Wheat Rust Early Warning and Advisory System in Ethiopia:

Impact Assessment in Two Major Wheat-Growing Regional States

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2. Methodology

2.1. Household survey sampling and data collection

In Ethiopia there are two cropping seasons: *meher* (May–September) and *belg* (February–April) The *meher* cropping season is the main season that produces more than three-quarters of the nation's total cereal output (USDA-FAS, 2008). Although some wheat is produced in the *belg* season, most is produced in the *meher* season, and wheat rust is a major problem during this season. Because of the severity of the problem, the rust early warning and advisory service (EWAS) was started as a pilot in 2015 and transitioned into a more operational system in 2017. To assess the impacts of the EWAS, we collected information directly from the intended clients, i.e., wheat farmers, using a structured questionnaire. The questionnaire was developed and pretested during September and October 2020. The survey questionnaire can be found in **Annexure A**. In addition, we conducted an opinion survey of agricultural extension agents using a simple questionnaire (**Annexure B**) and conducted targeted focused group discussions (FGDs) using structured questions (**Annexure C**), mainly to examine the opinions of the agriculture extension officers and officers at the Federal and Regional Bureaus of Agriculture on the usefulness of the EWAS. Finally, during November and December 2020, we deployed our trained enumerators to collect information from nine districts in the Amhara region: Basoliben, Motta, Wonberima, Burie, Lay Gaint, Misrak Estie, Mekiet, Wadila, and Debay Telatgin; and eight districts from the Oromia region: Arsi Robe, Hitosa, Gedeb Assosa, Dodola, Sinana, Agarfa, Ginir and Golocha. The selected districts are all important wheat-producing districts in Ethiopia. Historically, the Amhara region is more prone to yellow rust outbreaks, while the Oromia region is prone to outbreaks of both stem rust and yellow rust. Oromia represents a high-potential wheat-production area, with probably stronger connections than Amhara to research, extension, and inputs. Amhara is also an important wheat production area, but probably has weaker connections to services and inputs. The survey we deployed thus provides us with an opportunity to examine the relative importance of wheat yellow rust and stem rust in Ethiopia and to compare contrasting wheat production systems. Based on the sampling frame, the initial target was to interview 76 farmers from each district, resulting in a total of 1,275 farmers from 17 districts. However, at the end of our survey, we had collected information from about 1,017 farmers. The location of the sampled farm households by district is presented in Figure 1.

