

ANNUAL REPORT 2017



RESEARCH
PROGRAM ON
Wheat

Message from the WHEAT Director

Quality science and partnerships deliver better seed, cropping systems, and nutrition



Hans Braun, Director of the CGIAR Agri-Food Systems Research Program on Wheat.

In 2017, national research agencies in 19 countries released 63 new wheat varieties, derived all or in part from the research of CIMMYT and its principal WHEAT partner, the International Center for Agricultural Research in the Dry Areas (ICARDA).



2017 wheat varietal releases derived from WHEAT research. Based on best information from partners and farmers as of March 2018.

In response to Ethiopia's worst drought in 50 years and a critical shortage of maize and wheat seed, Ethiopian organizations, seed producers, and CIMMYT delivered over 3,400 tons of high-quality seed that farmers planted on 100,300 hectares, benefiting 1.6 million people. Bangladesh released a high-yielding, micronutrient-enhanced wheat

variety that resists wheat blast, a fungal disease from the Americas that now threatens some 7 million hectares of wheat land in South Asia. Researchers from ICARDA received the 2017 Olam Prize for Innovation in Food Security, in recognition of heat tolerant durum wheat varieties they developed for Africa's Senegal River Basin. The wheat-related report of a [major gender study](#) showed that seed of improved wheat varieties figured among the innovations most valued by women and men farmers.

A zinc-enhanced wheat variety released in Pakistan is spreading among farmers, who like its good yields, health benefits, and delicious taste. It is one of six zinc-enhanced varieties released in South Asia and stems from research to biofortify wheat and thus benefit the poor who cannot afford dietary supplements or cannot access sufficiently diverse foods.

Of course, breeding alone cannot address the need for sustainable crop productivity. A historical overview of WHEAT and predecessors' research and promotion of conservation agriculture in the Indo-Gangetic Plains of India concluded that much greater adoption in the region's rice-wheat cropping systems is possible, if key constraints are tackled.

With gracious permission from AACC International, in 2017 CIMMYT published "The wheat and nutrition series: A compilation of studies on wheat and health," part of a larger, multi-year science-based campaign about wheat-based foods that are nutritious and healthy.

I wish to thank WHEAT's numerous partners and funders for these and many other exciting achievements. In particular, stable CGIAR Window 1 and 2 funding enables WHEAT to react quickly to urgent needs, 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, Canada, France, India, Japan, Korea, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the World Bank. Funding agencies of Australia, the United Kingdom (DFID), USA (USAID), and China contribute vital Window 2 funding.

Thank you for taking time to read this Annual Report. Your continued support and participation are crucial and greatly appreciated.



Hans-Joachim Braun

Director, CGIAR Research Program on Wheat and Global Wheat Program, CIMMYT

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Energizing Ethiopia's wheat seed sector

Marketed in tandem with science-based recommendations for growing wheat, Ethiopia's annual seed supply has steadily increased since 2014 through the Wheat Seed Scaling Initiative.

Seed unions enlist farmer cooperatives to dramatically scale wheat seed production

A sunny November day brings hundreds of seed producers to Doyogena, a scenic highland village in Ethiopia's Southern Nations, Nationalities, and Peoples' Region (SNNP). The visitors form a bustling line to collect more than \$90 each, on average, in profits from representatives of the Zereta Kembata Seed Multiplication and Marketing Union.



“The union collects certified seed of wheat varieties grown by more than 1,100 farmers, several hundred of whom are women, belonging to 8 farmer cooperatives,”

– Yosef Balewold
The general manager of Zereta Kembata.

Pitted against a yearly onslaught of fast-evolving fungal diseases that can infect as much as \$200 million worth of the crop they are growing, over 75,000 small-scale wheat farmers in Ethiopia’s 4 major wheat-growing regions gained

access by late 2017 to a vital asset: over 400 tons of new, disease resistant wheat seed, much of it produced by other farmers.

Ethiopian farmer seed producers collect payment at the Zereta Kembata Seed Multiplication and Marketing Union facility in Doyogena.

Marketed in tandem with science-based recommendations for growing wheat, Ethiopia’s annual seed supply has steadily increased since 2014 through the Wheat Seed Scaling Initiative, led by the International Maize and Wheat Improvement Center (CIMMYT).

“We’re energizing and diversifying Ethiopia’s wheat seed sector, partly by involving and benefitting both formal and farmer seed producers, including women and men,”

– Bekele Abeyo
A CIMMYT scientist who leads the project.

