Evidences

Study #4274

Contributing Projects:
- P1370 - Build up rust screening capacity at Debre Zeit for durum wheat
- P1500 - Phenotypic evaluation of resistance to wheat stripe rust in advanced germplasm
- P858 - Mainstreaming the use and application of DNA Fingerprinting for plants for tracking crop varieties in Ethiopia
- P877 - Mitigating threat from Ug99, other races of stem rust and stripe rust pathogens through breeding and disseminating durably resistant wheat varieties
- P1881 - Build up breeding, rust and Septoria screening capacity in Ethiopia
- P873 - Ethiopia wheat rust scaling
- P1343 - Enhancing the impact of WHEAT AFS : Planning and coordination of FP/CoA/WP
- P1491 - Trait prioritization in wheat breeding in Ethiopia

Part I: Public communications

Type: OICR: Outcome Impact Case Report

Status: On-going

Year: 2021

Title: Wheat rust early warning works for Ethiopian farmers

Short outcome/impact statement:
In Ethiopia, almost 5 million smallholder farmers grow wheat and struggle with virulent, rapidly-evolving strains of stem and yellow rust. Working with national and international partners in Ethiopia and funded by bilateral donors, WHEAT scientists collaborated to fight rust through surveillance, advanced epidemiological modelling and an alert system for farmers.

Outcome story for communications use:

In Ethiopia, almost 5 million smallholder farmers grow wheat and struggle with virulent, rapidly-evolving strains of stem and yellow rust. Working with national and international partners in Ethiopia and funded by bilateral donors, WHEAT scientists collaborated to fight rust through surveillance, advanced epidemiological modelling and an alert system for farmers: Based on one the most comprehensive surveillance campaigns of wheat rusts in Africa (e.g. 13,000+ fields during last 13 years), researchers identified trends in the distribution of wheat stem, stripe and leaf rust. Results showed very high infection levels, with stem rust dominating (mean incidence: 44%). Recurrent rust outbreaks led to substantial economic losses (e.g. US$10s of millions p.a.). The widely adopted wheat variety, Digalu, showed a marked increase in disease prevalence, indicating a pronounced boom-and-bust cycle of major gene resistance (4; 2021).

Early warning activities helped farmers and authorities to respond opportunely to outbreaks of stem and yellow rust, avoiding catastrophic crop losses. A Farmers' Hotline, created by Ethiopia's Agricultural Transformation Agency (ATA), with 5.1 million+ registered farmers and extension agents, has enabled rapid information dissemination straight to their phones (1,2). The early warning systems are underpinned by long-term standardized surveillance efforts (4). MARPLE (Mobile And Real-time PLant disEase), a rapid diagnostic field test for all rust types (3) that was piloted in 2018, has revolutionized pathogen surveillance, reducing the risk for smallholder farmers. MARPLE has been scaled out to multiple hubs in Ethiopia, with support from the CGIAR Big Data Platform and UK partners (5, 8).

Challenges ahead: The performance of the predictive models is moderate for stem rust and still too poor for stripe and leaf rust. Applied research to advance modelling is needed. With regard to improved farming practices, scientists investigating Ethiopian yield gaps concluded that fine-tuning current crop management practices can deliver additional production, without expanding wheat area. But this requires inputs and technologies that too many farmers are not yet using, such as effective control of pests, diseases, weeds, and mechanization (9).

2nd user outcomes: The ARRCC project (10; started 2019) expanded rust early warning to South Asia. An EU-funded project (RustWatch) supports the introduction of rust tracking in Europe (8), which was featured at COP26 (9).

