Weathering Shocks: The Effects of Weather Shocks on Farm Input Use in Sub-Saharan Africa

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outlines

- Motivation
- Research Problem and Objectives
- Methods and Strategy
- Data and Context
- Preliminary Results
- Study coping mechanism

Motivation: Agriculture in Sub-Saharan Africa (SSA)

- **Raising farm productivity,through diffusing technology adoption (mainly hybrid seeds, chemical fertilizers and pesticides) is the best pathway :**
  - To promote inclusive economies (Koussoubé & Nauges, 2017)
  - Ensure food security (Sheahan and Barrett, 2014)
  - Combat poverty in Sub-Saharan Africa (Bold et al., 2017)

Motivation: Agriculture in Sub-Saharan Africa (SSA)

- **MAT, however, has been slowly adopted by SSA farmers & many reasons explain these limited rates, including:**
  - Asymmetric information & constrained market access, risk attitudes, missing markets and limited farm credits (Kebede et al., 1990; Karlan et al., 2014)
  - Limited knowledge and inability to save (Duflo et al., 2006)
  - Poor infrastructure and weak institutions (Aker, 2011)

Motivation: Agriculture and Weather shocks in SSA

Importantly, most of the farming systems in SSA are heavily reliant on rainfall, thus exposing livelihoods to weather shocks

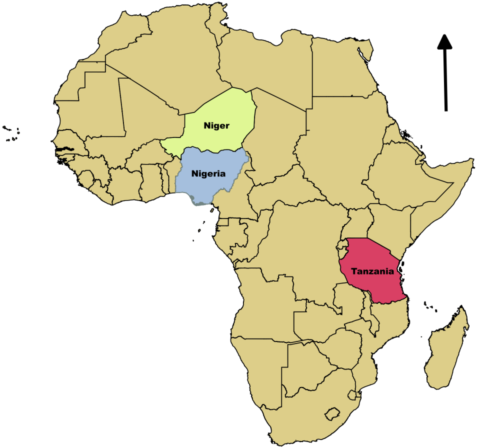
- *Unexpected weather shocks (droughts, flooding)*:
    - Likely to leave substantial adverse effects on farm productivity (Dell et al., 2014)
    - and might also influence farmers' attitudes towards adoption of farm technology
    - May, thus, affect investment decisions with upfront costs and uncertain outcomes (Yonas et al., 2008)

Research objective

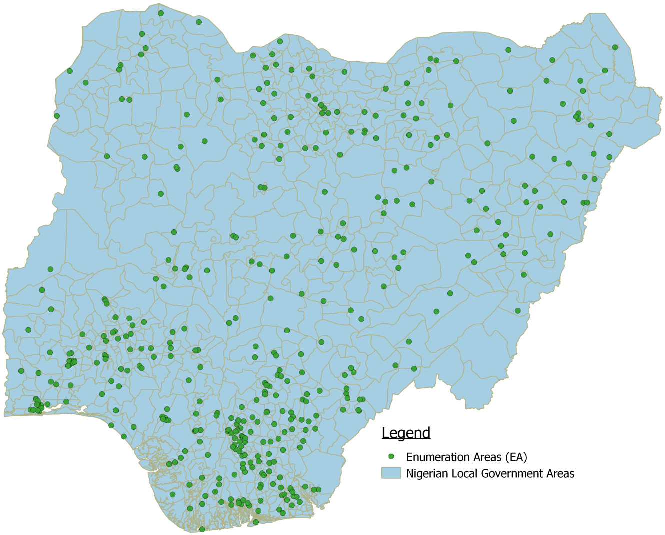
The main objective of this study is: **To provide evidence from the impact of weather shocks on the adoption decisions and intensity of farm input uptakes**.

