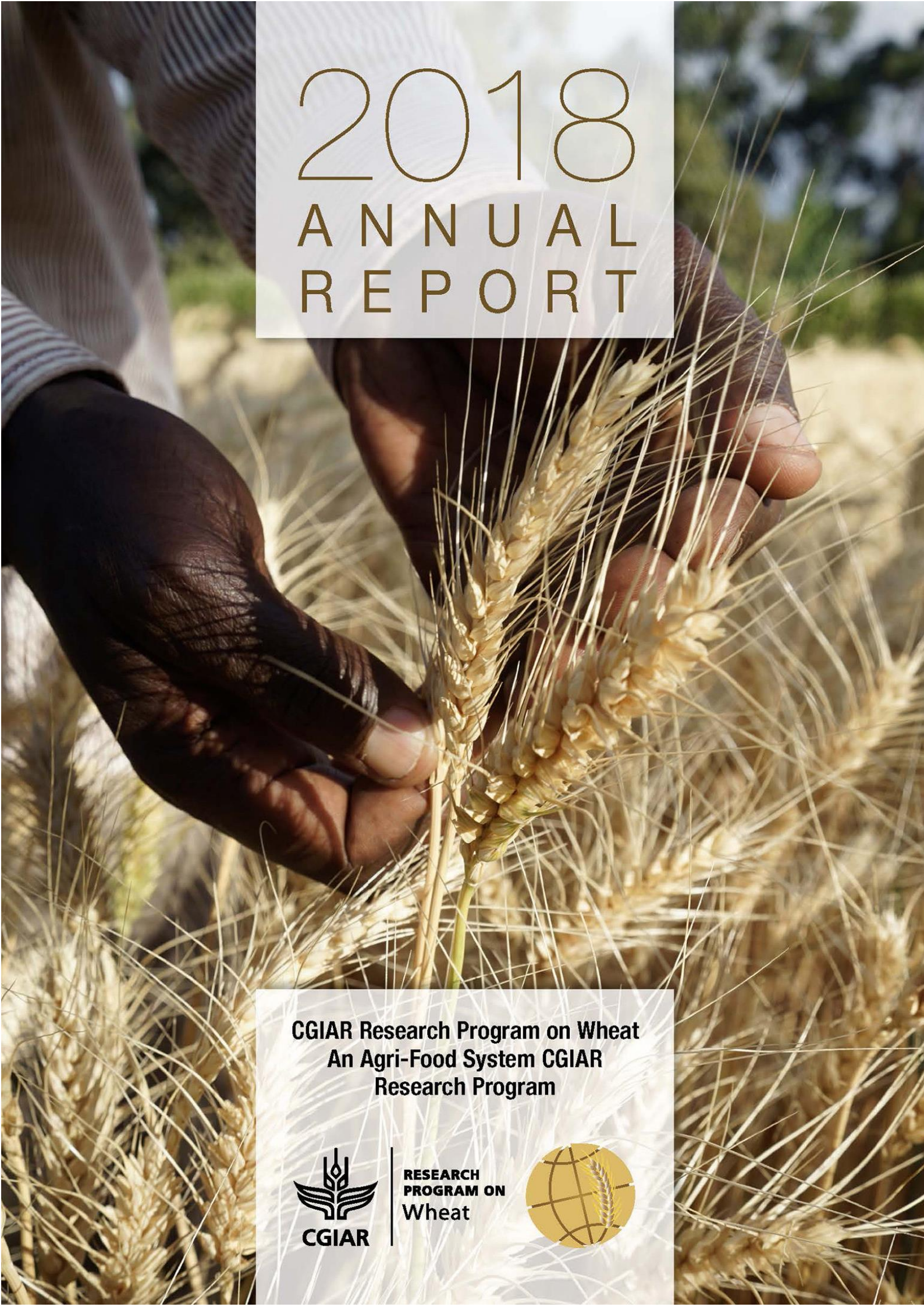
2018 ANNUAL REPORT



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

CGIAR

RESEARCH PROGRAM ON Wheat

Name of the CRP: **Agri-Food Systems CGIAR Research Program for Wheat**
Name of the Lead CGIAR Center: **CIMMYT**

Flagship lead institutions (CGIAR Centers or lead partners)
Flagship 1: CIMMYT
Flagship 2: CIMMYT
Flagship 3: CIMMYT
Flagship 4: CIMMYT
Other participating CGIAR Centers: **ICARDA, BBSRC (UK), ICAR (India), ACIAR (AU), INIA (Bolivia), INIAF (Uruguay), INRA (Morocco), IRESA (Tunisia), BARI (Bangladesh), G-20 Wheat Initiative, International Wheat Yield Partnership (iwyp.org). The complete list/map of partners is accessible here.**

Acknowledging our funders:
In 2018, Australia (ACIAR), UK (DFID) and USA (USAID) supported the CGIAR Agri-food Systems Research Program on Wheat (WHEAT) with Window 2 funding and 14 funders supported this CRP with Window 1 funds through the CGIAR Fund. Bilateral funders supported programs and projects matched to WHEAT Flagship Projects (FPs) and Clusters of Activity (CoAs) with US$40 million.

Cover photo: CIMMYT/Peter Lowe

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EXECUTIVE SUMMARY

Partners in the CGIAR Research Program on Wheat (WHEAT) reached intermediate development outcomes (IDOs) linked to SLO 1.1 (improved crops/methods adoption) and SLO 2.2 (increase yields) and identified the potential impact of achieving IDOs (ex ante studies) in all major WHEAT target regions. Related to this, WHEAT Management Committee approved an updated Impact Assessment Strategy – *See Tables 1 & 2.*

Multi-year bilateral projects delivered improved income outcomes relating to SLO 2.1 (exit poverty) and SDG 1 (end poverty in all its forms) and several ex ante studies show the poverty reduction potential of interventions under WHEAT FP3 and FP4 – *See Tables 1 & 2.*

WHEAT built new knowledge related to value chains (consumer demand, farmer adoption dynamics), climate smart agricultural practices (zero-till, water management and precision fertilizer) and nutritional quality (breeding for high zinc). The majority of 2018 innovations are at stage 3 (ready for uptake) – *see MARLO Evidences Table of Innovations*.

Part A: NARRATIVE SECTION

1. Key Results

1.1 Progress Towards SDGs and SLOs

Breeding for farmers: Impacts

Importance of International germplasm exchange for novel genetic diversity and high ROI of international breeding research collaboration. In **China**, wheat production has increased significantly over the past 30 years, despite a reduction in wheat area, thanks to rapid yield growth due in part to international germplasm exchange and breeding research collaboration. China's wheat breeding programs are increasingly combining exotic germplasms with local germplasms. Yield of Chinese germplasm-based varieties alone more than doubled between 1982 and 2014. Varieties combining local and exotic (foreign, from CGIAR and other countries) germplasms had even higher yield potential. The accumulated contribution of exotic germplasms to wheat production in China (1982-2014) represents about 343 million tons or 70 billion US$ at $200/ton, about 10% of total production, and led to an additional increase in annual production of 10.4 million tons. – *See Table 1, SLO 1.1. and 2.1.*

In **Ethiopia**, rapid wheat variety replacement (2009/10-2013/14, CIMMYT and ICARDA) following a major stripe rust epidemic was enabled by effective promotion and widespread availability of improved seed as well as investments to support development and promotion of rust resistant varieties. Over the four-year period, farmer net income grew from 4,320 Birr/ha to 5,339 birr/ha, despite rising input costs– *See Outcome case report & Table 1, SLO 1.1 and 1.2.*

Since 2014, scientists have been addressing risk of over-relying on a variety protected by single major gene, which was the case during 2010 to 2014. In the case of Race TKTTF stem rust, also epidemic in Ethiopia and now spreading to Europe, concerted research has identified several new resistant genes and gene combinations for use in breeding.

A long-standing collaboration between the Ethiopian Institute for Agricultural Research (EIAR), WHEAT and other national and international partners supported a recently announced Government of Ethiopia (GOE) objective to become wheat self-sufficient by 2022. CIMMYT and GOE convened a workshop in November 2018 to identify intermediate steps to achieve this goal. Improved, rust-resistant seeds and rapid disease diagnostics, such as via the MARPLE portable rust testing lab, are helping the country to make progress.

1.2 CRP Progress towards Outputs and Outcomes

1.2.1 Overall CRP progress

The developing world's appetite for wheat is growing swiftly, driven in part by rising incomes and rapid urbanization. WHEAT research is responding to this increased demand in the context of a hotter, dryer and more variable climate and limited natural resources. In 2018, the International Wheat Genome Sequencing Consortium published a genome map for wheat, opening the door for breeders and researchers to rewrite the story of wheat crop improvement. Data analysis from the genome map allows WHEAT scientists to deliver faster and better breeding products -- high-yielding, climate- and disease-resilient wheat varieties -- to farmers. WHEAT's work to develop varieties with elevated levels of zinc and other micronutrients continued in 2018, as a contribution to fight "hidden hunger" and meet micronutrient needs, while reducing agriculture's environmental impact.

Agriculture is a major source of climate change-exacerbating greenhouse gas emissions, and in India, for example, farming practices such as burning residues are a major culprit. The Cereal Systems in South Asia program (CSISA) is improving farmers' access to environmentally friendly technologies. Other WHEAT studies point to the benefits of "layering" climate smart agricultural practices, taking other conditions such as market and extension service access into account - to improve adoption of improved and climate friendly farming practices – *see FP4, p.8 and Table 1, SLO3.1; Report Table 2.*

1.2.2 Progress by flagships

FP1: Enhancing WHEAT's research for development (R4D) strategy for impact.

Foresight for better targeting and prioritizing research

Consumer demand and value chains. Research in Bangladesh, Asia and sub-Saharan Africa (Mottaleb, synthesis will be published in 2019) finds that wheat consumption will increase dramatically by 2030. CIMMYT scientists and partners are using a new conceptual framework for smallholder value chains to study how consumers access and buy processed wheat- and maize-based products in Mexico City, one of the world's largest cities.

Anticipate pests/disease outbreaks. A 2018 ex ante analysis of the threat of wheat blast found that in Bangladesh, India and Pakistan the annual potential post-harvest loss is an estimated 0.89 - 1.77 million tons, with 7 million hectares growing area at risk. An ex ante assessment of a "wheat holiday" in Bangladesh and West Bengal, India concluded this is feasible in the short term only, in combination with affordable fungicides and farmer education.

Research studying wheat-rice rotation farmers in the Indo-Gangetic Plains showed that layering Climate Smart Agricultural Practices[1] (CSAPs) improved yields, incomes and water and energy efficiency; and reduced greenhouse gases.

