

ANNUAL REPORT 2018



RESEARCH
PROGRAM ON
Wheat

Message from the WHEAT Director

Collaboration and exchange have a global impact for wheat farmers and consumers

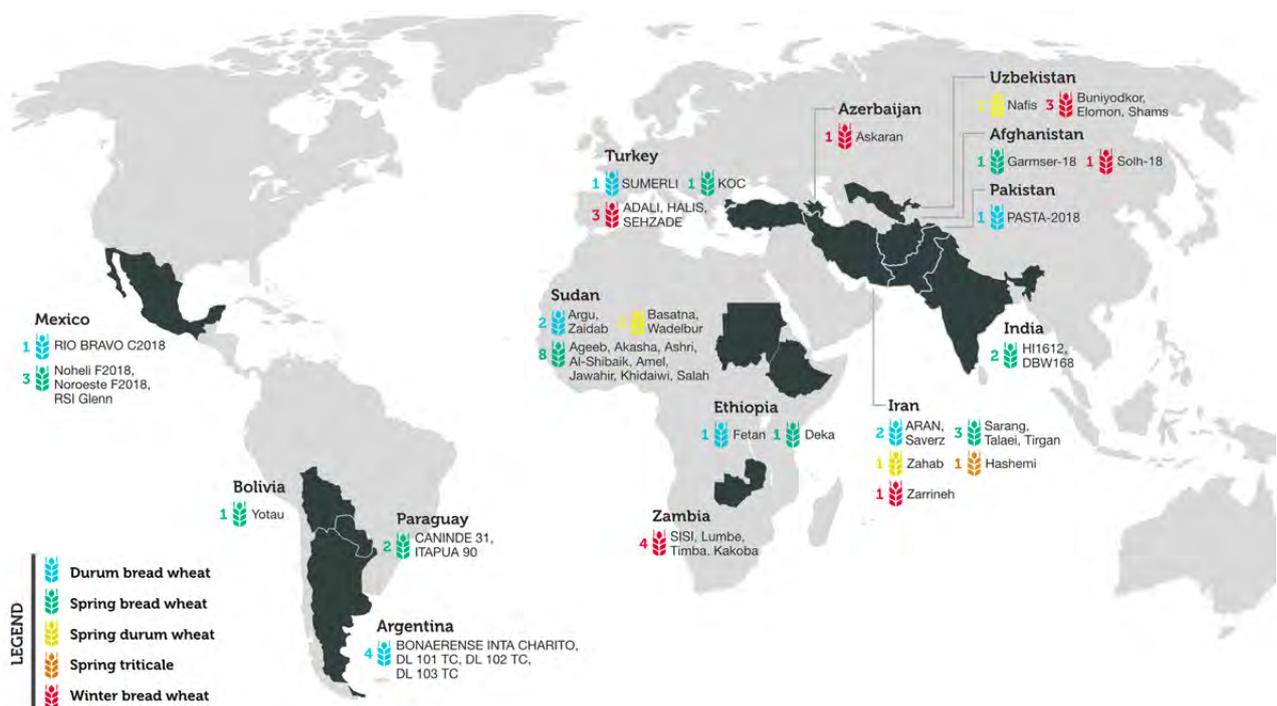
A recent impact study found that [global Semi-Arid Wheat Yield Trials](#), conducted in diverse growing environments in more than 66 countries, improved yields by 1.6% each year over the past 12 years, surpassing previous yield gains by nearly 1%.

Likewise, in China, international breeding research partnerships based on access to foreign germplasm have helped to more than double wheat yields over the last 30 years.



Hans Braun stands with Mexico's Secretary of Agriculture Victor Manuel Villalobos Arámbula. Photo: Ernesto Blancarte/CIMMYT.

International collaboration in wheat breeding research – the heart of the CGIAR Research Program on Wheat (WHEAT) – makes an invaluable contribution to global food security, especially for the 2.5 billion people who depend on wheat for their livelihoods).



2018 wheat varietal releases derived from WHEAT research based on best information from partners and farmers as of December 2018. As of November 2018, there was no CIMMYT/ICARDA presence in Azerbaijan, Iran, Zambia, Paraguay and Argentina.