- Specifically, this paper addresses the question:
  - **How do weather shocks affect the probability of adoption decision by small farmers?**
  - **How do small-farmers respond to climate variability in terms of farm input uptakes (Kg/ha) in SSA?**

Data and Context: Three SSA Countries



Data and Context: Nigeria

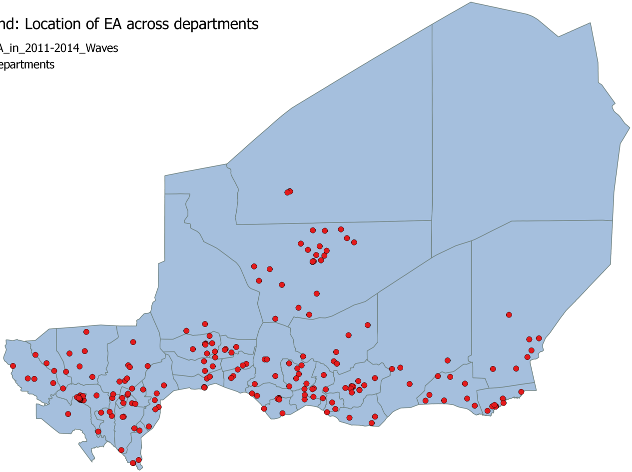


Data and Context: Niger

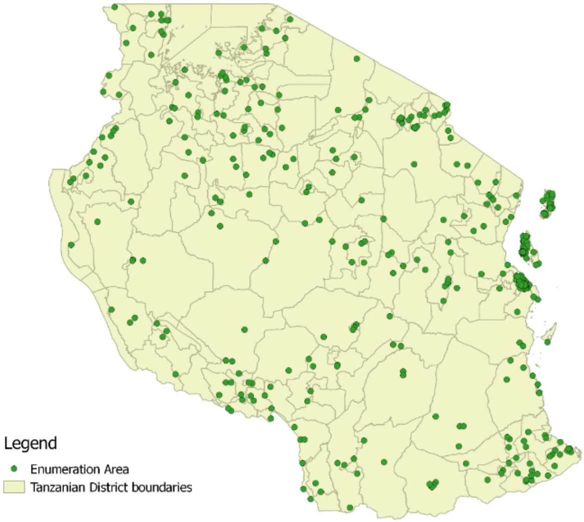
Ditribution of sampled EA in 2011 and 2014 Waves

Legend: Location of EA across departments

- EA_in_2011-2014_Waves
- Departments



Data and Context: Tanzania



Methods and Strategy

- To identify the causal effect of weather shocks on farmers' decision to adopt or not and the intensity of farm input use, I set the following expression:

$$Y_{jhct} = \alpha + \alpha_1 Drought_{cdt} + \theta_0 X_{jhct} + \theta_1 Z_{ct} + \phi_j + \pi_c + \lambda_t + \delta_d + \psi_{d*t} + \epsilon_{hjct} \quad (1)$$

Methods and Strategy

- I clustered the residuals by village to allow plausible correlations of residuals within the villages
- To derive the causal effect, I exploit a random exogenous variation in weather shocks over the village level beyond time invariant plot & household attributes,
- But also time invariant administrative and spatial attributes

Data sources

- **Two types of data**:
- *Living Standards Measurement Study- Integrated Surveys on Agriculture (LSMS-ISA)* provide useful farm plots information
- The dataset is geo-coded at the enumeration area (EA) level, making it possible to combine with other datasets.
- I augment these with monthly *Standardized Precipitation-Evapotranspiration Index (SPEI)*, which reflects a village's climatic water balance at different time scales.
- I use FAO Agricultural season calendars, to define:
  - Pre-planting seasons
  - Planting or Lean seasons

Data sources

- SPEI was developed by Vicente-Serrano et al. (2010)
- Climatic Research Unit of the University of East Anglia (available at: http://spei.csic.es/database.html)
- It is based on monthly precipitation and potential evapotranspiration
- SPEIbase, offers drought conditions at the global scale, with 0.5 degree spatial resolution

The distribution of household characteristics

Table 1: Nigeria

Variable	Mean	Std. Dev.	Min.	Max.	N
Age of household head	51.511	30.866	15	99	4970
Household size	6.551	3.331	1	31	4970
Gender of household head	0.893	0.309	0	1	4970
PP, Population age less 15 & over 64	2.176	1.769	0	11	4857

