize for African Soils
INIFAP	*Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias*
IPNI	International Plant Nutrition Institute
IRRI	International Rice Research Institute
ISC	Independent Steering Committee
IWMI	International Water Management Institute
KALRO	Kenya Agriculture & Livestock Research Organization
KIT	Royal Tropical Institute
LA	Latin America
LAC	Latin America and the Caribbean
M&E	Monitoring & Evaluation
MAIZE	CGIAR Research Program on Maize
MALRO	Managing Agricultural Research for Learning and Outcomes
MC	Management Committee
MCMV	Maize Chlorotic Mottle Virus
MEL	Monitoring, Evaluation and Learning
META-R	Multi Environment Trail Analysis with R
MLN	Maize Lethal Necrosis
MSc	Master of Science
MSV	Maize Streak Virus
NAFAKA	Tanzania Staples Value Chain
NARES	National Agricultural Research and Extension System
NARS	National Agricultural Research System
NIRS	Near-Infrared Reflectance Spectroscopy
NPPO	National Plant Protection Organization
NPT	National Performance Trial
NRM	National Resource Management
NSAF	Nepal Seed and Fertilizer Project
OA/OD	Open Access/Open Data
OPV	Open-Pollinated Variety
ORNL	Oak Ridge National Laboratory
PFSR	Post Flowering Stalk Rot
PhD	Doctor of Philosophy
PIM	CGIAR Research Program on Policies, Institutions, and Markets
POWB	Plan of Work and Budget
QC/QA	Quality Control/Quality Assessment
QPM	Quality Protein Maize
QTL	Quantitative Trait Locus
R4D	Research for Development
RICE	CGIAR Research Program on Rice
RTB	CGIAR Research Program on Roots, Tubers and Bananas

SAU	State Agricultural University
SC	Steering Committee
SFSA	Syngenta Foundation for Sustainable Agriculture
SI	Sustainable Intensification
SIMLESA	Sustainable Intensification of Maize and Legume Systems for Food Security in Eastern and Southern Africa
SIMLEZA	Sustainable Intensification of Maize-Legume Systems in Eastern Zambia
SLO	System Level Outcome
SMB	System Management Board
SMO	System Management Office
SMTA	Standard Material Transfer Agreement
SRFSI	Sustainable and Resilient Farming Systems Intensification in the Eastern Gangetic Plains
SSA	Sub-Saharan Africa
STMA	Stress Tolerant Maize for Africa
TAAT	Technologies for African Agricultural Transformation
TAMASA	Taking Maize Agronomy to Scale in Africa
TLB	Turcicum Leaf Blight
ToC	Theory of Change
ToR	Terms of Reference
TSC	Tar Spot Complex
UAV	Unmanned Aerial Vehicle
UCL	Université catholique de Louvain
USAID	U.S. Agency for International Development
USD	United States Dollar
USDA	United States Department of Agriculture
W1&2	Windows 1 & 2
W3	Window 3
WEMA	Water Efficient Maize for Africa
WHEAT	CGIAR Research Program on WHEAT
WLE	CGIAR Research Program on Water, Land and Ecosystems
WUR	Wageningen University & Research

MAIZE Annual Plan of Work and Budget (POWB) – 2017

A. CRP LEVEL

A1. Delivery

A1.1 Adjustments/changes to Theories of Change

Since submission of the MAIZE Phase-II Proposal, and based on the System Council's decision not to provide W1&2 funding for Flagship Project 5 (FP5), the MAIZE Phase-II Theory of Change (ToC) has been accordingly modified. Other changes include an enhanced focus on better understanding of adoption and innovation processes – including a greater focus on strategic capacity development – which directly contribute to the impact of MAIZE and tests assumptions inherent in the MAIZE Impact Pathway and ToC.

A1.2 Highlight expected outcomes and outputs in 2017

Some of the key outcomes that MAIZE expects to contribute in 2017 through its outputs are:

- Synthesis of previous foresight studies as input toward priority setting for MAIZE, including identification of potential opportunities, threats and game changers.
- A meta-analysis on maize adoption/impact assessment studies to draw out lessons for the MAIZE Impact Pathway and ToC, including completion of Global MAIZE Germplasm Impact Study.
- Enhanced selection efficiency in MAIZE breeding programs by availability of updated or new data analysis and decision support tools (e.g., for spatial analysis and genomic selection).
- Increased genetic gains in MAIZE breeding programs by validation and deployment of markers for at least two high-priority traits.
- Novel diversity for MLN and tar spot complex resistance from genebank accessions validated in pre-bred materials, and progress towards marker development for use in MAIZE breeding programs.
- Increased genetic gains in MAIZE product pipelines for key traits important for smallholders in targeted regions (monitored through regional on-station and on-farm trials)
- Maize seed systems strengthened in sub-Saharan Africa (SSA), Asia and Latin America (LA), in partnership with more than 175 seed companies, resulting in large-scale seed scale-up, continued commercialisation and adoption (gender-disaggregated, where possible) of MAIZE-derived elite, climate-resilient, disease-resistant and nutritious varieties, with associated capacity development.
- Methodological contribution to the development of sustainable intensification indicators and metrics at landscape level and upscaling of field/farm levels indicators, aiming at improving MAIZE MEL.
- Development of ICT based data collection tools (including crowdsourcing avenues) to improve M&E of FP4 work.
- Better targeting of technical innovations through the use of rapid assessment of farming systems
- Assessment of European Space Agency Sentinel suite of products for crop monitoring in maize-based systems
- Existing scaling approaches including public-private partnerships and context-specific business models evaluated in target geographies, leading to improved scaling models and defined critical scaling factors.
- At least 0.3 million additional farmers adopt improved resource and labour-saving MAIZE crop management practices and technologies (focusing on youth, gender and capacity development).

For more details, please see the individual FP-wise plans of work with budget (Tables 3 & 4), including mapping of gender, youth and capacity development. In 2017, MAIZE will implement some R4D initiatives (using mainly W1&2) on specific strategic areas; e.g., nutrition and value chain analysis to make MAIZE an agri-food system CRP; pilot studies on integrated management of Fall Army Worm and Spittlebugs, two invasive and highly-damaging insect-pests recently reported in Africa.

A.1.3 Use of different Funding Sources

W1&2 constitutes <20% of the overall MAIZE budget, but serves an important catalytic function by way of strategic and complementary investments to W3/bilateral projects in specific R4D areas and target geographies of MAIZE. W1&2 helps in setting the direction of the CRP, and for creating coherence in the CRP, by which the whole is more than the sum of the parts, especially through: a) proof-of-concept work; b) seed investment on emerging research priorities leading to funding of W3/bilateral projects (e.g., precision agriculture and geospatial research; invasive insect-pests like Fall Army Worm); c) building new strategic partnerships for scaling, and for better understanding scaling processes; d) MAIZE management functions: planning, monitoring and reporting; coordination among implementing centers and partners; open access and open data management; intellectual assets management; communications; knowledge management (e.g., MAIZE Atlas), and capacity development.

Table 1: MAIZE planned budget by Flagship for 2017.

Flagship	Planned Budget 2017 (USD)		
	W1/W2	W3/bilateral	Total
FP1: Enhancing MAIZE's R4D Strategy for Impact	1,330,260	3,171,924	4,502,184
FP2: Novel Diversity and Tools for Increasing Genetic Gains	1,841,463	5,206,026	7,047,489
FP3: Stress Tolerant and Nutritious Maize	3,978,090	24,789,300	28,767,390
FP4: Sustainable Intensification of Maize-based Systems	1,585,554	21,134,093	22,719,647
MAIZE Commissioned/Competitive Partner Grants	1,163,433	Above figures include Partner sub-grants	1,163,433
CRP Management & Support Cost (including MEL, Communications, Knowledge management, OA/OD, etc.)	1,401,200	-	1,401,200
Total	**11,300,000**	**54,301,343**	**65,601,343**

A1.4 Planned Revisions to Program of Work

Apart from the removal of FP5 from the overall MAIZE portfolio, there are no major planned changes with regard to MAIZE POWB in 2017. For the four approved flagship projects (FP1-4), detailed work packages were developed during MAIZE Planning Meeting (Jan 23-25, 2017) at Nairobi, based on 100% finance plan (US$ 11.3 M W1&2, as approved by the System Council in Nov 2016). MAIZE-MC will review the W1&2 funding situation in March/April 2017 to ascertain if any changes in POWB (especially with regard to W1&2 POWB) are required.

A2. Collaboration and Integration

A2.1 Contribution to and from Platforms

All MAIZE-AFS Flagship Projects contribute to and receive from the new platforms. The source of funding for most of the collaborations will come from each of the respective CRP/Platform and involve the exchange of knowledge and products. In some cases, there will be joint investments.