FP2: Novel tools for improving genetic gains and breeding efficiency

Genebanks a source of valuable pre-breeding material. Pre-breeding lines based on gene bank accessions have provided breeders with novel genetic diversity.

Harnessing genetic potential for nutrition and disease resistance. WHEAT scientists, with colleagues from India, Australia, the United States and Mexico, uncovered 39 marker-trait associations related to zinc concentration, as well as corresponding genes for zinc uptake, translocation and storage. Validation studies will provide breeders with new markers – and national agricultural research system (NARS) partners analyzed 240 rainfed and irrigated wheat lines (Pakistan), which showed overall protein and gluten is positively correlated with Iron (Fe) & zinc (Zn). A genetic diversity-into-use study on the reference genome of Aegilops tauschii (goat grass) provides insights for exploring adaptive traits, and two new genes for resistance to wheat stem rust. ICARDA and CIMMYT hold

[1] The CSAPs considered in this study include site-specific nutrient management (SSNM), crop diversification (CD), minimum tillage (MT) and stress-resistant improved seed (IS) varieties.

significant goat grass collections (see FP2 & Genebank Platform). ICARDA screened CIMMYT wheat breeding lines for Russian wheat aphid (Diuraphis noxia), a major global pest. At least one line, developed through crosses with wheat-related crop and grass species, showed high levels of resistance, and has entered CIMMYT's wheat genetic resource collections.

***Progress on genomic prediction for faster, cheaper and more precise breeding*:** To improve the predictive power of genomic selection, researchers performed a large-scale genome wide association study to dissect the genetic architecture of 50 traits, evaluated in South Asia, Africa, and the Americas, and anchored the markers to a genotype-phenotype map. The team also generated the genomic fingerprints of a panel of 44,624 wheat lines (key varieties cultivated worldwide & 469 CIMMYT parental lines) to characterize the role of selection in shaping patterns of allelic variation over time.

Genetic Resources for Wheat Blast Resistance. The 2NS gene in BARI Gom 33 variety is the major resistance factor against wheat blast. For more durable resistance, WHEAT scientists have identified lower-level resistant sources not carrying 2NS, for possible gene pyramiding.

Data and Molecular Markers. All grain yield and other data are open-access via the CIMMYT webpage. All data generated during the rusts resistance breeding process are currently available in Excel files where all data for distributed lines are combined in a single worksheet, stored in Dataverse and on Kansas State University (KSU) servers.

FP3: Better varieties reach farmers faster

CIMMYT and ICARDA international trials and nurseries went to over 100 countries in 2018. A majority of partners returned data. A number of new wheat lines had greater than 5% superior grain yields, and 70-80% carry sufficient levels of resistance to the Ug99 lineage of stem rust fungus. The International Winter Wheat Improvement Program (IWWP) released 6 new varieties in **Turkey and Central and West Asia**, for a total of 80 IWWIP-originated released varieties. For more information about 2018 releases (48 varieties) see the table here and click here.

Breeding for drought-tolerant germplasm can help to counter climate change effects on production. Analyzing the annual genetic gain for grain yield (GY) of the internationally distributed Semi-Arid Wheat Yield Trials (2002–3 to 2013–14; 740 locations across 66 countries), the authors estimated a 1.8% rate of genetic gain increase in low-yielding environments and 1.6% across low- and medium-yielding environments - *see Table 1, SLO 2.1.*

Nutritional quality. Scientists confirmed the nutritional value of whole grains and wheat and WHEAT scientists and partners identified 13 genotypes with higher concentrations of useful grain minerals that could be used in a biofortification breeding program.

Precision phenotyping platforms. Scientists evaluated 10,000+ accessions under field conditions (8 platforms, with CIMMYT or ICARDA as WHEAT partner) for biotic/abiotic stress traits, with co-participating NARS. High-quality phenotypic data was generated and shared. Capacity development activities strengthened linkages between national and international research programs.

More than 4,000 wheat accessions were screened for wheat blast in Bolivia, and trials are underway for two promising blast resistant lines in Bangladesh, in addition to the 2017-released BARI-Gom 33. Close to 42,000 accessions from 16 different countries/research partners were tested for stem rust at the Kenya Agricultural & Livestock Research Organization-CIMMYT screening site. Data was recorded for yellow and stem rust and shared with partners. More information about the *Delivering Genetic Gains in Wheat program* is available here.

Global Disease Monitoring. Global rust monitoring produced more than 35,000 survey records from more than 39 countries in 2018, the most comprehensive crop disease monitoring system worldwide. Scientists piloted MARPLE (Mobile And Real-time PLant disEase), a diagnostic tool, in Ethiopia, in partnership with John Innes Centre and EIAR.

DNA fingerprinting of yellow rust fungus shows it is evolving and migrating at an unprecedented rate between continents, leading to significant crop losses.

FP4: Sustainable intensification of wheat based-farming systems

Increasing soil organic matter by 1% can meet the nutrient needs of an extra 0.5 persons per hectare, according to a study in Ethiopia.

Wheat farmers in Mexico's Yaqui Valley could increase profits and radically reduce greenhouse gas emissions – by as much as 130,000 tons of carbon dioxide a year -- by more precise application of nitrogen fertilizer. Irrigated wheat production covers about 30% of the world's wheat area.

India could reduce 18 percent of its annual greenhouse gas emissions arising from agriculture and livestock. Half of this potential reduction of 85.5 $MtCO_2e$ per year could be realized through the combination of efficient fertilizer use, zero tillage and better water management in rice farming (CCAFS/WHEAT) – *see Report Table 2.*

A study on factors affecting the probability and intensity of adoption of climate smart agricultural practices in Bihar, India, notes climate risk, farm plot features and access to markets and extension services as factors, and recommends disseminating multiple practices in combination (see FP1). Also in Bihar, other WHEAT scientists applied scenario analysis to examine the potential impact of adopting climate smart agriculture (CSA) practices (Conservation Agriculture (CA) and improved livestock husbandry) and environmental shocks, on households' potential food availability, for 5 different farming system types. Their findings show that compared to livestock interventions, CA may hold considerable potential, though primarily for wealthier and medium-scale cereal farmers. But these farm types were more vulnerable to food insecurity risks due to simulated drought. Part-time farmers and resource-poor agricultural laborers generating income from off-farm pursuits were comparatively less vulnerable.

CSISA-Mechanization and Irrigation (CSISA-MI), in partnership with iDE, improved farm mechanization in Bangladesh by helping entrepreneurs buy machines for rental or for-hire farm work. To date, 191,000 farmers can now access services from a network of nearly 3,000 local providers, representing improved cultivation across 92,000 hectares in Southern Bangladesh.

1.2.3 Variance from Planned Program for this year

No research lines were dropped. FPs' impact pathways and Theories of Change (e.g direction) remain unchanged. However, CIMMYT and ICARDA had to suspend their project operations and close their offices in Iran in November, as sanctions made even basic R4D operations impossible.

In line with an updated Impact Assessment Strategy that supports better targeting and prioritizing, WHEAT has published more research about farmer adoption dynamics, reflecting a continued and greater effort on consumer and demand foresight.

Plans to expand R4D on soilborne diseases and to expand the precision phenotyping platforms network have been delayed into 2019/2020. The same applies to Scaling of Sustainable Intensification in North Africa, pending funder commitment/successful competitive proposals.

The launch of the bilateral TAAT-Wheat project, successor to SARD-SC-Wheat, in partnership with 7 sub-Saharan countries and funded by the African Development Bank, was delayed to end 2018.

1.2.4 Altmetric score and Publication highlights

A publication concerning the potential for a re-emergence of wheat stem rust in the United Kingdom had an Altmetric score more than two times higher than the second placed publication. Published in Nature Communications Biology and with an Altmetric score of 199, the publication was featured in several major news sources including Thompson Reuters and the Daily Mail. The publication was also tweeted by 131 unique users of the platform.

A second noteworthy publication discussed the fast forwarding of genetic gain, which had an Altmetric Score of 81. Discussing ways to increase the speed of genetic gain, with a focus on 'speed breeding', the publication was tweeted by 112 unique twitter users.

1.3 Cross-cutting dimensions (at CRP level)

1.3.1 Gender

The CIMMYT-led gender 11-CRP GENNOVATE program came to a close, with the release of a special issue in the Journal for Agriculture, Gender and Food Security and 17 tools or guidance notes that non-gender specialist researchers within and outside the CGIAR are using. Though proper tracking of the use of tools remains to be set up, there is evidence, for example, of gender awareness and gender-sensitive approaches spreading into Ethiopian agricultural research, extension and policy – *see Report Table 2*.

South Asia is experiencing a rise in farming innovations by women, fueled by strong male outmigration in some locations, and enabled by gender equality narratives, disseminated by social and women's movements and NGOs. The driving force surrounding the cases in this set of qualitative studies is the gender equality narrative. More women are demonstrably making more decisions about wheat, giving them more control. Analyzing 79 villages cases from 17 countries, categorized into transforming, climbing and churning village types (different normative climates & trajectories of change) researchers found that "transforming" villages, with significant increases in people's agency and poverty reduction, exhibited a highly inclusive normative climate fueling gender equality and agricultural innovation, infrastructural improvements and male labor migration.

What are key characteristics of rural women and men innovators? Results of a comparative study indicate that factors related to personality and agency are what most drive women's and men's capacity to innovate. Access to resources is not a prerequisite but rather an important enabling aspect. Different types of women have great potential for local innovation, but structural inequalities make men better positioned to access resources and leverage support. Men's support is important when women challenge the status quo.

1.3.2 Youth and other aspects of social inclusion / "Leaving no one behind[2]"

Climate smart agriculture, small and medium-sized enterprises (SMEs) and business models: The introduction of new CSA technologies such as the "Happy Seeder" or land laser levelers could trigger young farmers to joining or remain in agriculture.

A paper based on 25 case studies from a GENNOVATE global comparative study shows that across the study's regional contexts, young rural women and men predominantly aspire for formal blue- and white-collar jobs. Yet, they experience an aspiration-achievement gap and they continue to farm in their family's production. Whereas some young men aspired to engage in knowledge-intensive or "modern" agriculture, young women did not express any such interest. The researchers contend that various gender norms that discriminate against women in agriculture dissuade young women from aspiring to agriculture-related occupations.

1.3.3 Capacity Development

See also Table 8: Common Reporting Indicator on Individuals Participating in CapDev #C3,

Nearly all capacity development activities were co-productions with NARS partners: Expanding national scientists' capacity for wheat blast screening and surveillance; a two-week on the job training on how to use remote sensing in drought monitoring and crop mapping; incorporating young female award-winning scientists in the annually held breeding research training; reaching a broader

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

Pakistani public about improved varieties and the zero tillage Happy Seeder; and reaching out to farmers to replace outdated, disease-prone varieties in Pakistan or Ethiopia.