Source: Computed by author using SLMS-ISA

The distribution of household characteristics

Table 2: Niger

Variable	Mean	Std. Dev.	Min.	Max.
Age of household head	45.633	14.348	17	95
Household size	7.348	3.734	1	30
Gender of household head	0.941	0.235	0	1
PP, Population age less 15 & over 64	4.182	2.724	0	18
N		6011		

Source: Computed by author using SLMS-ISA

The distribution of household characteristics

Table 3:Tanzania

Variable	Mean	Std. Dev.	Min.	Max.	N
Age of household head	48.147	15.234	19	102	6718
Household size	5.609	3.084	1	46	6718
Gender of household head	0.779	0.415	0	1	6718
PP, Population age less 15 & over 64	2.843	2.05	0	24	6718

Source: Computed by author using SLMS-ISA

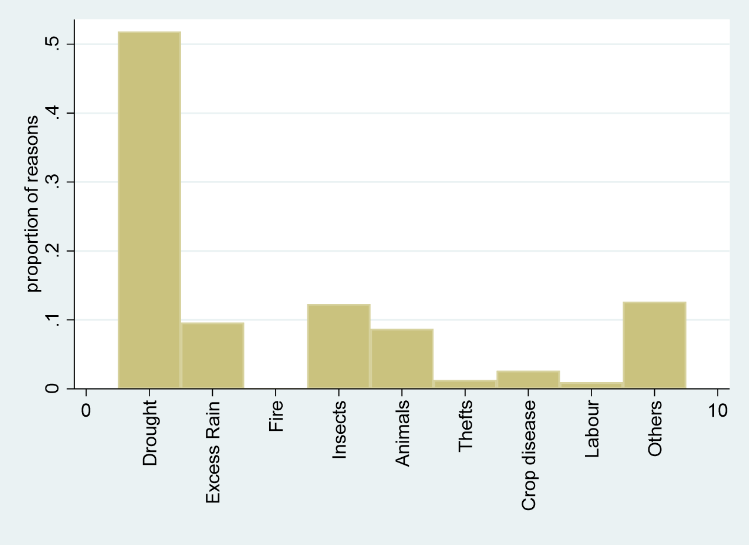
The distribution of plots sample size

Table 4: Distribution of plots sample size and weights in the data

Country	Year of survey	Number of plots in each wave
Tanzania	2008/09 (W1)	6,718
	2010/11 (W2)	8,093
	2012/13 (W3)	10,203
Nigeria	2010/11 (W1)	5,104
	2012/13 (W2)	5,911
	2015/16 (W3)	4,956
Niger	2011 (W1)	6,011
	2014 (W2)	4,257

Source: Computed by the Author, based on LSMS-ISA dataset.