Links to any communications materials relating to this outcome:
- https://tinyurl.com/y33aet8n
- https://tinyurl.com/y3yjsfvp
- https://tinyurl.com/y2ajkrok
- https://doi.org/10.1371/journal.pone.0245697
- https://www.ata.gov.et/programs/highlighted-deliverables/8028-farmer-hotline/
- https://acaciaafrica.org/marple-diagnostics/
- https://tinyurl.com/y2zoex5r
- https://tinyurl.com/y3lhh7oy
- https://doi.org/10.1007/s13593-020-00654-z
- https://tinyurl.com/y299pxxc

Part II: CGIAR system level reporting

Link to Common Results Reporting Indicator of Policies : No

Stage of maturity of change reported: Stage 2

Links to the Strategic Results Framework:
Sub-IDOs:
- Reduced smallholders production risk
- Reduce pre- and post-harvest losses, including those caused by climate change

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

Description of activity / study: <Not Defined>

Geographic scope:
- National

Country(ies):
- Ethiopia

Comments: Rusttracker.org operates in 35 countries. Farmers and extension agents using MARPLE (in Ethiopia) can share their data via https://rusttracker.cimmyt.org/

Key Contributors:
Contributing CRPs/Platforms:
- BigData - Platform for Big Data in Agriculture
- Wheat - Wheat

Contributing Flagships:
- FP4: Sustainable intensification of wheat-based farming systems
- FP1: Inclusive and profitable wheat opportunities
Contributing Regional programs: <Not Defined>
Contributing external partners:
- FCDO - Foreign, Commonwealth & Development Office (formerly DFID)(United Kingdom)
- AU - Aarhus University
- WUR - Wageningen University and Research Centre
- BMGF - Bill & Melinda Gates Foundation
- CABI - Centre for Agriculture and Biosciences International
- UKRI - UK Research & Innovation
- EIAR - Ethiopian Institute of Agricultural Research
- MET OFFICE - MET OFFICE (United Kingdom)
- CAM - University of Cambridge
- USDA - U.S. Department of Agriculture
- JIC - John Innes Centre

CGIAR innovation(s) or findings that have resulted in this outcome or impact:
wheat rust early warning system

Innovations: <Not Defined>

Elaboration of Outcome/Impact Statement:

Globally, wheat yellow rust is spreading, causing wheat yield losses of 10-70% and crop losses of 5.5M tons per annum (1). All rust spores can migrate long distances and mutate quickly to produce diverse populations difficult to control. In Ethiopia, almost 5 million smallholder farming households growing wheat struggle with virulent, rapidly-evolving yellow and stem rust.

Working with lead partners in Ethiopia and funded by bilateral donors, WHEAT scientists collaborated to fight rust through extensive surveillance, advanced epidemiological modelling and a new alert system for farmers: Based on a comprehensive surveillance campaign (13,000+ fields during last 13 years), researchers identified trends in the distribution of stem, stripe and leaf rust. Results showed very high infection levels, with stem rust dominating. Recurrent rust outbreaks led to substantial economic losses (e.g. US$10s of millions p.a.). A widely adopted wheat variety showed a marked increase in disease prevalence, indicating a pronounced boom-and-bust cycle of major gene resistance: Every year, there were many independent outbreaks in different areas; but also local wave-like spreads from an initial outbreak site (2).

Early warning activities helped farmers and authorities to respond opportunely to outbreaks of stem and yellow rust, avoiding catastrophic crop losses. A Farmers' Hotline, created by Ethiopia's Agricultural Transformation Agency (ATA), with 5.1 million+ registered farmers and extension agents, has enabled rapid information dissemination straight to their phones (3). The early warning systems are underpinned by long-term standardized surveillance efforts (2) and advanced epidemiological models (10). The MARPLE rapid all rust types diagnostic field test (4; piloted 2018) has revolutionized pathogen surveillance, reducing the risk for smallholder farmers. MARPLE has been scaled out to multiple hubs in Ethiopia (5, 6; CGIAR Big Data Platform and UK partners).

