2020 ANNUAL REPORT

Impact highlights from the CGIAR Research Program on Wheat

CGIAR

RESEARCH PROGRAM ON Wheat

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

Contents

Message from the Director General, International Maize and Wheat Improvement Center

Dear friends, supporters and stakeholders of the CGIAR Research Program on Wheat.

The year 2020, which this report highlights, will be remembered first and foremost for the tragic and destructive global COVID-19 pandemic. This crisis not only destroyed lives and economies but exposed the enormous vulnerability of our food system. More than ever, we realize the urgent need for actionable science-based solutions for food systems that deliver affordable, sufficient, and healthy diets produced within planetary boundaries. The dedication and resilience of the scientists, field and lab workers and supportive community of the CGIAR Research Program on Wheat (WHEAT) has allowed us to make important advances toward that vision.

CIMMYT MR
International Maize and Wheat Improvement Center

As the COVID-19 pandemic caused global labor shortages, WHEAT and partners delivered socially- and environmentally-friendly farm mechanization solutions to help smallholder farmers avoid crop losses and to support resilient crop production systems.

Thanks to long-standing partnerships and open exchange of information and materials, WHEAT supported the release of 63 CGIAR-derived high-yielding and climate-resilient wheat varieties in 2020, boosting farmer resilience and income throughout the wheat-growing world. Improved seeds go hand-in-hand with sustainable farming practices. As this report highlights, policymakers are taking note. WHEAT has made a consistent and impactful case for conservation agricultural practices – such as no-till farming and accessible mechanization – thus creating a triple win for farmer incomes, natural resource conservation and human health in the Indo-Gangetic Plains. As they enter their final year in 2021, it is clear that CGIAR Research Programs represent a model for scientific collaboration on global and cross-cutting issues, and for partnerships that deliver tangible science-based impact. The achievements of these programs offer lessons that we must build on as we transition toward a more impactful, dynamic, connected, and integrated One CGIAR.

I am proud of the role of the International Maize and Wheat Improvement Center as the lead Center for the CGIAR Research Programs on Wheat and Maize. I invite you to read this report for more stories of WHEAT's collaborative success and impact in farmers' fields. I look forward to continuing our joint work towards resilient and renewed agri-food systems that are strong in the face of current and future crises.

Martin Kropff
Director General

CIMMYT is the lead center for the CGIAR Research Program on WHEAT

Message from the WHEAT Director

As my first message to you as Director of the CGIAR Research Program on Wheat (WHEAT), I am thrilled to present highlighted impacts from WHEAT's research in 2020.

In 2020, the COVID-19 crisis devastated communities, economies, and livelihoods, especially of the world's most vulnerable populations. At the same time, climate change continued to threaten wheat systems around the world. Under unprecedented challenges, WHEAT scientists and partners responded swiftly, generating new research evidence, forming new global partnerships, and improving access to conservation agriculture and farm mechanization technologies.

This web-based report focuses on some of the major impacts the program has had on sustainable intensification, gender and social inclusion, and technological innovations for more productive wheat-based farming. Although they are reported for 2020, these impacts reflect years of dedicated science and strong collaborative relationships with partners. They range from income-generating and pollution-cutting farm mechanization solutions to large-scale adoption of conservation agriculture and nutrient-efficient practices to help wheat farmers sustainably improve yield and reduce agriculture's environmental footprint.

In parallel, WHEAT scientists and partners including the International Center for Agricultural Research in the Dry Areas (ICARDA) and national agricultural research systems, released 63 new CGIAR-derived wheat varieties globally – including six new high-yielding and nutritious varieties in Nepal, a historic first for the country. I am particularly proud of the advances WHEAT and its partners have made in improving our understanding of and raising awareness around the role of social norms and gender stereotypes in agriculture. Women increasingly have access to improved agricultural technologies and resources, and expanded influence in decision-making. WHEAT wants to make sure these efforts do not go unnoticed.

I'm deeply grateful for our partners in the science, research, policymaking, and funding communities who have allowed us to continue our work in the face of urgent and powerful challenges.

