Plot History, Soil Characteristics and Maize Response to Fertilizer in Kenya

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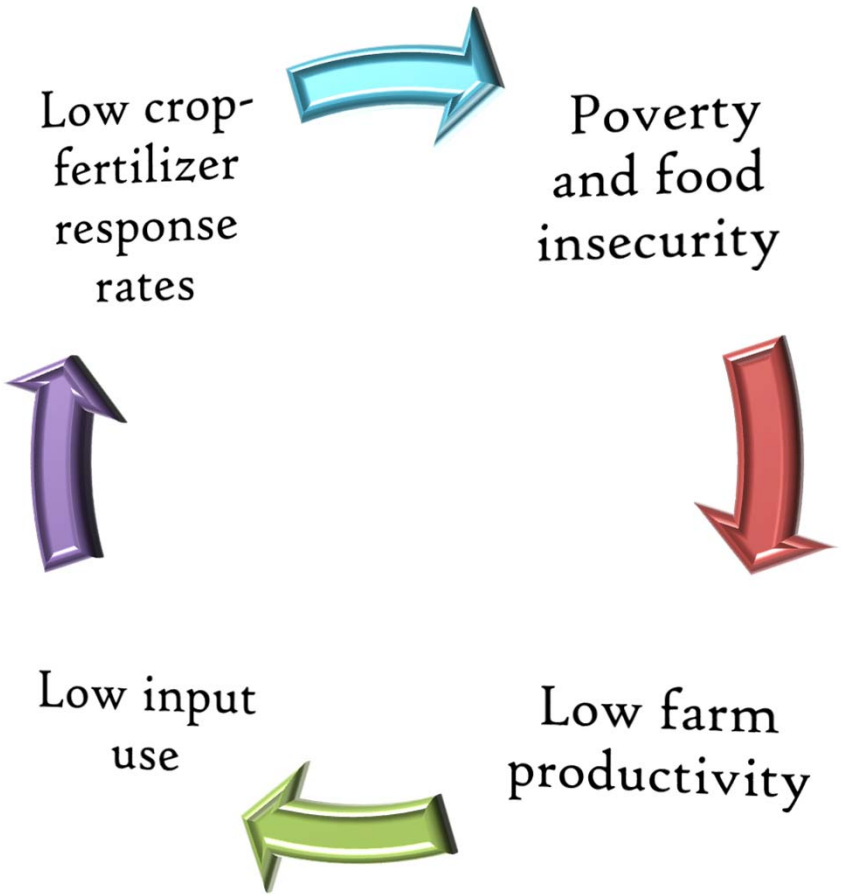
Background


Low crop-fertilizer response rates
Poverty and food insecurity
Low farm productivity
Low input use

Low maize-fertilizer response rates on farmer-managed fields

Study	country	Agronomic response rate (kgs maize per kg N)
Morris et al (2007)	W/E/S Africa	10-14
Sheahan et al (2013)	Kenya	14-21
Marenya and Barrett (2009)	Kenya	17.6
Liverpool-Tasie (2015)	Nigeria	8.0
Burke (2012)	Zambia	9.6
Snapp et al (2013)	Malawi	7.1 to 11.0
Holden and Lunduka (2011)	Malawi	11.3
Pan and Christiaensen (2012)	Tanzania	8.5 to 25.5
Minten et al (2013)	Ethiopia	11.7

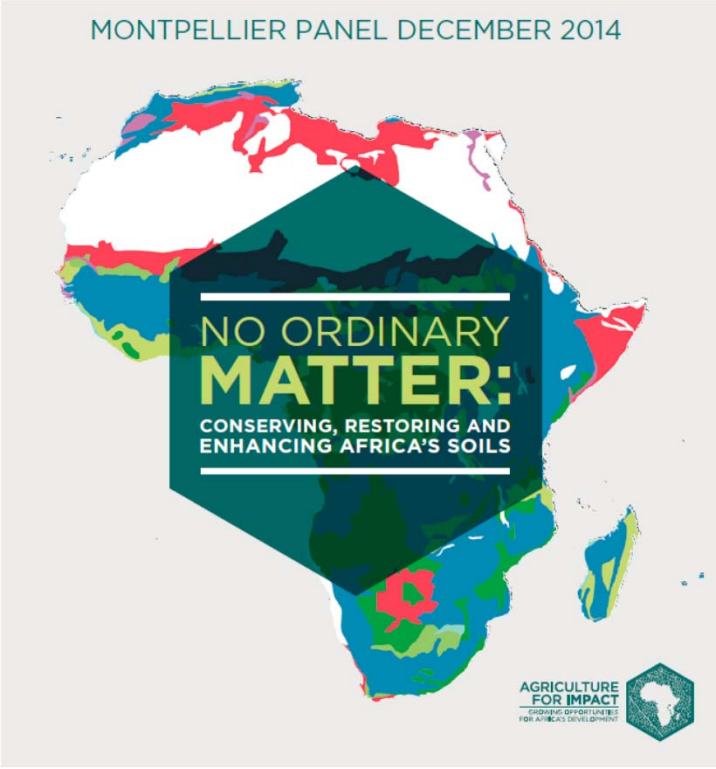
Factors depressing NUE of inorganic fertilizer use