Joint research with the Ethiopian Institute of Agricultural Research, to deliver improved wheat varieties and innovative disease diagnostics such as [MARPLE](#), are helping Ethiopia meet its goal to be wheat self-sufficient by 2022. Improving technical gender research capacity and following through with gender-focused agricultural policies are crucial to meeting this bold goal.

A revolution in phenotyping -- using state of the art technology to measure traits and breeding performance -- allows researchers to accurately and efficiently identify positive traits, speeding up breeding for greater yield and heat and drought tolerance. The newly-mapped wheat genome promises to drive even faster development of high-yielding, climate- and disease-resilient wheat varieties.

With its national partners, WHEAT released 48 new CGIAR-derived wheat varieties to farmers in 2018, and developed 11 innovations related to farm management practices or social sciences.

I was pleased to meet with a longtime WHEAT and CIMMYT supporter, Mexico's Secretary of Agriculture Victor Manuel Villalobos Arámbula, pictured here, earlier this year in Obregon. I am grateful for the support of all of WHEAT's numerous partners and funders, who make these and many other achievements possible.

In particular, stable CGIAR Window 1 and 2 funding enables WHEAT scientists to develop sustainable solutions that typical project timeframes do not allow for, as well as to improve program level coordination and learning, ensuring impact. The following countries and organizations are Window 1 funders of CGIAR: Australia, the Bill & Melinda Gates Foundation, Belgium, Canada, France, India, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the World Bank. Funding agencies of Australia, the United Kingdom (DFID) and USA (USAID) contribute vital Window 2 funding.



Hans-Joachim Braun

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Contents

- 2 Message from the WHEAT Director
- 4 International exchange and collaboration supports wheat food security in China
- 5 Towards gender equality in wheat farming
- 6 New roles for South Asia's farming women
- 8 High tech "eyes" boost efforts for climate resilient wheat
- 9 WHEAT partnership supports a bold goal in Ethiopia
- 10 Nutritional and health benefits of zinc-biofortified wheat
- 11 Financial summary
- 12 Acronyms and abbreviations



International exchange and collaboration supports wheat food security in China

Thanks in part to international collaboration with CIMMYT and other countries for both wheat germplasm exchange and breeding research, China's wheat production has more than doubled over the last 30 years, according to scientists.

The role of exotic wheat germplasms in wheat breeding and their impact on wheat yield and production in China (ScienceDirect 2018).

The wheat boom from 1982 to 2014 -- a period when the wheat farming area actually declined -- is a perfect demonstration of the value of international collaboration and modern wheat breeding -- the core of WHEAT's mission and work.

The study shows that over the 30-year period, Chinese farmers gradually adopted more modern wheat varieties, with many originating from "exotic," or foreign elite lines from CIMMYT or other countries (19% and 81%, respectively).

As China's wheat breeding programs improved, the use of exotic varieties decreased and farmers began to sow more local wheat varieties. However, breeders in China are increasingly using exotic germplasm to create varieties that combine local and exotic germplasm for higher average yields.

The yield of Chinese germplasm-based varieties alone more than doubled between 1982 and 2014, and the use of exotic germplasm increased annual production by an additional 10.4 million tons over the 30 years.



A farmer examines experimental plot under conservation agriculture, Ningxia, China Photo: Michelle DeFreese/CIMMYT.

In all, the accumulated contribution of exotic germplasm to wheat production in China over these three decades represents about 343 million tons of wheat, or \$70 billion.

The results of this study have important implications for plant breeders, policy makers in China, and international donors, said Victor Kommerell, WHEAT program manager.

"International germplasm exchange is essential for creating new genetic diversity in wheat -- and international breeding research collaboration is very good value for the money," said Kommerell.

A mother and daughter transport grain to market by donkey cart. Photo: Adefris Teklewold/CIMMYT).

Towards gender equality in wheat farming

Gender and innovation processes in wheat-based systems are intertwined: gender norms can constrict women's access and control over agricultural and natural resource management technologies and practices. Myths, such as that "wheat is a man's crop," can exacerbate these social inequalities.