Excellence in Breeding: MAIZE FP2 and FP3 will work closely with the EiB Platform, especially for implementing high-throughput genotyping/sequencing and phenotyping applications in breeding pipelines, and AFS-specific breeding program assessment to set breeding program directions. The EiB Platform, in turn, will contribute through developing metrics and standards to enhance breeding program effectiveness; establishing cross-CRP genotyping platforms; developing cross-CRP data management and informatics tools; documentation of existing best practices for high-throughput phenotyping, G x E x M analyses and Genotype-to-Phenotype predictions.

Big Data: MAIZE FP1 will work with the Big Data Platform in conjunction with its foresight work. FP4 will work with the Big Data Platform in relation to geospatial data provision and tools for SI monitoring and assessments. MAIZE FPs will make key contributions to the Big Data Platform in terms of providing extensive genotypic, phenotypic, agronomic and socio-economic data, and will prioritize 1-2 topics for consideration for Big Data Platform challenge grants. The Big Data Platform will provide access to an extensive range of new strategic partners from both the public and private sector, and will improve data interoperability and usage, thereby enhancing research outputs in MAIZE.

Genebank: MAIZE aligns strongly with the Genebank Platform, especially through FP2. MAIZE generates knowledge about genebank accessions (including definition of core sets to enhance use in breeding programs), develops informatics tools to extract knowledge from Genebank data, and to inform genebank decisions about gaps and duplications in collections. MAIZE expects to coordinate with the Genebank Platform about intellectual property issues affecting the use of genetic resources in breeding programs worldwide, besides exploring the application of genetic engineering tools.

Gender (hosted in PIM): MAIZE FP1 will work closely with Gender Platform (hosted in PIM) on developing a range of key outputs related to methods, training, coordination, and joint research on topics chosen by the gender network (including GENNOVATE). MAIZE will share gender research results and participate in the two planned workshops (one on methods and another on research) in 2017.

A2.2 Cross-CRP interactions

The MAIZE AFS Phase-II proposal provides an extensive overview of collaboration with other AFS and cross-cutting CRPs in Annex 3.7. Maize-legume cropping systems are highly important, but with the GLDC proposal not approved so far, some of the anticipated collaborative initiatives will have to be reviewed. Some major collaborative areas of MAIZE with other CRPs are highlighted below:

Other AFS CRPs: **WHEAT**: MAIZE will continue to work closely with WHEAT, especially on FP1 (foresight; value chain analysis, and market opportunities), and FP4 (developing and applying a framework for derivation, quantification and integration of indicators and metrics for sustainable intensification at different scales; crowdsourcing and ICT; Scaling). **RICE**: Continued collaboration with RICE on further improvement and dissemination of cereal-based cropping systems in South Asia (through the CSISA Project) as well as Nepal Seed and Fertilizer Project (NSAF). **RTB**: MAIZE will explore opportunities to initiate collaboration with RTB, focusing on: 1) strategic gender synthesis work in selected target areas; 2) scaling science research agenda and on technology suitability/readiness; and 3) further refinement of the youth strategy and its implementation This work will also include partners from Wageningen University and KIT in piloting this research framework in selected RTB (IITA) and MAIZE (CIMMYT, IITA) research sites.

Cross-cutting CRPs: **PIM**: MAIZE will have close collaboration with PIM through the Global Futures Project, including continuation of foresight work, and exploration of new collaboration opportunities in relation to biotech policy, rural transformation and value chain interventions. **CCAFS**: Collaboration with CCAFS will build on: 1) longitudinal/panel studies in targeted areas (maize observatory – with bilateral projects – TAMASA/SIMLESA) - linked with ORNL Proof-of-Concept for indicators and metrics; 2) Foresight and ex-ante (scenario) analysis of CC impact on maize based farming systems; 3) GxExM in South Asia - deepening climatic adaptability; 4) abiotic stress and impacts on maize; 5) value chain and market opportunities, and 6) geospatial data provision and tools for SI monitoring and assessments. **A4NH**: MAIZE will continue to collaborate strongly with A4NH on development and deployment of biofortified maize (through HarvestPlus), particularly focusing on provitamin A-enriched maize (for SSA), and high-Zinc maize (for SSA and Latin America). **WLE**: MAIZE-AFS will initiate work with WLE on: 1) resource use efficiency of maize based cropping systems; 2) geospatial data provision and tools for SI monitoring and assessments; and 3) better assessments of environmental services at landscape level and beyond.

A2.3 Expected Efforts on Country Coordination

MAIZE will actively engage in country coordination efforts, as committed in the Phase-II Proposal, and will be guided by the recommendations of the SMB working group (expected mid-March 2017). In 2017, MAIZE will particularly focus on eight selected countries (Bangladesh, D.R.Congo, India, Kenya, Nepal, Nigeria, Tanzania, and Zambia), and will explore: (i) how internal CGIAR communications and planning can be improved to identify opportunities for cross-CRP synergies; (ii) how joint engagement with national stakeholders and alignment with national priorities can be enhanced; and (iii) how coordination, cooperation and leveraging between ongoing MAIZE W3/bilateral projects and those of other CRPs operating in the selected countries can be improved. MAIZE Program Manager will be joining the Country Coordination CRP Task Force. Considering the limited W1&2 funding, resources for country coordination activities will be mainly leveraged from ongoing MAIZE W3/bilateral projects. Specific areas of focus for each of the target countries (with information on MAIZE focal points) are are provided in **Annex 1**.

A3. Management, Governance and Monitoring, Evaluation, Learning

A3.1 Relevant Changes in Management and Governance

MAIZE-Management Committee (MAIZE-MC) in Phase-I has key flagship leaders from CIMMYT and IITA responsible for day-to-day management of the CRP, besides representatives of Kenya Agriculture & Livestock Research Organization (KALRO) and Syngenta Foundation for Sustainable Agriculture (SFSA) providing key external inputs/advice. With the integration of some part of HumidTropics CRP into MAIZE in Phase-II, MAIZE-MC considers necessary to include an additional representative from IITA for strengthening work on sustainable intensification. Also, in 2017, the ToRs of MAIZE-ISC will be reviewed by MAIZE Lead center DG & Board of Trustees, and some members may be changed to make the Committee more dynamic and balanced in terms of disciplinary expertise.

A3.2 Monitoring, Evaluation, Impact Assessment and Learning Plans

- MAIZE will continue to support the CGIAR System Management Office's Taskforce on Indicators, which has been charged to identify a set of indicators to demonstrate the CGIAR portfolio's progress against the SLOs. MAIZE will also continue to participate in the cross-CGIAR system Monitoring, Evaluation and Learning Community of Practice to share challenges and best practices, and streamline the MEL work.
- MAIZE is working towards operationalizing a framework to monitor progress along both CRP and FP-level impact pathways and to test CRP and FP theories of change. Flagship Project teams will develop indicators, targets, data sources, data collection frequencies and data collection responsibilities for each output, outcome and assumption for the duration of Phase-II. A risk monitoring plan will also be developed. MAIZE is in the process of adopting the MALRO system, developed by CCAFS, for more effective planning, monitoring, and reporting.
- Notwithstanding budget restrictions, MAIZE will commission an evaluation of FP2: Novel Tools and Diversity, which will be performed jointly with WHEAT and IITA. This is part of the Phase-II Rolling Evaluation Plan as contained in the MAIZE Proposal.
- MAIZE will continue to build capacity in terms of project management, which includes sections to strengthen project-level monitoring, evaluation and learning.
- MAIZE will review and reflect on FP theories of change at the end of 2017 based on performance data collected and lessons learned and best practices will be documented. This exercise will inform planning, prioritization and decision making for the next year. In 2017, FP teams are coming together to collectively develop indicators, targets, data sources, data collection frequencies and data collection responsibilities for each output, outcome and assumption for the duration of Phase-II.
- MAIZE is undertaking a study on the impact of CGIAR-derived improved maize germplasm, especially in SSA, Asia and Latin America. The results of this study, based on feedback from the public and private sector institutions (through designed questionnaires) will be documented/published in 2017.

B. FLAGSHIP LEVEL

Flagship 1: Enhancing MAIZE's R4D Strategy for Impact

B.1 Delivery

B.1.1 Expected Annual Milestones towards Outcomes 2022

FP1 is set to contribute to four high-level Outcomes in 2017 through four key Milestones (**Table 3)**: 1) Ex-ante impact assessments identify potential opportunities, threats and game changes for MAIZE; 2) Adoption and impact studies on technologies-rolling plan based on progress of technologies along the theory of change; 3) Gender/social inclusion lenses applied to MAIZE innovation pipelines and assessments; and 4) Preparation and roll-out of rapid value chain assessments with proper gender lens in selected countries to identify opportunities and bottlenecks in MAIZE. The third milestone has a principal gender focus, while gender is also a major component in Milestones 2 and 4. Youth engagement and capacity development will be significant across FP1.

