A weekly report of our activities around the world

CIMMYT Informa

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Agriculture Can Help the World Meet Climate Change Emission Targets

Martin Kropff

As world leaders meet in Paris this week to agree on greenhouse gas emission targets, we in the field of agricultural research have a powerful contribution to make, by producing both robust estimates of the possible effects of climate change on food security, and realistic assessments of the options available or that could be developed to reduce agriculture's contribution to greenhouse gas emissions.

Agriculture is estimated to be responsible for about a fifth of global greenhouse gas emissions, and this share is increasing most rapidly in many developing countries; it may even increase as fossil fuels become scarcer and phased out in other sectors.

The solution being put forward today is climate-smart agriculture (CSA), which involves three components: adaptation, mitigation, and increased productivity. Adaptation is essential to cope with the impacts that cannot be avoided and to maintain and increase the global food supply in the face of resource constraints; mitigation can lessen but not prevent future climate changes.

Though CSA has been held up as an answer to the challenges presented by climate change, some would argue that it is no more than a set of agricultural best practices. Indeed, this is what lies at the heart of the approach.

In addition to making agriculture more efficient and resilient, the overall purpose remains to sustainably increase farm productivity and profitability for farmers. This is why over the last few years we have begun talking about the 'triple win' of CSA: enhanced food security, adaptation, and mitigation. But those who dismiss CSA as mere best practice ignore the value of seeing through the climate change lens, and guiding research to respond to expected future challenges.

To begin with, crop performance simulation and modeling, in combination with experimentation,

▲ Precision levelers are climate-smart machines equipped with laser-guided drag buckets to level fields so water flows evenly into soil, rather than running off or collecting in uneven land. This allows much more efficient water use and saves energy through reduced irrigation pumping, compared to traditional land leveling which uses animal-powered scrapers and boards or tractors. It also facilitates uniformity in seed placement and reduces the loss of fertilizer from runoff, raising yields. Photo: CIMMYT 2014 Annual Report

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has an important role to play in developing CSA strategies for future climates.

In a publication titled "Adapting maize production to climate change in sub-Saharan Africa," several CIMMYT scientists concluded that temperatures in sub-Saharan Africa will likely rise by 2.1°C by 2050 based on 19 climate change projections. This is anticipated to have an extreme impact for farmers in many environments. Because it takes a long time to develop and then deploy adaptation strategies on a large scale, they warned, there can be no delay in our work.

This explains why CIMMYT is taking the initiative in this area, seeking support to develop advanced international breeding platforms to address the difficulty of developing drought-tolerant wheat, or bringing massive quantities of drought- and heat-tolerant maize to farmers through private sector partners in Africa and Asia.

Our insights into the causes and impacts of climate change lead us to important research questions. For example, how can farmers adopt practices that reduce the greenhouse gas footprint of agriculture while improving yield and resilience?

Colleagues at CIMMYT have challenged the idea that the practice of no-till agriculture (which does not disturb the soil and allows organic matter to accumulate) contributes significantly to carbon sequestration. I think it is important that we, as scientists, explore the truth and be realistic about where opportunities for mitigation in agriculture lie, despite our desire to present major solutions. It is also important to take action where we can have the greatest impact, for example by improving the efficiency of nitrogen fertilizer use.