1. Soil fertility depletion
2. Soil acidification
3. Micro-nutrient deficiencies

Soil fertility depletion

1. Nutrient mining and erosion
2. Low soil organic matter
    - Significant decline in SOM over past 20 years in Malawi (Mpeketula and Snapp)

Healthy soils are the foundation of food production



2015
International
Year of Soils

healthy soils for a healthy life

Factors depressing NUE of inorganic fertilizer use

1. Soil fertility depletion
2. Soil acidification
3. Micro-nutrient deficiencies

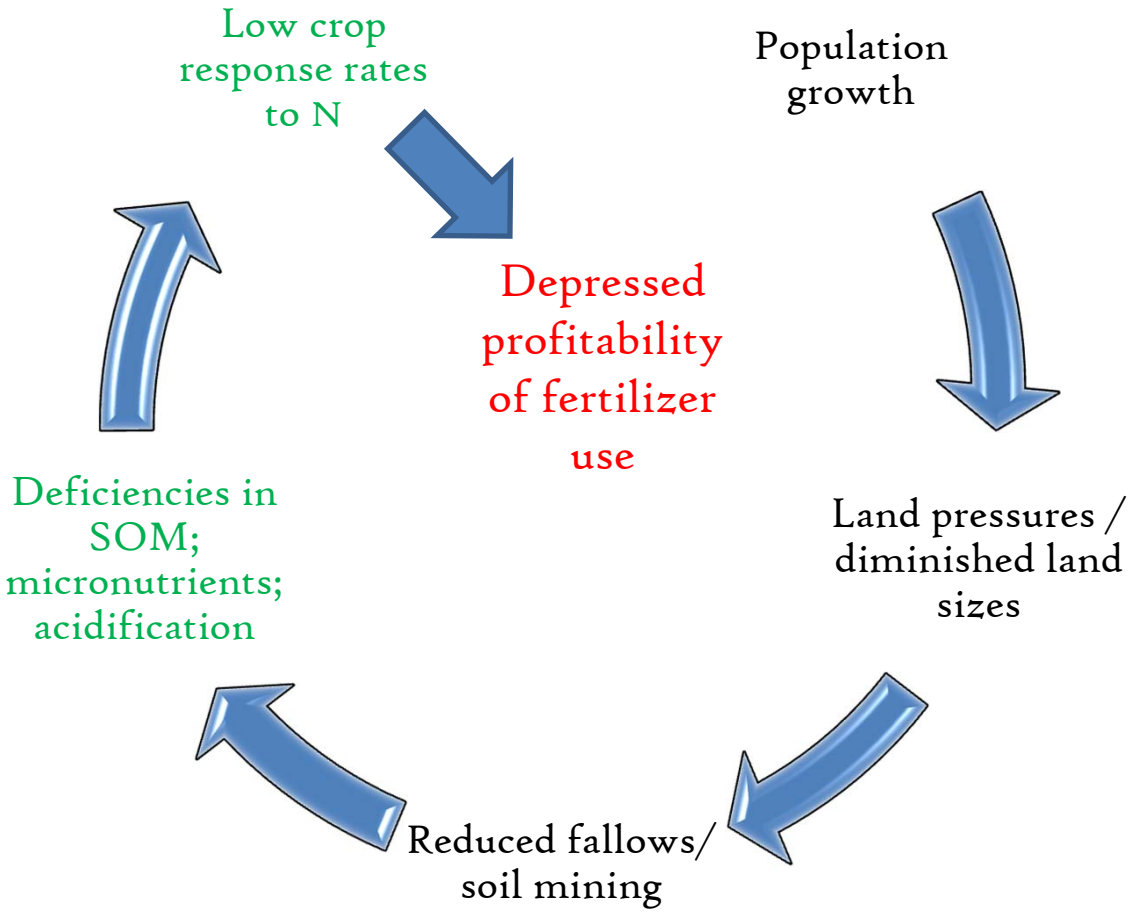
Soil acidification

- Long term and repeated use of nitrogen based fertilizers
- Constant mono-cropping
- Reduced farm yields
  - "...from now henceforth, we shall not be accepting inputs which cause more harm than good to our crops", Patrick Khaemba, Governor, Trans Nzoia County

Study objectives

- How does SOC influence maize response to fertilization (N)
- How does plot history affect soil organic carbon (SOC)

Conceptual framework



Methods

- Descriptive analysis
- Econometric analysis
  - Determinants of maize crop to N
  - Determinants of SOC

Data sources

- Rural household survey data
  - 650 households
  - 5 counties: Uasin Gishu, Trans-Nzoia, Kakamega, Kisii & Machakos
- Largest maize plot information
  - Characteristics (size, manager, etc.)
  - History (fallow, soil and water conservation, etc.)
  - Soil tests results (SOC, CEC, pH, etc.)