B.1.2 Outputs towards Outcomes 2022

FP1 Outcome 1.1 Increased capacity of partner organizations through MAIZE foresight and ex-ante analysis: In 2017, FP1 will continue to build and strengthen a foresight portfolio and strategy for MAIZE through three major outputs: 1) Synthesis of previous foresight studies on maize as input in conducting priority setting for MAIZE (with inputs from PIM); 2) Analysis of existing datasets for yield shocks, food security, changing diet patterns, rural transformation and alternative uses of maize, and implications distilled for MAIZE (in partnership with selected ARIs & NARES, and PIM); 3) Geospatial analysis of key stresses in target geographies for enhanced targeting and impact of MAIZE technologies, including reclassification of the maize mega- environments in South Asia, and generation of biotic stress maps (together with Univ. of Minnesota); MAIZE Atlas will be updated based on these studies.

FP1 Outcome 1.2 Increased capacity of beneficiaries to adopt research outputs through learning from MAIZE technology adoption and impact assessment studies: In 2017, FP1 will contribute to this outcome through three key outputs: 1) Finalization of the results from global MAIZE germplasm impact assessment, accomplished in close interface with a number of NARS and seed company partners in Africa, Asia and Latin America; 2) A review and meta-analysis of previous MAIZE adoption/impact assessment studies and lessons and implications for MAIZE, and; 3) implementation of new adoption studies rolled out in MAIZE target countries (in partnership with ARIs & NARES).

FP1 Outcome 1.3 Improved capacity of women and young people to participate in decision-making through MAIZE's gender and social inclusiveness: In 2017, FP1 will contribute to this outcome through the following major outputs: 1) Synthesis of strategic gender research in MAIZE target areas, including a write-up on lessons and implications for MAIZE from qualitative research on gender; 2) Implementation of new strategic gender studies in MAIZE target countries (in partnership with ARIs & NARES); and 3) Roll-out of Gender CapDev Framework and training of MAIZE researchers (in partnership with KIT).

FP1 Outcome 1.4 Increased capacity of partner organizations through MAIZE market/value chain opportunities prioritized for their livelihoods: In 2017, FP1 will contribute to this outcome through three key outputs: 1) Strategic R4D agenda on value chain and market opportunities (including nutritional aspects) developed around MAIZE; 2) Implementation of new strategic value chain studies in MAIZE target countries (in collaboration with a range of ARIs & NARES); and; 3) Capacity development through BSc/MSc/PhD student interns (in collaboration with ARIs & NARS institutions).

B.1.3 Contribution of W1&2 Funds

W1&2 funds are strategically used in FP1 to draw out the lessons from the previous MAIZE years and across MAIZE W3/bilateral studies and geographies to actively shape and coordinate the implications and priorities for enhancing the impact of MAIZE in Phase-II. Complementing the work done under W3/bilateral projects, the limited W1&2 funds will be strategically used in each of the four core Clusters of Activity, namely Foresight and targeting; Impact assessment, Gender; and Agri-food systems analysis. W3/bilateral funds will be primarily used to implement rolling data collection efforts in selected MAIZE geographies, especially for studies in relation to adoption/impact assessment, gender and value chains. Additional W3/bilateral funds are being actively sought to strengthen and expand the work portfolio under each CoA.

Flagship 2: Novel Diversity and Tools for Increasing Genetic Gains

B.1 Delivery

B.1.1 Expected Annual Milestones towards Outcomes 2022

FP2 will contribute to 2022 Outcomes through four higher-level Outcomes; key milestones in 2017 that will contribute to each of these outcomes are detailed in **Table 3**. FP2 is an essential "tool discovery, validation and deployment" step in the impact pathway of MAIZE, linking priority setting (FP1) to developing pre-bred germplasm with a broad genetic base and relevant traits, for effective use in MAIZE breeding programs (though FP3). A systematic effort to explore genetic variation in maize germplasm accessions and making the diversity usable in MAIZE breeding is the major focus of FP2. FP2 will have strong collaboration with EiB Platform in developing cross-CRP approaches in genotyping, phenotyping and breeding informatics. The major partnerships envisioned for achieving the key milestones in 2017 are detailed under section B.1.2.

B.1.2 Outputs towards Outcomes 2022

FP2 Outcome 2.1 Efficiency and effectiveness of MAIZE partners and global research community enhanced by use of new data capture, storage, dissemination and analysis tools: In 2017, FP2 will contribute to this important outcome through several key outputs: 1) Informatics, database management and decision support tools developed; 2) Selection, optimization, and initiation of deployment of enterprise breeding management tools, optimized for use at CIMMYT and IITA; 3) Capacity development of MAIZE partners in breeding design, data management, data analysis, and decision-support tools; 4) Biometric support for high throughput phenotyping (in collaboration with the Universities of Wisconsin & Michigan State, and de León and Gustavo de los Campos – Mexico); and 5) Biometrics and bio-informatics support for Big Data analysis.

FP2 Outcome 2.2 Increased use of doubled haploids and molecular breeding tools by MAIZE partners, accelerating genetic gains: In 2017, FP2 will contribute to this outcome through six key deliverables: 1) Second-generation tropicalized haploid inducers (with >10% haploid induction rate) made available to public and private sector partners; 2) A major QTL for Tar Spot Complex (TSC) resistance validated, towards development of marker(s) for use in forward breeding; 3) Marker development and molecular breeding for prioritized traits (TLB, PFSR, GLS, and acid soil tolerance) to accelerate development and deployment of stress tolerant maize (through FP3); 4) Discovery/validation of molecular markers for tolerance to *Striga* and MLN; 5) Improving MSV resistance in Africa-adapted tropical maize germplasm (in collaboration with Gembloux Agro-Bio Tech, University of Liège, Belgium); and 6) Optimizing genomic selection approaches for routine application in breeding programs (in partnership with Cornell University, INIFAP, and NARS).

FP2 Outcome 2.3 Novel genetic diversity is available to MAIZE researchers through gene discovery and advanced breeding tools: In 2017, FP2 will contribute to this outcome in two major ways: 1) Fine-mapping of the maize lethal necrosis (MLN) resistance locus in collaboration with DuPont-Pioneer toward efforts to isolate the causal gene; and 2) Establishment of in-house maize transformation platform with maize transformation successfully achieved in at least one CIMMYT line with >40% frequency;

FP2 Outcome 2.4 MAIZE partners and global research community use pre-bred germplasm with novel genetic variance for drought, MLN, Tar spot complex, and other key traits: In 2017, FP2 will contribute to this outcome through pre-breeding work on MLN, TSC, drought and heat tolerance (in partnership with FP3).

B.1.3 Contribution of W1&2 Funds

FP2 uses W1&2 funds in four broad ways (see Table 3 for details): 1) Supporting priority outcomes that cut across multiple W3/bilateral projects, CoAs, FPs and even CRPs (e.g., development of decision support tools to enhance genetic gains in breeding programs, in partnership with EiB Platform); 2) Enabling discovery and validation of molecular markers for key traits prioritized by MAIZE breeding programs (e.g., gene discovery and marker development for MLN and *Striga* resistance); 3) Investing in high-risk/high-potential-payoff cutting-edge research tools that are not yet funded through W3/bilateral projects (e.g., establishing genome editing capacity in MAIZE for traits like MLN); and 4) Supporting strategic planning within clusters of activities (CoAs), and coherence across CoAs, between FP2-FP3, and FP1-FP2, and between EiB-FP2-FP3.

FP3 Stress Tolerant and Nutritious Maize

B.1 Delivery

B.1.1 Expected Annual Milestones towards Outcomes 2022

FP3 will contribute to 2022 Outcomes through six higher-level Outcomes.. The key milestones in 2017 for each of these Outcomes are indicated in **Table 3**. These milestones will be complementarily co-generated by work undertaken through W1&2 and W3/bilateral projects, in partnerships with an array of NARES, seed company partners, and ARIs. In 2017, MAIZE will intensify work on developing and deploying MLN-tolerant/resistant hybrids in SSA. MAIZE breeding pipelines will be accelerated and modernized through integration of high-throughput genotyping (for validated trait-linked markers), genomic selection, doubled haploids (DH), high-throughput phenotyping, and decision support tools (in partnership with EiB Platform and FP2). Together with partners in SSA, MAIZE will devise and begin implementing an integrated pest management strategy for tackling the menace of two invasive pests (Fall Army Worm and Spittlebugs) that have caused significant damage to maize crops in SSA. MAIZE will also characterize a large array of elite/improved maize germplasm for prioritized nutritional quality and end-use traits demanded by farmers/consumers. MAIZE seed systems teams will work closely with NARS and seed company partners in target geographies to catalyze uptake of improved MAIZE varieties, while proactively embedding gender and youth lenses, and replacing some age-old/obsolete varieties. Capacity development of NARES and seed company partners on modern maize breeding strategies, seed production research, QC/QA, and seed business development will be intrinsic to the FP3 milestones.