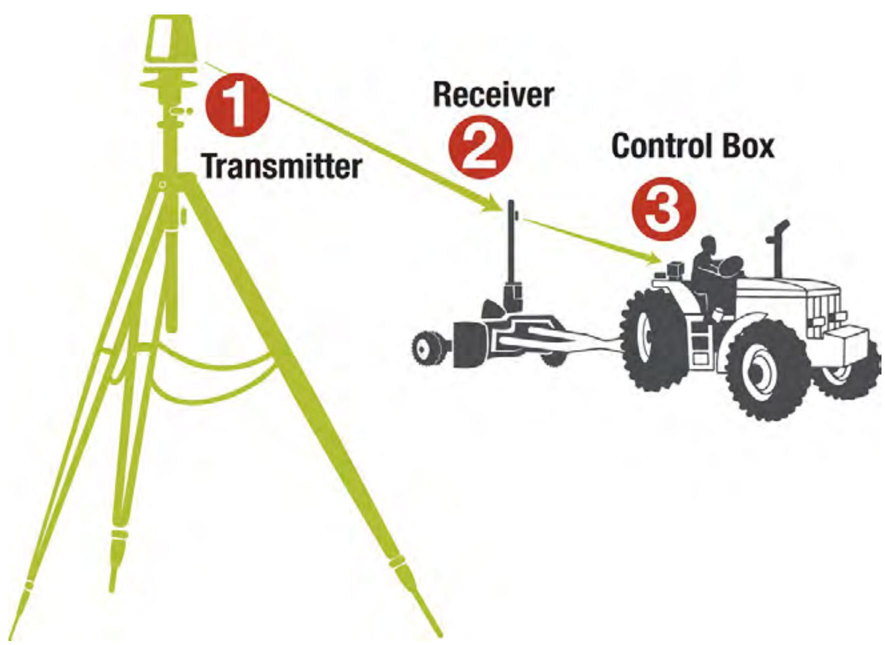
Nitrous oxide emissions from agriculture have a climate change potential almost 300 times greater than carbon dioxide, and account for about 7% of the total greenhouse gas emissions of China. Improved nutrient management could reduce agricultural greenhouse gas emissions by the equivalent of 325 Mt of carbon dioxide in 2030. Overall, supply-side efficiency measures could reduce total agricultural emissions by 30%.

Some practices, such as laser land leveling, fall into both the adaptation and mitigation categories. Preparing the land in this way increases yields while reducing irrigation costs, the amount of water used, nutrients leached into the environment, and emissions from diesel-powered irrigation pumps.

Findings such as this offer real hope of reducing the severity of climate change in the future, and help us build a case for more investment in critical areas of agricultural research.

For climate-smart agriculture, the challenge of feeding more people and reducing emissions and environmental impact is not a contradiction but a synergy. We are improving our ability to predict the challenges of climate change, and proving that it is possible to greatly reduce agricultural emissions and contribute to global emission goals.

To face challenges such as climate change, we need high quality multi-disciplinary science combined with approaches to address problems at the complex systems level. Since my involvement in early large-scale studies, such as Modeling the Impact of Climate Change on Rice Production in Asia (CABI/IRRI, 1993), I am pleased to see that so much progress has been made in this regard and encouraged that our research is contributing to greater awareness of this vital issue and solutions to address it. ■



CIMMYT Demonstrates Maize Varieties in Northern Pakistan

AbduRahman Beshir and Salman Saleem

Maize, along with wheat, is one of the dominant cereal crops in the Gilgit Baltstian (GB) region in northern Pakistan, which borders Afghanistan on the north and China on the northeast. The region is home to the world's second highest mountain (K2 Mountain) and also characterized by deep valleys and gorges.

Unlike other provinces of Pakistan where farmers have two cropping seasons, most farmers in GB have to harvest their crops before their land is covered with snow for the rest of the year. The major maize cropping season is from July to November and farmers prefer early maturing maize varieties that can be harvested before the onset of winter.

CIMMYT, under the Agricultural Innovation Program (AIP) for Pakistan, introduced early maturing open-pollinated varieties in summer of 2014 and was able to identify varieties that are best suited to the region. In collaboration with GB's Department of Agriculture, CIMMYT also held field days on 19-20 October 2015 in the Chilas and Goner areas of GB to demonstrate candidate maize OPVs.

A total of 120 farmers attended both field days which included orientation on improved maize production technologies. Four white kernel OPVs sourced from CIMMYT-Zimbabwe have been identified for the area based on their grain yield advantage over local checks. The candidate varieties yielded 8.2-9.3 ton/ha, showing a 25-35% yield advantage over the standard checks. The department is planning to further scale up the varieties in the coming seasons through community-based seed production. During the field days, farmers requested that seed of these varieties be delivered as quickly as possible because of the stay-green traits they exhibited during the evaluation. Stay-green varieties are in high demand in the area for feeding livestock after the maize ears are harvested for human consumption. ■

Photo: Salman Saleem

▲ Farmers visit CIMMYT's maize demo plots, Goner, Gilgit Baltstian, Pakistan.

Photo: Salman Saleem

▲ Nabi ur Rehman, from GB's department of agriculture, measuring an ear of a CIMMYT OPV.