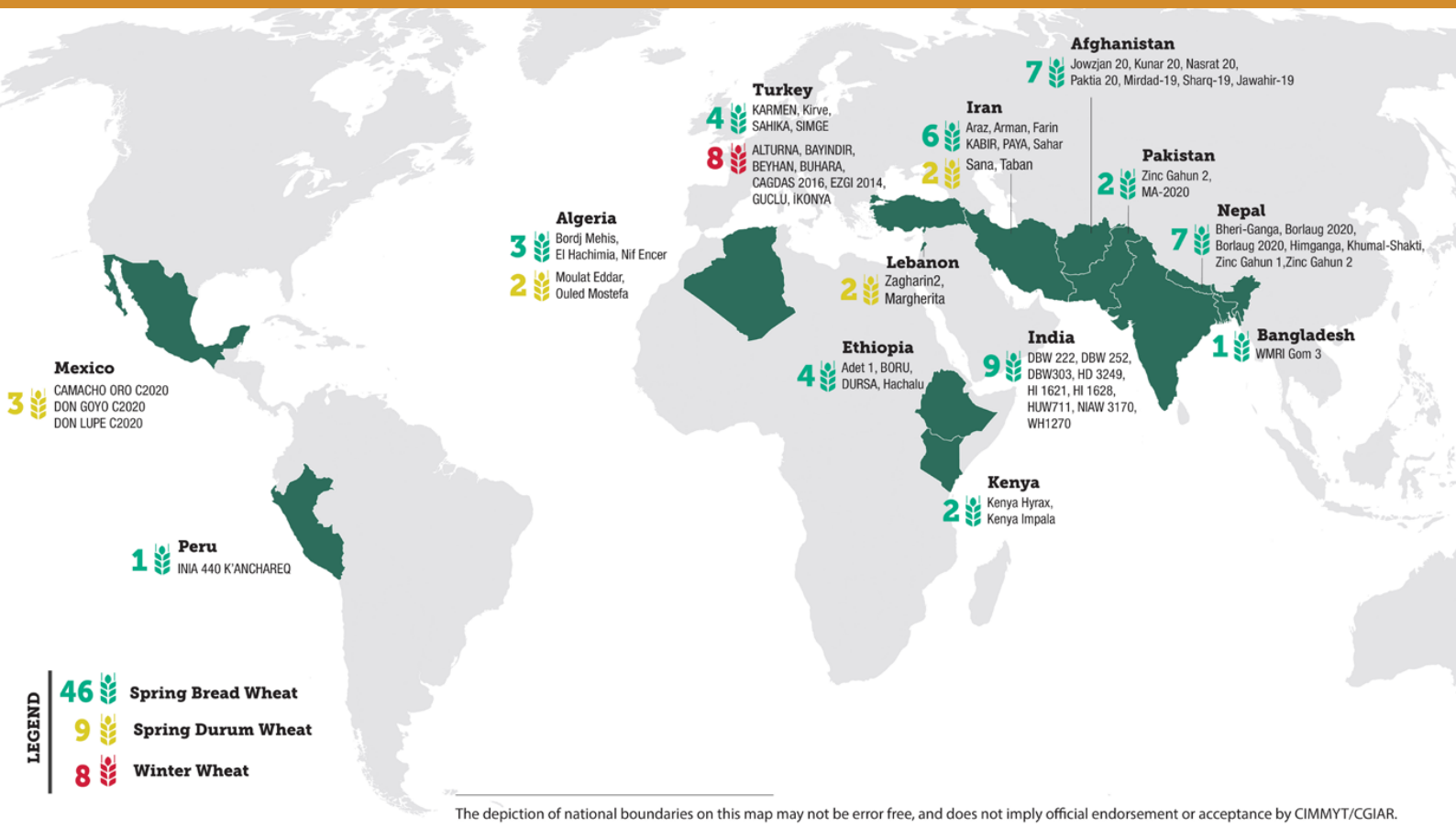
As the transition to One CGIAR progresses towards a more unified governance structure with robust funding and a single compelling mission, WHEAT's legacy, through One CGIAR, will continue to provide more sustainable, resilient and productive seeds

and solutions to the world's wheat farmers. Although 2021 will be the closing year of the CGIAR Research Programs, we look forward to working with our CGIAR colleagues to better deliver our vital poverty and hunger-fighting research through the One CGIAR organizational structure. In particular, we recognize our Windows 1 and 2 supporters from the Governments of Australia, Belgium, Canada, China, France, India, Japan, Korea, Mexico, Netherlands, Norway, Sweden, Switzerland, Turkey, the UK, the USA, and the World Bank.

We hope you enjoy this year's Annual Report as we look back upon our outcomes and achievements in 2020 and set our targets for the future.

Alison Bentley
Director, CGIAR Research Program, CIMMYT

2020 wheat varietal releases worldwide



The depiction of national boundaries on this map may not be error free, and does not imply official endorsement or acceptance by CIMMYT/CGIAR.

