EGERTON UNIVERSITY

TEGEMEO INSTITUTE OF AGRICULTURAL POLICY AND DEVELOPMENT

Adoption of maize technology bundles: Implications on productivity and food Security

Tim Njagi, Mary Mathenge, Eric Mukundi & Michael Carter

Motivation

- Recent studies show positive impact of technology adoption on income, poverty & food security (Asfaw et al, 2012; Magrini & Vigani, 2014; Mathenge et al., 2014; Khonje et al., 2015)
- However, this studies have looked at technology adoption singly e.g. adoption of improved seed or fertilizer
- Most of these studies have looked at impacts on production & income with the exception of Magrini & Vigani (2014)

Motivation

- In practice, these technologies are used jointly/package (Byerlee and Hesse, 1982)
- There exists systematic or stochastic interdependence for adoption for various choices (Smale and Heisey, 1993)
- Important to consider other indicators of household welfare
  - Food security and nutrition indicators
- This study introduces technology bundles
  - How different technologies interact and complement each other

Motivation

Key questions:

- What are the drivers of different technology bundles use?
- How do adoption of technology bundles impact productivity & food security?
- Use the case of maize farmers in Kenya

Data

- 1,800 maize growing HH
  - Study areas in mid-altitude areas in Kenya
    - Western region
    - Central region
  - Three wave panel data (2013, 2015 and 2016)
  - Matched households (11% attrition)
  - Collected data
    - HH characteristics
    - Farm characteristics
    - Input use

Methods

- Estimate a choice model for adoption of technology bundles (Panel MNL following Valletta, 1997)
  - Non Adopters (local varieties without inorganic fertilizer)
  - Fertilizer only (local varieties with inorganic fertilizer)
  - Improved seed only
  - Improved seed and inorganic fertilizer
- FE to estimate effect on key outcome variables
  - Productivity
  - Per capita output (food availability)
  - (Count regression)Dietary diversity (food intake)
  - Consumption coping strategy

Trends in farm characteristics by year

Variables	2013	2015	2016
Total cultivated land (acres)	1.5	1.7	1.6
Proportion of land allocated to maize (%)	0.75	0.76	0.71
Proportion of land under maize with Hybrids			
Proportion using Improved seed (%)	0.71	0.75	0.72
Seed use intensity (kgs/acre)	9.06	7.80	8.50
Proportion using inorganic fertilizers (%)	0.66	0.81	0.72
Maize productivity (kgs/acre)	618	602	691
Off farm income	181,571	213,977	202,172
Crop Income	85,599	75,516	70,709

Characteristics by use of technology bundle -2013

Variable	Non-improved seed only	Non-improved+ fertilizer	Improved seed only	Improved seed + fertilizer
Age of household head	54.80	54.19	52.29	50.07
Household size	5.58	5.27	5.84	5.49
Total cultivated land (acres)	1.61	1.31	1.60	1.63
Proportion of land allocated to maize (%)	0.84	0.80	0.75	0.70
Proportion of Maize land under hybrids				
Seed use intensity (Kg/acre)	10.63	10.47	8.54	8.36
Fertilizer application rate (Kg/acre)	-	26.14	-	32.88
Maize productivity (kgs/acre)	333	479	502	774
Off farm income	68,985	88,676	94,875	136,121
Crop Income	31,956	37,090	46,348	65,658

Characteristics by use of technology bundle -2015

Variable	Non-improved seed only	Non-improved+ fertilizer	Improved seed only	Improved seed + fertilizer
Age of household head	54.47	56.52	55.84	51.36
Household size	6.13	5.82	5.95	6.02
Total cultivated land (acres)	1.59	1.65	1.35	1.76
Proportion of land allocated to maize (%)	0.88	0.84	0.71	0.72
Proportion of Maize land under hybrids				
Seed use intensity (Kg/acre)	8.71	8.68	6.80	7.58
Fertilizer application rate (Kg/acre)	-	28.54	-	35.61
Maize productivity (kgs/acre)	300	372	503	711
Off farm income	69,743	103,032	92,839	164,397
Crop Income	21,126	30,171	42,347	60,756

Characteristics by use of technology bundle -2016

Variable	Non-improved seed only	Non-improved + fertilizer	Improved seed only	Improved seed + fertilizer
Age of household head	56.9	54.5	53.1	52.3
Household size	5.3	5.8	5.9	5.5
Total cultivated land (acres)	1.5	1.5	1.6	1.7
Proportion of land allocated to maize (%)	0.8	0.8	0.7	0.7
Proportion of Maize land under hybrids				
Seed use intensity (Kg/acre)	9.9	10.0	8.0	7.9
Fertilizer application rate (Kg/acre)	-	22.8	-	34.7
Maize productivity (kgs/acre)	410	452	626	820
Off farm income	121,280	100,090	111,575	149,973
Crop Income	28,297	33,530	46,468	70,321

Complementarity of inputs (2013)

