Extended Abstract
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Paper/Poster Title	Climate information, production decision making, and technical efficiency in the face of climate change: panel data evidence from smallholder farmers in Ethiopia.

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Abstract	***200 words max***

Providing climate information has been widely suggested as an alternative strategy to lessen the effect of climate change and improve farmers' resilience capacity. However, to what extent utilising climate information in agricultural production decision-making impacts the production efficiency of subsistence farmers is not well scrutinized. In this study, using plot-level panel data collected from about 7,500 plots in Ethiopia, we examine the impact of climate information use in different agricultural production activities on technical efficiency. We employ propensity score matching (PSM) and Green's (2010) selection bias correction method in the stochastic frontier framework to account for selection biases stemming from observed and unobserved heterogeneities, respectively.

We find that using climate information for agricultural production decision-making significantly improves technical efficiency. On average, climate information user farmers attain a higher level of efficiency by about 12 per cent than non-users. We also document that the impact of climate information use is crop-specific. Our findings imply that in countries like Ethiopia where the impact of climate change is highly prevalent, the dissemination and promotion of climate information use in agricultural production decision-making could serve as a robust climate adaptation option to improve the climate resilience and efficiency of agricultural production.

Keywords	Climate information, climate resilience, technical efficiency, selection bias, Ethiopia.
JEL Code	Q1, Q00, O2

Introduction	***100 – 250 words***

Ethiopian agriculture is highly vulnerable to climate-related risks. This is mainly because subsistence farming characterized by low adaptive capacity and limited improved agricultural technology adoption dominates the sector. Providing up-to-date climate information could serve as an effective strategy to lessen the impact and build resilience to climate change. However, empirical evidence indicates that access to climate information per se is not a golden thread to hedge against the effects of climate change and improve agricultural productivity. This is mainly due to the presence of a substantial climate information usability gap (Lemos et al., 2012).

In the nascent literature on climate information, very few attempts have been made to measure the relationship between climate information and adaptation (Owusu et al., 2021; Alidu et al., 2021; Gitonga et al., 2020), food security (McKune et al., 2018), and crop productivity (Laetitia 2019). However, these studies either do not consider selection bias from observed and unobserved heterogeneities, do not disentangle information access from practical use of information, or are based on a small sample.

Against this backdrop, in this study, we first answer the question of why farmers do not make important agricultural production decisions based on the received climate information. Finally, we measure the impact of integrating climate information in agricultural decision-making on technical efficiency accounting for selection bias.

Methodology	***100 – 250 words***

Our identification strategy relies on the joint use of propensity score matching (PSM) and selection bias correction in the SPF framework introduced by Greene (2010). We conduct the PSM exercise using a "1-to-1" nearest neighbourhood matching technique with replacement. After excluding unmatched data points, we left with a total of 5, 252 matched observations, of which 3,939 are users and 1,313 are non-users. We check the validity of the matching procedure using two main approaches. First, we compare the distribution of the propensity scores across the two groups before and after matching. Next, we evaluate the standardized percentage bias of the covariates used in the matching exercise for the matched and unmatched samples. Both checks confirm that our matching procedure worked well.

We follow the following steps to generate the selection bias corrected average TE scores for users and non-users.

1. Using all the available data, we conduct PSM to address the bias from observed factors by matching users with non-users.
2. Estimate a pooled SPF (*Pooled-M*) model with the matched sample. It includes *climate information use* dummy variable (zero for non-users, one for users) as an explanatory variable.
3. Without addressing selection bias from unobserved factors, two distinct conventional SPF models are estimated using the matched subsamples, one for users (*Users-M*) and the other for the non-users (*Non-Users-M*). This model addresses only biases from observed heterogeneities.
4. Two separate SPFs are estimated using the matched subsamples, correcting for selectivity bias. These models address both types of selection biases.

Results	***100 – 250 words***

The average technical efficiency estimates for climate information user and non-user farm plots generated from the conventional and selection bias correction SPF models are presented in Table 1. The results reveal that climate information users are more technically efficient than non-users. And the difference is statistically significant. After accounting for biases from observed and unobserved factors (Selectivity-corrected SPF), the average TE differential between users and non-users is about 28.3 per cent, which is higher than the conventional counterpart (11.02%). The results indicate that by using climate information for agricultural production decision-making, farmers attain a higher level of production efficiency.

However, the effect is crop-specific. In our case, the highest efficiency gain of climate information use is attributed to Barley and Wheat crops. We also document that failure to address selection bias from observed and unobserved factors in the context of technical efficiency overestimates technical inefficiency scores and the efficiency gap between climate information user and non-user farming plots.

We also find that owning a phone, higher household size, being a male farmer, and perception of relying on the government during bad harvest seasons are associated with a higher chance of using climate information in agricultural production decision-making.

Table *1*: Average TE levels across different models

	Conventional SPF				**Selectivity-corrected SPF**		
	Pooled-M	**Users-M**	**Non-users-M**	**t-test of means**	**User-M-S**	**Non-users-M-S**	**t-test of means**
TE	45.75	47.24	42.55	4.69***	57.24	44.62	12.62***
TE Differential	11.02 %				28.28%		

Notes: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. M-S, Matched selection bias corrected.

Discussion and Conclusion

100 – 250 words

Ethiopia is one of the most at risk from climate change impacts standing among the top 20 % of vulnerable countries worldwide. While high-quality climate information tailored to the end users' needs, enables farmers to appropriately plan and implement key farming activities, there is a strong climate information usability gap. This makes climate information utilization more important than access to climate information per se.

In this study, we examine the impact of using forecasted climate information in agricultural activity decision-making on the technical efficiency of subsistence farmers in Ethiopia. We use three-year plot-level panel data collected from smallholder farmers in the Nile basin of Ethiopia. We address selection bias from observed and unobserved heterogeneities using PSM and Green's (2010) selection bias correction method in the SF analysis framework.

We find that using climate information in key agricultural activity decision-making significantly improves the technical efficiency of specific crops.

Our study implies that in subsistence farming where rain feed agriculture dominates the production system, climate information could serve as an early warning signal to reduce climate-related risks such as crop failure. By effectively utilising climate information to decide on important agricultural activities like the planting dates, the start of the harvest dates the type of seeds to use, farmers could allocate farm inputs and limited agricultural resources optimally. This not only improves production efficiency but also increases the resilience capacity of farmers by reducing asset depletion and climate-induced yield losses.