Owing to the rapid rise of new and deadly strains of stem and yellow rust, farmers must swiftly begin to sow a range of varieties bearing new resistant genes, but limited access to the seed has been a bottleneck, according to Abeyo.

In addition to assisting government-managed seed enterprises and 4 private seed producers, CIMMYT supports 10 farmer cooperative unions that purchase, pack, and sell the seed grown by numerous primary cooperatives, as well as 12 farmer seed producer associations, including 4 women’s groups, who profit from growing and selling quality seed of the new varieties.



Ethiopian farmer seed producers collect payment at the Zereta Kembata Seed Multiplication and Marketing Union facility in Doyogena.

CIMMYT promotes gender awareness in Ethiopia



and SNNP regions to receive seed threshers through the Initiative. Association members had been threshing the wheat seed manually, a long and laborious process, according to Desta. “With the new machine, we will be able to thresh in one hour what would take us three days by hand,” she said.

Partners:

The success of the Wheat Seed Scaling Initiative depends on the commitment and contributions of diverse national and global partners, including key partner Ethiopian Institute of Agricultural Research. The work is funded by the U.S. Agency for International Development (USAID). Other important partners include state and district level officials in the Amhara, Oromia, SNNP, and Tigray regions. Most of the varieties come from breeding lines from CIMMYT and the International Center for Agricultural Research in the Dry Areas (ICARDA); a number of varieties were developed through the Delivering Genetic Gain in Wheat project, led by Cornell University and funded by the Bill & Melinda Gates Foundation and the UK's Department for International Development (DFID).

A report on gender research methodologies offers a collection of research tools and activities designed to make participants think, learn, analyze, and plan for action.

Based on in-depth interviews with over 45 agricultural sector stakeholders in Ethiopia, the report identifies 7 people-centered methodologies that can be applied in many settings to help improve gender equity and more quickly achieve program goals.

Diverse professionals and practitioners in agricultural research, extension and policy in Ethiopia are applying these and other gender-sensitive approaches.

Gender transformative methodologies in Ethiopia's agricultural sector: a review, [click here](#).

Funded by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

“In 2016, with support from CIMMYT, we sold more than \$7,400 worth of seed,” said Amarech Desta, Tembo Awtena chairwoman, adding that news of the association's success had attracted 30 additional women farmers in 2017, bringing the total membership to 133.

Desalech Ashamo, an association member who is a single head of a household, received nearly \$300 for the seed she grew in 2017 and used the earnings to paint her house. “A big advantage is that all our seed is sold in one lot, rather than piecemeal, so we receive a lump sum that can be used for a significant household project.”

Tembo Awtena members are especially pleased at being one of the three women's seed production groups in the Oromia

Women seize chance to advance

The Tembo Awtena Women's Seed Producers Association in Angacha District, SNNP, began producing wheat seed for sale in 2015, with support from the Wheat Seed Scaling Initiative.



Sustainable Development Goals tied to work mentioned in this story. Of the 17 United Nations (UN) Sustainable Development Goals, 10 relate directly to CGIAR activities and to CIMMYT's mandate. The SDGs have set the pathway for the next 15 years of agricultural, social and economic development. Likewise, CGIAR has transformed its approach to ensure that its work aligns with the ambitious goals.



Zinc-enriched wheat fights malnutrition in Pakistan

A zinc-enhanced wheat variety released in Pakistan is spreading among farmers, who like its good yields, health benefits, and delicious taste. It is one of six zinc-enhanced varieties released in South Asia and stems from research to biofortify wheat and thus benefit the poor who cannot afford dietary supplements or cannot access sufficiently diverse foods.

Years of biofortification research and breeding have resulted in Zincol, a wheat variety with 20 percent more zinc than conventional varieties

Years of biofortification research and breeding have resulted in Zincol, a high-yielding, zinc-enhanced variety that was released in 2016 and is gaining popularity in Pakistan.

Consuming just three chapattis – an unleavened flatbread common in South Asia – made with flour from Zincol can provide up to 40 percent of a child’s daily zinc requirement and 20 percent of an adult’s.

In 2017, farmers from 22 seed producer associations in Pakistan planted large portions of their wheat fields with Zincol. Established to grow quality seed of new wheat varieties, these associations received assistance from the country’s National Rural Support Program, a key partner in the Pakistan Agricultural

Innovation Program, led by the International Maize and Wheat Improvement Center (CIMMYT).

“Over the 2016 and 2017 cropping seasons, 400 tons of seed of Zincol have been shared with farmers, seed companies and promotional partners,” said Imtiaz Muhammad, CIMMYT country representative in Pakistan and a wheat improvement specialist.