2020 wheat varietal releases derived from WHEAT research based on the best information from partners and farmers.

A farmer in the Ara district, in India's Bihar state, applies NPK fertilizer, composed primarily of nitrogen, phosphorus and potassium
Photo: Dakshinamurthy Vedachalam/CIMMYT.

Rice-wheat farmers reap the climate and cost benefits of conservation agriculture

Covering some 13.5 million hectares, the Indo-Gangetic Plains (IGP) cover Bangladesh, India, Nepal and Pakistan and make up South Asia's breadbasket.

Farmers there face multiple challenges: low yields, poor soil fertility, water shortages, and harmful pollution caused by over-fertilization and crop residue-burning. These issues have serious effects on the planet, but more specifically, on those living in the region. Air pollution caused by agricultural burning, for example, has been attributed with some 66,000 deaths a year in India.

In response to these challenges, WHEAT scientists have been working on new ways to make farming more nutrient-, water- and energy-efficient to minimize damage to the environment, but still meet global demand for food.

To curb agricultural burning, researchers have been exploring no-burn alternatives such as conservation agriculture and zero-tillage technologies. In 2020, WHEAT experts and partners found that, compared to conventional tillage practices, sowing wheat directly into just-harvested rice fields without burning or removing straw or other residues will not only reduce pollution in New Delhi and other parts of northern India, but will save over $130 per hectare in farmer expenses, lessen irrigation needs by as much as 25%, and allow early planting of wheat to avoid yield-reducing heat stress.

The authors found that the Happy Seeder – a tractor-mounted implement that opens grooves in the soil, drops in wheat seed and fertilizer and covers the seeded row in one pass – was an especially effective technology. The Happy Seeder helps save farmers' time, money and water, while delivering equal or slightly better yields than conventional tillage.

Meanwhile, in the Eastern Indo-Gangetic Plains, wheat farmers experience even lower yields than their Western IGP counterparts, despite higher rains, better groundwater, and healthier soils. While zero-tillage has been tested in the region using controlled field trials, less research has been carried out in farmers' fields, particularly under diverse climatic conditions.

To address this knowledge gap, a WHEAT-funded study tested the stability and performance of zero-tillage versus conventional-tillage wheat under different growing seasons and climate conditions in farmers' fields across Bihar, India.

The authors found that zero-tillage practices significantly increased wheat yields in three out of four growing seasons and boosted farmers' total household income by 5% on average across all four seasons. The results of the study provide compelling evidence for policymakers to continue supporting and scaling out zero-tillage practices in the region.

While the Happy Seeder has not yet been scaled out in the Eastern Indo-Gangetic Plains, the authors recommended that a slightly smaller and lighter version should be developed and adapted for the smaller plots and lower-horsepower tractors typical of the area.

Tailored fertilizer recommendations

Overuse of fertilizers is a widespread problem in India, leading to higher greenhouse gas emissions, poorer soil health, and increased costs for farmers. Farmers often overuse nitrogen fertilizers and underuse valuable nutrients like sulphur, calcium, magnesium, zinc, and iron.

In 2020, a ground-breaking study led by CIMMYT scientists demonstrated how better nutrient management using digital tools, such as the Nutrient Expert decision support tool, can boost rice and wheat productivity and increase farmers' income while reducing chemical fertilizer use and emissions.

The study found that Nutrient Expert-based recommendations lowered global warming potential by 12-20% in wheat and by around 2.5% in rice, compared to conventional fertilization practices. Over 80% of farmers were also able to increase their crop yields and incomes using the tool.

According to the Intergovernmental Panel on Climate Change (IPCC), agriculture is responsible for almost a quarter of greenhouse gas emissions worldwide. Conservation agriculture methods such as zero-tillage, the Happy Seeder technology, and fertilizer management are vital to achieve more environmentally friendly and sustainable farming.

Funders for this work include WHEAT, the Indian Council of Agricultural Research (ICAR), the Nature Conservancy, the Bill & Melinda Gates Foundation, the United States Agency for International Development (USAID), the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), and CGIAR Fund Donors.

Direct sowing of wheat seed into a recently-harvested rice field using the "Happy Seeder" implement, a cost-effective and eco-friendly alternative to burning rice straw, in northern India. Photo: Love Kumar Singh/BISA.

Improved seed ready to bring better yields to farmers in Bangladesh. Photo: S. pi Mojumder/Drik/CIMMYT.