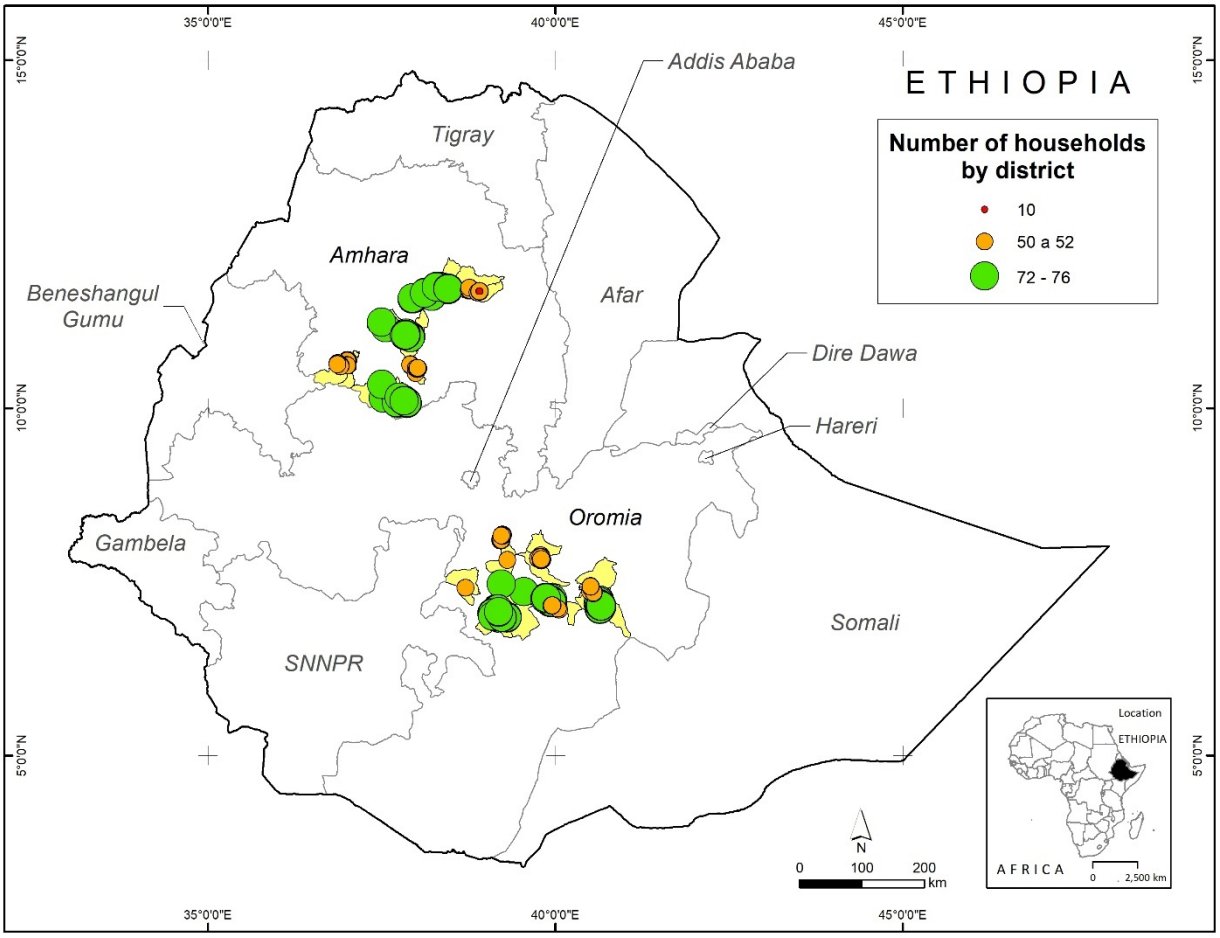

Figure 1: Location of the sampled households.

Source: Authors, based on a CIMMYT household survey, 2020.

We collected information on the demographic composition of the sampled households, occupation of the household members, housing conditions, social networks, access to infrastructure, wheat crop management information from the 2019 and 2020 *meher* seasons, the major biotic and abiotic stresses of wheat including yellow rust and stem rust, the actions of the wheat farmers based on whether or not they received early warning messages and whether or not they applied fungicides. We also asked farmers to evaluate the early warning messaging service. We collected plot-level information on wheat crops: at the time of data collection, the 2020 *meher* season wheat was still in the field, so only the yield and production information from the 2019 *meher* season wheat is available in our data.

To estimate the approximate economic benefits of the early warning messaging service, we asked the sampled farmers directly what they perceived to be the yield benefit from receiving the messages. The sampled farmers replied to our question in the form of a percentage gain such as <25%, 33%, 50%, or >50%. In calculating the economic benefits of the EWAS, however, we treated the reported yield benefit of >50% as the same as the reported yield benefit of 50% for ease of calculation. Our approach to calculating the economic benefits of the EWAS is subjective but

aims to give an initial impression of the potential benefits of the EWAS. Using this information, we calculated the economic gain of the early warning messaging service as follows:

$$EV_i = RV_i \times YLD_{2019i} \qquad (1)$$

$$EMG_i = EV_i \,/\, Wheat\ price\ in\ US\$/kg \qquad (2)$$

Where EV_i in Eq. (1) is the equivalent yield gain calculated as the reported yield gain RV_i multiplied by the actual yield (kg/ha) in 2019. Finally, the equivalent monetary gain EMG_i from the early warning messaging is calculated as RV_i divided by the price of wheat in US$/kg. In this study, the exchange rate between the US$ and the Ethiopia birr is set at US $1= 37.461 birr (Exchange Rate U.K. 2021).

In this report, data are mostly presented in a simple descriptive tabular format. We have also employed inferential statistics, such as the Ordinary Least Square (OLS), probit, multinomial and multivariate probit, two-part model estimation procedure, and Poisson regression analysis to elucidate the opinions of the farmers on the severity of rust, on whether or not the early warning service was beneficial, and finally, on whether or not they would like to purchase the early warning services. In the econometric estimation process, we have mainly used education, experience, family composition, and district of the households as the independent variables.

2.2. Focus group discussions

To triangulate findings from the household survey, data was collected from development agents at the *kebele (sub-district)* level using a separate questionnaire. To assess changes at the institution level, focus group discussions (FGDs) were conducted with federal and regional institutions. The FGDs were made with purposively selected federal and regional institution representatives and experts who had a direct responsibility for guiding high-level decision-making and/or providing expert advice and/or services for crop production and protection. The institutions involved in the focus group discussions were the Ministry of Agriculture, Ethiopian Institute of Agricultural Research, Oromia Region Agriculture Bureau, Amhara Region Agriculture Bureau, and CGIAR centers. In terms of responsibility, individuals involved in the group discussions were directors, bureau/division heads, researchers, and experts. The list of the participants is given in Table 1.

Table 1: List of institutions and representatives involved in the focused group discussion.

No.	Institution	Participant
1	Ministry of Agriculture	Director, Crop Development
2	Ministry of Agriculture	Director, Crop Protection and Regulatory (CPR)
3	Ministry of Agriculture	Former Director, CRP, and crop protection advisor and expert
4	Oromia Agric and NR Bureau	Crop protection team leader
5	Amhara Agric and NR Bureau	Crop protection team leader
6	Amhara Agric and NR Bureau	Crop Protection expert
7	EIAR	Crop Protection Researcher
8	CIMMYT	Researcher
9	Kulumsa Agric Res Center	Breeder
10	Debre Zeit Agric Res Center	Breeder

Source: Authors, based on CIMMYT household survey, November-December 2020.

The group discussions compared the situation before 2014 and after 2015 and were based on structured guiding questions on the detection and monitoring of rust epidemics, planning for fungicide purchase and wheat rust management, communication of rust incidences from federal to regional institutions and development agents and farmers, and major rust management practices. The discussants forwarded their views freely on the questions presented, and after listing all the ideas forwarded, those points agreed by all the participants were recorded as the final views of the group. Since the wheat rust early warning advisory service started in 2015, the guiding questions were designed to compare crop protection/rust management practices, processes, capacity, and policies over two periods: 2010–14 (before) and 2015–2020 (after) the rust early warning advisory service began.