B.1.2 Outputs towards Outcomes 2022

FP3 Outcome 3.1 Increase in the rate of genetic gain for grain yield (as measured in breeders' trials) in rainfed, climate-vulnerable environments of SSA from 0.6% to 1.2% annually, and from ≤1% to at least 1.75% in Asia and LA (linked to MAIZE FP2 and EiB Platform): MAIZE will develop and integrate key GIS information into breeding pipelines of SSA and South Asia for developing improved varieties targeted for specific markets and with traits required for present and future environments. Disaggregated cohort analysis (at Stage 4) will be used to monitor genetic gains of different breeding programs. MAIZE breeding pipelines will incorporate new diversity (Ex-PVP temperate germplasm) and trait combinations to enhance genetic gains for multiple stress tolerance and improved grain yield.

FP3 Outcome 3.2 Effective pest/disease surveillance, monitoring and diagnostics protocols / procedures for controlling the spread and impact of existing/emerging threats (e.g., MLN), established in SSA: MAIZE has been at the forefront in tackling the MLN in SSA through a comprehensive set of actions, in partnerships with

a diverse array of public and private sector partners. In 2017, MAIZE will initiate systematic studies to better understand the factors contributing to seed transmission of MCMV; make the MLN Web Portal comprehensive with updates on availability of MLN tolerant/resistant hybrids, MLN phenotyping services, and recommendations for MLN-free commercial seed production. A functional MLN Phytosanitary Community of Practice has been recently established, enabling MAIZE partners to discuss and communicate on best management practices with regard to MLN. Due to the recent and devastating incidence of two invasive pests in SSA, MAIZE will initiate pilot work through W1&2 resources on developing and implementing an integrated pest management strategy against the two insect-pests.

FP3 Outcome 3.3 Nutritious maize hybrids/varieties with superior agronomic performance and desirable gender-informed traits (processing properties, palatability and storability) adopted in targeted geographies in SSA, Asia and LA: MAIZE is a key partner under HarvestPlus In terms of introgressing high provitamin A and high-Zn traits in improved MAIZE germplasm. In 2017, MAIZE will use W1&2 resources strategically to develop rapid, high-throughput phenotyping protocols for nutritional quality and selected end-use traits, and for characterizing an array of selected MAIZE hybrids (vis-à-vis relevant commercial hybrids) in SSA, Asia and LA for micronutrients, post-harvest storability, processing and relevant end-use traits. Building on the encouraging results from Phase-I, MAIZE will identify/develop dual-purpose maize inbred lines and hybrids for potential deployment in South Asia.

FP3 Outcome 3.4 Reduction in product development and elite line recycling time and costs through integration of novel tools/technologies in breeding programs: MAIZE will intensify deployment of high-throughput field-based phenotyping tools (both proximal and remote sensing) in breeding programs in SSA, Asia and LA, while initiating new work on using such tools in disease phenotyping (in partnership with University of Barcelona). Capacity of NARS partners with regard to generation of high quality multi-location phenotyping data for drought/heat stress, as well as phenotyping for important disease traits, will be improved, especially in South Asia and SSA.

FP3 Outcome 3.5 Reduced cost of seed production (= reduced "cost of goods sold or COGS") of newly developed and released maize varieties: MAIZE, in 2017, will invest in generating comprehensive information on flowering synchronization, seed producibility, herbicide sensitivity, and other relevant agronomic traits on advanced MAIZE hybrids, and make this information widely available to the seed company partners. MAIZE will also work closely with DuPont-Pioneer on male-sterility based seed production system in maize (through IMAS-II) for reducing the COGS of MAIZE hybrids for partners.

FP3 Outcome 3.6 Enhanced adoption of climate resilient and nutritious maize varieties by smallholder farmers in stress-prone rainfed environments of SSA, Asia and LA providing better yields and stability: In 2017, MAIZE-FP3 will continue to strive for equitable maize seed systems in SSA, Asia and LA, where women and men farmers have equal opportunities to adopt new MAIZE products, and benefit from opportunities available in maize value chains. Digitization of seed road maps (new activity), and catalyzing adoption of improved MAIZE varieties in target countries, through strong public-private partnerships, will be implemented in 2017 for enhanced impacts. Based on the recommendation of MAIZE-ISC, MAIZE will devote W1&2 resources to improve selected Mexican maize landraces through participatory breeding, and benefiting special landrace-growing farming communities through fair trade markets

B.1.3 Contribution of W1&2 Funds

The scope and geographies of W3/bilateral funding largely influences strategic use of W1&2 resources in implementing priority areas of FP3 in Phase-II. In 2017, W1&2 resources will be mainly used to: a) effectively integrate the trait pipelines in MAIZE breeding programs across SSA, Asia and LA; b) ensure effective linkages among the breeding pipelines in the three continents, and maximize the value for money; c) initiate pilot work on Fall Army Work, a major invasive pest, that has been reported for the first time in SSA, devastating

maize crops in southern, eastern, West & central Africa; d) undertake pilot work on cold and salinity stress tolerance (not funded through any W3/bilateral project) to meet client needs in South Asia; e) implement Latin American tropical maize regional testing network, with focus on yield potential and tolerance to major diseases, by leveraging improved germplasm generated at CIMMYT-Mexico (through MasAgro); f) increasing yield potential and stress tolerance of QPM in SSA; and g) enhance germplasm diversity, yield potential, stress tolerance, input use efficiency and agronomic architecture of tropical MAIZE germplasm through temperate (Ex-PVP) germplasm introgression.

Flagship 4: Sustainable Intensification of Maize-based Systems for Improved Smallholder Livelihoods

B.1 Delivery

B.1.1 Expected Annual Milestones towards Outcomes 2022

FP4 will contribute to 2022 Outcomes through four higher-level Outcomes; the key Milestones for each of these Outcomes in 2017 are indicated in **Table 3**. For FP4, milestones complementarily co-generated by work undertaken through W1&2 and W3/bilateral projects revolve around methodological aspects contributing to economies of scales, lateral learning between major projects / target regions, and aiming at more efficient scaling through better understanding of diverse farming systems dynamics, more effective targeting of technical interventions, improved MEL at FP level, and development of various business models (for more details, refer to MAIZE Phase-II proposal). The major partnerships envisioned for achieving the key milestones in 2017 have been detailed for each outcome under section B.1.2.

B.1.2 Outputs towards Outcomes 2022

FP4 Outcome 4.1: Improved understanding of farmers' livelihood strategies and their diversity, allowing NARES and extension partners to target and implement institutional and technical interventions (CoA 4.1, 4.2 & 4.4): In 2017, FP4 will contribute to this outcome by: 1) Developing standardized protocols and data collection tools for multi-criteria assessment of advanced crop management packages, including multilevel sustainable intensification (SI) indicators and metrics. Such multi-criteria assessment will take into account environmental and social acceptability aspects and be tested in targeted geographies (new collaboration with ORNL); 2) Developing tools for data collection at landscape level (IISA); 3) Developing methodologies for adoption studies and learning using mixed methods, and combining household survey analysis and geo-spatial analysis from UAV and satellite remote sensing data (new collaboration with UCL and WUR); and 4) Moving from proof-of-concepts to implementation of targeting interventions at landscape-level rapid typology methods. Expected benefits of these outputs: 1) Standardized protocols and tools at farm and landscape levels used from 2017 onward in MAIZE target geographies through W3/bilateral projects (Buena Milpa and MasAgro in LAC; CSISA and SRFSI in South Asia; TAMASA, FACASI, SIMLESA, SIMLEZA, N2-Africa in Africa); and 2) Methods for better targeting of MAIZE technologies according to farm types across landscapes built in the new projects on sustainable intensification.

FP4 Outcome 4.2: Decision support systems for nutrient and water management used by MAIZE development partners allowing best combination of SI alternatives per farm-type and agro-ecology (CoA 4.2, 4.3 & 4.4): In 2017, FP4 will contribute to this outcome by developing innovative methods (including participatory approaches) and tools for improved resource use efficiency; testing those tools/ methods in targeted agro-ecologies; and developing training and extension material for their application by local partners and collaborating institutions. Key outputs that support this outcome include: 1) Synthesis of the decision support system (DSS) work from Phase-I which included collaboration with IPNI Asia/Africa and IRRI on nutrient management and BMGF Star project on water management; 2) Institutional and partnership dimensions required for scaling decision support tools analyzed; 3) Work plan developed to move from proof-of-concept to implementation; 4) Business models developed for DSS in a range of socio-economic environments; 5) Contribution of geospatial/remote sensing data in DSS explored for a range of geographies;

and 6) Role of fertilizer industry in scaling SI assessed in Asia, Africa and South America. Major funding source for this work will be W3/bilateral projects (e.g., TAMASA, CSISA, MasAgro), while W1&2 will be strategically used for lateral learning across regions and discovery research (e.g., use of UAV and satellite remote sensing in collaboration with UCL for European Space Agency Sentinel suite of products).