Delivering genetic gains in wheat around the world

With the world population projected to rise to 9.9 billion by 2050 – over 25% above 2020 levels – demand for food is predicted to increase with it. To meet demand, wheat production alone must increase by 60%, with minimal use of additional land. Meanwhile the impacts of climate change continue to threaten cropping systems and endanger food production.

To meet these challenges, WHEAT scientists have been working tirelessly to increase the rate of genetic gain of this staple food crop. In 2020, researchers in WHEAT's bread wheat-breeding program continued to deliver significant genetic gains to national agricultural research system (NARS) partners around the world by developing high-yielding, disease-resistant wheat germplasm.

Using a set of previous studies for the period from 2007 to 2016, the performance of bread wheat-breeding germplasm developed by the Global Wheat Program (GWP) at the International Maize and Wheat Improvement Center (CIMMYT) was assessed through the extensive analysis of international data sets. The analysis revealed genetic gains ranging from 0.5-1% per annum, which on average represents 46.6 kg/ha/year.

In another long-term study, WHEAT researchers assessed the progress of a historical, 50-year set of CIMMYT varieties across a variety of environments. Using field trials conducted over five crop seasons, the authors estimated genetic gains ranging from 24.7-35.3 kg/ha/year in optimally irrigated environments and 18.1-25.6 kg/ha/year in drought environments.

Better, faster, sustainable breeding

Building on this foundation of high-yielding, disease-resistant varieties, the wheat breeding program is testing faster cycling approaches to shorten the breeding cycle and accelerate genetic gain even further.

In 2020, an ambitious new project, Accelerating Genetic Gains in Maize and Wheat for Improved Livelihoods (AGG), brought together partners in the global science community and in national agricultural research and extension systems to accelerate the development of higher-yielding varieties of maize and wheat.

CIMMYT's historic Toluca station – where CIMMYT scientist Norman Borlaug famously received news of his 1970 Nobel Peace Prize win – was announced as the new testing site for rapid generation advancement and speed breeding in wheat.

At the new Toluca facility, the team has established a new screenhouse facility that will allow breeders to grow wheat year-round, using tools like continuous lighting and temperature control. With an expected cycle time of three months, the facility will allow four crop cycles in a year, a massive improvement when compared to the current 2 crop cycles in-field. This approach will also follow early-yield testing of developed germplasm at targeted locations, thus accelerating germplasm availability for national partners.

The wheat component of the AGG project serves more than 30 million wheat-farming households in Bangladesh, Ethiopia, India, Kenya, Nepal and Pakistan, and will provide national partners with the tools and capacity to implement their own state-of-the-art breeding strategies, including genomic selection.

Funders for this work include the Bill & Melinda Gates Foundation, the United States Agency for International Development (USAID), Indian Council of Agricultural Research (ICAR), Foundation for Food and Agriculture Research (FFAR) and UK's Foreign, Commonwealth & Development Office (FCDO).

Early photo of Toluca station. Photo: Fernando Delgado/CIMMYT.

Women harvest wheat in India.
Photo: J. Cumes/CIMMYT.

Insights on gender norms pave way for more equitable farming

According to the Food and Agriculture Organization (FAO), women represent 43% of the labor force in low and middle-income countries, on average. Despite their significant contributions to agriculture, women tend to have less access to agricultural resources and technologies than men. One major reason for this is gender and social norms which often inhibit women's equality and progress.

Through the GENNOVATE (Enabling Gender Equality in Agricultural and Environmental Innovation) initiative, which is in-part supported by the CGIAR Trust Fund Donors via 11 CGIAR Research Programs, CGIAR scientists have engaged over 7,500 women and men from 137 agricultural communities in 26 countries across the Global South. The initiative has made huge progress in helping development practitioners understand the dynamics of gender norms, power relations, labor-use, and processes for decision-making in access to and control of resources.

In 2020, in a MAIZE-funded study, researchers from lead center CIMMYT built on GENNOVATE findings to explore how women in Nigeria negotiated power dynamics to access improved maize varieties and expand their influence on decision-making.

In India, a provocative study funded by WHEAT challenged stereotypes of men being the sole decision makers in wheat-based farming systems. Using data collected from 12 communities across four Indian states, the authors shed new light on how

women are gradually innovating and influencing decision-making on wheat farms.

The team developed a typology of six strategies – ranging from from quiet and co-performing, to managing and deciding – that women adopt to actively take part in decision-making. The new typology will allow researchers and development partners to better understand empowerment dynamics and women's agency in agriculture.