An additional 15 tons of Zincol was shared free of charge for testing with 600 farm families in Sukkar District, Sindh Province, through an initiative of World Vision-Canada and HarvestPlus, a CGIAR research program dedicated to the study and delivery of biofortified foods.



Zinc links to health

In Pakistan, 39 percent of children and 48 percent of pregnant women suffer from zinc deficiency, according to a 2011 National Nutrition Survey. These deficiencies lead to child stunting rates of over 40 percent and high infant mortality.

Zinc is essential for immune and nervous system development, making it especially vital for combatting malnutrition during pregnancy and in young children, according to the World Health Organization. South Asia has one of the highest rates of zinc-deficiency, resulting in a host of harmful effects.

Zincol resulted from CIMMYT's biofortification breeding research, focused on enhancing nutrient levels in the grain of key food crops. The creators of Zincol drew upon diverse genetic resources, including wheat landraces and wild relatives with the genetic potential to accumulate zinc in the grain. Genes for enhanced grain zinc content from those sources were crossed into adapted, high-yielding varieties over repeated cycles of selection involving many thousands of plants.

"Zincol also carries the genetic background of NARC 2011, a popular, high-yielding Pakistan wheat variety that resists wheat stem rust, a deadly disease that threatens wheat worldwide,"

added Velu Govindan, a CIMMYT wheat breeder who specializes in biofortification and helped develop Zincol.

Zincol took nearly a decade to reach farmers after the initial breeding cross in 2007, several years faster than is the norm in Pakistan. Today enough Zincol seed has been distributed to cover over 20,000 hectares, and that could expand to more than half a million hectares by 2019.

Funders:

U.S. Agency for International Development (USAID), HarvestPlus and World Vision-Canada

Cost of zinc deficiency

- Zinc deficiency causes stunting, lowers immunity, and increases risk of diarrheal disease and respiratory infections.
- 45% of children under 5 in Pakistan are estimated to be zinc deficient (WHO).
- Mineral and vitamin deficiencies cost Pakistan nearly 3 billion USD in GDP losses annually (World Bank).



Sustainable Development Goals tied to work mentioned in this story. Of the 17 United Nations (UN) Sustainable Development Goals, 10 relate directly to CGIAR activities and to CIMMYT's mandate. The SDGs have set the pathway for the next 15 years of agricultural, social and economic development. Likewise, CGIAR has transformed its approach to ensure that its work aligns with the ambitious goals.





A little girl eats a freshly-made roti and watches as the women of her family prepare more at her home in the village of Chapor, in the district of Dinajpur, Bangladesh. Photo: S. Mojumder/Drik/CIMMYT

Scientists confirm value of whole grains and wheat for nutrition and health

An exhaustive review of scientific studies on cereal grains and health has shown that gluten- or wheat-free diets are not inherently healthier for the general populace and may actually put individuals at risk of dietary deficiencies.

According to a compilation of 12 reports published in the scientific journal *Cereal Foods World* during 2014-2017, eating whole grains is actually beneficial for brain health and associated with reduced risk of diverse types of cancer, coronary disease, diabetes, hypertension, obesity and overall mortality.

Wheat accounts for a fifth of the world's food and is the main source of protein in many developing and developed countries and second only to rice as a source of calories. "Among wheat's greatest benefits, according to the research, is fiber from the bran and other grain parts," Guzmán explained. "Diets in industrialized countries are generally deficient in such fiber,

which helps to regulate digestion and promote the growth of beneficial gut bacteria."

Inhabitants in developing and industrialized countries are experiencing higher incidences of diabetes, allergies, inflammatory bowel disorder, and obesity. A profitable industry has developed around gluten- and wheat-free food products, which the popular press has promoted as beneficial for addressing such disorders. But

scientific evidence contradicts popular writings about these food products.

"Much of the anti-grain messaging comes from publications produced by supposed 'specialists' who are not nutritionists, and are often built on faulty premises," according to Julie Miller Jones, Distinguished Scholar and Professor Emerita at St. Catherine University, U.S.A., and a key contributor to the review studies in the compilation.



Bakers mix, roll and bake bread at La Conchita bakery in Texcoco, Mexico. Photo: Mike Listman/CIMMYT.

First blast resistant, biofortified wheat variety released in Bangladesh



Bleached spikes infected with wheat blast hold shriveled grain, if any. Photo: Etienne Duveiller/CIMMYT

As wheat farmers in Bangladesh struggle to recover from a 2016 outbreak of a mysterious disease called “wheat blast,” in 2017 the country’s National Seed Board (NSB) released a new, high-yielding, blast-resistant wheat variety.