FP4 Outcome 4.3: Adoption of productivity enhancing technologies by smallholder farming communities through participatory methods (CoA 4.3): In 2017, FP4 will contribute to this outcome by testing (on-station and on-farm) individual and combination of SI technological options in various agro-ecologies in LA, South Asia, and SSA. Testing will be increasingly guided by 'in-silico' assessments through cropping system modelling to assess profitability, stability, and resilience of SI technologies at field level. Past assessments of SI technical innovations at field level have often failed to integrate with most recent improved MAIZE varieties. FP4 will increasingly include testing of improved climate-resilient MAIZE varieties in cropping systems under a range of agro-ecologies, biotic/abiotic stresses and management practices (G x E x M). Findings and knowledge generated from field level assessments will contribute (serve as a building block) to farm and landscape levels research in CoA 4.1 and CoA 4.2. On-farm and on-station work is reasonably covered by W3/bilateral funding, and W1/2 will be mainly used for modelling, meta-analyses, and filling G x E x M research gaps. W1&2 will also be used to pursue evaluation of remote sensing tools. Strategic partners include WUR, CIRAD, and University of Florida. Strong collaboration will also take place with RTB CRP.

FP4 Outcome 4.4: Impact at scale through adoption of SI technical innovations and practices and capacity reinforcement of scaling partners (mainly through CoA 4.4 based on knowledge generated by other CoAs): While scaling-out component is usually well-funded in FP4 W3/bilateral projects, science on scaling remains a major gap. In 2017, FP4 will support research on improved understanding of farmers' livelihood strategies and their diversity, allowing NARES and extension partners to target and implement institutional and technical interventions. Through refining and validating impact pathways for a range of large W3/bilateral projects, we aim to strengthen capacity of partners on systems approaches and developing context- and technology-specific business models for SI interventions in different agro-ecologies. W1/2 will be strategically used to support: 1) development of a collaborative scaling science research agenda on technology suitability/readiness in collaboration with RTB, WUR and KIT; 2) design and assessment of business models for a range of interventions and geographies, building on lessons learnt from projects like CSISA, MasAgro, and FACASI.

B.1.3 Contribution of W1&2 Funds

In case of FP4, W1&2 resources will be mainly used to implement some of the strategic components of the flagship, particularly addressing the following priorities: 1) Reinforcing MAIZE's system analysis capabilities for better framing and assessing sustainable intensification options (including social equity and environmental services aspects) in various landscapes and geographies, and linking that component to the more meta-level analyses taking place in FP1; 2) Contributing to the development of SI indicators and metrics at farm and landscape levels for baselining and impact assessment of FP4 R4D interventions; 3) Maintaining and reinforcing long-term experiments to assess the benefits of improved agronomy practices on productivity, stability, resilience, resources use efficiencies, and soil conservation in key agro-ecologies, with increasing focus on G x E x M; 4) Supporting lateral learning (cross-regional and cross-CRP), so that knowledge generated by W3/bilateral projects is better used, and future W3/bilateral projects are better designed and benefit from coherent and sound methodological approaches; 5) Providing seed investment on emerging research priorities leading to funding of W3/bilateral project proposals (e.g., precision agriculture and geospatial research); 6) Scoping to develop project proposals in new geographies (FP4 out-scaling in South East Asia, Central Africa, and Latin America), and; 7) Facilitating collaborations with key ARIs on strategic priorities of FP4.

Table 2: Flagship-level sub-IDO Indicators and 2017 Targets

FP No.	Mapped and contributing to Sub-IDO	Relevant CRP sub-IDO indicators*	2017 Targets**
FP1 FP2 FP3 FP4 (SLO1)	Sub-IDO 1.1.2	▪ Number of additional farmers adopting MAIZE technologies (improved varieties/management practices) that reduce production risks	▪ At least 0.75 million additional farmers adopt MAIZE technologies (improved varieties/management practices) that reduce production risks
	Sub-IDO 1.3.3	▪ Number of additional farmers with % increase in income, gender disaggregated, where possible	▪ At least 0.5 million additional farmers increase their income by 5%, of which 50% are female
	Sub-IDO 1.3.4	▪ Number of additional farmers adopting MAIZE technologies (improved varieties/management practices) that increase input use efficiency	▪ At least 1 million additional farmers adopt MAIZE technologies (improved varieties/management practices) that increase input use efficiency
	Sub-IDO 1.4.1	▪ Number of additional farmers adopting MAIZE technologies (improved abiotic and biotic stress tolerant/resistant varieties and integrated weed management practices) that contribute to reduced pre- and post-harvest losses	▪ At least 0.5 million additional farmers adopt MAIZE technologies (improved abiotic and biotic stress tolerant/resistant varieties and integrated weed management practices) contributing to reduced pre- and post-harvest losses
	Sub-IDO 1.4.2	▪ Number of additional farmers adopting improved MAIZE management practices that reduce yield gaps	▪ At least 0.3 million additional farmers adopt improved MAIZE crop management practices
	Sub-IDO 1.4.3	▪ % increase in maize genetic gain for the targeted agro-ecologies in SSA, Asia and Latin America ▪ Number of new MAIZE varieties with improved abiotic and biotic stress resilience released by NARS institutions and seed company partners ▪ Number of additional farmers adopting improved MAIZE varieties with abiotic and biotic stress tolerance	▪ At least 1.0-1.5% increase in maize genetic gain recorded in the On-farm Trials ▪ At least 60 new MAIZE varieties released in 2017 across SSA, Asia and Latin America by NARS institutions and seed company partners ▪ At least 0.75 million additional farmers adopt improved MAIZE varieties with abiotic and biotic stress tolerance
	Sub-IDO 1.4.4	▪ Number of additional germplasm bank accessions, and traits from these, used in breeding programs targeting resource-poor farmers	▪ At least 20 additional pre-bred families, derived from identified maize germplasm accessions with target traits relevant for SSA and Latin America, evaluated through MAIZE breeding programs
FP1 FP2 FP3 FP4 (SLO2)	Sub-IDO 1.4.1	▪ % increase in genetic gain for key traits in the target agro-ecologies assessed in the MAIZE breeding programs ▪ Number of personnel from public and private sector institutions trained on improved pathogen/pest diagnostics and surveillance tools	▪ At least 3% increase in genetic gain of Stage 4 hybrid advancement cohorts under targeted abiotic and biotic stresses in SSA, Asia and LA, as compared to benchmark commercial hybrids and internal genetic gain checks from previous years. ▪ At least 50 persons from public and private sector institutions in SSA trained on harmonized protocols for effectively detecting and preventing trans-boundary movement of MLN pathogens.
	Sub-IDO 1.4.4	▪ Number of additional maize germplasm bank accessions and pre-bred lines using germplasm bank accessions distributed to public and private sector partners (through SMTA) from CIMMYT and IITA maize genebanks ▪ Number of additional novel, functionally useful alleles/haplotypes identified in maize germplasm accessions for trait improvement and germplasm enhancement	▪ At least 1000 additional high-value maize accessions and pre-bred lines developed using germplasm bank accessions comprehensively characterized and distributed to public and private sector partners ▪ Breeder-ready markers/high-value haplotypes for at least two additional prioritized traits validated (under FP2) and/or deployed in MAIZE breeding programs (FP3)

