Evidences

Study #2566

Contributing Projects: <Not Defined>

Part I: Public communications

Type: OICR: Outcome Impact Case Report

Status: On-going

Year: 2018

Title: Heat and drought-resistant wheat varieties in Pakistan help farmers combat climate change stress and is success of physiological breeding approach

Short outcome/impact statement:
The stress of climate change on wheat production means farmers urgently need more heat and drought tolerant varieties. An innovative approach by WHEAT scientists, combining genetic diversity with physiological and molecular breeding and bio-informatic technologies, has resulted in several successful outcomes, including three lines of wheat varieties specifically bred for increased tolerance to heat and drought in Pakistan. The Pakistan Agricultural Research Council has taken on certified seed multiplication more than 100,000 Pakistani farmers currently grow one or more of the 3 varieties.

Outcome story for communications use:
To meet increased demand for heat and drought tolerance in South Asia, WHEAT scientists succeeded in applying state-of-the-art genetic research tools to dissect complex physiological traits, permitting more precise and effective high-throughput phenotyping, genome sequencing and genomic selection.

Over the past six years, CGIAR and NARS breeders have developed and released, in addition to 30 varieties bred for irrigated and rainfed conditions, 3 lines specifically bred for heat and drought tolerance in Pakistan: The Pakistan Agricultural Research Council released Kohat-17, Borlaug 2016 and Pakistan 2013 lines. As of 2018, farmers have rapidly adopted them, in contrast to generally slower varietal replacement, which pushes down yields (Battese et al., 2014; Lantican et al, 2016, pp.35-36). Pakistan-13, drought and heat tolerant and 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, which, based on the FAO estimate of 2 acres per farmer, means that 93,860 farmers have opted for this new variety, benefiting from a noticable yield advantage of 0.39t/ha compared to all other newly released varieties. In 2018, it was planted on an estimated 40,000 hectares. Around 600 tons of Borlaug-2016 seed have been distributed and 6,175 farmers used it. The 7.3 tons of Kohat-17 seed have been planted on 61 hectares. Note that farmers benefit from 34% more grain yield by planting new varieties using certified seed, compared to using farmer-saved seed.
For context: Pakistan farmers grow wheat on roughly 9M hectares (2017-18; one third rainfed), achieving an average yield of 2.8 tons/ha, replacing varieties every 8-10 years (national average). CGIAR-related varieties make up 63% of all releases (2004-2014) and over 90% of area sown (2014) in South Asia.

In addition to helping farmers build resilience to growing climate stresses, these lines represent a proof of concept for combining genetic diversity with physiological and molecular breeding and bio-informatic technologies. This approach permits an better understanding of a crops' physiology to improve traits - a more vigorous root system, improved photosynthesis, or translocation of carbohydrates in the stem - which translates into increased tolerance to heat and drought.

Links to any communications materials relating to this outcome: <Not Defined>

Part II: CGIAR system level reporting

Link to Common Results Reporting Indicator of Policies : No

Stage of maturity of change reported: Stage 1

Links to the Strategic Results Framework:
Sub-IDOs:

- Adoption of CGIAR materials with enhanced genetic gains
- Reduced smallholders production risk

Is this OICR linked to some SRF 2022/2030 target?: Yes

SRF 2022/2030 targets:

- Increased rate of yield for major food staples from current 1%/year
- # of more farm households have adopted improved varieties, breeds or trees

Description of activity / study: <Not Defined>

Geographic scope:

- National

Country(ies):

- Pakistan

Comments: Innovation and outcome is relevant to all increasingly heat/drought-prone wheat-producing regions in South Asia.

Key Contributors:

Contributing CRPs/Platforms:

- Wheat - Wheat

Contributing Flagships:

- FP3: Better varieties reach farmers faster
- FP2: Novel diversity and tools for improving genetic gains and breeding efficiency

Contributing Regional programs: <Not Defined>

Contributing external partners:

- Agriculture Department (Punjab, Pakistan)
- PARC - Pakistan Agricultural Research Council
- Government of Pakistan
- USAID - U.S. Agency for International Development

CGIAR innovation(s) or findings that have resulted in this outcome or impact:

3 improved lines released by PARC (Kohat-17, Borlaug 2016 and Pakistan-2013, or PAK-13); seed systems innovation (certified seed production & distribution, farmer participatory variety selection)

Innovations:

- 285 - 30 CIMMYT advanced lines with high yield potential, good grain quality and disease resistance selected for national evaluation.