Descriptive results

	Quintile -- SOC					
	1_lowest	2	3	4	5_highest	Full sample
Total Org. Carbon (%)	0.90	1.47	1.84	2.24	3.28	1.95
Kgs of maize/kg of N	83.38	86.58	87.37	100.50	178.64	105.25
Plot size (ha)	0.25	0.52	0.50	0.41	0.49	0.44
'00kgs of maize produced	0.59	1.42	1.71	1.59	1.54	1.37
'000kgs of maize/ha harvested	2.61	2.69	2.95	2.73	3.03	2.80
Kgs of maize/kg of fertilizer	19.71	20.38	19.95	20.55	40.17	23.71
Soil pH (value)	5.47	5.34	5.19	5.26	5.50	5.35
Cation Exchange Capacity (%)	17.36	19.60	23.12	24.16	25.00	21.86
Sand %	70.10	60.52	55.95	52.41	55.20	58.82
Silt %	8.32	9.17	11.00	14.52	12.68	11.14
Clay %	21.58	30.22	33.12	32.28	31.35	29.73

Econometric results: Maize response to N

Ln(kgs of maize/ha harvested)	[I]	
	Coef.	P>t
N kgs/ha harvested	0.013	0.00
SOC	0.054	0.08
Maize hectares harvested	-0.098	0.00
Number of crops grown on plot	-0.036	0.04
1=hybrid seed; 0=otherwise	0.167	0.07
Seed rates (kgs/ha)	0.108	0.00
Sq. seed rate	-0.002	0.06
1=manure; 0=otherwise	0.112	0.03
Mode of land prep (none=base)		
Oxen	0.136	0.04
Tractor	0.061	0.41
Family labor costs '000KSh	0.014	0.00
Hired labor costs '000KSh	0.018	0.00
pH	-0.005	0.08
No Obs.	633	

Econometric results: Maize response to N

Ln(kgs of maize/ha harvested)	[II]	
	Coef.	P>t
N kgs/ha harvested	0.012	0.00
SOC	0.043	0.17
N kgs*SOC	0.001	0.03
Plot size	-0.140	0.00
Number of crops grown on plot	-0.036	0.04
1=hybrid seed; 0=otherwise	0.175	0.06
Seed rates (kgs/ha)	0.106	0.00
Sq. seed rate	-0.002	0.08
1=manure; 0=otherwise	0.108	0.03
Mode of land prep (none=base)		
Oxen	0.150	0.02
Family labor costs '000KSh	0.014	0.00
Hired labor costs '000KSh	0.018	0.00
pH	-0.005	0.07

Econometric results: Maize response to N

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Seed rates (kgs/ha)	0.108	0.00
Sq. seed rate	-0.002	0.06
1=manure; 0=otherwise	0.112	0.03
Mode of land prep (base=manual)		
Oxen	0.136	0.04
Family labor costs '000KSh	0.014	0.00
Hired labor costs '000KSh	0.018	0.00
pH	-0.005	0.08
No Obs.	633	

Dep. var. Soil Organic Carbon (%)

	[I]	
	Coef.	P>t
Plot size	0.079	0.02
Years since the field was first cultivated	-0.085	0.00
1=dispute concern; 0=dispute free	-0.014	0.02
_cons	2.705	0.00

Dep. var. Soil Organic Carbon (%)

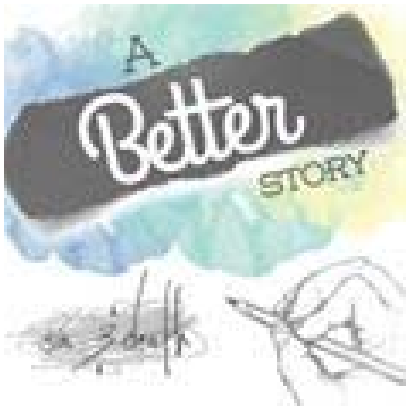
	[II]	
	Coef.	P>t
Years since the field was first cultivated	-0.052	0.06
1=dispute concern; 0=dispute free	-0.015	0.00
Soil and water conservation practice dummies		
bench/cut-off/contour farming (1=yes; 0=no)	0.252	0.00
crop residue/household refuse (1=yes; 0=no)	0.335	0.00
terracing (1=yes; 0=no)	0.169	0.06

Dep. var. Soil Organic Carbon (%)

	[III]	
	Coef.	P>t
Years since the field was first cultivated	-0.058	0.04
1=dispute concern; 0=dispute free	-0.015	0.00
Soil and water conservation practices- years in use		
bench/cut-off/contour farming	0.004	0.08
crop residue/household refuse	0.011	0.00
grazing on fields	-0.005	0.10
_cons	2.554	0.00

Policy question

How to move from a situation where ISPs are the cornerstone of agricultural development to a holistic program of sustainable productivity growth?