▲ Field discussions during a maize field day, Chilas, Gilgit Baltstian, Pakistan. Photo: Salman Saleem

CIMMYT Supports the Adoption of the Zero-Tillage Happy Seeder in Pakistan

Imtiaz Hussain, Abdul Hamid, and Amina Nasim Khan

In the basmati rice-wheat area of Punjab province in Pakistan, burning of rice residues followed by heavy tillage is a traditional residue management practice. However, today, a new environmentally friendly wheat planting technique enables farmers to reduce cultivation costs and reduce greenhouse gas emissions while increasing their wheat yields. The zero-till (ZT) happy seeder helps farmers to plant wheat in combine-harvested rice fields without burning residues.

Photo: Abdul Hameed

▲ Testing a locally manufactured ZT happy seeder in a farmer's field in Punjab province, Pakistan.

In 2014, ZT happy seeders were brought into Pakistan from India in collaboration with CIMMYT-India. Under the USAID-funded Agricultural Innovation Program, CIMMYT, in collaboration with national partners, evaluated the ZT happy seeder for planting wheat and compared it with the traditional farmers' practice at 32 sites in four districts of Punjab province, namely Faisalabad, Sheikhupura, Gujranwala, and Sialkot, in 2014-15. Using the happy seeder and without burning rice residues, farmers were able to reduce the number of tillage operations from 5 to 1 and improve their wheat grain yields up to 0.5 t/ha.

In September 2015, CIMMYT initiated local manufacturing of the ZT happy seeder with the help of Shareef Engineering, a private manufacturer from Faisalabad, Punjab province. Shareef Engineering had been producing ZT drills for the farming community since 2010 and was able to develop the first local version of the ZT happy seeder within two months.

The new locally manufactured ZT happy seeder was evaluated at Muhammad Rafi's farm in Nanakana Sahib district, Punjab province. Rafi used this technology to plant wheat on a combine-harvested 4-acre field. Wheat planting was done in 1.5 hours/acre using the ZT happy seeder without burning rice residues. Local manufacturing of these planters is a step towards increased adoption of this technology among farmers in this rice-wheat area. ■

Photo: Abdul Hameed

▲ Manufacturer from Punjab province during the evaluation of a locally manufactured ZT happy seeder.

CIMMYT Scientist Ravi Singh Receives Honor for Wheat Genetics, Breeding

Julie Mollins

Last week Scientist Ravi Singh was named Fellow of the American Association for the Advancement of Science (AAAS) for his "distinguished contributions to the field of agricultural research and development, particularly in wheat genetics, pathology and breeding."

Singh, who leads CIMMYT's wheat improvement and rust resistance research, is among 347 members awarded the honor this year by AAAS, which also publishes the journal "Science." The fellows were honored due to their scientifically or socially distinguished efforts to advance science or its applications.

During more than 30 years at CIMMYT, Singh has made significant contributions to enhancing food security throughout the developing world. His work led to the development of durable resistance to control fungal wheat rust diseases, which cause almost US$ 3 billion in crop losses a year. As a result of this work, many farmers do not need to protect their crops with costly fungicides, boosting the potential for organic farming.

Singh's research has shown that globally effective, durable resistance to leaf, yellow, and stem rust in wheat involves interactions of slow-rusting genes that have additive effects; the accumulation of four or five of these genes results in a level of resistance comparable to immunity. His research team has identified 11 diverse slow-rusting genes and discovered that some confer partial resistance to multiple diseases. These include genes *Lr34/Yr18/Sr57/Pm38*, *Lr46/Yr29/Sr58/Pm39*, and *Lr67/Yr46/Sr55/Pm46* for leaf, yellow, and stem rusts, and powdery mildew, respectively.

Singh was a co-investigator for research that led to the cloning of pleiotropic gene *Lr34*, a landmark in understanding the genetic mechanism for slow-rusting resistance that is conferred by a unique gene belonging to the ABC (ATP Binding Cassette) transporter of the PDR (Pleiotropic Drug Resistance) subfamily.

His research team has identified and designated 25 genes in wheat, including: *Sr8b*, *Sr55*, *Sr57*, and *Sr58* for stem rust resistance; *Lr31*, *Lr46*, *Lr61*, *Lr68*, and *Lr72* for leaf rust resistance; *Yr18*, *Yr27*, *Yr28*, *Yr29*, *Yr30*, *Yr31*, *Yr46*, *Yr54*, and *Yr60* for yellow rust resistance; *Pm39* and *Pm46* for powdery mildew resistance; *Bdv1* for barley yellow dwarf tolerance; *SuLr23* for suppression of leaf rust resistance; *Sb1* for spot blotch resistance; and *Ltn1*, *Ltn2*, and *Ltn3* for leaf tip necrosis.