Elaboration of Outcome/Impact Statement:
For over half a century, the International Wheat Improvement Network (IWIN) coordinated by CIMMYT has been a global leader in breeding and disseminating improved wheat varieties, with the major focus on the constraints of resource poor farmers. Improvements in yield are essential to keep pace with population growth and increased demand. Yet long-term climate trends threaten to reduce wheat yields in many regions.

The need to develop more heat and drought tolerant lines is more urgent than ever. Scientists (including two WHEAT scientists) from 15 countries used data from 30 crop models and widely distributed field experiments to prove that for every 1o C increase in growing season mean temperatures, wheat production decreases by 6% — equivalent to a worldwide loss of 42 million tons of grain. Rising temperatures are already reducing global wheat production.

South Asia is at high risk. Rice-wheat rotations are grown on more than 13 million hectares in the region and help feed the world's largest concentration of impoverished and food-insecure people, but these wheat crops stand to lose 20% of their output due to rising temperatures by mid-century. As previous studies have demonstrated (4, 5, 6), climate change is projected to be particularly disruptive to poor farming communities in South Asia.

To respond to this demand, WHEAT scientists are using novel techniques to increase the rate of genetic gain for heat and drought tolerance, as well as yield. Physiological breeding involves strategic trait-based crossing to combine complementary traits in progeny, high throughput phenotyping to enrich for desirable alleles in intermediate generations and exploration of genetic resources to broaden the genetic base for hybridization. Physiological breeding is increasing genetic gains under a range of environments. The approach has successfully resulted in distribution of advanced lines to rain-fed environments worldwide by the International Maize and Wheat Improvement Center (CIMMYT).
In addition, the CIMMYT-led Seeds of Discovery project is mobilizing useful genebank diversity for drought and heat tolerance through wheat pre-breeding work, and offers drought-tolerant and heat tolerant wheat pre-breeding lines.

As previously reported (7) the need for these seeds in Pakistan is acute. A study published in the Journal of Crop Improvement and involving data from 367 wheat farmers found that farmers with access to certified seed achieved higher crop yields, higher income, and less poverty. Access to certified wheat seed must be increased to feed Pakistan's steadily growing population.

References cited:
1. Asseng et al. 2015 Rising temperatures reduce global wheat production Nature Climate Change
2. Reynolds et al. 2009 Phenotyping approaches for physiological breeding and gene discovery in wheat. Annals of Applied Biology
3. Reynolds et al. 2016 Physiological breeding, Current Opinion in Plant Biology, https://doi.org/10.1016/j.pbi.2016.04.005
4. Ali, A., et al. 2017. Assessing farmer use of climate change adaptation practices and impacts on food security and poverty in Pakistan. Climate Risk Management
5. Ali, A., et al. 2017. Impacts of changing weather patterns on smallholder well-being: evidence from the Himalayan region of Northern Pakistan. Climate Risk Management
6. Rahut, et al. 2017. Coping with climate change and its impact on productivity, income, and poverty: Evidence from the Himalayan region of Pakistan International Journal of Disaster Risk Reduction
7. Ali et al. 2014. Farmers' Access to Certified Wheat Seed and its Effect on Poverty Reduction in Pakistan Journal of Crop Improvement
8. Lantican, M.A., H.J. Braun, T.S. Payne, R.P. Singh, K. Sonder, M. Baum, M. van Ginkel, and O. Erenstein. 2016. Impacts of International Wheat Improvement Research, 1994-2014. Mexico, D.F.: CIMMYT
9. Krishna D. Joshi, Attiq U. Rehman, Ghullam Ullah, Mian F. Nazir, Mahreen Zahara, Jamil Akhtar, Muhammad Khan, Amanullah Baloch, Jaleelullah Khokhar, Ehsan Ellahi, Attaullah Khan, Muhammad Suleman & Muhammad Imtiaz (2017) Acceptance and competitiveness of new improved wheat varieties by smallholder farmers, Journal of Crop Improvement, 31:4, 608-627, DOI: 10.1080/15427528.2017.1325808.

Quantification: <Not Defined>

Gender, Youth, Capacity Development and Climate Change:
Gender relevance: 1 - Significant
Main achievements with specific **Gender** relevance: GENNOVATE findings regarding importance of improved variety access to women and men farmers
Youth relevance: 0 - Not Targeted
CapDev relevance: 1 - Significant
Main achievements with specific **CapDev** relevance: design and implement innovations in seed systems (greater, sustained access to more variety of certified seeds) - concerns NARES, policy-makers, seed producers at national and sub-national levels
Climate Change relevance: 2 - Principal
Describe main achievements with specific **Climate Change** relevance: As described in the outcome case report.

Other cross-cutting dimensions: NA

Other cross-cutting dimensions description: <Not Defined>

Outcome Impact Case Report link: Study #2566

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