Policy recommendations

1. R&D (national ag research)
2. Extension programs / soil testing
3. Programs to help farmers restore soil quality
4. More appropriate fertilizer use recommendations

Thanks

Maize response to N

Ln(kgs of maize/ha harvested)	[I]		[II]	
	Coef.	P>t	Coef.	P>t
N kgs/ha harvested	0.013	0.00	0.012	0.00
N kgs*SOC	--	--	0.001	0.03
Maize hectares harvested	-0.098	0.00	-0.140	0.00
Number of crops grown on plot	-0.036	0.04	-0.036	0.04
1=monocrop; 0=intercrop	-0.016	0.84	-0.014	0.85
1=hybrid seed; 0=otherwise	0.167	0.07	0.175	0.06
Seed rates (kgs/ha)	0.108	0.00	0.106	0.00
Sq. seed rate	-0.002	0.06	-0.002	0.08
1=manure; 0=otherwise	0.112	0.03	0.108	0.03
Mode of land prep (none=base)				
Oxen	0.136	0.04	0.150	0.02
Tractor	0.061	0.41	0.086	0.27
Family labor costs '000KSh	0.014	0.00	0.014	0.00
Hired labor costs '000KSh	0.018	0.00	0.018	0.00
Decision maker (1=Spouse; 0=head)	-0.121	0.12	-0.107	0.17
Decision maker- age	-0.004	0.83	-0.002	0.99
Decision maker - gender (1=male; 0=female)	-0.042	0.52	-0.037	0.57
Decision maker- education attainment	0.003	0.69	0.003	0.68
Decision make number of months at home	-0.015	0.18	-0.016	0.16
CEC	-0.005	0.08	-0.005	0.07
SOC	0.054	0.08	0.043	0.17
Sand	-0.002	0.49	-0.002	0.45
Silt	-0.002	0.66	-0.002	0.64
_cons	6.834	0.00	6.880	0.00
No Obs.	633.000		633.000	
R2	0.320		0.330	

Dep. var: SOC

	[I]		[II]		[III]	
	Coef.	P>t	Coef.	P>t	Coef.	P>t
Maize hectares	0.036	0.29	0.052	0.12	0.079	0.02
Distance to the field (minutes)	0.003	0.43	0.003	0.52	0.002	0.40
Years since the field was first cultivated	-0.052	0.06	-0.058	0.04	-0.085	0.00
1=dispute concern; 0=dispute free	-0.015	0.00	-0.015	0.00	-0.014	0.02
Soil and water conservation practice dummies						
farm yard manure (1=yes; 0=no)	-0.074	0.36	--	--	--	--
slash and burn (1=yes; 0=no)	-0.011	0.88	--	--	--	--
bench/cut-off/contour farming (1=yes; 0=no)	0.252	0.00	--	--	--	--
crop residue/household refuse (1=yes; 0=no)	0.335	0.00	--	--	--	--
grass strips (1=yes; 0=no)	-0.055	0.47	--	--	--	--
grazing on fields (1=yes; 0=no)	-0.151	0.15	--	--	--	--
terracing (1=yes; 0=no)	0.169	0.06	--	--	--	--
drainage (1=yes; 0=no)	-0.085	0.55	--	--	--	--
compost (1=yes; 0=no)	0.086	0.65	--	--	--	--
planting basins (1=yes; 0=no)	0.211	0.16	--	--	--	--
Soil and water conservation practices- years in use						
farm yard manure	--	--	-0.003	0.34	--	--
slash and burn	--	--	-0.002	0.32	--	--
bench/cut-off/contour farming	--	--	0.004	0.08	--	--
crop residue/household refuse	--	--	0.011	0.00	--	--
grass strips	--	--	-0.004	0.28	--	--
grazing on fields	--	--	-0.005	0.10	--	--
terracing	--	--	0.004	0.25	--	--
drainage	--	--	0.002	0.81	--	--
compost	--	--	0.004	0.59	--	--
planting basins	--	--	0.010	0.28	--	--
_cons	2.511	0.00	2.554	0.00	2.705	0.00