	Sub-IDO 1.4.2		▪ Number of additional farmers adopting improved crop management practices that reduce yield gaps in maize-based farming systems	▪ At least 0.3 million additional farmers adopt improved crop management practices that reduce yield gaps in maize-based farming systems
	Sub-IDO 2.1.1		▪ Number of additional people (including men, women, children), of which 50% are female, consuming biofortified maize, especially Quality Protein Maize (QPM), in target countries in SSA, LA and Asia. ▪ Number of women of reproductive age in maize-based farming households consuming adequate number of food groups through farm diversification.	▪ At least 100,000 additional people consume biofortified maize, especially QPM. ▪ At least 150,000 additional women consume adequate number of food groups through farm diversification
FP1 FP2 FP3 FP4 (SLO3)	Sub-IDO 3.2.2		▪ Number of additional farmers adopting MAIZE technologies (improved varieties and management practices) that diversify and intensify MAIZE AFS and increase input use efficiency	▪ At least 0.5 million additional farmers adopt MAIZE technologies (improved varieties and management practices) that diversify and intensify MAIZE AFS and increase input use efficiency
			▪ Number of additional farmers adopting MAIZE technologies (conservation agriculture, soil C sequestration, and land-sparing) that reduce GHG emissions	▪ At least 0.25 million additional farmers adopting MAIZE technologies (conservation agriculture, soil C sequestration, and land-sparing) that reduce GHG emissions
FP1, FP2, FP3, FP4	Cross Cutting IDOs	A.1.4	▪ Number of additional farmers adopting MAIZE technologies (climate-resilient varieties and climate-smart management practices) that enhance capacity to deal with climatic risks and extremes	▪ At least 0.5 million additional farmers adopt MAIZE technologies (climate-resilient varieties and climate-smart management practices) that enhance capacity to deal with climatic risks and extremes
FP1, FP2, FP3, FP4		B.1.3	▪ Number of additional women and young people improving their capacity through MAIZE knowledge products and technologies	▪ At least 0.2 million additional women and young people improve their capacity through MAIZE knowledge products and technologies
FP1, FP2, FP3, FP4		C.1.1	▪ Number of existing/new public and private sector institutions strengthening their research/development capacity using MAIZE tools/technologies/know-how and decision support systems ▪ Number of policy decisions taken based on engagement and information dissemination by MAIZE	▪ At least 250 existing/new private sector institutions and 50-60 existing/new public sector partner institutions continue to engage under MAIZE and strengthen their research/development capacity in the target geographies using MAIZE tools/technologies/know-how and decision support systems ▪ At least one policy decision taken based on engagement and information dissemination by MAIZE
FP1, FP2, FP3, FP4		D.1	Number of existing/new NARS institutions benefiting from MAIZE research outputs, infrastructure development, and capacity strengthening programs	At least 40-50 existing/new NARS partner institutions benefit from MAIZE research outputs, infrastructure development, and capacity strengthening programs

Disclaimer

2.1) Keep in mind that the indicators for sub-IDOs are still work in progress.
2.2) *Relevant CRP Sub-IDO indicators as provided to SMO in Nov. 2016 for SC3-03 item)
2.3) **Whenever available please provide targets.

Table 3: Expected Annual Milestones (progress markers) towards Outcomes 2022

FP No.	FP Outcomes 2022	Milestones for 2017	Mapped budget request for 2017 (USD)	
			W1/ W2	W3/ bilateral
FP1	Outcome 1.1 Increased capacity of partner organizations through MAIZE foresight and ex-ante analysis	Milestone 1.1 Ex-ante impact assessments identify potential opportunities, threats and game changes for MAIZE	491,511	100,901
	Outcome 1.2 Increased capacity of beneficiaries to adopt research outputs through better MAIZE learning from adoption studies and impact assessment	Milestone 1.2 Adoption and impact studies on technologies-rolling plan based on progress of technologies along the theory of change	360,293	3,373,011
	Outcome 1.3 Improved capacity of women and young people to participate in decision-making through MAIZE's gender and social inclusiveness	Milestone 1.3 Gender/social inclusion lenses applied to 2-4 MAIZE innovation pipelines and assessments	259,257	1,543,454
	Outcome 1.4 Increased capacity of partner organizations through MAIZE market/value chain opportunities prioritized for their livelihoods enhancing potential	Milestone 1.4 Preparation and roll-out of rapid value chain assessments with proper gender lens in selected countries to identify opportunities and bottlenecks in MAIZE.	219,199	2,000,970
FP2	Outcome 2.1 Efficiency and effectiveness of MAIZE partners and global research community enhanced by use of new data capture, storage, dissemination and analysis tools	Milestone 2.1 Most recent 5 years phenotypic, genotypic and geneological data curated and stored in centralized data repositories.	562,167	470,000
	Outcome 2.2 Increased use of doubled haploids by MAIZE partners, accelerating genetic gains	Milestone 2.2 Second-generation tropicalized haploid inducers with at least 10% haploid induction rate (HIR) developed and made available to maize researchers globally.	131,000	856,198
	Outcome 2.3 New germplasm sources of genetic variation and molecular markers for prioritized traits used by MAIZE partners	Milestone 2.3 Comprehensive characterization of genebank accessions using genotypic, geospatial and adaptive distribution data conducted, and at least 1000 high-value accessions identified through in-silico approaches	891,554	3,692,828
	Outcome 2.4 MAIZE partners and global research community use novel sources of useful	Milestone 2.4 Multi-location testing of at least 300 pre-breeding germplasm entries for at least two priority traits	256,742	250,000

	genetic variance for drought, MLN, Tar spot complex, and other key traits	(MLN, Tar spot complex) and general hybrid performance		
FP3	Outcome 3.1 Increase in the rate of genetic gain for grain yield (as measured in breeders' trials) in rainfed, climate-vulnerable environments of SSA from 0.6% to 1.2% annually, and from ≤1% to at least 1.75% in Asia and LA (linked to MAIZE FP2 and EiB Platform)	Milestone 3.1.1 At least 3% increase in genetic gain of Stage 4 hybrid advancement cohorts under targeted abiotic and biotic stresses in sub-Saharan Africa (SSA), Asia and Latin America (LA), as compared to benchmark commercial hybrids and internal genetic gain checks from previous years.	1,114,178	8,372,071
		Milestone 3.1.2 At least 5 new MLN tolerant hybrids released or recommended for release, and at least 10 new MLN-tolerant hybrids under National Performance Trials (NPTs) in MLN-endemic countries in eastern Africa	849,167	
		Milestone 3.1.3 Germplasm diversity, yield potential, stress tolerance, input use efficiency and agronomic architecture of tropical MAIZE germplasm improved through temperate (Ex-PVP) germplasm introgression.	376,039	
	Outcome 3.2 Effective pest/disease surveillance, monitoring and diagnostics protocols / procedures for controlling the spread and impact of existing/emerging threats (e.g., MLN), established in SSA	Milestone 3.2.1 MAIZE Atlas, along with a functional MLN Phytosanitary Community of Practice and MLN Web Portal, effectively disseminate latest updates on major transboundary pathogens and best management practices.	150,000	2.105,704
		Milestone 3.2.2 Systematic studies on seed transmission of MLN pathogens, especially MCMV, initiated in partnership with ARIs (USDA/Ohio State University, Univ. of Minnesota) and KALRO.	-	
		Milestone 3.2.3 An integrated pest management strategy designed for effectively tackling two invasive pests on maize in SSA – Fall Army Worm and Spittlebugs.	228,243	
	Outcome 3.3 Nutritious maize hybrids/varieties with superior agronomic performance and desirable gender-informed	Milestone 3.3.1 At least 300 hybrids and 30 OPVs with high levels of micronutrients and desirable grain quality traits evaluated in multiple	300,237	2,219,914

	traits (processing properties, palatability and storability) adopted in targeted geographies in SSA, Asia and LA	locations for agronomic performance and nutrient levels.		
		Milestone 3.3.2 Robust, high-throughput tools/techniques for assessing different nutritional and end-use quality traits developed, validated and disseminated to increase cost-effectiveness and to speed-up the varietal development process.	59,210	
	Outcome 3.4 Reduction in product development and elite line recycling time and costs through integration of novel tools/technologies in breeding programs.	Milestone 3.4.1 High throughput field-based phenotyping tools, high-throughput genotyping for trait-linked markers, doubled haploid technolohgy, and decision support tools integrated into MAIZE breeding programs for increasing genetic gains, improving breeding efficiency, and reducing the cost of product development	378,951	1,019,915
		Milestone 3.4.2 A new open-source image analysis program developed by University of Barcelona (MAIZE partner) for disease phenotyping validated in a range of field environments.	132,029	
		Milestone 3.4.3 MAIZE partners' capacity for generating high-quality multi-location phenotyping data for major abiotic (drought; heat) and biotic stresses improved.	165,036	
	Outcome 3.5 Reduced cost of seed production (= reduced "cost of goods sold or COGS") of newly developed and released maize varieties.	Milestone 3.5.1 Parental lines of at least 200 improved MAIZE pre-commercial hybrids (Stage 4) evaluated for flowering synchronization, seed producibility, herbicide sensitivity, and other desirable agronomic traits.	125,000	3,012,446
		Milestone 3.5.2 Gender and socio-economic considerations included when designing crosses for developing products, seed production research and determining recommendation domains.	100,000	
	Outcome 3.6 Enhanced adoption of climate resilient and nutritious maize varieties by smallholder farmers in stress-prone rainfed environments of SSA, Asia and	Milestone 3.6.1 Availability and affordability of MAIZE-derived novel varieties improved in target geographies in partnership with an array of seed companies in SSA, Asia and LA.	178,000	12,037,340
		Milestone 3.6.2 Targeted efforts by	200,000	