Called “BARI Gom 33,” the variety was developed by the Bangladesh Wheat Research Centre (WRC), using a CIMMYT breeding line, according to Naresh C. Deb Barma, Director of WRC.

“This represents an incredibly rapid response to blast, which struck in a surprise outbreak on 15,000 hectares of wheat in southwestern Bangladesh just last year, devastating the crop and greatly affecting farmers’ food security and livelihoods, not to mention their confidence in sowing wheat,” Barma said.

Caused by the fungus *Magnaporthe oryzae* pathotype triticum, wheat blast was first identified in Brazil in 1985 and has constrained wheat farming in South America for decades. Little is known about the genetics or interactions of the fungus with wheat or other hosts. Few resistant varieties have been released in Brazil, Bolivia and Paraguay, the countries most affected by wheat blast.

"The Bangladesh outbreak was its first appearance in South Asia, a region where rice-wheat cropping rotations cover 13 million hectares, a billion inhabitants eat wheat as a main staple, and the disease will likely spread,"

– Pawan Singh
A CIMMYT wheat pathologist

“Many blast fungal strains are impervious to fungicides,” Singh explained. “The Bangladesh variant is still sensitive to fungicides, but this may not last forever, so we’re rushing to develop and spread new, blast-resistant wheat varieties for South Asia,” Singh explained.



Researchers take part in a Wheat Blast screening and surveillance course in Bangladesh. Photo: Tim Krupnik/CIMMYT

Preliminary assessments by CIMMYT have identified 7 million hectares of wheat cropping areas in Bangladesh, India, and Pakistan whose agro-climatic conditions resemble those of the Bangladesh outbreak zone. Even modest blast damage of 5-10 percent to wheat in a single season in those areas would cause grain losses amounting to as much as 1.7 million tons and worth \$350 million, straining the region’s already fragile food security and forcing up wheat imports and prices.

As an added benefit for the nutrition of wheat consuming households, BARI Gom 33 grain features 30 percent higher levels of zinc than conventional wheat. Zinc is a critical micronutrient missing in the diets of many of the poor throughout South Asia and whose lack particularly harms the health of pregnant women and children under 5 years old.

Key partners and supporters include the Australian Centre for International Agricultural Research (ACIAR), the Bangladesh Agricultural Research Institute (BARI), the Indian Council of



Members of National Technical Committee of NSB evaluating BAW 1260, the breeding line used to develop BARI Gom 33. Photo: CIMMYT

Agricultural Research (ICAR), the Instituto Nacional de Innovación Agropecuaria y Forestal in Bolivia, Kansas State University (KSU), the U.S. Department of Agriculture-Agricultural Research Services (USDA-ARS), USAID through its Feed the Future project, and other national and provincial research organizations in India, Nepal, and Pakistan.

Stable window 1 and 2 (W1W2) funding from CGIAR enabled CIMMYT and partners to react quickly and screen breeding lines in Bolivia, as well as working with KSU to identify sources of wheat blast resistance. The following W1 funders have made wheat blast resistance breeding possible: Australia, the Bill & Melinda Gates Foundation, Canada, France, India, Japan, Korea, New Zealand, Norway, Sweden, Switzerland, the United Kingdom and the World Bank. The following funders also contributed vital W2 funding: Australia, China, the United Kingdom (DFID) and USAID.

Pushing for full conservation agriculture in South Asia

Research over the last decade has found conservation agriculture solutions for both the wheat and rice phases of the rice-wheat cropping systems of the Indo-Gangetic Plains, according to a far-reaching review study by WHEAT scientists.

Study: Conservation agriculture in the Indogangetic plains of India: past, present and future, [click here](#).

Breeding alone cannot address the need for sustainable crop productivity, and WHEAT partners and predecessors' have for decades studied and promoted resource-conserving practices for South Asia, a region where rice-



The wheat blast fungus is turning the grain to chaff. Photo: Etienne Duveiller/CIMMYT

wheat cropping rotations cover 13 million hectares and over a billion inhabitants eat wheat as a main staple.

A prime example is the direct seeding of wheat into unplowed paddy fields, including stubble and straw, in a single tractor pass following rice harvest. Known as zero tillage (ZT), the practice replaces the long, laborious, costly, and soil-depleting conventional practice of reforming paddies to plant wheat.

