Drought Tolerant Maize Adoption in East Africa

Laura A Paul
PhD Candidate
UC Davis Agricultural and Resource Economics
lpaul@ucdavis.edu

Selected Paper prepared for presentation at the 2017 Agricultural & Applied Economics Association Annual Meeting, Chicago, Illinois, July 30-August 1

Drought Tolerant Maize Adoption in East Africa

Agricultural & Resource Economics
UCDAVIS

Laura A Paul

PhD Candidate, Agricultural and Resource Economics, University of California, Davis

Introduction

- Adoption of improved seed has been slow in Eastern Africa, for example, in Tanzania, only 22% of maize farmers are using any type of improved seed, despite their introduction decades ago (LSMS, 2013).
- The lag in adoption could stem from increased risks, higher costs, or information failures.
- I provide an analysis of drought tolerant (DT) maize response to rainfall and models farmer decisions to give insight into low adoption rates.

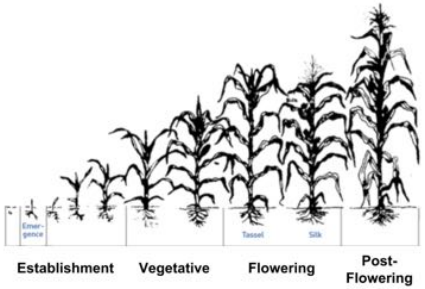
Would a farmer adopt DT maize with complete information of the production function and a known distribution of rainfall outcomes, given different risk preferences? How does the distribution of drought outcomes impact adoption?

Background

- CIMMYT has developed over one hundred new maize varieties through the DTMA program in the past two decades (CIMMYT, 2012).
- DT maize can withstand moderate drought with only small yield penalties (Fisher et al., 2015).
- In one study, only 12% of farmers have adopted drought tolerant maize (Fisher et al., 2015).
- Mid-altitude areas of Tanzania have experienced drought and subsequent crop failure in one in five years.

Maize Yield

- Maize yields have a nonlinear and asymmetric response to precipitation.
- Maize is particularly susceptible to water shortages during the establishment and flowering stages of the season.

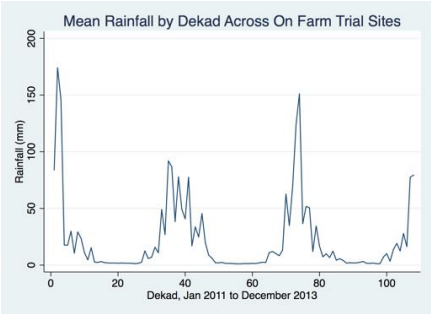


Methodology

- Using on-farm maize trial data obtained from CIMMYT and precipitation estimates from CHIRPS, I test the impact of precipitation and the DT trait on yields.
- I then develop a theoretical model of adoption given known distribution of precipitation outcomes.

Data

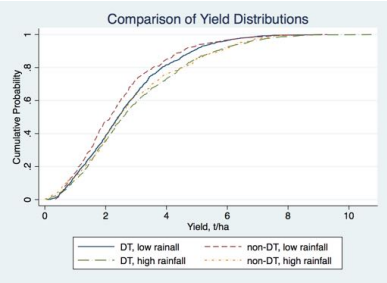
- The Climate Hazards group Infrared Precipitation with Stations (CHIRPS) dataset provides global precipitation estimates for every ten day period (dekad) beginning in 1981. CHIRPS data are observed at pixels of about five kilometers by five kilometers.
- The high frequency and density of these data allow me to investigate the temporal response of maize yields to rainfall.



- CIMMYT On Farm Trial data are cross sectional and span five years and four countries in eastern and southern Africa. The trials are conducted with DT and local varieties for comparison.
- The On Farm Trial data do not include planting date information.

Empirical Approach

- I estimate the impact of total precipitation over a season on maize yields.
- Then, use the CHIRPS data to estimate season start dates for each of the on farm trial locations, I estimate the impact of the temporal distribution of rain on precipitation.



Theoretical Model

- In a theoretical model, I test the impacts of several factors on drought tolerant adoption, including risk preferences, yield gain of the DT maize, cost, and different distributions of drought outcomes.

Preliminary Results

- The yield gain of the drought tolerant maize over the comparison varieties is significant and positive.
- The advantage of the drought tolerant trait is mitigated with more precipitation.
- The DT trait has a significant and positive impact on yields, even when controlling for intraseasonal precipitation and interaction.
- From the theoretical model: The marginal impact of an increase in the cost difference on adoption is negative. Increased probability of a catastrophic year also decreases adoption rates. Risk aversion, as found in Lybbert and Bell (2010), decreases adoption.

Next Steps

- Acquire updated on farm trial data for the 2016 season
- Match farm observations to build a panel dataset
- Use updated and higher resolution weather data
- Update model to incorporate more nuanced temporal effects of rainfall on yield outcomes
- Conduct simulations of adoption with range of precipitation distributions

Conclusions

- This analysis of the drought tolerant maize technology adoption explains the puzzling disconnect between the promoted advantages of drought tolerant seed (and other improved varieties) and the actual lagging adoption rates.
- I demonstrate the importance of understanding the response of DT technology to precipitation, as well as the role of risk preferences on DT maize adoption
- For a policy maker, this could indicate that a greater focus is needed on making seeds available at subsidized prices, or to reduce risk through crop insurance.
- This paper will contribute to discussions of technology adoption under risk, climate risk and staple production, and potential for stabilizing food security and income for farmers in Eastern and Southern Africa.

References

CIMMYT. The drought tolerant maize for Africa project: Six years of addressing African smallholder farmers' needs. Brief, International Maize and Wheat Improvement Center, Nairobi, 2012.

Fisher, Monica, Tsedeke Abate, Rodney W Lunduka, Woinishet Asnake, Yoseph Alemayehu, and Ruth B Madulu. Drought tolerant maize for farmer adaptation to drought in sub-Saharan Africa: Determinants of adoption in eastern and southern Africa. Climatic Change, 133(2):283–299, 2015.

Kostandini, Genti, Bradford Mills, and Elton Mykerezi. Ex ante evaluation of drought-tolerant varieties in eastern and central Africa. Journal of Agricultural Economics, 62(1):172–206, 2011.

Kostandini, Genti Roberto La Rovere, and Tahirou Abdoulaye. Potential impacts of increasing average yields and reducing maize yield variability in Africa. Food Policy, 43:213–226, 2013.

LSMS. Living standards measurement survey: Tanzania, 2013.

Lybbert, Travis and Michael R Carter. Bundling drought tolerance and index insurance to reduce rural household vulnerability to drought. Sustainable Economic Development: Resources, Environment, and Institutions, Elsevier Academic Press, USA, 2015.

Acknowledgements and Contact

I would like to thank professors Michael Carter, Travis Lybbert, and Steve Boucher for their guidance. I would also like to thank our CIMMYT colleagues, especially Peter Setimela.

Comments and ideas are appreciated: lpaul@ucdavis.edu.