More recently, the team identified various quantitative trait loci that confer slow-rusting resistance to stem rust including the highly virulent Ug99 stem rust race group.

Singh was also part of the global research team that isolated wheat gene Lr67, revealing how it hampers fungal pathogen growth through a novel mechanism. CIMMYT scientists created and field tested genetic mutations of *Lr67* to pinpoint the gene's exact location in the wheat genome.

CIMMYT-derived wheat cultivars with durable rust resistance cover more than 25 million hectares in the developing world, contributing billions of dollars through enhanced yield potential and yield savings in epidemic years.

Singh's research team has also developed various widely grown wheat varieties in several countries with enhanced grain yield potential of 5-15% combined with heat and drought tolerance and good processing quality. More recently, the team also started breeding wheat varieties with enhanced levels of zinc and iron in the grain, which are being tested in India and Pakistan to improve the nutrition of women and children with chronic micronutrient deficiency.

Singh has authored or co-authored 200 peer-reviewed journal articles, 26 book chapters/extension publications, 80 published symposia, and 212 symposia abstracts.

He has also received the "Outstanding CGIAR Scientist Award," the 2015 China Friendship Award, and awards from governments in the provinces of Sichuan, Yunnan, and Xinjiang in China. He is a fellow of the American Society of Agronomy, Crop Science Society of America, American Phytopathological Society, and India's National Academy of Agricultural Sciences.

Singh and the other new AAAS fellows will be presented with an official certificate and a gold and blue rosette pin in February during the organization's 2016 annual meeting in Washington, D.C. ■

Toluca Field Day 2015

Jennifer Johnson

Mexico is the center of origin of maize, and is home to some of the most diverse varieties found anywhere in the world, adapted over time to perform well under local conditions. Many of these varieties have been collected and stored by CIMMYT's maize germplasm bank to safeguard the valuable traits they possess, and have been utilized in breeding programs in Mexico and all over the world to create improved varieties and hybrids to meet producers' specific needs in various environments.

However, many local producers in the highland regions of Mexico are not aware that these varieties even exist. "We came here and realized that local producers were planting unimproved native varieties, which made me wonder: 'What ever happened to the improved varieties that were developed specifically for highland regions?'" said Denise Costich, head of CIMMYT's maize germplasm bank. "What if we could take our highland materials from the germplasm bank and use them to help local farmers?"

Photo: Jennifer Johnson/CIMMYT

▲ Local producer Brigido Jardon Contreras fills out a variety preference survey.

To showcase highland maize varieties held in the CIMMYT germplasm bank to local producers, CIMMYT, in partnership with ICAMEX (Spanish acronym for Agricultural, Livestock, and Fishery Research and Training Institute), held its second annual field day at the Toluca Experiment Station, state of Mexico, on 18 November 2015.

"We want to put these materials back in the hands of local farmers, as this is where the material is originally from," emphasized Pedro Mijares Oviedo, Director General of ICAMEX, in his welcome address.

The event was attended by 136 local producers, students, and agricultural technicians who

Photo: Jennifer Johnson/CIMMYT

▲ Highland maize landraces from Latin America on display at the field day.

▲ ICAMEX Director General Pedro Mijares addresses visitors. Photo: Jennifer Johnson/CIMMYT examined the varieties and took note of any they themselves would be interested in adopting. Over 177 varieties from highlands of Mexico and South America were showcased at the event, ranging from large "cacahuacintles" used to make pozole, a traditional maize stew, to "palomeros," used to make popcorn.

During the event, visitors were also taught how to request seeds from CIMMYT's online catalog, as well as how to create their own F1 hybrids by crossing different varieties. "Our mission at the bank is not just moving the germplasm, but to teach people how to use it themselves," explained Costich.

The final results of the variety preference survey found that the number one preferred variety among participants was a yellow highland maize variety from a breeding program in Ecuador, followed by a white variety created here in Mexico by crossing a pool of Andean accessions. Also popular were several cacahuacintles. Some of the preferred varieties have average yields as high as 8 tons per hectare (t/ha), a vast improvement on the regional average of 3 t/ha.

"We have a lot of accessions like this in the bank, but no one really requests them because no one knows they exist," said Costich. "That's what we're trying to do with our demonstration days: we want to get this material out there, see what it looks like and see if it is useful."