Reported reasons of loss of crop yields: Tanzania



Reported reasons of loss of crop yields: Nigeria

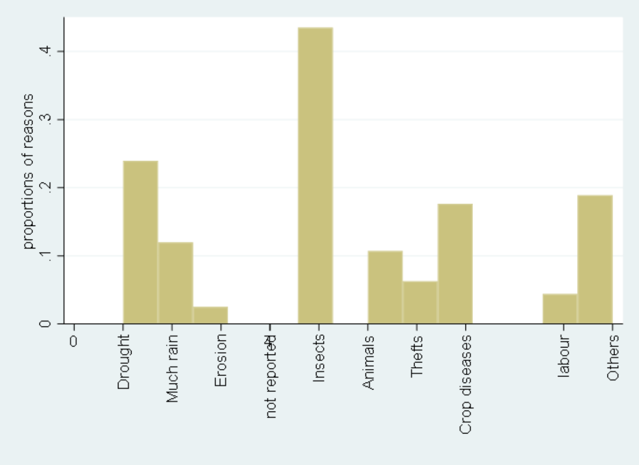


Table 5: Descriptive statistics of plots, inputs use and farm yield

	Nigeria			Niger		Tanzania		
	W1	W2	W3	W1	W2	W1	W2	W3
Any fertilizer (binary)	0.38(0.48)	0.37(0.50)	0.47(0.49)	0.35(0.47)	0.60(0.48)	0.15(0.36)	0.16(0.37)	0.14(0.34)
Any inorganic use (binary)	0.34(0.47)	0.34(0.47)	0.37(0.48)	0.12(0.33)	0.20(0.40)	0.10(0.30)	0.12(0.33)	0.11(0.31)
Any org. fertilizer. use (binary)	– –	– –	0.46(0.49)	0.31(0.46)	0.36(0.48)	0.10(0.31)	0.10(0.30)	0.11(0.32)
Pesticide use(binary)	0.14(0.34)	0.14(0.35)	0.18(0.39)	0.06(0.23)	0.07(0.24)	0.10(0.30)	0.09(0.28)	0.09(0.30)
Intensity of NPK (Kg/plot)	91.1(86.3)	108(105.6)	81.1(79.7)	68.9(191)	38 (75.8)	87.8(148)	95.2(135)	73.0(100)
Intensity of UREA(Kg/plot)	93.8(79.4)	105(87.67)	78.1(80.5)	66.3(168)	56 (91.7)	59.1(92.1)	69.6(74.0)	72.3(103)
Intensity of others chem. (Kg/plot)	68.1(72.2)	99.2(85.63)	91.6(71.3)	– –	188(226)	68.4(68.3)	72.2(74.2)	88.0(109)
Maize yield (Kg/plot)	347(252.4)	323(269.8)	309(260.3)	– –	– –	262 (227)	264 (227)	255 (228)
Beans yield (Kg/plot)	230(192.5)	240(200.3)	213(219.3)	54 (83.7)	95 (118)	92.0(132)	98.0 (125)	101 (127)
Millet yield (Kg/plot)	– –	– –	– –	280 (224)	283 (225)	– –	– –	– –
Average distance to the plot (Km)	1.60(3.28)	1.30(2.80)	1.20(2.40)	2.10(5.27)	2.40(2.46)	2.30(2.80)	2.60(3.17)	2.30(2.93)
Number of plot per household	4.50(3.08)	2.50(1.28)	4.80(2.98)	4.10(3.10)	4.30(3.20)	2.90(1.50)	3.00(1.60)	2.40(1.90)
Average land hh size(hectare)	0.50(0.69)	0.40(0.59)	0.40(0.57)	0.70(0.51)	0.70(0.45)	0.60(0.58)	0.70(0.60)	0.60(0.61)

Source: Computed by the Author based on LSMS-ISA dataset

Table 6: Weather shocks, intensity of fertilizer and pesticide in Nigeria

Variables	Fertilizer use	Pesticide use	Fertilizer intensity (kg/ha)
Pre-planting	-0.072**	0.052*	-0.366*
	(0.036)	(0.030)	(0.193)
Planting	0.056	0.043	0.491***
	(0.043)	(0.037)	(0.177)
Parcel Cntls	Yes	Yes	Yes
Household Cntls	Yes	Yes	Yes
District FE	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes
District-year FE	Yes	Yes	Yes
Observations	12,473	12,523	11,245
R-squared	0.718	0.610	0.659

Table7: Weather shocks, intensity of fertilizer and pesticide use in Niger

Variables	Fertilizer use	Pesticide use	Fertilizer intensity (kg/ha)
Pre-planting	-0.023	0.002	-0.828***
	(0.032)	(0.011)	(0.171)
Planting	0.068**	0.026**	-0.031
	(0.030)	(0.012)	(0.294)
Parcel Cntls	Yes	Yes	Yes
Household Cntls	Yes	Yes	Yes
District FE	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes
District-year FE	Yes	Yes	Yes
Observations	5,186	9,363	2,090
R-squared	0.618	0.510	0.696

Table 8: Weather shocks, intensity of fertilizer and pesticide use in Tanzania

Variables	Fertilizer use	Pesticide use	Fertilizer intensity (kg/ha)
Pre-planting	-0.420***	0.985***	-1.998***
	(0.107)	(0.206)	(0.626)
Planting	-0.163**	0.057**	-0.751**
	(0.065)	(0.024)	(0.330)
Parcel Cntls	Yes	Yes	Yes
Household Cntls	Yes	Yes	Yes
District FE	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes
District-year FE	Yes	Yes	Yes
Observations	24,185	24,794	24,266
R-squared	0.769	0.731	0.767

