Evidences

Study #3929

Contributing Projects:

- P1329 - Crop modeling to simulate the implications of climate change and technological options in WHEAT AFS
- P1390 - Coordination of CoA 4.3
- P829 - BMGF- Cereal Systems Initiative for South Asia (CSISA)- Phase III
- P1383 - Generate science based evidence on CA based SI to help governments on their investment prioritization and coordination of CoA 4.3

Part I: Public communications

Type: OICR: Outcome Impact Case Report

Status: Completed

Year: 2020

Title: Early sowing of heat-tolerant wheat, new machinery and agronomic management enable 1.1M farmers in South Asia: Greater resilience, productivity and climate change adaptation

Short outcome/impact statement:
High-yielding wheat varieties with tolerance to heat stress, in combination with systemic innovations for climate change adaptation, enabled farmers in the Eastern and Western Indo-Gangetic Plains (IGP) to sow earlier and grow their income, while reducing their environmental footprint by avoiding burning crop residue and reducing irrigation. 0.3 million farmers in Western IGP and 0.8 million in Eastern IGP practiced the innovations, achieving extra yields with less irrigation, and earning an additional income of ~US$ 200/ha.

Outcome story for communications use:

Smallholder rice-wheat rotation farmers in the Eastern Indo-Gangetic Plains (IGP) of South Asia -- a global food insecurity and poverty hotspot -- experience significantly lower yields than that of Western IGP, despite higher rains, better groundwater and healthier soils. One key factor is late wheat planting, which results in a shorter growing window coinciding with grain filling at warmer temperatures (1).

Mistimed planting can reduce yields in South Asia by as much as 50%, and increases farmers' environmental footprint. Timely planting aligns crop cycles with favorable climatic conditions, delivering higher and more stable yields and climate adaptation benefits.
From 2010 to 2020, CIMMYT and partners generated science-based evidence focusing on systemic innovations for climate change adaptation, while enhancing local stakeholders' capacity through participatory research. WHEAT findings informed policymaking, ultimately enabling a systematic change to early seeding of wheat.

The research focused on rice production-focused innovations, stress-tolerant high-yielding wheat varieties, and zero till farming -- all solutions that do not reduce yield -- as the primary entry points (10). Combining these different "no-regret" technologies, 0.8 million households planted wheat earlier (e.g. one week generates ca 0.5 - 1.0 t/ha yield gain). Farmers preserved their yield potential and avoided the terminal heat stress stage.

Early seeding also drives business opportunities. WHEAT/Cereal Systems Initiative for South Asia (CSISA) developed business models for custom service providers of zero-till machines and social inclusion in technology development and validation, reinforcing adoption of early seeding. This has led to mainstreaming of early seeding in front-line extension systems, via knowledge and capacity building (2) and policy changes in Eastern IGP.

Similarly, early sowing successes were achieved in Punjab and Haryana, India (Western IGP), benefiting from the residual moisture of the previous monsoon.

Adapted varieties must be tolerant to early- and late-season warmer temperatures (14). The Borlaug Institute for South Asia (BISA), CIMMYT and the Indian Council of Agricultural Research (ICAR) initiated early-sown wheat trials with six national centers India in 2012, funded by the Bill & Melinda Gates Foundation. The significantly higher yields of early-sown BISA wheat genotypes built the foundation of ICAR's Special High Potential Yield Trial. Three best performing wheat varieties were released for October sowing in 2020, thanks to fast-track seed multiplication (13), with 300,000 farmers planting on 20% of total wheat area. The variety DBW 187 is now among the top 3 varieties grown in India.

Links to any communications materials relating to this outcome:

- https://tinyurl.com/ygm4a93c
- https://doi.org/10.5194/hess-23-711-2019

Part II: CGIAR system level reporting

Link to Common Results Reporting Indicator of Policies : Yes

Policies contribution:

- 138 - Agricultural Policies and Investment Priorities for Managing Natural Resources, Climate Change and Air Pollution
- 137 - The conservation agriculture roadmap for India : policy brief

Stage of maturity of change reported: Stage 2

Links to the Strategic Results Framework:

Sub-IDOs:

- Enhanced individual capacity in partner research organizations through training and exchange
- Agricultural systems diversified and intensified in ways that protect soils and water
- Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (More sustainably managed agro-ecosystems)

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

SRF 2022/2030 targets:

- # of more farm households have adopted improved varieties, breeds or trees
- Increase in water and nutrient (inorganic, biological) use efficiency in agro-ecosystems, including through recycling and reuse

Comment: <Not Defined>

Geographic scope:

- Regional

Region(s):

- Southern Asia

Comments: South Asia

Key Contributors:

Contributing CRPs/Platforms:

- BigData - Platform for Big Data in Agriculture
- Wheat - Wheat

Contributing Flagships:

- FP4: Sustainable intensification of wheat-based farming systems

Contributing Regional programs: <Not Defined>

Contributing external partners:

- IFPRI - International Food Policy Research Institute
- ICAR - Indian Council of Agricultural Research

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

New knowledge and skills of key stakeholders using evidence from large number of participatory validation trials on system-based optimization of rice-wheat rotation using zero-tillage and adapted crop varieties

Innovations: <Not Defined>

Elaboration of Outcome/Impact Statement:
Smallholder rice-wheat rotation farmers in the Eastern Indo-Gangetic Plains (IGP) of South Asia -- a global food insecurity and poverty hotspot -- experience significantly lower yields than that of Western IGP, despite higher rains, better groundwater and healthier soils. One key factor is late wheat planting (1). On-station and on-farm participatory research over 10 years focused on landscape-scale analysis and systemic intervention targeting (2, 5).

A systematic characterization of landscapes by remote sensing identified target areas. Social surveys pointed to causes of late planting. Researchers determined the tractability of influencing primary and secondary causes (3). Early planting promotion campaigns were married with targeted guidance to farmers, co-owned by National Agricultural Research and Extension (NARES) partners and modelled after the social marketing campaigns implemented by the governments of Bihar and eastern Uttar Pradesh (UP). A recent survey (12,100 HH) showed that 0.85 million households advanced wheat seeding by over a week, on 0.53 million ha across 38 districts of Bihar and 8 districts of Eastern UP (3, 10). Despite the increasing climatic risks, during 2018-19, average wheat grain yields increased by 1.0 tons/ha compared to base year, translating to p.a. production gains of ~0.5 million tons (US$ 145 million) (6, 7).

Similarly, early sowing successes were achieved in Punjab and Haryana, India (Western IGP), benefiting from the residual moisture of the previous monsoon and saving on irrigation costs. When farmers combine agronomic practices, water productivity improves significantly (8, 9, 11).

Understanding that adapted varieties need to be tolerant to early- and late-season warmer temperatures (14), the Borlaug Institute for South Asia (BISA), CIMMYT and the Indian Council of Agricultural Research (ICAR) initiated early-sown wheat trials with six national centers India in 2012, funded by the Bill & Melinda Gates Foundation. The significantly higher yields of early-sown BISA wheat genotypes built the foundation of ICAR's Special High Potential Yield Trial. Three best performing wheat varieties were released for October sowing in 2020, thanks to fast-track seed multiplication. The variety DBW 187 is now among the top 3 varieties grown in India (15). During the 2020/2021 season, 300,000 farmers planted early on 20% of total wheat area (16), saving one irrigation cycle, and leading to additional income of roughly US$ 200/ha. This early-sown area did not witness residue burning, thus reducing air pollution.

References cited:

(1) Dubey, R., Pathak, H., Chakarbarti, B., Singh, S., Gupta, D.K. and Harit, R.C. 2020. Impact of terminal heat stress on wheat yield in India and options for adaptation. Agricultural Systems, 181: 102826. https://doi.org/10.1016/j.agsy.2020.102826 (2) A., D'souza, A., & McDonald, A. J. (2015). Zero-tillage as a pathway for sustainable wheat intensification in the Eastern Indo-Gangetic Plains: Does it work in farmers' fields. Food Security, 7(5), 983?1001. https://doi.org/10.1007/s12571-015-0492-3 (3) Keil, A., Archisman Mitra, Amit K. Srivastava, Andrew McDonald (2019) Social inclusion increases with time for zero-tillage wheat in the Eastern Indo-Gangetic Plains. World Development, 123; 104582. https://doi.org/10.1016/j.worlddev.2019.06.006 (4) Keil, A., D'souza, A., & McDonald, A. J. (2016). Growing the service economy for sustainable wheat intensification in the Eastern Indo-Gangetic Plains: Lessons from custom hiring services for zero-tillage. Food Security, 8(5), 1011-1028. https://link.springer.com/article/10.1007/s12571-016-0611-9 (5) Keil, A., D'souza, A., & McDonald, A. J. (2017). Zero-tillage is a proven technology for sustainable wheat intensification in the Eastern Indo-Gangetic Plains: What determines farmer awareness and adoption. Food Security, 9(4), 723-743. https://doi.org/10.1007/s12571-017-0707-x (6) Keil, A., Mitra, A., D'souza, A., & McDonald, A. J. (2018a). Assessing the adoption dynamics of zero-tillage (ZT) wheat and the growth dynamics of related custom hire services in Bihar. Survey 1: ZT adoption and its welfare impacts at the farm household level. CIMMYT Research Data & Software Repository Network http://hdl.handle.net/11529/10548164. (7) Keil, A., Mitra, A., D?souza, A., & McDonald, A. J. (2018b). Assessing the adoption dynamics of zero-tillage (ZT) wheat and the growth dynamics of related custom hire services in Bihar. Survey 2: ZT service provision as a business opportunity. CIMMYT Research Data & Software Repository Network http://hdl.handle.net/11529/10548165. (8) Bhatt, R., Kaur, R., Ghosh, A., 2019. Strategies to Practice Climate-Smart Agriculture to Improve the Livelihoods Under the Rice-Wheat Cropping System in South Asia, in: Sustainable Management of Soil and Environment. Springer Singapore, Singapore, pp. 29?71. https://doi.org/10.1007/978-981-13-8832-3_2 (9) Jain et al (2017) Using satellite data to identify the causes of and potential solutions for yield gaps in India's Wheat Belt. Environ. Res. Lett. 12 094011 https://iopscience.iop.org/article/10.1088/1748-9326/aa8228 (10) Keil, A., Archisman Mitra, Andrew McDonald & Ram Kanwar Malik (2020). Zero-tillage wheat provides stable yield and economic benefits under diverse growing season climates in the Eastern Indo-Gangetic Plains, International Journal of Agricultural Sustainability, DOI:10.1080/14735903.2020.1794490 (11) Jat RK, P Singh, ML Jat, M Diac, HS Sidhua, SL Jat, D Bijarniya, HS Jat, CM Parihar, U Kumar, L Santiago L. Ridaura (2018) Heat stress and yield stability of wheat genotypes under different sowing dates across agro-ecosystems in India. Field Crops Research 218: 33-50 https://doi.org/10.1016/j.fcr.2017.12.020 (12) Joshi, a. K., Mishra, B., Chatrath, R., Ortiz Ferrara, G., Singh, R.P., 2007. Wheat improvement in India: present status, emerging challenges and future prospects. Euphytica 157, 431-446. https://doi.org/10.1007/s10681-007-9385-7 (13) Mondal, S., Singh, R.P., Crossa, J., Huerta-Espino, J., Sharma, I., Chatrath, R., Singh, G.P., Sohu, V.S., Mavi, G.S., Sukaru, V.S.P., Kalappanavarg, I.K., Mishra, V.K., Hussain, M., Gautam, N.R., Uddin, J., Barma, N.C.D., Hakim, A., Joshi, A.K., 2013. Earliness in wheat: A key to adaptation under terminal and continual high temperature stress in South Asia. F. Crop. Res. 151. https://doi.org/10.1016/j.fcr.2013.06.015 (14) The increasing adoption of early sown wheat has been demonstrated using satellite images, which was reported in several papers. https://doi.org/10.1016/j.agsy.2012.09.003 (2013); https://doi.org/10.1088/1748-9326/aa8228 (2017); https://doi.org/10.1175/WCAS-D-19-0122.1 (2020)

Quantification:

Type of quantification: a) Actual counts or estimates from a particular study (please provide reference)
Number: 500000.00
Unit: hectare
Comments: # hectares under early wheat seeding practice in Eastern Indo-Ganges plain https://doi.org/10.1080/14735903.2020.1794490 https://data.cimmyt.org/dataset.xhtml?persistentId=hdl:11529/10548164

Type of quantification: a) Actual counts or estimates from a particular study (please provide reference)
Number: 800000.00
Unit: farmers in Eastern India
Comments: US$200/ha from practicing early seeding of wheat in Bihar, Eastern India, 2014/15 & 2015/16 seasons clustered sampling technique; DOI:10.1080/14735903.2020.1794490

Type of quantification: b) Extrapolated estimates
Number: 300000.00
Unit: farmers
Comments: that planting October-sown wheat varieties, using machines that can plant wheat seeds under rice residue, in Punjab & Haryana states, India, 2020-2021 season Project satellite data, Balwinder Sidhu, CIMMYT

Type of quantification: b) Extrapolated estimates
Number: 20.00
Unit: percent
Comments: 20% of total wheat area, Punjab & Haryana, India with early sowing/seeding, e.g. October planting Project satellite data, Balwinder Sidhu, CIMMYT

Gender, Youth, Capacity Development and Climate Change:
Gender relevance: 0 - Not Targeted
Youth relevance: 1 - Significant
Main achievements with specific **Youth** relevance: Rural youth were empowered through creating service provisioning and business models for mechanization
CapDev relevance: 1 - Significant
Main achievements with specific **CapDev** relevance: Large number of training events were organized for farmers, extension agents and service providers
Climate Change relevance: 1 - Significant
Describe main achievements with specific **Climate Change** relevance: Helped in saving water and adapting to climatic risks specially heat stress and also reduced environmental foot prints

Other cross-cutting dimensions: Yes

Other cross-cutting dimensions description: This OICR has covered the cross-cutting analysis on social inclusion specially for small holder farmers, labour dimensions, business opportunities and climate change adaptation

Outcome Impact Case Report link: Study #3929

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