	Fertilizer	Improved Seed
HH size	-0.000251	0.0160
Age of head (years)	0.0175	-0.0101
Gender of head (1=male)	-0.0159	-0.0257
Completed primary school	0.122	0.0779
Completed secondary school	0.112	0.276*
Completed college or higher	0.472**	0.450*
Total cultivated land (acres)	0.0262	0.0604*
Proportion of land under maize production	-0.0881	-0.486***
Received credit	0.0283	0.169**
Alritude (MASL)	0.00244***	0.00219***
Visited a demo plot	0.420***	0.252***
Region (western=1)	-1.049***	-0.781***
Correlation btw fertilizer & improved seed	0.38***	

Complementarity of inputs (2015)

	Fertilizer	Improved Seed
HH size	-0.0229	0.0247
Age of head (years)	0.0293*	-0.0415**
Gender of head (1=male)	0.00360	-0.00952
Completed primary school	-0.0993	0.141
Completed secondary school	-0.00817	0.419**
Completed college or higher	0.0317	0.609**
Total cultivated land (acres)	0.138***	0.0297
Proportion of land under maize production	0.151	-0.681***
Received credit	0.208**	0.208**
Alritude (MASL)	0.00158***	0.00262***
Visited a demo plot	0.477***	0.427***
Region (western=1)	-0.482***	-0.706***
Correlation btw fertilizer & improved seed	0.52***	

Complementarity of inputs (2016)

	Fertilizer	Improved Seed
HH size	0.00830	0.0198
Age of head (years)	0.00180	-0.0441**
Gender of head (1=male)	0.00228	-0.0441
Completed primary school	0.0441	0.231
Completed secondary school	0.0136	0.321*
Completed college or higher	0.228	0.517**
Total cultivated land (acres)	0.0721**	0.0892**
Proportion of land under maize production	-0.192	-0.709***
Received credit	0.287***	0.205**
Alritude (MASL)	0.00250***	0.00263***
Visited a demo plot	0.446***	0.405***
Region (western=1)	-0.908***	-1.065***
Correlation btw fertilizer & improved seed	0.49***	

Choice of technology bundle

Technology choices (non-improved seed used as base category)	Non-improved seed with fertilizer	Improved seed only	Improved seed with fertilizer
Age of Head	0.0819**	-0.0227	0.00342
Gender of head (1=male)	-0.390**	-0.376**	
Education level of head (base=no formal education)			
Primary education	-0.0196	0.25	0.307
Secondary	-0.154	0.482	0.546**
College and above	0.485	1.108**	1.291***
Total arable land (acres)	0.00572	0.024	0.165***
Received credit dummy	0.213	0.294*	0.531***
Altitude (MASL)	0.00288***	0.00364***	0.00708***
Visited demo plot dummy	0.262*	0.126	0.903***
Geographical region (1=western)	-1.381***	-1.542***	-2.641***
Year=2013	0.925***	0.052	1.130***
Year=2015	0.0775	-0.185	0.404***
Constant	-5.340***	-3.580***	-8.020***

Effect on productivity & food security

	Daily Per Capita Maize Output	Yield	Diet Diversity	Consumption Coping Strategy
Non-improved seed with fertilizer	13.87**	-10.60	-0.000358	-2.220
	(5.555)	(33.68)	(0.0170)	(1.942)
Improved seed only	24.36***	73.98**	0.0130	1.033
	(7.445)	(35.57)	(0.0163)	(2.143)
Improved seed with fertilizer	29.66***	79.62**	0.0435***	-2.517
	(6.928)	(35.49)	(0.0148)	(1.936)
Completed college education or higher	212.0***	1,400***	-0.295***	27.23**
	(70.47)	(281.3)	(0.0874)	(10.92)
Household size	-24.35***	0.599	-0.000495	0.728**
	(2.627)	(7.227)	(0.00327)	(0.354)
Age of head	0.372	1.004	-0.00440***	0.483**
	(0.791)	(4.963)	(0.00156)	(0.206)

Effect on productivity & food security

	Daily Per Capita Maize Output	Yield	Diet Diversity	Consumption Coping Strategy
Total cultivated land	33.43***	-70.08***	0.00918**	-0.769*
	(5.344)	(12.38)	(0.00395)	(0.437)
Received credit	-6.451	-1.390	0.00255	1.533*
	(4.995)	(24.18)	(0.00768)	(0.920)
Year=2013	6.334	-11.82	0.109***	-11.19***
	(6.601)	(19.94)	(0.00733)	(0.887)
Year=2015	10.73**	74.33***	0.0437***	-14.45***
	(5.453)	(23.84)	(0.00758)	(0.936)
Constant	93.25	760.4		24.20
	(136.2)	(520.3)		(29.15)

Conclusion & Recommendation

- Use of either improved seed or fertilizer can improve productivity & household food security
- Highest gains observed with improved seed & fertilizer bundle
  - Complementarity of technology
  - Use intensity of improved is okay but fertilizer is still low
- Constraints may exist
  - Knowledge
  - Finance
  - Gender
- Providing information to farmers, access to finance

Thank you