

Within-Season Producer Response to Warmer Temperatures: Defensive Investments by Kenyan Farmers

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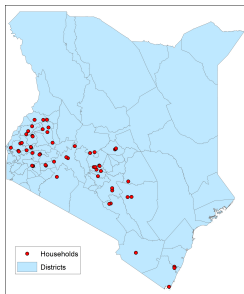
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This Paper

Research Questions: Do farmers in low-income countries promptly adjust to exogenous temperature shocks to production? If so, how?

What We Do: Use household-level panel data from maize farmers in Kenya, and daily temperature data disaggregated across different stages of the crop growth cycle, to investigate how farmers adjust agricultural inputs in response to within-season temperature variation.

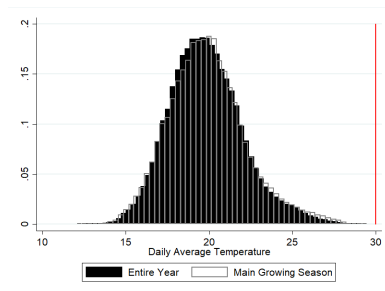


Data: Balanced household panel (TAMPA): 1242 households over 5 rounds: 1996-97, 1999-00, 2003-04, 2006-07, and 2009-10.

Daily gridded weather data: temperature (ERA-Interim), precipitation (CHIRPS) relative humidity (NASA-POWER).

Context

Daily average temperatures in maize-growing regions of Kenya range from 12-29C.



Maize yields only decline above 29-30C (Lobell et al., 2011; Schlenker and Roberts, 2009). So crop physiological yield response to warmer temperatures may be positive.

Importantly, any adverse yield effects in this context are almost surely result from indirect, biotic stresses arising from the temperature response of weeds, pests and pathogens.

Research Design

We estimate the following primary model:

$$Y_{ijqt} = \beta_1(GDD_{PP} > 21C)_{jqt} + \beta_2(GDD_{GS1} > 21C)_{jqt} + \beta_3(GDD_{GS2} > 21C)_{jqt} + f(Rain_{jqt}) + \alpha_i + \mu_{qt} + \varepsilon_{ijqt} \quad (1)$$

Y_{ijqt} is outcome of interest, for household i in village j in province q in round t ; village (α_j) and province-by-year (μ_{qt}) fixed effects; standard errors clustered by village.

Outcomes of interest: Pesticide use, weeding days, fertilizer use

$(GDD > 21C)_{jqt}$ is the sum of growing degree days over 21C (and <30C) during each stage of the main growing season (PP=pre-planting, GS1=planting through top dressing, GS2=post-top dressing)

Robust to household FE, district-by-province FE, controls for humidity and soil moisture, alternative measure of growing degree days, etc.

Headline Results

Kenya farmers adjust agricultural inputs in response to within-season temperature variation:

Result #1: Increase pesticide use in response to higher early season temperature to combat heat-induced increase in biotic stress from diseases and pests that are most effectively addressed soon after emergence

Result #2: Increase household weeding effort throughout the season in response to higher temperatures that promote weed growth

Result #3: Reduce inorganic fertilizer use early in the growing season, contemporaneously with increased pesticide use; binding financial liquidity constraints plausibly induce trade-offs among input expenditures

Result #4: Poorest tercile landholding hhs' pesticide (fertilizer) increase (decrease) is lower (higher), suggesting regressive distributional yield and income effects due to liquidity constraints

Main Results

Temperature, Fertilizer and Pesticide Use (Per Acre)

	(1) Pesticides 0/1 β / SE	(2) Ln Pesticide β / SE	(3) Fertilizer 0/1 β / SE	(4) Ln Fertilizer β / SE	(5) HH Weeding Days β / SE
CY PP DD >21C	0.0019 (0.0014)	0.0084 (0.0090)	-0.0003 (0.0005)	-0.0054 (0.0055)	0.0323** (0.0149)
CY GS1 DD >21C	0.0063** (0.0026)	0.0450*** (0.0159)	-0.0018** (0.0008)	-0.0180** (0.0087)	0.0375 (0.0271)
CY GS2 DD >21C	-0.0004 (0.0015)	-0.0108 (0.0079)	0.0003 (0.0004)	0.0005 (0.0044)	0.0392* (0.0219)
Village FE	Yes	Yes	Yes	Yes	Yes
Prov-by-Year FE	Yes	Yes	Yes	Yes	Yes
Rainfall Controls	Yes	Yes	Yes	Yes	Yes
Observations	3726	3726	6210	6210	3726
R	0.336	0.354	0.594	0.656	0.165

Notes: The table presents the effects of temperature (captured via growing degree days (DD) over 21C) on agricultural input use. CY: current year; PP: pre-planting or land preparation - onset of planting; GS1: planting or basal fertilizer application - onset of top dressing fertilizer; GS2: top dressing fertilizer application - onset harvest. Standard errors are in parentheses, clustered by village. *Significant at 10%. **Significant at 5%. ***Significant at 1%.