MasAgro received an honorable mention alongside the 10 most sustainable and scalable rural development initiatives in Latin America, selected by the UN Food and Agriculture Organization (FAO). An important selection criteria was scalability of capacity development approaches. MasAgro has trained certified extension agents since 2012 and manages 10 wheat production-related innovation hubs in Mexico, for example the Guanajuato hub, which has brought together 2,446 farmers, networked another 11,120 farmers and thus impacted more than 34,142 hectares with improved varieties and farming practices.

Collaboration with the International Centre for Biosaline Agriculture (ICBA) on the Arab Women Leaders in Agriculture program (previously called Tamkeen) was delayed into 2019.

1.3.4 Climate Change

Historical yield increases in wheat have occurred across most regions of the world, but climate trends threaten to dampen or reverse these gains, with yields expected to decrease by 5–6% despite rising atmospheric CO2 concentrations.

Scientists from 4 CGIAR Centers proposed a framework for prioritizing agricultural research investments across scales and reviewing different approaches to setting priorities among agricultural research projects. Many priority-setting case studies address the short- to medium-term and at relatively local scales. The scientists suggest a mix of actions that spans spatial and temporal time scales, to adapt to a changing climate, address immediate problems and create enabling conditions for more effective climate smart agriculture R4D.

Researchers performed an ex ante adoption of climate smart agriculture (CSA) practices assessment across five primary farming system types in Bihar, India. Conservation agriculture boosts food security for wealthy and medium-scale farmers, while simulated drought has considerable negative impacts on all farm types. Farmers with diversified income are less vulnerable to environmental shocks. The findings underscore the importance of prior planning for development initiatives aimed at increasing smallholder food security while maintaining social equity, making use of a robust methodology to vet the implications of agricultural interventions on an ex ante basis.

What are critical issues and drivers of small and medium enterprise (SME) business models for the adoption and scaling of climate smart agriculture technologies in a developing country context? To strengthen SMEs' role as change agents for CSA, policy makers should reconsider current subsidy regimes and ensure flexible and targeted (financial) incentives. Research and extension services can help SMEs in the acquisition of new knowledge and skills, which they can in turn share with their customers. From a scientific perspective, this study is the first to distinguish between adoption and scaling of CSA technologies.

2. Effectiveness and Efficiency

2.1 Management and governance

WHEAT-ISC recommended that WHEAT invest more in nutrition-related R4D and increase the pace of (pre)breeding research integration among CIMMYT and ICARDA (One Global CGIAR Wheat Program). WHEAT-ISC asked both Center DGs to put the defense of international germplasm exchange for research and for value chains higher on the CGIAR agenda.

Both DGs have become full voting members of WHEAT-ISC.

W1&2 volatility and unpredictability remained a challenge in 2018. WHEAT-MC maintained a buffering budget. In December, WHEAT learned that it would receive a budget $670k higher than anticipated. SMO had to change W1&2 per CRP FinPlan2018 figures three times during the year.

2.2 Partnerships

2.2.1. Highlights of External Partnerships

See also Table 9 & Common Reporting Indicator on External Partnerships #C2.

Biological Nitrification Inhibition (BNI) Consortium: Japan International Research Center for Agricultural Sciences (JIRCAS) started the BNI consortium in 2014 with 3 CGIAR Centers (CIAT, ICRISAT, and CIMMYT), collaborating on BNI research. It has grown into 13 members comprising several CRPs/Centers and non-CG members from USA, Germany, France, China, India and Austria, along with several Japanese national agricultural research institutes. Member scientists exchanged knowledge during the 3rd Symposium and updated a global projects database. BNI research is a topic in the World Resources Institutes' *Creating a Sustainable Food Future* Report (2019).

Co-organized by CIMMYT and the International Association for Cereal Science and Technology (ICC), the 4th Latin American Cereals Conference (LACC) drew 220 participants from 46 countries, including professionals in agricultural science, food industry, regulatory agencies and trade associations. The 13th International Gluten Workshop complemented the 4th LACC. Participants discussed the large body of studies associating whole grain foods with a significantly reduced risk of chronic diseases and obesity - and how to respond to rising consumer demand for whole grain products. Participants wanted to learn about improving milling and baking quality.

WHEAT scientists participated in most of the 11 Expert Working Groups of the G20 Wheat Initiative, the only crop/cropping system-focused initiative to better coordinate and prioritize research at an international scale. WHEAT scientists are junior partners in several International Wheat Yield Partnership (IWYP) projects.

The Borlaug Training Foundation secured funding from the Islamic Development Bank to support 12 trainees for the in-service wheat improvement course in Mexico.

2.2.2. Cross-CGIAR Partnerships (Centers, other CRPs and Platforms)

One Global CGIAR Wheat Program: Progress has been made in joint wheat nursery trials ("best of the best," FP3), the appointment of an INRA (Morocco)-seconded agronomist (FP4), activities to prioritize agronomic challenges in North Africa, seed multiplication of CIMMYT wild relatives in Lebanon and the completion of sequencing of ICARDA genebank accessions (FP2).

New in 2018:

- WHEAT FP2 and FP3 scientists interacted with the Excellence in Breeding Platform (EiB) to develop breeding program improvement plans under the emerging Crops to End Hunger Initiative (continuing in 2019).
- A4NH, MAIZE and WHEAT collaborate on healthier food systems research.
- PIM is convening a multi-CRP effort on re-thinking foresight research (ongoing in 2019).
- Most Centers and CRPs have contributed to a System Council and Management Board convened effort to describe what CGIAR crop pests and diseases rapid response preparedness should look like.

There has been no significant progress yet in realizing collaboration with FTA and WLE. The proposal development collaboration with CCAFS and GIZ was not successful.

2.3. Intellectual Assets

Note: Further information can be found at https://www.cgiar.org/wp/wp-content/uploads/2018/10/CGIAR-2017-Intellectual-Asse.

(a) Have any intellectual assets been strategically managed by the CRP (together with the relevant Center) this year?

To support the sub-IDO on *more efficient use of inputs*, during 2018 WHEAT started to work (in collaboration with other CGIAR Centers and partners) on the development of open source software that will improve the ability to manage the Center's germplasm, including any IA related restrictions or specific conditions. Once the development is completed, the software solution will be made available to other CGIAR Centers.

Finally, CIMMYT and ICARDA, during 2018 and continuing in 2019, are reviewing their research policies, to support greater transparency in different areas, including partnerships and different strategies to disseminate results. Such policies will be shared with other CGIAR Centers.

*(b) **If relevant**, indicate any published patents and/or plant variety right applications (or equivalent) associated with intellectual assets developed in the CRP and filed by Centers and/or partners.*

CIMMYT has not filed, nor has any CIMMYT partner informed CIMMYT, of any application for patent or plant variety protection associated with intellectual assets developed under WHEAT.

(c) List any critical issues or challenges encountered in the management of intellectual assets in the context of the CRP (or put N/A).]

- Ensure sufficient funding and adequate human resources to implement on a timely basis all actions needed for a proper IA management.
- 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.
- Collecting, exporting and licensing seed in view of the ITPGRFA and the Nagoya Protocol.
- Some IP policies or practices from certain 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)

FP1: The updated WHEAT impact assessment strategy is being put into practice, with foresight, ex ante and ex post adoption dynamics and impact studies realized between 2018 and 2021.

WHEAT is fully utilizing MARLO to link individual projects and areas of research to FP theories of change and to monitor research progress. MARLO helps the CRP collect important lessons across projects and incorporate these in program decision making and institutional learning. WHEAT reviewed its FP theories of change at the end of 2018, based on performance data collected and lessons learned. Best practices were taken into account for next year.

WHEAT participated in the MEL CoP steering committee, where it contributed to practical guidance for the common reporting indicators, adjusted POWB and AR templates, the development of a CGIAR MEL glossary, and helped generate MEL-related consensus across the CGIAR.

WHEAT continued its efforts to build project management capacity, conducting two more trainings. These trainings include sections to strengthen project monitoring, evaluation and learning.

WHEAT conducted regular follow-ups on 2014-15 Evaluation recommendations, now completed (See

table 11). Due to budget restrictions, WHEAT was not able to commission its planned evaluation of FP2. This will be re-considered for 2019, budget permitting.

2.5 Efficiency

WHEAT- and MAIZE-MCs decided to re-structure their shared CRPs-PMU effective 1st January, to better streamline routine work processes and associated methods and tools, with a cost saving of 1.5 FTE.

2.6 Management of Risks to Your CRP

[Brief summary of any encountered risks including any mitigation measures taken. Please provide your summary under the three following headings: programmatic, contextual and institutional risks (see the CGIAR Risk Management Guidelines).]

The three major risks remain unchanged during Phase II:

W1&W2 budget insecurity and delayed transfer of W1&2 funds, which directly affects CRP research and development operations;

Unfulfilled obligations by the partners for commissioned and competitive grants;

Lack of a systematic and integrated approach for monitoring and evaluation at the outcome level.

To mitigate risk (1), the W-MC gives priority to multi-year investments of centers and partners, and uses the issuing of new partner grants as the most flexible component of the budget. WHEAT continues to sign only one-year partner grant contracts, to manage partner expectations and minimize any delays of payments to them. For risk (2), WHEAT regularly monitors the fulfillment of obligations by partners and intervenes when necessary to ensure proper completion of grant requirements. As for risk (3), the SMO has realized improvements, in collaboration with the CRP/PF Leaders Group; and more are planned as part of the CGIAR Business Plan 1st cycle.

2.7 Use of W1-2 Funding

WHEAT is guided by the high-level framework for W1&2 deployment shown below, while Table 11 shows in more detail, where W1&2 has been invested during 2018, based on the 80 activities W1&2-per-FP annual work plan.

	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 and / or environmental data; Biological Nitrification Inhibition	FP3 new diseases & pests: Wheat blast in S-Asia	FP2-3: Germplasm improvement methodologies, methods, data mgmt (e.g. Genetic gain, cross-crops) FP4: Research on scaling out, innovation pathways	WHEAT-ISC, WHEAT-MC. SMB Member (DG), CRPs Rep in SMB, MEL CoP co-leadership
Validation	FP3: New traits into elite lines: Heat and Drought. Precision Phenotyping Platforms with NARS partners; expanded yield testing		FP4: Country coordination, systems research approaches	
Scaling out (down-stream)	FP1, 4: Research on adoption dynamics, scaling out, targeting, prioritizing, M&E approaches	FP3-4: post-conflict emergency support	FP3.7, 4.4: Country coordination, companion crops into wheat-based	

	FP3: Research on farmer adoption, seed systems innovation		systems, capacity development	
CGIAR-SRF Cross-cutting themes	Gender / social inclusion applied to 2 to 4 WHEAT innovation pipelines and assessments rapid value chain assessments with proper gender lens		FP1, 4: AFS-CRPs & CCAFS FP3: WHEAT & A4NH on improved nutrition Inter-CRP: How to improve gender mainstreaming into research	

3. Financial Summary

SMB12-approved	WHEAT
2018 final W1&2 allocation (net of CSP)	**13.004**
W1	4.063
W2	8.940
Difference to M/W-MC endorsed (85%)	12.325 = 679k

In 2018, WHEAT received US$8.94M W2 support from Australia (ACIAR), UK (DFID) and USA (USAID) and $4.06M W1 from Australia, Belgium, Canada, France, India, Japan, Korea, Netherlands, New Zealand, Norway, Sweden, Switzerland, UK and the World Bank. Bilateral funder support is documented in the WHEAT Annual Financial Report.