The CGIAR Research Program on Wheat forms part of a multidisciplinary team that is leading the way debunking gender myths and unseating gender norms in wheat-based systems, through [GENNOVATE](#), a project carried out by 11 CGIAR Research Programs.

This global comparative research initiative addresses how gender norms influence men, women and youth to adopt innovative practices and technologies in agriculture and natural resource management.

[A new report](#) - based on the experiences of around 2,500 women and men in wheat farming communities in Afghanistan, Bangladesh, Ethiopia, India, Morocco, Nepal, Pakistan and Uzbekistan – finds that deep-seated gender norms limit women's access to new technologies.

For example, surveyed men in Nepal believe good male farmers are the ones that adopt new technologies and tools and are knowledgeable about fertilizers, diseases, and planting times; while good female farmers plant, weed and nurture crops – in addition to their household responsibilities.

The authors propose gender-based approaches to agricultural innovation: working with progressive opinion leaders, developing and testing agricultural extension arrangements that cater to women as well as men, and supporting female-household heads to open space for other women in their communities.

Findings from this project show that equal opportunity enables innovation and economic development, especially in agriculture.



A farmer harvests wheat in Bangladesh Photo: T. Krupnik/CIMMYT.



In the village of Nalma, Lamjung District, Nepal, most of the adult male population has gone abroad for work. (Photo: Mokhammad Edliadi/CIFOR)

New roles for South Asia's farming women

Strong male out-migration in parts of South Asia, together with efforts to promote equality through social education, have fueled a rise in innovative farming – and agricultural decision making - by women in the region.

The feminizing face of wheat farming in South Asia

In wheat systems throughout South Asia, the gender myth that “wheat is a man’s crop” is still pervasive. To debunk this myth, the International Maize and Wheat Improvement Center (CIMMYT) is combatting stereotypical norms of women in agriculture through GENNOVATE, a project carried out by 11 CGIAR Research Programs. Led by CIMMYT, this global comparative research initiative strives to address the questions of how gender norms influence men, women and youth to adopt innovative practices and technologies in agriculture and natural resource management.

Surprisingly, there was little knowledge and little literature on the intersection of wheat farming and gender before 2013. What was peculiar about the narrative of women wheat farmers in South

Asia was that they were described – by rural advisory services, research organizations and even farmers themselves – as if they had never set foot in a field. On the ground, however, the local reality has long been different. Women, typically from particular castes and income groups, are involved in field operations.

South Asia is experiencing a rise in innovative undertakings by women in agriculture. This change, fueled by strong male outmigration in some locations, has been promoted by equality narratives created through social and women’s movements, NGOs and education. They have all contributed to strengthen women’s desire to have a voice in decision-making. “The face of agriculture in South Asia, particularly wheat farming, is feminizing,” says Cathy Rozel Farnworth. She is a social inclusion, gender and agriculture expert working with CIMMYT’s Gender Research Unit to analyze interactions between changing gender norms and agricultural innovation.

This shift was one of the findings in a series of comparative studies conducted through GENNOVATE in three research hotspots in South Asia: Bangladesh, India and Nepal. Farnworth and co-authors from the region, CIMMYT and Glasgow Caledonian University analyzed the similarities and distinctions in each country.

Shifting rules

In Nepal, women are traditionally seen as destitute and far from equals in the farming community. However, migration of men to urban areas and to other countries has given way to more opportunities in agriculture for women in rural communities. “This translates to a fundamental change in the social structure of communities and the roles of men and women, due to the absence of men,” says Farnworth. Women in the community are increasingly taking on the challenging managerial roles that men once occupied.

While women in Nepal support themselves and their families, they rarely have institutional support from rural advisory services, for example, training on new wheat technologies. On occasion, support comes from individual male extension workers, and women report that NGOs have been critical to building their sense of empowerment and entitlement. Learning networks between women farmers are also important. Overall, the gender myth that “wheat is a man’s crop” is shifting in Nepal, but extension services, researchers, the private sector and others need to catch up quickly with this new reality to help provide women with adequate support.