	LA providing better yields and stability	MAIZE seed systems teams lead to replacement of at least 10-15 obsolete (15/20+ year old) varieties with recently derived improved MAIZE varieties.		
		Milestone 3.6.3 Selected Mexican maize landraces improved through participatory breeding, and special landrace-growing farming communities benefited through fair trade markets	125,000	
FP4	Outcome 4.1 Improved understanding of farmers' livelihood strategies and their diversity, allowing NARES and extension partners to target and implement institutional and technical interventions (in collaboration with other CRPs with a systems Flagship)	Milestone 4.1 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)	317,111	600,000
	Outcome 4.2 Decision support systems for nutrient and water management used by development partners	Milestone 4.2 Innovative tools, methods and multi-media extension materials to enhanced soil quality, nutrient and water use efficiency through participatory approaches	554,944	800,000
	Outcome 4.3 Adoption of productivity enhancing technologies by smallholder farming communities through participatory methods	Milestone 4.3 Increased adoption of combinations of SI strategies, resource and labour saving technologies in specific target geographies compared to 2016.	554,944	10,000,000
	Outcome 4.4. Impact at scale through adoption of SI technical innovation and practices and technical capacity reinforcement of scaling partners	Milestone 4.4 Existing scaling approaches including public/ private partnership and context specific business models evaluated in target geographies leading to improve scaling models and critical scaling factors defined.	158,555	8,000,000

Disclaimer:

3.1) Milestones could be outputs or outcomes as appropriate to the scale and maturity of the work. **In this table 3 please focus as much as possible on milestones towards outcomes to avoid overlaps and duplication with table 4**.

3.2) Budget amounts are mapped to outcomes from costing outputs and activities that are required to enable changes that we expect to happen.

3.3) It is important to acknowledge that the budget amounts are likely not directly correlated to the work proposed for this year, but build on investment and outputs from the past.

Table 4: Expected Key Outputs in 2017 towards Outcomes 2022

			Tagging of expected outputs 2017		
FP No.	**FP Outcomes 2022**	**CoA Outputs for 2017**	**G**	**Y**	**CD**
FP1	Outcome 1.1 Increased capacity of partner organizations through MAIZE foresight and ex-ante analysis	CoA 1.1.1 Synthesis of previous foresight studies as input in conducting priority setting for MAIZE	0	1	1
		CoA 1.1.2 Yield Shocks, Food Security, Changing Diet Patterns and Rural transformation: Implication for MAIZE	0	1	1
		CoA 1.1.3. Geospatial Analysis of Stresses for enhanced targeting and Impact in MAIZE	0	1	1
	Outcome 1.2 Increased capacity of beneficiaries to adopt research outputs through better MAIZE learning from adoption studies and impact assessment	CoA 1.2.1 Global MAIZE germplasm impact assessment report	1	1	1
		CoA 1.2.2 Meta analysis on maize adoption /impact assessment	1	1	1
		CoA 1.2.3 Adoption Studies in Developing Countries in MAIZE	1	1	1
	Outcome 1.3 Improved capacity of women and young people to participate in decision-making through MAIZE's gender and social inclusiveness	CoA 1.3.1. Strategic gender synthesis MAIZE target areas	2	1	1
		CoA 1.3.2. Strategic Gender Studies in MAIZE	2	1	1
		CoA 1.3.3 Gender capacity building	2	1	1
	Outcome 1.4 Increased capacity of partner organizations through MAIZE market/value chain opportunities prioritized for their livelihoods enhancing potential	CoA 1.4.1. Strategic research agenda on value chain and market opportunities (including nutritional aspects) around MAIZE	1	1	1
		CoA 1.4.2 Strategic value chain studies in MAIZE	1	1	1
		CoA 1.4.3 Capacity development, including BSc/MSc/PhD student interns	1	1	1
FP2	Outcome 2.1 Efficiency and effectiveness of MAIZE partners and global research community enhanced by use of new data capture, storage, dissemination and analysis tools	CoA 2.1.1 Data curation and database support, coupled with updated/improved data analysis tools (BGLRR, BIO-R, spatial META-R, selection Index, line x tester and head-to-head analysis) result in increased volume of MAIZE data openly accessible and enhanced efficiency of MAIZE breeding	0	1	2
		CoA 2.1.2 Analysis and recommendations for use of high throughput image data (captured through proximal and remote sensing tools) in MAIZE breeding programs	0	1	2

		CoA 2.1.3 Historical genealogy and phenotypic data migrated to breeding management database	0	0	1
	Outcome 2.2 Increased use of doubled haploids and molecular breeding tools by MAIZE partners, accelerating genetic gains	CoA 2.2.1 Second-generation tropicalized haploid inducers with high haploid induction rate and red root and R1-nj markers available to MAIZE partners for testing.	0	0	2
		CoA 2.2.2 Key genomic regions/haplotypes for prioritized biotic stress traits (MLN/MCMV, Striga, Tar Spot Complex, TLB, GLS, PFSR) and abiotic stress tolerance (heat, soil acidity) discovered/validated	0	1	1
		CoA 2.2.3 High-throughput phenotyping tools (spectral image analysis, NIRS, digital phenotyping) tested and validated for use by MAIZE breeders.	1	1	2
	Outcome 2.3 Novel genetic diversity is available to MAIZE researchers through gene discovery and advanced breeding tools	CoA 2.3.1 MLN resistance locus fine-mapped (in collaboration with DuPont-Pioneer) toward isolation of the causal gene.	0	0	1
		CoA 2.3.2 Maize transformation successfully achieved in at least one CIMMYT line with >40% frequency	0	0	0
		CoA 2.3.3 Experimental approach developed and executed to make transformation genotype-insensitive in maize in order to carry out gene editing in any genetic background.	0	0	1
	Outcome 2.4 MAIZE partners and global research community use pre-bred germplasm with novel genetic variance for drought, MLN, Tar spot complex, and other key traits	CoA 2.4.1 Phenotypic and genotypic evaluation, and line development (advancement) for novel resistance to MLN.	0	0	1
		CoA 2.4.2 Phenotypic and genotypic evaluation, and line development (advancement) for novel resistance to Tar Spot Complex (TSC).	0	0	1
		CoA 2.4.3 Progress towards marker development for MLN and TSC.	0	0	1
FP3	Outcome 3.1 Increase in the rate of genetic gain for grain yield (as measured in breeders' trials) in rainfed, climate-vulnerable environments of SSA from 0.6% to 1.2% annually, and from ≤1% to at least 1.75% in Asia and LA (linked to MAIZE FP2 and EiB	CoA 3.1.1 MAIZE testing network and breeding programs guided by reclassification of maize mega-environments in South Asia and SSA, for developing and deploying targeted products with traits required for present and future environments.	0	1	1
		CoA 3.1.2 MAIZE breeding pipelines strengthened through effective integration of upstream research outputs, especially validated molecuar markers for multiple stress resilience.	1	1	2

	Platform)	CoA 3.1.3 Elite MAIZE lines with tolerance/resistance to prioritized abiotic (drought, heat, salinity, cold, acidity) and biotic (MLN in SSA; TSC and Corn Stunt in LA; PFSR, GLS, TLB, Ear rots in Asia) developed and disseminated to public and private sector partners.	0	1	2
	Outcome 3.2 Effective pest/disease surveillance, monitoring and diagnostics protocols / procedures for controlling the spread and impact of existing/emerging threats (e.g., MLN), established in SSA	CoA 3.2.1 MLN surveillance, diagnostics and management in SSA significantly strengthened, in partnership with public sector (NPPOs) and commercial seed company partners.	1	2	2
		CoA 3.2.2 Through stakeholder consultations and partnerships, an integrated pest management strategy devised and action initated for effectively tackling the recent major incidence of Fall Army Worm (Spodoptera frugiperda), an invasive insect-pest now in SSA.	0	1	1
		CoA 3.2.3 MAIZE Atlas populated with information on key sources of resistance to important maize diseases, insect-pests and parasitic weeds in MAIZE lines and advanced hybrids, phenotyping procedures and locations for use in developing stress resilient maize.	0	0	2
	Outcome 3.3 Nutritious maize hybrids / varieties with superior agronomic performance and desirable gender-informed traits (processing properties, palatability and storability) adopted in targeted geographies in SSA, Asia and LA	CoA 3.3.1 Nutritional and end-use quality traits in improved MAIZE germplasm (vis-a-vis commercial hybrids) characterized in SSA, Asia and LA	2	1	1
		CoA 3.3.2 Yield potential and stress tolerance of QPM varieties for SSA, Asia and LA enhanced, and improved QPM varieties deployed.	2	1	1
		CoA 3.3.3 Dual-purpose maize hybrids with hgih yield and stover quality identified/developed for rice-fallows and mixed farming systems in South Asia	1	1	1
	Outcome 3.4 Reduction in product development and elite line recycling time and costs through integration of novel tools / technologies in MAIZE breeding programs.	CoA 3.4.1 Genomic selection and foward breeding strategies implemented in MAIZE breeding programs resulting in selection among greater than 5000 individuals for advancement of top lines directly into Stage 2 from predicted values (instead of phenotypes), and delivery of more than 5000 haplotype-enriched families or lines to MAIZE breeding teams	0	1	1
		CoA 3.4.2 High-throughput field-based phenotyping tools (both proximal and remote sensing based) validated and deployed for improving efficiency of selection for abiotic and	1	1	1