During 2018, WHEAT-MC

- Endorsed total 2018 W1&2 budget = 85% of 14.5M plus carry-over (unspent 2017 budget, retained within FP's/Programs; DFID additional);
- Agreed that carry-over within programs stays with Center programs and FP leaders can make allocation decision.
- Maintained WHEAT Partner Budget allocations as is, but did not approve any additional grants beyond those prioritized and approved by WHEAT-MC 171205 and on 18.3.2018.

Part B. TABLES

Table 1: Evidence on Progress towards SRF targets (sphere of interest) (Report Table)

Please complete this table as best you can based on solid evidence, such as findings of published adoption or impact studies. Do not hesitate to state, "no new evidence available this year", throughout the second column of the table if necessary, since we are trying to demonstrate evidence gaps and the need for additional funding for this area.

SLO Target (2022)	Brief summary of new evidence of CGIAR contribution	Expected additional contribution before end of 2022 (if not already fully covered).
1.1. 100 million more farm households have adopted improved varieties, breeds, trees, and/or management practices	Ex post IA: Despite the gradual fall in China's wheat area, production has increased significantly due to the rapid yield growth/ha since the early 1980s, also thanks to international germplasm exchange and breeding research collaboration. The growth of wheat production (1982 – 2014) is a success story of increasing productivity by using modern technologies. **The number of major wheat varieties adopted by farmers has gradually increased over time. Exotic (non-Chinese) germplasms constituted a significant part, with elite lines from CIMMYT accounting for 19%** and other countries (USA, Canada, Russia, etc.) 81%, respectively (1982-2014). Data comes from 17 regions producing 98% of all wheat. Authors did not distinguish between winter and spring wheat varieties. China grows mostly winter wheat. CIMMYT has mainly provided spring wheat elite lines. Germplasm-based CGIAR impact would likely be much higher than the 19% mentioned above. Authors state that future research will capture the regional differences in the impacts of exotic germplasms (see footnote 10, p.8). Ex post, project outcome: **Farmer Hotline for Wheat Rust Monitoring in Ethiopia**: Formally launched in September 2016 to broadcast surveys on the occurrence of various crop diseases. In the survey's pilot, MoALR, EIAR, CIMMYT, and the UK Met office to identify and verify the occurrence of wheat rust and develop detailed dispersal forecasts on how the disease will spread through time. As the system was expanded to callers all over the country, nearly 3.6 million registered callers had logged 30.3 million phone calls by 29 June 2018 (*see slide at bottom of weblink*	

	provided), illustrating that the Farmer Hotline and similar technologies have staying power and the ability to support farmers receive information faster than they would in the past. Sources: Goodier, R.; Gebeyehu, T. (2017): Ethiopia's hotline aids farmers through text and voice messages. In *Appropriate Technology* 44 (3), p. 52. Ex post adoption study: among of 820 smallholder households producing wheat and barley in Syria showed that increasing exposure and awareness of the zero tillage technology increases the possibility, speed, and intensity of adoption: **Enhancing adoption of agricultural technologies requires high initial investment among smallholders.**	
1.2. 30 million people, of which 50% are women, assisted to exit poverty	Ex post IA: **Wheat varietal adoption by farmers in Ethiopia** from 2009/10 to 2013/14. 2010/11, one of the most devastating stripe (yellow) rust epidemics in recent times hit many of Ethiopia's wheat growing regions. A new stem rust race (race TKTTF) was detected in Ethiopia for the first time in 2012. Survey results (16 HH in 120 kebeles in 148 major wheat growing districts) in showed substantial shift in varietal use over the four-year period. Previously dominant cultivars *Kubsa* and *Galema* became highly susceptible to stripe rust in 2010/11 and declined in share of area. Reported total average wheat yields in sampled kebeles showed a modest increase of 3% in 2013/14 (1.75 t/ha) compared to 2009/10 (1.70 t/ha)*. However, despite rising input costs over the four-year period, **production significantly increased the average net income of the surveyed farmers: 5,339 Birr/ha in 2013/14**, compared with 4,320 birr/ha in 2009/10. Study illustrates the **widespread and rapid turnover** of varieties within the four years. Stripe rust epidemic was a key driver of change, as was effective promotion and widespread availability of seed of alternative rust resistant varieties. Recent investments to support varietal development and the promotion of rust resistant varieties played a big role in making rapid varietal change possible. There was/is a risk of over-relying on a mega variety protected by single major gene resistance, as opposed to cultivars whose resistance is race-non-specific = more durable. * Yield figures are not the same as national average yield levels (about 1 t/ha greater).	
2.1. Improve the rate of yield increase for major food staples from current <1% to 1.2-1.5% per year	Ex post IA: Although the yield of Chinese germplasm-based varieties alone more than doubled between 1982 and 2014, **varieties with exotic germplasms normally had even higher yield potential, particularly for those with both local and exotic germplasms**. In addition to the gain in wheat production from the Chinese germplasm-derived varieties alone, the estimated average additional increase in annual production reached 10.4 million tons from the use of exotic germplasms in the past three decades. The **accumulated contributions** of exotic germplasms to wheat production in China represent about 343 million tons (1982 to 2014), **about 10% of the total production.** Ex post IA: **Breeding can significantly contribute to the mitigation of climate change effects** on production by developing drought-tolerant wheat germplasm. The authors determined the annual genetic gain for grain yield (GY) of the internationally distributed Semi-Arid Wheat Yield Trials (2002–2003 to 2013–2014) under IWIN. They analyzed data from 740 locations across 66 countries (low-yielding (LYE) and medium-yielding (MYE)	

	environments). Results: The rate of GYC in LYE was 1.8% (38.13 kg $ha^{-1}yr^{-1}$) and in MYE, it was 1.41% (57.71 kg ha^{-1} yr^{-1}). **The increase in GYC across environments was 1.6%** (48.06 kg ha^{-1} yr^{-1}) = CGIAR global wheat breeding program continues to **deliver adapted germplasm for suboptimal conditions of diverse wheat growing regions worldwide**.	
2.2. 30 million more people, of which 50% are women, meeting minimum dietary energy requirements		
2.3. 150 million more people, of which 50% are women, without deficiencies in one or more essential micronutrients		
3.1. 5% increase in water and nutrient efficiency in agroecosystems	Ex ante: Study results (India, IGP) showed that Conservation Agriculture-based mungbean-wheat system (Permanent Bed +residue retention) integrated with short duration mungbean enhanced system productivity by 29.3%, net returns by 38.4% and water productivity by 24.3%, compared to conventional till (CT). Nutrient Expert® based SSNM and RDF increased crop and water use efficiency by ~13 and 7% and net returns by ~15 and 7% respectively, compared to farmers' fertilizer practice. Permanent raised bed planting and partial retention of crop residues, and integration of mungbean along with Nutrient Expert ® based SSNM are possible approaches for sustainable intensification of MW system in North-West IGP, while improving the natural resources (water and air). Ex post, Pakistan, policy recommendation: Adoption of laser-land leveling has a positive impact on irrigation water savings, wheat and rice yields and household income*. The study suggests policy implications for making laser land leveling access and performance more socially inclusive through enhanced awareness, institutional support to service providers and public-private partnerships. *Water: 1-2 irrigation per crop, wheat yield: 64-110 kg/ha, rice yields: 126-174 kg/ha and household income: 32-68 thousand Pakistani rupees p.a.	

3.2. Reduction in 'agriculturally'-related greenhouse gas emissions by 5%		
3.3. 55 M ha degraded land area restored		
3.4. 2.5 M ha forest saved from deforestation		

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

Name and description of policy, legal instrument or investment	Level of Maturity	Link to sub-IDOs	CGIAR cross-cutting markers				Whose policy is this	Geographic Scope	Evidence(s)
			Gender	Youth	Cap Dev	Climate Change			
138 - Agricultural Policies and Investment Priorities for Managing Natural Resources, Climate Change and Air Pollution (From Project P1390) FP4 convinced the Government of Punjab to purchase machinery (15,000 units) to reduce stubble burning and made the Government of India implement a policy change. Policy brief: The conservation agriculture roadmap for India.	Level 1	• Conducive agricultural policy environment • Enabled environment for climate resilience	1	1	1	2	• Funder • Public Sector	**National** India	1. The Evergreen Revolution 2. Reuters news article 3. Times of India news article 4. The conservation agriculture roadmap for India: policy brief

Table 3: List of Outcome/ Impact Case Reports from this reporting year (Sphere of Influence)

Outcome/ Impact Case Reports (OICR) generated in this reporting year

Title of Outcome/ Impact Case Report (OICR)	Maturity level	Status	SRF Targets	Sub-IDOs
New OICR2566 - Heat and drought-resistant wheat varieties in Pakistan help farmers combat climate change stress and is success of physiological breeding approach	Level 1	New Outcome/Impact Case	• Increased rate of yield for major food staples from current <1%/year • # of more farm households have adopted improved varieties, breeds or trees	• Adoption of CGIAR materials with enhanced genetic gains • Reduced smallholders production risk
New OICR2567 - Wheat blast-resistant varieties, research, education in South Asia prevent yield losses of 10 percent, 1.77 million tonnes worth $264 million dollars	Level 1	New Outcome/Impact Case	• # of more farm households have adopted improved varieties, breeds or trees • Increased rate of yield for major food staples from current <1%/year	• Reduce pre- and post-harvest losses, including those caused by climate change • Adoption of CGIAR materials with enhanced genetic gains
New OICR2743 - Uptake and use of gender research methodologies, approaches and tools from the project "GENNOVATE" by agriculture researchers worldwide	Level 1	New Outcome/Impact Case	# of people, of which 50% are women, assisted to exit poverty	• Gender-equitable control of productive assets and resources • Improved capacity of women and young people to participate in decision-making
New OICR2751 - Ethiopia's repeated facing of drought and disease struggles transform into wheat self-sufficiency	Level 2	New Outcome/Impact Case	• Increased rate of yield for major food staples from current <1%/year • # of more farm households have adopted improved varieties, breeds or trees	• Increased resilience of agro-ecosystems and communities, especially those including smallholders • Adoption of CGIAR materials with enhanced genetic gains