Wheat is also increasingly becoming a [women’s crop in India](#), despite limited institutional support and neglect. In some locations, women are responding to male outmigration not only by increasing their work in the field, but also taking key decisions, for example on hiring labor and machinery. Some women are also driving machinery themselves. In other locations, women, though not involved in fieldwork, are trying to strengthen their participation in decision-making around wheat technologies. They have an understandable interest in what happens on the farm and in how investments will impact family income. Overall, the GENNOVATE data shows that, “Women are limited by, working with and increasingly renegotiating gender and caste identities,” says Farnworth.

In [Bangladesh](#), a women-only agricultural organization dominated by the Santal indigenous community is strongly innovating in wheat. Interestingly, the organization is drawing in and supporting low-income Muslim women innovators as well. This case study is particularly valuable in relation to achieving [Sustainable Development Goals](#) because it shows that even though Santal women are truly

“left behind” in Bangladesh, very small institutional modifications have enabled them to take charge of the organization and inspire a whole community.

Taking decisions and innovating

The driving force surrounding these cases in South Asia is the gender equality narrative. The narrative is not driven by men or external partners; rather, it is being transformed by women from within. Women have been long working in the fields; they have always been part of the wheat story. Now many women are demonstrably taking more decisions about wheat, giving them more control over their own lives and households.

GENNOVATE researchers are now looking for ways to work with women themselves, with their partners, with rural advisory sectors, the private sector, community leaders and others to address the demand for technological advances to improve

their wheat harvest, including machinery. The starting point is that women need to be seen as capable farmers. Partners need to get on board and start working the new realities of “who does what,” “who decides” and “who benefits,” rather than continue subscribing to old myths. Rural women farmers have critical interests in wheat, whether they farm in the field or not. Women want and are seeking inclusion. Women are collectively expressing, “We have the right to be interested, and participate in innovating around wheat,” Farnworth states.

The comparative studies are available for download:

[CHALLENGING GENDER MYTHS: Promoting inclusive wheat and maize research for development in Nepal.](#)

[LEAVING NO ONE BEHIND: Supporting women, poor people, and indigenous people in wheat-maize innovations in Bangladesh.](#)

[STRENGTHENING WOMEN IN WHEAT FARMING IN INDIA: Old challenges, new realities, new opportunities.](#)



Women use a mini-tiller for direct seeding in Ramghat, Surkhet, Nepal. Photo: P. Lowe/CIMMYT.



"This is a very hot place," said Pakistani farmer Sadia Ijaz (left). "And in this area, the new Pakistan-13 variety has more capacity to tolerate heat than other varieties." Photo: Peter Lowe/CIMMYT.

High tech "eyes"

boost efforts for climate resilient wheat

WHEAT researchers are taking advantage of the most recent advances in remote sensing, genomics and bio-informatics to collect information about wheat traits at an unprecedented level of detail and precision, measuring traits such as plant development and architecture, radiation use efficiency, root length, photosynthesis and biomass productivity.

Digital and cutting edge tools such as spectroscopy, image analysis, robotics, drones and satellites are collecting these data on hundreds to thousands of plants each day.

Known as phenotyping, this approach permits an enhanced understanding of a crops' physiology to improve traits -- such more vigorous root systems and improved photosynthesis and translocation of carbohydrates in the stem -- that increase tolerance to heat and drought, and help to create plant types tailored to future climates.

The Heat and Drought Wheat Improvement Consortium (HeDWIC) is one initiative that is

capitalizing on these advanced methods. The consortium brings together wheat researchers from around the globe in the common mission to produce climate-resilient varieties -- combining genetic diversity with physiological and molecular breeding and bio-informatic technologies.

The approach already has proof of concept in Pakistan, a wheat powerhouse struggling with increased heat and drought. Over the past six years, breeders from CGIAR and the Pakistan Agricultural Research Council developed and released three widely adopted heat and drought-tolerant wheat lines: Kohat-17, Borlaug 2016 and Pakistan

2013. Pakistan-13, a drought and heat tolerant variety that is also resistant to yellow and leaf rust, is the biggest success story. Since its release, an estimated 9,120 tons of Pakistan-13 seed went to farmers, meaning that 93,860 farmers (based on the FAO estimate of 2 acres per farmer) have switched to the new variety.