Robustness

Table A1: Weather shocks, farm input use in Nigeria

Variables	Fertilizer use	Pesticide use	Intensity(Kg/plot)	Fertilizer use	Pesticide use	Intensity(Kg/plot)
	Clustered at district level			Clustered at district by Survey year		
Pre-planting	-0.013***	0.009***	-0.032	-0.013***	0.009***	-0.032
	(0.005)	(0.003)	(0.030)	(0.004)	(0.003)	(0.026)
Planting	0.015*	0.013*	-0.046	0.015**	0.013**	-0.046
	(0.008)	(0.007)	(0.047)	(0.007)	(0.006)	(0.042)
Parcel Cntls	Yes	Yes	Yes	Yes	Yes	Yes
Household Cntls	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes	Yes	Yes	Yes
District-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,509	12,558	11,290	12,509	12,558	11,290
R-squared	0.623	0.521	0.577	0.623	0.521	0.577

Robustness

Table A2: Weather shocks, farm input use in Niger

Variables	Fertilizer use	Pesticide use	Intensity(Kg/plot)	Fertilizer use	Pesticide use	Intensity(Kg/plot)
	Clustered at district level			Clustered at district by survey year		
Pre-planting	-0.023	0.002	-0.828***	-0.023	0.002	-0.828***
	(0.027)	(0.012)	(0.171)	(0.025)	(0.010)	(0.149)
Planting	0.068	0.026	-0.031	0.068	0.026*	-0.031
	(0.049)	(0.018)	(0.324)	(0.042)	(0.015)	(0.285)
Parcel Cntls	Yes	Yes	Yes	Yes	Yes	Yes
Household Cntls	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes	Yes	Yes	Yes
District-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,186	9,363	2,090	5,186	9,363	2,090
R-squared	0.618	0.510	0.696	0.618	0.510	0.696

Robustness

Table A3: Weather shocks, farm input use in Tanzania

Variables	Fertilizer use	Pesticide use	Intensity(Kg/plot)	Fertilizer use	Pesticide use	Intensity(Kg/plot)
	Clustered at district level			Clustered at district by surveyed year		
Pre-planting	-0.420***	0.012	-1.998***	-0.420***	0.012*	-1.998***
	(0.097)	(0.008)	(0.598)	(0.100)	(0.006)	(0.610)
Planting	-0.163**	0.017**	-0.751*	-0.163**	0.017***	-0.751**
	(0.081)	(0.007)	(0.423)	(0.076)	(0.005)	(0.379)
Parcel Cntls	Yes	Yes	Yes	Yes	Yes	Yes
Household Cntls	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Survey year FE	Yes	Yes	Yes	Yes	Yes	Yes
District-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,141	24,255	24,218	23,185	24,255	24,266
R-squared	0.769	0.256	0.767	0.769	0.256	0.767

Main results

- A one month of drought in pre-planting results into a probability of 7% decrease in chemical fertilizer in Nigeria, 2% decrease in Niger and 42% in TZ respectively
- In the second column, I explore the results from equation (2) showing the causal effects of drought on pesticide use on a given plot.
- In all three countries, the signs of the parameter estimates on drought indices are positive throughout, in lean season, as expected
- A one month of drought in pre-planting reduces significantly the uptakes of fertilizer (intensity) of NPK and UREA (Kg/ha) across all three countries

Coping Mechanism

- Due to limited access to farm credits and uninsured farming, the small-farmers tend to become risk averse when exposed to weather shocks in SSA
- From these results, the suggestive evidence shows that drought weather induces the farmers to reduce purposively farm investments
- This further suggests the recurrence of the poverty traps for those farmers in case of unexpected climate shocks
- A targeted farm credit and weather-based insurance for low-income small-farmers would reduce those weather-based obstacles in SSA

Thank you very much for kind attention