Title of Outcome/ Impact Case Report (OICR)	Maturity level	Status	SRF Targets	Sub-IDOs
New OICR2764 - Factors identified that lead to large-scale adoption of sustainable intensification practices in the Indo-Gangetic Plain (Cereal Systems Initiative for South Asia - CSISA)	Level 1	New Outcome/Impact Case	Reduce agriculturally related greenhouse gas emissions compared to business-as-usual scenario 2022	• Closed yield gaps through improved agronomic and animal husbandry practices • Enhanced capacity to deal with climactic risks and extremes (Mitigation and adaptation achieved)

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

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
282 - 28 new pre-breeding wheat lines with high yield potential and climate resilience for Mexico's growing regions.	28 outstanding wheat lines identified with physiological traits conferring high yields and climate resilience for Mexico's growing regions.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Early discovery/successful identification of outstanding wheat lines, with potential impact due to its high yield and climate resilience traits. Said lines have been tested on-station.	Centro Internacional de Mejoramiento de Maíz y Trigo	SAGARPA - Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food/Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (Mexico)	**National** Mexico
283 - Seven bread and five durum wheat lines selected in collaboration with INIFAP are variety release candidates.	Seven bread and five durum wheat lines selected in collaboration with INIFAP are variety release candidates.	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	The new variety release candidates have been tested under conditions intended to resemble those that the potential users will encounter, demonstrating potential performance.	Centro Internacional de Mejoramiento de Maíz y Trigo	• INIFAP - Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias • SAGARPA - Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food/ (Mexico)	**National** Mexico

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
284 - 10 new wheat varieties multiplied in collaboration with seed producers located in strategic growing areas of Mexico.	10 new wheat varieties multiplied in collaboration with Mexican seed producers located in strategic growing areas. The multiplied seed (more than 85 tons) was distributed to farmers in the states of Baja California, Chihuahua, Guanajuato, Hidalgo, Nuevo León, Sinaloa and Sonora.	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV);	The new multiplied wheat varieties comply with the necessary conditions, such as certification, so that end users can use it.	Centro Internacional de Mejoramiento de Maíz y Trigo	CIMMYT	**National** Mexico
285 - 30 CIMMYT advanced lines with high yield potential, good grain quality and disease resistance selected for national evaluation.	30 CIMMYT advanced lines with high yield potential, good grain quality and disease resistance selected for INIFAP's nation-wide wheat yield trials in Mexico.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	30 CIMMYT advanced lines have been selected to complete broader testing under conditions intended to resemble those that the potential users will encounter.	Centro Internacional de Mejoramiento de Maíz y Trigo	• SAGARPA - Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food/ (Mexico) • INIFAP - Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias	**National** Mexico
292 - Implementation of a test to analyze PPO activity (PPO activity controls the darkening of flours and wheat products)	A new high throughput, low cost method, to analyze PPO activity was tested and implemented in the lab. In 2018, all BW lines from breeding program were analyzed for this important trait and	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV);	Breeding lines analyzed already for PPO activity and data available for CIMMYT breeders and partners to start making selection for this trait.	Centro Internacional de Mejoramiento de Maíz y Trigo	USDA - U.S. Department of Agriculture	**Global**

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
	selection for it can be done by the breeders.						
296 - foresight into changing consumption patterns and implications for research	The foresight, ex-ante impact assessment and targeting team conducts research into changing diets and food systems in order to inform CIMMYTs technology development research.Key findings of this research related to South Asia were published Mottaleb, et al. 2018. Changing Food Consumption of Households in Developing Countries: A Bangladesh Case. . DOI: 10.1080/08974438.2017.1402727 and Mottaleb, et al. 2018. Evolving food consumption patterns of rural and urban households in developing countries: A Bangladesh case DOI: 10.1108/BFJ-12-2016-0620	Social Science	Stage 3: available/ ready for uptake (AV);	published papers and an outreach blog	Centro Internacional de Mejoramiento de Maíz y Trigo	CIMMYT	**National** Bangladesh
357 - Incorporating Genome-wide Association Mapping Results into Genomic Prediction Models for Grain Yield and Yield Stability in CIMMYT Spring Bread Wheat	The first time in wheat that GWAS results were incorporated into GS prediction models	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Initial analysis performed and in publication	Centro Internacional de Mejoramiento de Maíz y Trigo	• USAID - U.S. Agency for International Development • KSU - Kansas State University	**Global**

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
358 - APP freely available to farmers which provides crop recommendation	Project using satellite data to help Mexican smallholder farmers grow sugar cane and wheat with optimized crop productivity by identifying factors that cause the yield gap between crop potential and actual field performance. Mobile application aimed at helping Mexican farmers improve crop productivity and stabilize their incomes	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Validation process	Rezatec	• University of Nottingham • CIMMYT	**National** Mexico
463 - Improvement of wheat landraces, collected from farmers, through evaluation and selection.	New synthetic winter wheat varieties were developed using winter durums from Ukraine, Romania and Ae. taushii. The new synthetic wheat contained important sources of resistance to diseases such as rusts. They also demonstrated strong grain mineral content and drought tolerance. The innovation is the techniques used.	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	The synthetic germplasm has been developed, characterized, published and offered to CIMMYT cooperators through IWWIN (International Winter Wheat Improvement Network). The seeds have been deposited to CIMMYT Gene bank and shared with several breeding and research programs. The new varieties are now available through here :http://www.iwwip.org/Nursery	Centro Internacional de Mejoramiento de Maíz y Trigo	• ICARDA • ARIA - Afghanistan Research Institute of Agriculture • DARI - Dryland Agricultural Research Institute • AARI - Aegean Agricultural Research Institute • BDIARI / BDUTAE - Bahri Dagdas International Agricultural	**Regional** Central Asia

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
						Research Institute	
464 - Development and utilization of primary winter synthetics.	New winter and facultative wheat varieties developed by IWWIP(Turkey-CIMMYT-ICARDA)for irrigated and semi-arid environments and it has been made available to public and private breeding and research programs globally	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV);	The seeds of the elite lines have been distributed through IWWIP international nurseries framework and are available via the website (see evidence link)	Centro Internacional de Mejoramiento de Maíz y Trigo	• UNL - University of Nebraska • ICARDA • BDIARI / BDUTAE - Bahri Dagdas International Agricultural Research Institute	**Global**
465 - Elite winter wheat lines.	New winter and facultative wheat developed by IWWIP (Turkey-CIMMYT-ICARDA) for irrigated and semi-arid environments has been made available to public and private breeding and research programs globally.	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV);	The seeds of the elite lines have been distributed through IWWIP international nurseries framework.	Centro Internacional de Mejoramiento de Maíz y Trigo	• BDIARI / BDUTAE - Bahri Dagdas International Agricultural Research Institute	**Global**

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
						• ICARDA - International Center for Agricultural Research in the Dry Areas	
470 - Village Seed Bank	The project has supported the development of local seed system, through farmer owned seed business. These businesses are critical for ensuring old varieties are replaced with the improved varieties containing the traits necessary for the areas in question. The banks sell quality wheat seed for up to 12 percent less than local markets.	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	It is in piloting stage and as such little evidence exists.	Centro Internacional de Mejoramiento de Maíz y Trigo	NRSP - National Rural Support Programme	**Regional** Southern Asia
495 - Ex-ante analysis to determine potential benefits from BNI-technology	Incorporating Biological Nitrification Inhibition into crops offers the potential of simultaneously increasing Nitrogen use efficiency and reducing nitrous-oxide emissions into the atmosphere, thus reducing the greenhouse gas emission footprint of agricultural production systems. BNI will potentially be available in crop varieties for farmers in 12 to 25 years. The time frame depends	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	The ex-ante impact assessment process is just starting. As the BNI technology is incorporated in key crops, we need to iteratively identify how the technology fits into overall complex agri-food systems, landscapes and farming systems, and finally livelihood strategies in target geographies. This implies zooming in and zooming out.	Centro Internacional de Mejoramiento de Maíz y Trigo	• CIMMYT - • JIRCAS - Japan international research center for agricultural sciences	**Global**

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
	on crop, the environment, management options and the broad socio-economic context, requiring both foresight and ex-ante impact assessment.						
496 - ex-ante impact assessment of wheat blast in south Asia	A spatial mapping and ex ante study regarding the risk and potential spread in South Asia of wheat blast, a mysterious and deadly disease from the Americas that unexpectedly infected wheat in southwestern Bangladesh in 2016, identified 7 million hectares of wheat cropping areas in Bangladesh, India, and Pakistan whose agro-climatic conditions resemble those of the Bangladesh outbreak zone.	Social Science	Stage 3: available/ ready for uptake (AV);	blog post to highlight a new publication	Centro Internacional de Mejoramiento de Maíz y Trigo	• BARI - Bangladesh Agricultural Research Institute • CIMMYT - Centro	**Regional** Southern Asia
497 – Fluctuating Milling Quality in wheat: The Achilles Heel of Cereal Foresight Studies?	One of the expected consequences of climate change is the occurrence of more erratic rainfall patterns. This implies that there will always be production areas that will be confronted with weather conditions that are not conducive to high levels of wheat grain quality (milling quality, processing and end-use quality). The question is, if fluctuating grain quality matters in the long-run for food security and if	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Presentation of preliminary findings at Latin American Cereals Science conference	Centro Internacional de Mejoramiento de Maíz y Trigo	CIMMYT - Centro Internacional de Mejoramiento de Maíz y Trigo	**Global**

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
	fluctuating wheat grain quality could spark a food crisis.						
510 - Precision fertilizer application for smallholders	Precision nutrient management to increase efficiency and reduce drudgery	Production systems and Management practices	Stage 3: available/ ready for uptake (AV);	Advanced stage in India, semi-advanced in Nepal, still in research stage in Bangladesh	Nepal Agricultural Research Council	• ICAR - Indian Council of Agricultural Research • NARC - Nepal Agricultural Research Council • BARI - Bangladesh Agricultural Research Institute	**Regional** Southern Asia
512 - Laser land leveling	Machinery and service provision models for Laser Land Leveling to increase water and energy productivity	Production systems and Management practices	Stage 3: available/ ready for uptake (AV);	Advanced stage of adoption in India, early adoption in Nepal, only research stage in Nepal	Centro Internacional de Mejoramiento de Maíz y Trigo	• ICAR - Indian Council of Agricultural Research • NARC - Nepal Agricultural Research Council • BRRI - Bangladesh Rice Research Institute • BARI - Bangladesh Agricultural	**Regional** Southern Asia