In 2018 alone, it was planted on an estimated 40,000 hectares. In an environment that is expected to become hotter, dryer, and more volatile, wheat varieties must keep up. WHEAT partnerships such as HeDWIC offer hope to meet this urgent food security challenge.

Wheat Partnership supports a bold goal in Ethiopia

In 2018, the Government of Ethiopia announced a goal to be wheat self-sufficient by 2020, a remarkable ambition.

A long-standing collaboration between International Maize and Wheat Improvement Center (CIMMYT), the International Center for Agricultural Research in the Dry Areas (ICARDA) – both partners of the CGIAR Research Program on Wheat -- with the Ethiopian Institute of Agricultural Research (EIAR) has led to a steady rise in wheat production, productivity and varietal turnover that makes this goal a possibility.

After a rust epidemic in 2009, the CGIAR Research Program on Wheat supported the promotion and widespread availability of improved, rust-resistant varieties that led to rapid wheat variety replacement among Ethiopian farmers from 2009 to 2014. A study shows that farmer net income grew over this period from 4,320 to 5,339 Birr per hectare, despite rising costs of agricultural inputs.

In November 2018, CIMMYT and EIAR collaborated on a workshop to set out a “road map” for self-sufficiency. Investments in soil health, increased mechanization, and improved, rust-resistant seeds were noted as priorities. A revolutionary tool to rapidly diagnose rust diseases in farmers’ fields, the MARPLE portable rust testing lab, is another game-changer for the country’s production.



Ethiopian Farmer Gashu Lema harvests improved variety "Kubsa" wheat in his own field. Photo: (Peter Lowe/CIMMYT).

WHEAT-supported research on gender in wheat production found that gender equality is another crucial factor. Women head a quarter of rural households in Ethiopia. However, faced with low or no wages, limited access to credit and constrained access to land and other resources, they produce 23% less per hectare than men. In addition, women in male-headed households are often excluded from community power structures, extension services and technical programs.

The Ethiopian government has taken great strides towards recognizing the important role of women in agricultural productivity. These efforts must continue, a CIMMYT report argues, including improving technical gender research capacity and implementing existing gender-focused policies, if the country is to meet its bold goal.



Left: Harvesting wheat by hand in Pakistan: Photo: A. Yaqub/CIMMYT. Center: An Ecuadorian farmer holds a spike of wheat. Photo: Nathan Russell/CIMMYT). Right: Grain of INIAP Vivar 2010. Photo: Nathan Russell/CIMMYT.



A Bangladeshi woman makes roti.
Photo: (S. Mojumder/Drik/CIMMYT).

Nutritional and health benefits of zinc-biofortified wheat

A [2018 study](#) supported by HarvestPlus shows that when vulnerable young children in India consume foods with wheat-enriched zinc, the number of days they spend sick with pneumonia and vomiting significantly diminishes. Globally, more than 17% of humans, largely across Africa and Asia, lack zinc in their diets, a factor responsible for the deaths of more than 400,000 young children each year.

An estimated 26% of India's population lacks adequate micronutrients in their diets. Developed through biofortification — the breeding of crop varieties whose grain features higher levels of micronutrients — high-zinc wheat can help address micronutrient deficiencies.