		biotic stress traits in MAIZE breeding programs of SSA, Asia and LA			
		CoA 3.4.3 Capacity of MAIZE partners in SSA, Asia and LA for generating high-quality phenotypic data for abiotic and biotic stress traits strengthened	1	1	2
	Outcome 3.5 Reduced cost of seed production (= reduced "cost of goods sold or COGS") of newly developed and released maize varieties.	CoA 3.5.1 Seed production research on parents of at least 100 best-bet MAIZE hybrids undertaken in SSA, Asia and LA	1	1	1
		CoA 3.5.2 Work on male sterility-based seed production system implememted (in collaboration with DuPont-Pioneer) to make seed of MAIZE-derived hybrids more affordable to smallholders (by reducing the cost of seed production).	1	1	1
		CoA 3.5.3 Web-based documentation and dissemination of recommendation domains for cost-effective seed scale-up of MAIZE hybrids by seed companies.	1	1	1
	Outcome 3.6 Enhanced adoption of climate resilient and nutritious maize varieties by smallholder farmers in stress-prone rainfed environments of SSA, Asia and LA providing better yields and stability	CoA 3.6.1 Performance of new elite MAIZE hybrids validated (vis-a-vis commercial checks) through regional on-farm trials in target agro-ecologies.	2	2	1
		CoA 3.6.2 At least 100 elite MAIZE hybrids (with traits preferred by farmers and consumers) allocated to public and private sector partners in SSA, Asia and LA for varietal release, seed scale-up and commercialization.	1	1	2
		CoA 3.6.3 Capacity of at least 100 SME seed company partners in SSA, Asia and LA strengthened with regard to seed road map implementation, seed marketing, gender, and seed business management.	1	1	2
FP4	Outcome 4.1 Improved understanding of farmers' livelihood strategies and their diversity, allowing NARES and extension partners to target and implement institutional and technical interventions (in collaboration with other CRPs with a systems Flagship)	CoA 4.1.1 Standardized protocols for multi-criteria assessment of advanced crop management packages, including multilevel SI indicators and metrics	1	0	1
		CoA 4.1.2 Multi-criteria assessment taking into account environmental and social acceptability aspects tested in 2 geographies	1	1	1
		CoA 4.1.3 Data collection tools developed and tested in the three target regions (SSA, Asia and LA)	1	1	1

	Outcome 4.2 Decision support systems for nutrient and water management used by development partners	CoA 4.2.1 Innovative methods (including participatory approaches), tools for improved resource use efficiency	1	1	1
		CoA 4.2.2 Proof of concept on the use of those tools in 2-3 geographies	1	1	1
		CoA 4.2.3 Training and extension material developed	1	1	2
	Outcome 4.3 Adoption of productivity enhancing technologies by smallholder farming communities through participatory methods	CoA 4.3.1 Individual and combination of SI technological options tested through on-station and on-farm trials and demonstrations	1	0	1
		CoA 4.3.2 Ex-ante assessment of SI technologies and practices through cropping system modelling approaches	1	0	1
		CoA 4.3.3 Framework to assess profitability, stability, resilience of SI technologies at field level developed	0	0	0
	Outcome 4.4 Impact at scale through adoption of SI technical innovation and practices and technical capacity reinforcement of scaling partners	CoA 4.4.1 Impact pathways refined and validated for a range of large bilateral projects	1	1	1
		CoA 4.4.2 Capacity building in systems approaches	1	0	2
		CoA 4.4.3 Context- and technology-specific business models developed in Bangladesh, India, Ethiopia, Zimbabwe, and Mexico	1	2	2

Disclaimer

4.1) Please see explanations in the instructions and guidance below to complete the tagging columns for the cross-cutting topics.

4.2) G = Gender, Y = Youth, CD = Capacity Development;

4.3) Markers: 0 = not targeted, 1 = significant, 2 = principal

4.4) CoA (Cluster of Activity) Outputs or Key Outputs reported in the POWB are expected to be key products, new knowledge and services produced through a variable number of deliverables reported at the project level; for output's definition, see glossary.

Annex 1. List of MAIZE-AFS Focus Countries for Country Coordination (2017).

Countries	CGIAR Center Lead	Focal Points for Country Coordination	MAIZE W3/Bilateral Projects operational in the country	Priority areas for Country Coordination
Bangladesh	IRRI / WorldFish	Paul Fox (IRRI) Craig Meisner (WorldFish)	CSISA; CSISA- MI; Harvest Plus; ACIAR-Sustainable & resilient farming systems; HTMA	Determine how to link better between different CRPs (especially through bilateral projects) for effectively addressing major issues through synergies
D.R. Congo	IITA	Nzola Mahungu	Harvest Plus	• MAIZE will focus on improved variety testing and release, in conjunction with ongoing NRM work, to support national partners in improving the maize production system. This will link directly into IITA's initiative on Country Coordination. • If approved for funding, the upcoming AfDB project TAAT will greatly improve coordination across CRPs working in DRC (see note below)
India	ICRISAT	Peter Carberry	CSISA; CRMA; Harvest Plus, HTMA; Strengthening simulation approaches for understanding, projecting and managing climate risks in stress prone environments across the central and eastern Indo-Gangetic Plains; Stress Resilient Maize for Odisha; Rythu Kosam in Andhra Pradesh	• Determine how to link better between various W3/bilateral projects led by CGIAR institutions in India, and enhance synergies with NARES (ICAR; SAUs) and private sector • Overcoming the bottleneck of not able to use UAVs for crop phenotyping work through ICRISAT's coordination with the Ministry of Civil Aviation
Kenya	ICRAF	Ravi Prabhu	STMA; DTMASS; SIMLESA; FACASI; FPL; WEMA-II; MLN Diagnostics & Management; AMEXCID; IFPRI-Global Futures; IITA/USAID-AR, NAFAKA and Tuboreshe Chakula Partnership-Phase-III	• How to collectively address the recurring droughts in ESA through a suite of relevant climate-resilient technologies from CGIAR, in partnership with Government organizations and development partners?
Nepal	IWMI and CIMMYT (co-lead)	Andrew McDonald (CIMMYT) & Fraser Sugden (Srabani Roy) (IWMI)	NSAF; CSISA; HTMA	• How to strengthen the local seed sector in Nepal, especially rice, wheat, maize and vegetables, on which Nepalese farmers depend extensively? • How to address issues associated with gender and social inclusiveness in Nepal's agricultural development?

Nigeria	IITA	Alfred Dixon	STMA; TAMASA; Harvest Plus	• MAIZE will continue strong linkages between STMA and TAMASA, where new MAIZE varieties are used in the cropping systems work of TAMASA. • Maize breeding and deployment efforts will benefit from crop modelling and decision support tool development under TAMASA. MAIZE-AFS will link closely with the Nigerian Government's Enhancing Productivity in Maize programme and into IITA initiative on Country Coordination.
Tanzania	IITA	Regina Kapinga	STMA; DTMASS; SIMLESA; TAMASA; FACASI; UC DAVIS	• Effectively link the improved MAIZE varieties scaled-up and deployed through STMA and DTMASS with TAMASA for improving national maize productivity.
Zambia	CIMMYT	Peter Setimela	STMA; DTMASS; Africa Rising; HarvestPlus; TLC/MoA-Zambia	• Coordination on drought risk management in southern Africa • Tackling the epidemic of Fall Army Worm on maize through multi-disciplinary and inter-institutional synergies

Note: In Africa, MAIZE will play a key role in contributing to Country Coordination efforts through the participation of CIMMYT and IITA in the Maize Value Chain component (in the Savannah zone) under the proposed TAAT (Technologies for African Agricultural Transformation) in support of the AfDB's FeedAfrica Agenda; TAAT was formulated by 12 CGIAR centers—AfricaRice, CIAT, CIMMYT, CIP, ICRAF, ICARDA, ICRISAT, IFPRI, IITA, ILRI, IWMI, WorldFish Center—along with FARA, AVRDC, AATF, and CAB International.