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
						Research Institute	
513 - Integrated weed management (IWM)	IWM complex weed flora in rice, maize, and wheat	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Details are available in annual reports found here: https://csisa.org/annual-reports/	Bangladesh Rice Research Insitute	NARC - Nepal Agricultural Research Council	**Regional** Southern Asia
514 - Yield potential estimation for variable fertilizer rate adjustments	Several on-farm and on-station experiments conducted in collaboration with the National Wheat Research Program and farmers' groups for different production environments showed that wheat yields can be doubled through balanced fertilizer application.	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	On farm and on station experiments have been conducted showing wheat yield improvements of up to double through fertilizer application management	Centro Internacional de Mejoramiento de Maíz y Trigo	NARC - Nepal Agricultural Research Council	**National** Nepal
515 - Precision crop establishment methods for wheat and rice	Risk-reducing agronomy for directly-sown rice (2); NP, BD Zero tillage wheat to boost productivity and profitability while reducing environmental impacts of production in South Asia (4); NP Mechanical transplanting for rice (3); NP Healthy rice seedlings (4); NP, BD Early planting of long-duration wheat varieties for resilience and yield optimization (3); NP, BD Decision rules for timely rice	Production systems and Management practices	Stage 3: available/ ready for uptake (AV);	Details are available in annual reports found here: https://csisa.org/annual-reports/	*Not defined*	• IRRI - International Rice Research Institute • BRRI - Bangladesh Rice Research Institute • BARI - Bangladesh Agricultural Research Institute	**Regional** Southern Asia

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
	transplanting and irrigation management (1); NP, BD					• NARC - Nepal Agricultural Research Council • iDE - International Development Enterprise	
516 - Multiple disease management innovations for maize and wheat	Integrated management of fungal diseases in lentil through agro-climatology and effective fungicides (2); NP, BD Integrated management of stalk rot in maize (1); NP Dry chain management for reducing aflatoxin in maize (1); NP Safe planting windows to avoid wheat blast (2); BD Climate services for disease prediction and management (2); NP, BD (note: includes lentil and wheat) Fungicides for wheat blast (4); BD	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Details are available in annual reports found here: https://csisa.org/annual-reports/	Nepal Agricultural Research Council	• NARC - National Agricultural Research Centre • BARI - Bangladesh Agricultural Research Institute • DAE - Department of Agriculture Extension (Bangladesh) • ICAR - Indian Council of Agricultural Research	**Regional** Southern Asia

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
517 - Scale-appropriate mechanization innovations (Multiple)	Multi-crop planters for the 2-wheel tractor (3); NP Scale-appropriate reaper technologies to address labor bottlenecks at harvest (4); NP, BD Low-cost solar pumps for field crops (2); NP Axial flow pump (4); BD	Production systems and Management practices	Stage 3: available/ ready for uptake (AV);	Details are available in annual reports found here: https://csisa.org/annual-reports/	International Development Enterprise	• iDE - International Development Enterprise • ICAR - Indian Council of Agricultural Research • BARI • BRRI - Bangladesh Rice Research Insitute	**Regional** Southern Asia
518 - Precision fertilizer broadcasting for increasing efficiency and reducing drudgery	Prime Minister's Agriculture Modernization Project (PMAMP) units and District Agriculture Development Offices in the Terai have included the precision spreader in their machinery subsidy programs, allowing farmers to procure the equipment at a reduced price from local suppliers.	Production systems and Management practices	Stage 3: available/ ready for uptake (AV);	Precision spreader units have been made available at a reduced price from local suppliers.	Centro Internacional de Mejoramiento de Maíz y Trigo	• MOAD - Ministry of Agricultural Development (Nepal) • NARC - Nepal Agricultural Research Council	**National** Nepal
	The mini tiller is a low-cost option for rural traction has been implemented and used through a group-based service provision model to recoup costs and share the technology across the village	Production systems and Management practices	Stage 3: available/ ready for uptake (AV);	Details are available in annual reports found here: https://csisa.org/annual-reports/	Centro Internacional de Mejoramiento de Maíz y Trigo	NARC - Nepal Agricultural Research Council	**Sub-national** Nepal

Title of innovation	Description of the innovation	Innovation type	Stage of innovation	Description of Stage reached	Lead organization	Top five contributing partners	Geographic Scope
521 - Mini-tillers for cropping systems productivity in Nepal							
539 - The Scaling Scan	The Scaling Scan helps an individual analyze, reflect on, and sharpen one's scaling ambition and approach through a series of questions and prompts. It focuses on ten scaling 'ingredients' that need to be considered (e.g. knowledge and skills, public sector governance, awareness and demand) to reach the desired outcome.	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV);	The tool "The Scaling Scan" is available and ready for uptake by CIMMYT staff, partners and general public. First, it was proofed and then it was piloted in different projects.	Centro Internacional de Mejoramiento de Maíz y Trigo	SNV - Netherlands Development Organisation	**Global**

Varietal releases derived from breeding research by CIMMYT, 2018*

***As of April 2019**

Bread wheat-Spring (13 Varieties)

Afghanistan	Garmser-18
Bolivia	Yotau
Ethiopia	Deka
India	HI1612, DBW168
Iran	Sarang, Talaei, Tirgan
Mexico	Noheli F2018, Noroeste F2018, RSI Glenn
Paraguay	CANINDE 31, ITAPUA 90
Sudan	Ageeb, Akasha, Ashri
Turkey	KOC

Bread wheat-Durum (12 Varieties)

Argentina	BONAERENSE INTA CHARITO, DL 101 TC, DL 102 TC, DL 103 TC
Ethiopia	Fetan
Iran	ARAN, Saverz
Mexico	RIO BRAVO C2018
Pakistan	PASTA-2018
Sudan	Argu, Zaidab
Turkey	SUMERLI

Spring Triticale (1 Variety)

Iran	Hashemi

Varietal releases derived from breeding research by ICARDA and the Turkey-CIMMYT-ICARDA winter wheat program, 2018*

***As of April 2019**

Bread wheat-Spring (9 Varieties)

Sudan	Al-Shibaik, Amel, Jawahir, Khidaiwi, Salah
Zambia	SISI, Lumbe, Timba, Kakoba,

Durum wheat-Spring (4 Varieties)

Iran	Zahab
Sudan	Basatna, Wadelbur
Uzbekistan	Nafis

Bread wheat-Winter (9 Varieties)

Afghanistan	Solh-18
Azerbaijan	Askaran
Iran	Zarrineh
Turkey	ADALI, HALIS, SEHZADE
Uzbekistan	Buniyodkor, Elomon, Shams

Table 5: Summary of status of Planned Outcomes and Milestones (Sphere of Influence-Control)

FP	Outcome	Outcome Progress	Milestone	Status	Milestone Evidence	Cross-Cutting Markers			
						Gender	Youth	Cap Dev	Climate Change
FP1	FP1 Outcome: 1.8 National and regional policy makers improved policy-making and increased investment based on evidence **CC** Increase capacity of beneficiaries to adopt research outputs	Highlights foresight/targeting studies to inform policy: -wheat blast ex ante analysis S Asia: call for action identifying extent of threat -abiotic stresses (drought) and climate change implications for wheat in Mexico and Ethiopia -monitoring & targeting waterlogging implications Bangladesh -wheat disease monitoring and implications - including modern and mobile tools/surveillance -review of potential of crop modelling in crop research -synergies between WHEAT foresight/targeting and CRP PIM and Big Data	2018 - Targeting incorporates competition for land and spatial dimensions of soil & water degradation	Complete	Published 5 papers 2018 -CC Mexico wheat AFM www.sciencedirect.comspatiotemporal dynamics Bangladesh RSASE www.sciencedirect.com Ethiopia IJCCSM doi.org blast ex ante South Asia PLOS1 doi.org modelling Agronomy www.mdpi.com	N/A	N/A	1	1

	FP1 Outcome: 1.10 Farmers have greater awareness and access to, and increased adoption and adaptation of improved technologies **CC** Increase capacity of beneficiaries to adopt research outputs	Highlights studies to enhance adoption/impact and gender/social-inclusiveness: -DNA fingerprinting at national scale in Ethiopia underscores significant for adoption/impact of WHEAT. -WHEAT Impact assessment strategy developed and pragmatically and strategically operationalized; with various 2018 adoptions studies on sustainable intensification innovations. -reviews of remote sensing opportunities for monitoring adoption dynamics -WHEAT supported gender cross-CRP flagship project (GENNOVATE) brought to completion, with release special issue (Agri-Gender-JGAFS3(1)) and resource materials. -BMZ gender project generated numerous knowledge products & resource materials in 2018 ahead of its closure in 2019. -gender research and mainstreaming position created and recruited in S Asia - incl linkage with CCAFS.	2018 - Adoption and impact studies on technologies- rolling plan based on progress of technologies along the theory of change	Complete	Published 16 papers 2018 8 adoption/impact papers -Ethiopia onlinelibrary.wiley.com -2x Pakistan www.sciencedirect.com dx.doi.org 3x India www.emeraldinsight.comdoi.org onlinelibrary.wiley.com - Bangladesh www.sciencedirect.com - Syria www.sciencedirect.comgender papers -6x GENNOVATE special issue JGAFS agrigender.netagrigender.net agrigender.netagrigender.net agrigender.netagrigender.net -Women ag labour Morocco DiP doi.org -review gendered ag Pakistan WSIF www.sciencedirect.com	1	1	1	1