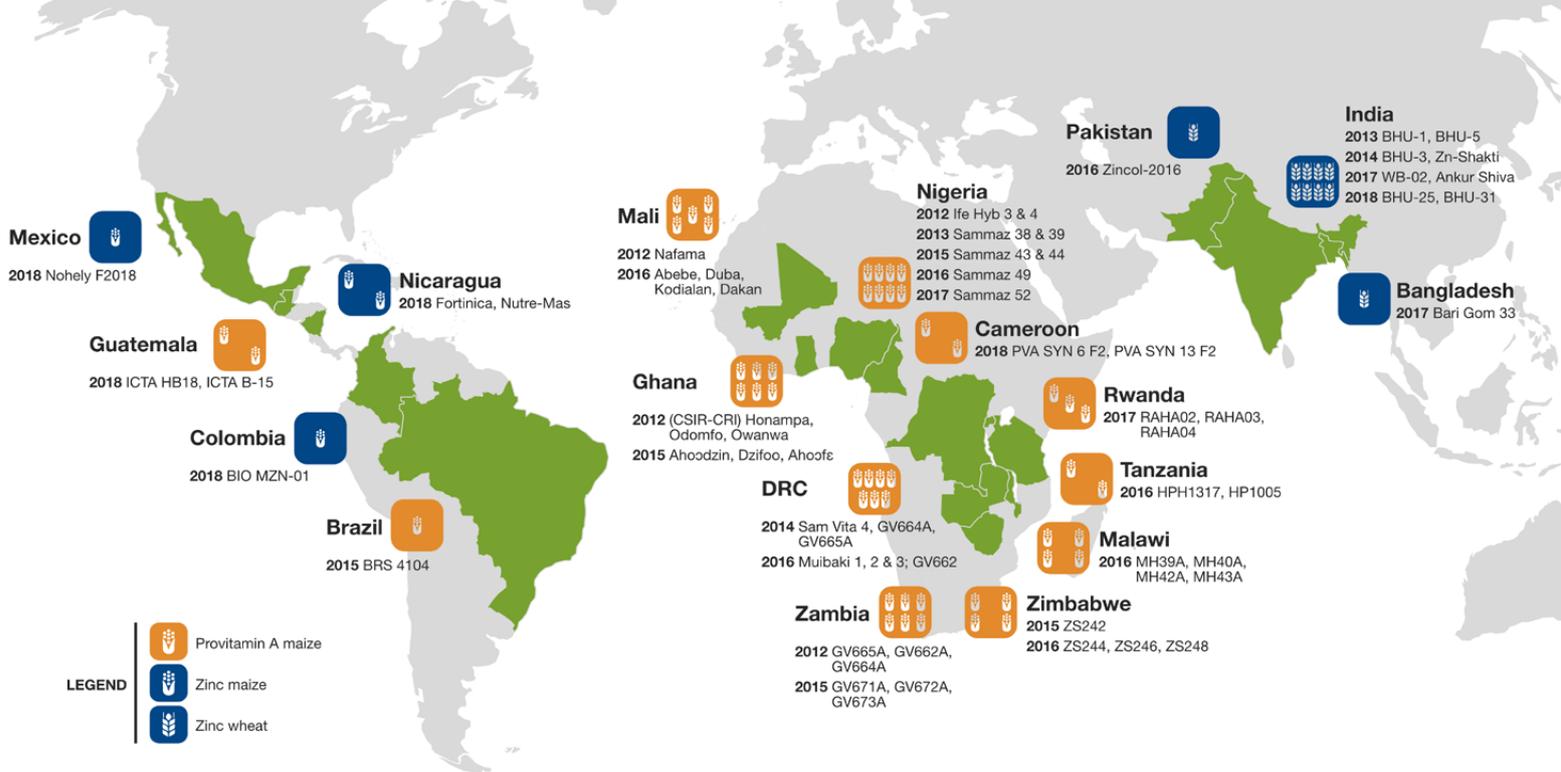
The results of the study, which took place over six months, confirm zinc-enhanced wheat's potential to improve the diets and health of disadvantaged groups who consume wheat-based foods, but the authors conclude that longer-term studies are needed.

In a [second set of findings](#), a team of international scientists analyzed zinc concentrations in the grain of 330 bread wheat lines across diverse environments in India and Mexico. This endeavor uncovered 39 new molecular markers associated with the trait, as well as two wheat genome segments that carry important genes for zinc uptake, translocation, and storage in wheat.

“This work will expedite breeding for higher zinc through use of [hotspot](#) genome regions and molecular markers,” said Velu Govindan, wheat breeder at CIMMYT and first author of the report.

This research advances efforts to make selection for zinc a standard feature of CIMMYT wheat breeding.

“Because varieties derived from CIMMYT breeding are grown on nearly half the world's wheat lands, mainstreaming high zinc in breeding programs could improve the micronutrient nutrition of millions,” said Govindan.



Farmer and consumer interest has grown for some 60 maize and wheat varieties whose grain features enhanced levels of the essential micronutrients zinc and provitamin A, developed and promoted through collaborations of CIMMYT, HarvestPlus, and partners in 19 countries of Africa, Asia, and Latin America over the last 7 years. All were developed using conventional cross-breeding (Map: Sam Storr/CIMMYT).