Direct seeding maize with push row planter in Ramghat, Surkhet, Nepal 2016. Photo: P. Lowe/CIMMYT.

Reducing poverty through gender equality

In Nepal, as part of the Cereal System Initiatives for South Asia (CSISA) project, CIMMYT researchers provided policy recommendations to governments after identifying significant gender gaps in the adoption of agricultural technologies. The authors estimated that when given similar access to production resources, women have a higher probability of adopting mini tillers, which means higher farm yields and profits.

The evidence generated by GENNOVATE and CSISA experts – and expanded on by MAIZE, WHEAT and CGIAR partners – highlights why it is necessary to understand the complex nature of women's empowerment when introducing new agricultural technologies.

Despite making up less than half of the labor force, women are responsible for 60-80% of food production in low- and middle-income countries. Often, official statistics ignore unpaid work – whether in the field, at a home garden or preparing food in the household – thus misrepresenting women's real contribution to agricultural work, production and economies.

According to the FAO, if the world's women farmers had the same access to resources and agricultural financing as men, 150 million people could be lifted out of poverty.

GENNOVATE is funded by the CGIAR Trust Fund Donors, the CGIAR Research Programs, the CGIAR Gender and Agricultural Research Network, the World Bank, the Bill & Melinda Gates Foundation, and the governments of Germany and Mexico. The CSISA study was funded by the United States Agency for International Development (USAID) and Bill & Melinda Gates Foundation.

Contracter operating his combine harvester in wheat field in Boru Lencha village, Hetosa district, Ethiopia. Photo: P. Lowe/CIMMYT.

Farm mechanization helps farmers avoid COVID-19-related crop losses

As the COVID-19 pandemic continues to transform the way the world operates, agricultural production systems are no exception.

Even in countries that have identified the agricultural sector as an essential one, ongoing restrictions on transport and freedom of movement caused disruptions across the value chain — with potentially devastating impact on already fragile food systems in Latin America, sub-Saharan Africa and South Asia.

With farmers around the world struggling to meet the rising costs of hired labor at peak, time-sensitive moments in the production process, socially- and environmentally- friendly agricultural mechanization interventions have never been more important to avoid crop losses and ensure resilient crop production systems.

Through projects like CSISA, Farm Mechanization and Conservation Agriculture for Sustainable Intensification (FACASI) and MasAgro, researchers from WHEAT and its lead center CIMMYT have enabled farmers across Latin America, sub-Saharan Africa and South Asia to access and use technologies such as two-wheel tractors, combine harvesters, crop reapers and direct seeders. Access to these technologies has allowed farmers to sustainably increase yields, reduce labor requirements, and create new pathways for rural women and youth.

In 2020, WHEAT and CIMMYT scientists assessed how the three large projects have scaled service provision models for agricultural mechanization in Bangladesh, Mexico and Zimbabwe. In possibly the first cross-continental assessment of these issues to date, the study gauged the extent to which each initiative fit with the needs of its environment to enable sustained machinery use by farmers at a large scale, while acknowledging the influence of project design on outcomes.

The authors found that each of the projects had made considerable progress towards increasing the adoption of agricultural machinery in their target area. In Bangladesh and Mexico, through valuable geospatial and market data on client segmentation and appropriate cropping systems, mechanization service providers and machinery dealers were able to strengthen their business cases.

In Zimbabwe, CIMMYT and partners worked to strengthen the market for two-wheeled tractors by creating demand among smallholders, developing the capacity of existing vocational training centers, and spurring private sector demand. This was achieved through the long term FACASI project, which wound down in 2020 after strong results.

Warding off catastrophe

In northern India, where 2.4 million farmers grow variations of the rice-wheat cropping rotation, researchers had feared that the COVID-19 lockdown would delay rice sowing and disrupt the fine-tuned cropping system. Worst-case scenarios forecast economic losses of nearly $1.5 billion and an exacerbation of the region's air pollution from the late burning of rice-straw. Fortunately, technologies and solutions that CIMMYT had refined for decades with national partners, including direct-seeding technologies, Happy Seeder, and crop diversification along with policies to promote them, helped stave off the worst effects of the crisis.