	FP1 Outcome: 1.9 Last mile provider (extension partners, farmers organizations, community-based organizations, private sector) increased access and promotion of technologies to farmers **CC** Increase capacity of beneficiaries to adopt research outputs	Highlights markets/value chain studies to enhance last mile linkages: - Wheat consumption/production dynamics and opportunities in Bangladesh: studies show changes in wheat consumption and implications for wheat production and varieties. - Wheat value chain development in Africa: Progress in implementing varietal and innovation testing and value chain studies. - Nutritional opportunities WHEAT-AFS: Analysis in various countries using secondary data incl evolving diets and food security implications. Visiting fellow identified but only available in 2019 Q4. Nutrition and food systems task force initiated at CIMMYT in 2019 building on earlier preparatory work in 2018 (science week; Nutrition Learning Initiative).	2018 - Rapid value chain assessments with proper gender lens conducted to identify opportunities and bottlenecks in WHEAT	Complete	Published 7 journal papers in 2018. - 3x W-AFS in Bangladesh: JIFAM doi.org BFJ www.emeraldinsight.com EJDR. doi.org Agricultural information/knowledge networks India - JAEE doi.org Cereal consumption/marketing responses/cereal prices - JADEE doi.org review gender-equitable value chain development guides - DiP doi.org - WTP GM crops Pakistan. GMCF doi.org	1	N/A	1	N/A
FP2	FP2 Outcome: 2.4 Crop researchers world-wide increased use of novel	Novel germplasm is being developed and made available to researchers in the form of pre-	2018 - More partners use IWYP platform for precision phenotyping	Complete	8 PhD students from Mexico, Univ. of Nottingham, Tunisia and Univ. of Barcelona, spent a long term at	0	2	2	2

	germplasm and tools for validation, refinement and development of products Adoption of CGIAR materials with enhanced genetic gains	bred lines, trait-specific source lines and bank accessions. Numerous tools are being developed to manage and utilize data, including software for data analysis and inclusion in breeding selection pipelines. FP2 also identifies haplotypes and markers associated with performance under drought, heat and various biotic stresses (disease tolerances). Several methodologies developed by CIMMYT to measure spike photosynthesis have been validated and shared with users who may apply them in breeding programs. Many capacity development activities enhance the use of FP2 products by researchers worldwide.			the IWYP hub, conducting thesis research. Sixteen Australian (5), United Kingdom (6), China (2), USA (2) and Israeli (1) scientists participated in research at the IWYP hub.				
	FP2 Outcome: 2.5 Breeders develop improved varieties more efficiently through greater access and use of documented germplasm and tools Adoption of CGIAR materials with enhanced genetic gains	Pre-bred materials distributed internationally included 25 new lines of the 6th WYCYT which were grown during the 2017/2018 wheat cycle by 85 collaborators in 39 countries. Other documented germplasm was distributed via ad-hoc seed shipments to WHEAT colleagues and partners.	2018 - Greater number of breeder-ready markers/high value haplotypes (compared to 2016) for prioritized traits identified and validated (under FP2) and	Complete	Marker for high biomass and radiation use efficiency identified from an association mapping panel developed at CIMMYT. Singh (2018, Nature Scientific Reports 8:12527) reported favorable haplotypes for grain yield under heat stress, and for yellow rust resistance, contributed by exotic germplasm	N/A	N/A	2	2

		Several methodologies developed by CIMMYT to measure spike photosynthesis have been validated and shared with users who may apply them in breeding programs.	deployed in CGIAR breeding programs		bank accessions to offspring of crosses with elite lines.				
			2018 - New alleles for heat and drought, other climate change-related traits identified and moved into breeding pipeline	Complete	Several exotic lines in elite background were distributed to WHEAT breeders to serve as sources of drought or heat tolerance, disease resistance, high harvest index, and novel sources for yield adaptive traits. This was achieved via international nurseries and ad-hoc seed shipments to breeders.	N/A	N/A	2	2
FP3	FP3 Outcome: 3.2 Partner breeding teams increased multidisciplinary and multi-institutional collaboration **CC** Enhanced institutional capacity of partner research organizations	Multisite analysis of cooperators' data shows: a # of new lines in International Yield Trials had >5% superior grain yields. Reflects continuous genetic gain in grain yield in combination with other necessary traits and high chance that new, more productive varieties will continue to be released by NARS. Major publication on Moroccan seed system (policy influencing), continuous progress in Rwanda,	2018 - sustainable seed system optimized in 2-3 countries (pilots, with scaling-out potential)	Extended	Delayed in replacement rate % tracking.	1	0	1	0
			2018 - New alleles for heat and drought, other climate change-related traits identified and moved into breeding pipeline	Complete	Multisite analysis of cooperators' data shows: a # of new lines in International Yield Trials had >5% superior grain yields. Reflects continuous genetic gain in grain yield in combination with other necessary traits and high chance that new, more productive varieties will continue to be released by NARS.	N/A	N/A	0	2

		Zambia (IFAD project), Ethiopia (DGGW).							
	FP3 Outcome: 3.3 Partner breeding teams improved breeding processes by adopting new technologies, methodologies, approaches and genetic resources Adoption of CGIAR materials with enhanced genetic gains	>45,000 spring wheat breeding lines genotyped during past five years. Replicate grain yield data available under favorable environment, and for a subset of >4000 lines grain yield under a range of environments, disease resistance, agronomic and quality traits available. Meta-GWAS studies reveal several trait-marker associations and chromosomal regions associated with grain yield and other traits.	2018 - Improved knowledge of genetic basis of climate change adaptation on global scale thru combination of GS, platforms, unified databases	Complete	Data uploaded and accessible	N/A	0	1	2
	FP3 Outcome: 3.6 National regulators of crop variety release improved enabling environment to speeding-up release of improved varieties Reduced smallholders production risk	Progress in Ethiopia, Kenya. 15 spring, 12 durum wheat originating directly from CIMMYT & 8 winter wheat varieties derived from IWWIP released in 12 countries.	2018 - National regulators of variety release and seed supply provide enabling environment to speed up release of improved varieties and farmers' access to quality seed, in 2-3 target countries	Complete	Variety registration list; India permits pre-release seed multiplication	1	0	1	0
	FP3 Outcome: 3.7 Extension partners (universities, national/state/provincial governments) increased	Several value chain- and adoption dynamics-related findings published (S Asia).	2018 - improved, documented understanding of specific wheat seed systems	Extended	NARS cap dev needs assessment delayed.	1	1	1	0

	Access and promotion of adoption of improved varieties to farmers, and increased investment in emerging private sector circumstances Reduced smallholders production risk		(farmer's seed commercial behavior, seed demand and marketing, economics of seed production) / 2-3 NARES identified performance gaps, capacity development needs, to identify, realize relevant cap dev interventions at appropriate levels						
	FP3 Outcome: 3.8 Farmer organizations increased access and promotion of adoption of improved varieties to farmers **CC** Technologies that reduce women`s labor and energy expenditure adopted	Major (compilation) publication, Cereal Foods World; major conferences focused on LAC held Novel approach to identify marker-trait associations related to baking/milling quality traits within a breeding program	2018 - Improve consumer acceptability of high flour extraction rate and whole grain flour	Extended	www.cimmyt.org resources to engage with partners to monitor impact on consumer behavior.	1	0	0	0
	FP3 Outcome: 3.12 Non-and-subsistence farmers adopted improved varieties	International Trials and Nurseries distributed to over 100 countries. Multisite analysis of cooperators' data shows: a # of new lines in International Yield Trials had >5% superior grain yields. Reflects	2018 - greater farmer adoption of released varieties (based on CGIAR research) in specific WHEAT target countries,	Complete	Variety adoption studies in Afghanistan and Ethiopia using fingerprinting technique	1	0	0	1

	Reduce pre- and post-harvest losses, including those caused by climate change	continuous genetic gain in grain yield.	compared to 1994-2014 average						
FP4	FP4 Outcome: 4.4 NARS increased use of participatory approach in system research **CC** Enhanced institutional capacity of partner research organizations	Made progress on approaches to prioritize R4D invests (global), climate smart ag practices targeting and adoption dynamics and service provider business model scaling (S Asia). It does include as well capacity building in farming systems approaches	2018 - 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)	Complete	Peer reviewed publications and project reports under sections 1.2.2 & 1.3.4. Training material available upon request and soon being upload in CIMMYT capdev website	1	0	1	1
	FP4 Outcome: 4.8 Actors in SI increased consideration and integration of gender and social inclusion into policies, processes and practices. **CC** Technologies that reduce women`s labor and energy expenditure adopted	Progress based on GENNOVATE WHEAT report/comparative studies/17 tools & CIMMYT 2017-2018 roll-out of gender mainstreaming training	2018 - 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)	Complete	GENNOVATE publications, CIMMYT Gender Capacity Strengthening Program Roll Out Report, CSISA, MasAgro Productor/Trigo annual reports, FP1/FP4 collaborations	1	1	1	1

			2018 - increased adoption of combinations of SI strategies, technologies in specific target geographies compared to 2016	Extended	ex ante and ex post adoption/outcomes pub/reports for IGP overall, Bihar, Bangladesh (CSISA-MI), MasAgro Productor/Trigo; publications on assessment frameworks, SI outcome indicators. Major scaling achievements of rice crop residue management in NW IGP through adoption of Happy seeder. More than 700,000ha adoption reported hopefully leading to reduce air pollution	1	0	1	1
	FP4 Outcome: 4.9 Smallholder farmers increased their capacity to adopt and adapt SI practices and products (associated with crosscutting sub-IDO). Increased access to productive assets, including natural resources	Improved or updated technologies, technology combinations, better understanding of farmer adoption dynamics and train-the-trainer/service provider, PPP/extension approaches. Lessons learned from farmer decision making support scaling.	2018 - optimisation of cropping systems support adaptation to climate change validated in specific WHEAT target geographies	Complete	Tracking of farmer access to agro-climate information services, initial and sustained adoption (or disadoption) of Conservation Agriculture for Sustainable Intensification (CASI) / CSA practices, via bilateral project progress reports, peer-reviewed publications.	1	0	1	1
	FP4 Outcome: 4.6 Private sector (and public sector)	New, ongoing PPP partnerships sourcing/contract farming,	2018 - better understand scaling up processes in	Complete	Project reports CSISA-MI, MasAgro/PPP, Scaling pilots	1	1	1	1

	increased provision of services to smallholder farmers to increase their ability to adopt SI practices and products **CC** Increase capacity of beneficiaries to adopt research outputs	mechanization & remote sensing service-providers and seed multiplication (FP3.8). New project funder by private miller in Morocco to improve grain quantity and quality through better N management	multi-actor innovation networks, to ensure sustainability of institutional mechanisms, structures		(FP4.4.), multi-CRP Scaling Conference documentation and Scaling expert networks.				
	FP4 Outcome: 4.10 Smallholder farmers adopted and adapted SI practices and products Closed yield gaps through improved agronomic and animal husbandry practices	More W1&2 invested in adoption/impact studies by FP1/FP4. Better understanding of farmer adoption dynamics and train-the-trainer/service provider, PPP/extension approaches. Lessons learned from farmer decision making support piloting.	2018 - Improve consumer acceptability of high flour extraction rate and whole grain flour	Cancelled	This milestone refers to FP3.7	N/A	N/A	N/A	N/A
			2018 - Smart mechanization lessons learned routinely applied in other FP4 projects	Extended	Cross-project learning /CoP workshop documentation, bilateral project reports, peer-reviewed publications. Challenges: No critical mass in some regions, low donor interest	1	1	1	0

Table 6: Numbers of peer-reviewed publications from current reporting period (Sphere of control)

Separate Evidence table with full listing of 178 publications.