Financial summary

\$13,004,229
total funding:

18% CRP management
53% CIMMYT Research
19% ICARDA Research
10% Partners



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 2012-2018 would not have been possible.

Joining advanced science with field-level research and extension in lower- and middle-income countries, the Agri-Food Systems CGIAR Research Program on Wheat (WHEAT) works with public and private organizations worldwide to raise the productivity, production and affordable availability of wheat for 2.5 billion resource-poor producers and consumers who depend on the crop as a staple food. WHEAT is led by the International Maize and Wheat Improvement Center (CIMMYT), with the International Center for Agricultural Research in the Dry Areas (ICARDA) as a primary research partner. Funding for WHEAT comes from CGIAR and national governments, foundations, development banks and other public and private agencies, in particular the Australian Centre for International Agricultural Research (ACIAR), the UK Department for International Development (DFID) and the United States Agency for International Development (USAID).



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Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research	IPRI	International Food Policy Research Institute
ANEP	Agriculture, Nutrition and Extension Project	IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
BARI	Bangladesh Agriculture Research Institute	INAT	National Agronomy Institute of Tunisia
BGRI	Borlaug Global Rust Initiative	INIAF	Bolivia National Institute for Innovation in Agriculture and Forestry
BISA	Borlaug Institute for South Asia	ISPC	CGIAR Independent Science and Partnership Council
BMGF	Bill & Melinda Gates Foundation	IWIN	International wheat improvement network
BMZ	Federal Ministry for Economic Cooperation and Development, Germany	IWYP	International Wheat Yield Partnership
BTF	Borlaug Training Foundation	JIRCAS	Japan International Research Center for Agricultural Sciences
CA	Conservation agriculture	KALRO	Kenya Agricultural & Livestock Research Organization
CCAFS	CGIAR research program on Climate Change, Agriculture and Food Security	KASIB	Kazakhstan-Siberian Network on Wheat Improvement
CENEB	Norman E Borlaug Experimental Station	KSU	Kansas State University
CIAT	International Center for Tropical Agriculture International	MC	Management committee
CIMMYT	International Maize and Wheat Improvement Center	MEL	Monitoring, Evaluation, and Learning
CRP	CGIAR Research Program	PEP	Partnership for Economic Policy
CSISA	Cereal Systems Initiative for South Asia	PIM	CGIAR Research Program on Policies, Institutes and Markets
DARtseq	Diversity Arrays Technology	R4D	Research for development
DGGW	Delivering Genetic Gains in Wheat	SAGA	Genetic Analysis Service for Agriculture
DFID	Department for International Development, UK	SAGARPA	Mexico's Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food
EIAR	Ethiopian Institute of Agricultural Research	SARD-SC	Support to Agricultural Research for Development on Strategic Commodities of the African Development Bank
FACASI	Farm Mechanization and Conservation Agriculture for Sustainable Intensification project	SeeD	Seeds of Discovery
FAO	Food and Agricultural Organization of the United Nations	USAID	U.S. Agency for International Development
FP	Flagship projects	USDA-ARS	United States Department of Agriculture - Agricultural Research Service
GFSF	Global Futures and Strategic Foresight Project	WIT	Jeanie Borlaug Laube Women in Triticum Early Career Award
ha	hectares	WHEAT	CGIAR Research Program on Wheat
ICAR	Indian Council of Agricultural Research	W-ISC	WHEAT-Independent Steering Committee
ICARDA	International Center for Agricultural Research in the Dry Areas	ZT	Zero tillage
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics		
IDOs	Intermediate development outcomes		

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Photo Credits: Ernesto Blancarte, Alfonso Cortes, Michelle DeFreese, Adefris Teklewold, T. Krupnik, Mokhamad Edliadi, Peter Lowe, Nathan Russell, S. Mojumder

Infographics: Nancy Valtierra

Graphic Design and Layout: Marcelo Ortiz Sánchez

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Correct citation: WHEAT. 2019. The CGIAR Research Program on Wheat 2018 Annual Report. Mexico City: WHEAT.



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