Farmers on some 1.8 million hectares in the region are growing wheat after rice this way, linked to the expanding business of entrepreneurs who provide ZT on contract using specialized, locally-manufactured sowing implements designed and refined by WHEAT partners.

The success of ZT wheat, along with rising labor costs and concerns about soil health and water supplies, are driving farmer and researchers' interest in radical innovations such as non-flooded, direct seeded rice. Gaining ground as well are precision land leveling and nutrient management for more effective irrigation and fertilizer use, and retaining crop residues on fields to store carbon and prevent noxious smog from residue burning.

The study says that full conservation agriculture for rice-wheat cropping raises yields, profits, and water use efficiency, while reducing labor and greenhouse gas emissions.

At the same time, results show that it's better to introduce conservation agriculture practices to farmers in a step-wise fashion, so they can test the new technology and understand how it benefits them.



Participants in a CIMMYT conservation agriculture workshop in India examine a multi-use, multi-crop zero tillage seeder. Photo: CIMMYT.

Heat-tolerant wheat can help farmers adapt to climate change

In research recognized with the prestigious Olam Prize for Innovation in Food Security in 2017, WHEAT scientists developed a set of durum wheat varieties adapted for Africa's Senegal River Basin and able to withstand temperatures of up to 40 degrees C.

If scaled up, the technology offers the potential to fight hunger and help farmers adapt to rising temperatures, according to Filippo Maria Youssef Bassi, durum wheat breeder at the International Center for Agricultural Research in the Dry Areas (ICARDA) and leader of the effort.

"This prize is really dedicated to the hard work by Mauritania and Senegal partners," said Bassi "It's also validation and recognition for this crazy vision we had five years ago to grow durum wheat in the Savannah at 40 degrees Celsius."

The Senegal River supports cropping on 200,000 hectares of land from Senegal through Guinea, Mauritania, and Mali. Farmers in the region cultivate rice



Farmers grow durum wheat in the oasis. Photo: Filippo Bassi/ICARDA

during eight months of the year then leave the land fallow.

Using conventional breeding aided by DNA markers, Bassi and partners developed super-early-maturing and heat-tolerant durum wheat lines and tested them for three years at multiple locations of fallow land in the Basin.

"Because the varieties grow fast, farmers can produce them during the fallow between rice crops," adding that the varieties yielded over 3 tons per hectare in just 90 days in the Senegal River Valley.



Filippo Bassi at Terbol Station, Lebanon. Photo: Michael Major/Crop Trust

"If widely adopted in the region, the varieties could yield up to 600,000 tons of additional food, worth more than \$200 million in additional revenue for smallholder farmers, without affecting rice production."

– Filippo Maria Youssef Bassi
Durum wheat breeder at the International Center for Agricultural Research in the Dry Areas (ICARDA) and leader of the effort

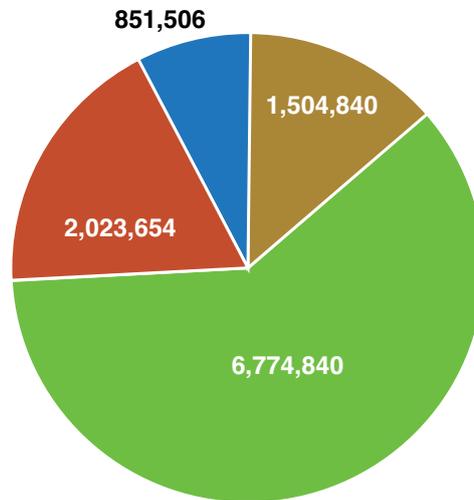
The varieties and related data are freely available for use in other dryland durum wheat production areas worldwide, according to Bassi.



The durum wheat team in Senegal. Photo: Filippo Bassi/ICARDA

Financial summary

Total: U.S. \$11,154,840



- CRP Management
- CIMMYT Research
- ICARDA Research
- 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 2012-2017 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). Coupling advanced science with field-level research and extension in lower- and middle-income countries, WHEAT works to raise wheat productivity, production and affordable availability for 2.5 billion resource-poor consumers who depend on the crop as a staple food. Partners include the Australian Centre for International Agricultural Research (ACIAR), the British Biotechnology and Biological Sciences Research Council (BBSRC), the International Center for Agricultural Research in the Dry Areas (ICARDA), the Indian Council of Agricultural Research (ICAR), and a community of more than 200 public and private organizations worldwide, among them national governments, companies, international centers, regional and local agencies and farmers. Funding for WHEAT comes from CGIAR and generous donors including national governments, foundations, development banks and other public and private agencies.

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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