	Number	Percent
Peer-Reviewed publications	178	100%
Open Access	92	52%
ISI	144	81%

Table 7: Participants in CapDev Activities

Number of trainees	Female	Male
In short-term programs facilitated by CRP	2,663	15,305
In long-term programs facilitated by CRP	105	54

Degrees awarded in 2018	Female	Male
PhD	11	6
MsC	11	4
Bachelor	1	1

Table 8: Key external partnerships

Please list up to five important partnerships for 2018 for each flagship, using the following table

Lead FP	**Brief description of partnership aims (30 words)**	**List of key partners in partnership. Do not use acronyms.**	**Main area of partnership** dropdown: Research/Delivery/Policy/Capacity Development/Other, please specify _
FP1	DNA extraction; survey analysis & policy engagement	Ethiopian Institute for Agricultural Research, DArT - Diversity Arrays Technology	Research
FP1& 4	Supervising data collection, co-funding, developing the analytical frame	The Nature Conservancy	Policy
FP2	Sabbatical arrangement	Volcani International	Research / Cap Dev
	Biological Nitrification Inhibition (BNI) Consortium Global coordination of and implementation of joint research projects focused on BNI, across crops, cropping systems and scientific disciplines. 3rd symposium held in 2018.	Japan International Research Center for Agricultural Sciences (JIRCAS) is lead coordinator. 3 CGIAR Centers (CIAT, ICRISAT, and CIMMYT), collaborating on BNI research. In 2018, total of 13 members, including Chinese Institute of Soil Science (CAAS), Nanjing Agricultural University, Japanese National Agricultural Research Organization (NARO), Texas A&M University, University of Hohenheim, University of Vienna.	Research
	Methods, tools, data storage genetic discovery, genotypic data linked to new breeding management software	Earlham Institute, James Hutton Institute, Cornell University	Cap Dev
FP3	Agriculture Innovation Project in Pakistan: Deploy seed varieties (multi-crop) and	PARC - Pakistan Agricultural Research Council NARS - National Agricultural Research System, Pakistan AKRSP - Aga Khan Rural support Program	Delivery, Policy

	capacity building, improved agronomic practices		
	National partners, precision phenotyping platforms	BARI - Bangladesh Agricultural Research Institute MDRyT - Ministerio de Desarrollo Rural y Tierras (Bolivia) INIAF - Instituto Nacional de Innovación Agropecuaria y Forestal, Bolivia INRAT - Institut National de Recherche Agronomique de Tunis IRESA - L'Institution de la Recherche et de l'Enseignement Supérieur Agricoles, Tunisia KALRO - Kenya Agricultural and Livestock Research Organization INIA - Instituto Nacional de Investigacion Agropecuaria (Uruguay)	Research, Cap Dev
	High-throughput genotyping and phenotyping projects partners	USDA, Cornell University, InterTek, TraitGenetics	Research
	4th Latin American Cereals Conference (LACC; 20 participants, 46 countries), & 13th International Gluten Workshop	International Association for Cereal Science and Technology (ICC)	Cap Dev
FP4	Catalyze and initiate an innovation platform in Purnea, Madhubani, Rangpur and Rajshahi districts, incorporating farmers, researchers, change agents representing key components of the principal value chains	BAU - Bihar Agriculture University ICAR - Indian Council of Agricultural Research UBKV - Uttar Banga Krishi Viswavidyalaya/North Bengal Agriculture Univ BARI - Bangladesh Agricultural Research Institute RDRS - RDRS Bangladesh NARC - Nepal Agricultural Research Council Saki Bihar	Delivery
	Plan, backstop and process documentation around potentials for scaling of Innovation Platforms	CSIRO	Delivery

FP2-4	Expert Working Groups participation; identify gaps, priorities for wheat research coordination across borders	G20 Wheat Initiative	

Table 9: Internal Cross-CGIAR Collaborations

Brief description of the collaboration	**Name(s) of collaborating Platform(s), Platform(s) or Center(s)**	**Optional: Value added, in a few words** e.g. scientific or efficiency benefits
Healthier food systems	A4NH, MAIZE	Demand, consumer availability component of R4D on diverse diets
BPAT, Crops to End Hunger Initiative	EiB and other AFS-CRPs	Cross-crop collaboration on breeding research
Approach to foresight	PIM, other CRPs	Build critical mass, deploy scares resources, joint partnering
Climate-smart Agriculture validating technologies, policy	CCAFS, RICE	

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

Studies/learning exercises planned for this year (from POWB)	Status	Type of study or activity	Comments
S1161 - Leasing of agricultural machinery (From Project P835) FP4	On Going	Other	Yield has been increased in average about 30%
S1241 - IMPACT OF RUST RESISTANT VARIETIES DEPLOYED IN TARGET REGIONS (From Project P1371) FP3	On Going	Program evaluation (including project evaluations)	bottle necks could be accurate varietal identification which may affect the adoption studies
S1251 - One new evidence-based study analyzing the negative consequences of climate change on food security in the targeted areas of Turkey, Iran and Morocco developed and disseminated. (From Project P880) FP3FP4	On Going	EPIA: Ex-post Impact assessment (at scale)	*Not defined*
S1261 - Strategies developed for the diversification of local agricultural and food systems through the use of a wider range of locally adapted crops and varieties. (From Project P880) FP3FP4	On Going	Adoption study: Ex-post adoption survey (at scale)	*Not defined*
S1551 - Adoption of wheat using DNA technology in Ethiopia (From Project P858) FP1	On Going	Adoption study: Ex-post adoption survey (at scale)	*Not defined*

Studies/learning exercises planned for this year (from POWB)	Status	Type of study or activity	Comments
S1561 - Adoption of improved wheat technologies (varieties) in Central Asia (Tajikistan, Kyrgyzstan, Uzbekistan) (From Project P1335) FP1	On Going	Adoption study: Ex-post adoption survey (at scale)	*Not defined*
S1591 - Adoption of improved wheat varieties (From Project P1489) FP1	On Going	Adoption study: Ex-post adoption survey (at scale)	*Not defined*
New S2671 - Outcome case study of no-burning management solutions for rice crop residues and zero-till wheat sowing (From Project P1390) FP4	Complete	Quali Outcome Study: Qualitative outcome studies (mainly to substantiate contribution to policy or similar)	The science based evidence generated by CCAFS on happy seeder and SMS technology led to development of the Policy brief. The policy brief helped Govt of India to make investment decisions to address the residue burning issue
New S2672 - CCAFS informed tools and approaches mainstreamed in Indian national progress for targeting and scaling climate smart multi-commodity smallholder farming systems (From Project P1390) FP4	Complete	Quali Outcome Study: Qualitative outcome studies (mainly to substantiate contribution to policy or similar)	Science based approaches and tools for farm level exploration of farm-type specific productive, economical and environmentally sound alternative multi-commodity farming systems were developed and validated through multi-location pilots across the All India Network of Integrated Farming Systems Research of ICAR-Indian Institute of Farming Systems Research using evidence base generated by CCAFS and Wheat Agri-Food Systems by CIMMYT, ICAR, & Wageningen University. This has not only led to better targeting the farming systems for smallholders but also the science evidence, learning and enhanced capacity of researchers helping in achieving Government of India's mission of doubling farmers income in a sustainable way.
New S2695 - Publication from FP1 (From Project P1344) FP1	Complete	Adoption study: Ex-post adoption survey (at scale)	Research from developing across South Asia, Latin America and Africa

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

Not applicable. Tracking of 2014/15 Evaluations closed.

Table 12: Examples of W1/2 Use in this reporting period (2018)

	Strategic, longer-term research, seed invests	**Rapid response (incl flexibility)**	**Cross-Portfolio, -CRP learning for impact**	**CRP Gov. & Mgmt.**
FP1 See pp 5-6	Rural transformation and evolving food dietary patterns in South Asia Ex ante impact assessment Biological Nitrification Inhibition (ongoing) Updated impact assessment (IA) strategy, synthesis of IA to date Position paper on political economy in cereal based Agri-food Systems (ongoing)	Ex-ante impact assessment of a new blast resistant wheat in Bangladesh	(w/FP3) Manuscript on wheat mega- environments under climate change scenarios in 2030 and 2050 for Mexico; on impact of climate change in CWANA and heat adapted wheat germplasm Framework for monitoring gender integration in portfolio; learning accountability system and reference material on gender	WHEAT-ISC WHEAT-MC SMB CRPs Rep support CGIAR CoP participation
FP2 See pp 6-7	data migration, curation support, software training for adoption and use of an enterprise breeding system and associated tools for wheat scientists HeDWIC resource mobilization, research plan updated		High throughput phenotyping methods developed and implemented Gene editing capacity established Report on top three interventions focused on maximizing the utility of existing germplasm resource data for breeding gain	
FP3 See pp 7-8	IWIN cooperators receive GCIAR wheat germplasm Lines with high yield potential and high biomass used in crossing programs Elite durum wheats available to cooperators for crossing and to NARS for release	Wheat blast, rusts resistance breeding, 3 associated phenotyping platforms	Co-funding with NARS: Precision phenotyping platforms (Morocco, Uruguay) Pests/diseases: Novel diversity for resistance / tolerance into elite lines	
FP4 See p.8 & 10	high impact publications on meta-data analysis of Conservation Agriculture / Climate-smart Agriculture in wheat systems, S Asia, contributing to multiple sustainable development objectives, smallholder precision nutrient management tools and techniques Scaling Tool developed, scaling mainstreamed into FP4 projects (ongoing)		Scalable smallholder precision input management technologies, tools, techniques, strategies developed, adapted Geospatial, remote sensing: Spatial framework, methods and tools, peer-reviewed publications Provided state of the art support and training for the use of UAV in South Asia for nutrient, water management and crop residue burning assessment	

Table 13: CRP Financial Report

	Planned budget 2018			Actual expenditure 2018*			Difference			Comments
	W1/2	W3/bilateral	Total	W1/2	W3/bilateral	Total	W1/2	W3/bilateral	Total	
FP1	1,428	1,806	3,234	1,786	1,780	3,566	-358	26	-332	
FP2	2,595	5,160	7,755	2,200	6,380	8,580	395	-1,220	-825	
FP3	6,913	9,967	16,880	5,674	11,254	16,928	1,239	-1,287	-1,157	
FP4	1,467	12,449	13,916	1,976	8,969	10,945	-509	3,480	2,971	
any other main program planned budget outside FPs (if relevant)	1,840		1,840							Incorporated per FP under actual expenditure
CRP Management & Support Cost	1,361		1,361	1,209		1,209	1,209		1,209	
Less Collab Costs		-1,000	-1,000		-956	-956		-44	-44	
CRP Total	15,604	**28,382**	**43,986**	**12,845**	**27,418**	**40,263**	**1,976**	**955**	**1,822**	Closing balance of **3,599M** reported, as actual 2018 W1&2 new income (13,004M) surpassed WHEAT-MC endorsed budget (12,325M). SC-endorsed 2018 'indicative' W1&2 had been 14,5M.

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