Next year the plan is to conduct individual trials in farmers' fields, working directly with a group of 10 interested local producers to see how well the materials do under local conditions.

Seed from the preferred varieties of the 2014 demonstration day will be available to farmers in 2016, and seed from this year's winning varieties will be available by spring 2017. ■

Marcial Rivas, research assistant at the maize germplasm bank, explains the variety preference survey to visitors. Photo: Jennifer Johnson/CIMMYT

National Wheat Genetics and Breeding Conference Held in China

Zhonghu He

The 7th National Wheat Genetics and Breeding Conference, jointly organized by Chinese Academy of Agricultural Science (CAAS), Henan Academy of Agricultural Science (Henan AAS), and CIMMYT, was held from 18-21 November in Zhengzhou, Henan Province. This event has been organized every five years by CAAS-CIMMYT since 2000, with over 1,100 participants from 125 institutes across 21 provinces attending this year.

CIMMYT scientists gather with former trainees and visiting scientists. Photo: Simin Li

▲ Participants in the 7th National Wheat Genetics and Breeding Conference. Photo: Henan Academy of Agricultural Sciences

In Henan Province, nine million hectares produce 35 million tons of wheat annually. Despite the significant increase in Chinese wheat production over the last ten years, challenges in four areas remain, including climate change, the spread of Fusarium Head Blight, a shortage of high quality wheat and lack of new varieties suitable for reduced application of fertilizer, irrigation, and fungicide.

These challenges require that CIMMYT and Chinese research institutions such as CAAS and Henan AAS continue to collaborate. Since the 1980's, over 100 Chinese scientists have been trained by CIMMYT's Global Wheat Program (GWP) and are now playing active roles in Chinese wheat industry as presidents and professors of provincial academies, directors of research institutes, and one alumni as the general manager of a national seed company. According to a preliminary finding by the Center for Chinese Agricultural Policy of Chinese Academy of Science in 2014, 53% of visiting Chinese scientists and 68% of training course participants thought CIMMYT trainings were highly useful for their research.

▲ CIMMYT wheat demonstration field in Wuqing, China. Photo: CAAS-CIMMYT

During the conference, Ravi Singh, CIMMYT Wheat Breeder and Distinguished Scientist, Javier Peña, Wheat Quality Specialist, and Zhonghu He, CIMMYT-China Country Representative, gave an overview of CIMMYT wheat breeding, quality, and molecular marker application in breeding. Methodologies for developing rust and powdery mildew resistant germplasm were particularly well received by Chinese wheat breeders.

On 18 November, Singh, He, Peña, and 32 Chinese GWP alumni gathered during the conference, where He declared CIMMYT-China will provide a platform for former trainees and visiting scientists to share views and exchange research progress. He also said an alumni meeting will be organized in 2016 for trainees and visiting scientists to share experiences.

Alumni attending reflected on their CIMMYT training, discussed their research progress and achievements after returning to China, and expressed their desire to collaborate with CIMMYT in the future. Jianjun Liu, Wheat Breeder and Professor at Shandong Academy of Agricultural – who attended CIMMYT's basic training course in 1997 and advanced course in 2001 – highlighted the impact CIMMYT's training programs have had on research in China and hoped that more young Chinese scientists will train at CIMMYT. ■

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Towards Inclusive and Sustainable Grain Marketing

Víctor López, Louis García, and Paola López, MasAgro Productor

MasAgro holds its first farmer-market exchange forum

To build an adequate strategy for marketing basic grains that includes incorporating small- and medium-scale farmers into the market, it is important to consider aspects such as sustainable production and farm organization and the information farmers may have on these subjects. But how can we help farmers organize themselves, plan their work, determine their group requirements, and access timely information for strategic decision making? How much additional value does a supplier or group of suppliers that are efficient, sustainable, and reliable bring to agro-industries or other grain buyers? To answer these and other questions, the MasAgro program organized its first forum on grain marketing titled "Towards Inclusive and Sustainable Grain Marketing" at CIMMYT headquarters on 9 November.

Read more about the event here. ■

▲ Participants from various sectors involved in production and marketing systems of basic grains. Photo: Luz Paola López Amezcua

▲ Producers from various regions of Mexico share their marketing experiences with attendees. Photo: Luz Paola López Amezcua

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