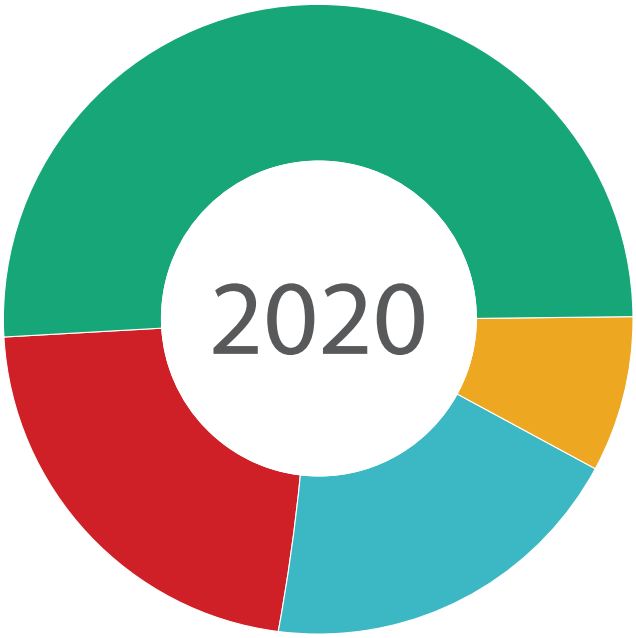
Meanwhile, in the Eastern Indo-Gangetic Plains region of Bangladesh, India, and Nepal, through the Sustainable and Resilient Farming Systems Intensification in the Eastern Gangetic Plains (SRFSI) initiative, researchers reached around 300,000 farmers with 110,000 hectares of land with mechanization solutions. By 2020, around 11,000 Happy Seeders were in use in northwest India, while 7,000 Super Straw management systems for combine harvesters were employed on 0.4 million hectares of farmland. At the same time, service providers and farmers deployed 10,000 multi-crop direct seeding planters to directly seed rice on 1 million ha. These technologies provided a vital safety net during COVID-19 related restrictions and labor shortages.

The COVID-19 labor crisis has highlighted the need for continued investment in agricultural technology and mechanization solutions. A food secure future depends on it.

CSISA receives funding from USAID and the Bill & Melinda Gates Foundation. FACASI was funded by the Australian Centre for International Agricultural Research (ACIAR), as well as the CGIAR Research Programs on Maize and Wheat. MasAgro receives funding from the Inter-American Development Bank (IDB) and Mexico's Secretariat of Agriculture and Rural Development (SADER). The SRFSI project is a collaboration between CIMMYT and the project funder, the ACIAR and includes over 20 partner organizations in focus countries across the Eastern Indo-Gangetic Plains.

A combine harvester equipped with the Super SMS (left) harvests rice while a tractor equipped with the Happy Seeder is used for direct seeding of wheat. Photo: Sonalika Tractors.

Financial summary



$14.1 million in 2020

CRP management	8%
ICARDA	19%
Partners	22%
CIMMYT	51%

*Including 2019 carryover, 2020 budget at $10.5 million

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WHEAT greatly appreciates the contributions of all Window 1 and Window 2 funding partners for their support during Phase 1 through the CGIAR Fund. Without these donors 2012-2019 would not have been possible.

WHEAT is a CGIAR Research Program launched in 2012 and led by the International Maize and Wheat Improvement Center (CIMMYT).

Joining advanced science with field-level research and extension in lower- and middle-income countries, WHEAT works to raise the productivity, production and affordable availability of wheat for 2.5 billion resource-poor consumers who depend on the crop as a staple food.

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Correct citation: WHEAT. 2021. The CGIAR Research Program on Wheat 2020 Annual Report. Mexico City: WHEAT.

Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research
AGG	Accelerating Genetic Gains in Maize and Wheat
BISA	Borlaug Institute for South Asia
CGIAR	Consultative Group on International Agricultural Research
CA	Conservation agriculture
CCAFS	CGIAR research program on Climate Change, Agriculture and Food Security
CIMMYT	International Maize and Wheat Improvement Center
CRP	CGIAR Research Program
CSISA	Cereal Systems Initiative for South Asia
FACASI	Farm Mechanization and Conservation Agriculture for Sustainable Intensification project
FAO	Food and Agricultural Organization of the United Nations
FFAR	Foundation for Food and Agricultural Research
FCDO	Foreign, Commonwealth & Development Office
ha	hectares
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
IDB	Inter-American Development Bank
NARS	National Agricultural Research Systems
USAID	U.S. Agency for International Development
SADER	Secretariat of Agriculture and Rural Development
SRFSI	Sustainable and Resilient Farming Systems Intensification
WHEAT	CGIAR Research Program on Wheat

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International Center for Agricultural Research in the Dry Areas (ICARDA) 2016.
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Annual Report 2016. Mexico, CDMX: CIMMYT-ICARDA.