Challenges ahead: The performance of simple predictive models is moderate for stem rust and still too poor for stripe and leaf rust, reinforcing the need for the advanced modelling approach. With regard to improved farming practices, scientists investigating Ethiopian yield gaps concluded that fine-tuning current crop management practices can deliver additional production, without expanding wheat area. But this requires inputs and technologies that too many farmers are not yet using, such as effective control of pests, diseases, and weeds, and mechanization (7).

2nd user outcomes: The ARRCC project (started 2019; https://www.cimmyt.org/projects/asia-regional-resilience-to-a-changing-climate-arrcc/) expanded rust early warning to South Asia. An EU-funded project (RustWatch) supports the introduction of rust tracking in Europe (8), which was featured at COP26 (9).

References cited:
- [1] MARPLE description (https://acaciaafrica.org/marple-diagnostics/)
- [2] Ali, Sajid, Rodriguez-Algab et al, Yellow Rust Epidemics Worldwide Were Caused by Pathogen Races from Divergent Genetic Lineages, Frontiers in Plant Science, 8, 2017 (https://doi.org/10.3389/fpls.2017.01057)
- [3] Allen-Sader et al., An early warning system to predict and mitigate wheat rust diseases in Ethiopia, 2019 (https://iopscience.iop.org/article/10.1088/1748-9326/ab4034/pdf)
- [4] New European rusts early warning project (https://tinyurl.com/y3yjsfvp)
- [5] Silva, J.V., Reidsma, P., Baudron, F. et al. Wheat yield gaps across smallholder farming systems in Ethiopia. Agron. Sustain. Dev. 41, 12 (2021) (https://doi.org/10.1007/s13593-020-00654-z)
- [6] 20 people trained online in 2021 by UK partner John Innes Center (https://tinyurl.com/y33aet8n)
- [7] Meyer M, Bacha N, Tesfaye T, Alemayehu Y, Abera E, Hundie B, et al. (2021) Wheat rust epidemics damage Ethiopian wheat production: A decade of field disease surveillance reveals national-scale trends in past outbreaks. PLoS ONE 16(2): (https://doi.org/10.1371/journal.pone.0245697)
- [8] University of Cambridge report about presentation at COP26 (https://tinyurl.com/y2ajkrok)
- [9] D. Hodson, Food System Impacts of Pests & Pathogens in a Changing Climate, August 19-23, 2019, Aspen, USA, presentation (https://tinyurl.com/y2zoex5r)
- [10] Big Data Inspire Award to rust early warning system (https://tinyurl.com/y299pxxc)

Quantification:

> **Type of quantification:** a) Actual counts or estimates from a particular study (please provide reference)
> **Number:** 5.00
> **Unit:** million
> **Comments:** farmers and extension agents subscribed to ATA phone advisory by 2021. Not only focused on rusts management. ATA confirmed the figure to Dave Hodson.

Gender, Youth, Capacity Development and Climate Change:
Gender relevance: 0 - Not Targeted
Youth relevance: 0 - Not Targeted
CapDev relevance: 1 - Significant
Main achievements with specific **CapDev** relevance: Train-the-trainer approach to enable extension agents to train farmers to use and participate in early warning system.
Climate Change relevance: 1 - Significant
Describe main achievements with specific **Climate Change** relevance: Increasing rusts damage in wheat fields in Ethiopia and the Global South is associated with climate change effects. Better managing and preventing rusts damage in farmers' fields is a contribution to adaptation.

Other cross-cutting dimensions: <Not Defined>

Other cross-cutting dimensions description: Other relevant bilateral non-CGIAR projects:
- Real-time and seasonal forecasting of wheat rust epidemics to inform surveillance and control: Ethiopia as a LMIC test case. GCRF project funded by BBSRC led by University of Cambridge Improved Disease Monitoring and Management for Wheat and Cassava Through Epidemiological Modeling . BMGF/FCDO funded project led by University of Cambridge
- African Crop Epidemiology System (ACES) funded by BMGF/FCDO and led by CABI

Outcome Impact Case Report link: Study #4274

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