The Possibility of a Maize Green Revolution in the Highlands of Kenya :an Assessment of an Emerging Intensive Farming System

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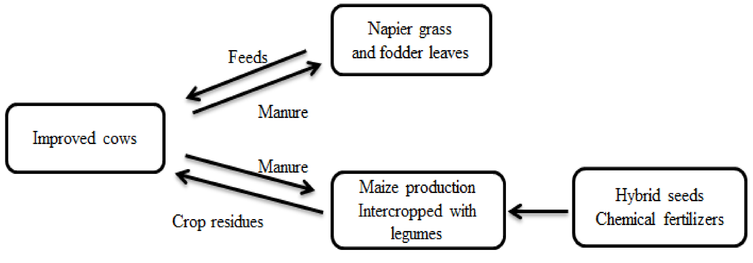
A New Intensive Farming System

- As population pressure on land grows rapidly in Kenya, rural farmers have started to intensify land use, which has led to the emergence of **a new maize farming system**.
- A typical farmer in this system grows Napier grass, which is a common feed crop for cattle that can also repel pests, feeds it to improved cattle that are raised in stalls, collects manure from the stalls, and applies it on maize fields, where intercropping hybrid maize with nitrogen-fixing legumes is practiced.



Objectives

- To explore the determinants of the new maize farming system
- To estimate the effects of each element of the new farming system on productivity. Spherically, this study attempts to estimate the effects of each improved production practice element of the new farming system on productivity and to measure the impact of the entire system by creating a single agriculture intensification index that captures this multidimensional input intensification.

Data

- Two rounds of panel household surveys were implemented jointly by GRIPS and Egerton University - Tegemeo Institute in 2004 and 2012.
- Limit samples to households who grow maize on at least 20% of their farm land.
- Panel sample size: 622 households.
- A typical household have land parcels each of which is subdivided into multiple plots to grow multiple crops.
- Parcel ID is traceable over time, but plot ID is not.
  - Example: Parcel 1 in main season in year t / Parcel 1 in short season in year t

Plot 1 (potato)	Plot 2 (maize)
Plot 3 (maize and beans)	

Plot 1 (banana)	Plot 2 (fallow)
Plot 3 (maize and beans)	

- This data structure makes it possible to estimate parcel and parcel-year fixed effects models.

Agricultural Intensification Index

- It is difficult to measure the overall effect of the farming system, which consists of multiple changes in input uses and production practices, by simply looking at individual elements of the new farming system separately because their effects on agriculture production could be interactive. Therefore, it will be useful to construct a single index that represents the degree of adoption of the new maize farming system.
- Principal component analysis is used to construct an index of agricultural intensification.

$$AI_{it} = \sum_{k=1}^{4} F_k \left[\frac{(x_{kit} - \bar{x}_k)}{s_k}\right],$$

where
- AI_{it} : agricultural intensification index
- k∈{1,2,3,4} corresponds to each of the factors constructing the agricultural intensification index, namely, a dummy for hybrid maize seed adoption, quantity of intercropped legume seeds, quantity of manure, and quantity of chemical fertilizer.
- F_k: factor score for the variable k which consists of the farming system
- x_{itk}: the variable k
- $\bar{X}_k$ and S_k are the mean and standard deviation of the variable k

Estimation Results

Table 1. Determinants of input intensification per cropping season (parcel fixed effects model, plot level data)

	Manure (t/ha)	Chemical fertilizer (10kg/ha)	Hybrid maize seeds (=1)	Intercropping legume seeds (kg/ha)	Intensification index
Log of sub-location population density (persons/km^2)	0.47	0.34	0.152*	5.227	0.328*
	(0.722)	(0.907)	(0.078)	(4.364)	(0.194)
Log of owned land size per working age member (ha)	0.069	-0.370**	-0.010	-1.056	-0.068*
	(0.118)	(0.177)	(0.017)	(0.973)	(0.039)
Log of cultivated plot size (ha)	-0.544***	-0.985***	0.017	-4.513***	-0.231***
	(0.104)	(0.198)	(0.016)	(0.923)	(0.043)
Observations	2,879	2,884	2,908	2,883	2,831
R-squared	0.068	0.164	0.189	0.106	0.155
Number of parcels	1,118	1,119	1,122	1,120	1,113

Household & sub-location covariates, a short season dummy, a year dummy, division dummy, year & division interaction terms, & a constant term are included.

Table 2. Effects of input intensification on crop production per cropping season (parcel-year fixed effects models, plot level data)

	Log of maize yield (kg/ha)		Log of value of crop production (KSh/ha)		Log of net crop income (KSh/ha)	
Hybrid maize seeds (=1)	0.079		0.0806		0.156*	
	(0.065)		(0.085)		(0.092)	
Intercropping legume seeds (kg/ha)	-0.001		0.003**		0.004***	
	(0.001)		(0.001)		(0.001)	
Manure (t/ha)	0.018*		0.031***		0.019	
	(0.009)		(0.012)		(0.012)	
Chemical fertilizer (10kg/ha)	0.0180***		0.0103		-0.01	
	(0.006)		(0.009)		(0.009)	
Intensification index		0.167***		0.217***		0.176***
		(0.031)		(0.04)		(0.039)
Log of cultivated plot size (ha)	-0.530***	-0.534***	-0.450***	-0.457***	-0.435***	-0.430***
	(0.045)	(0.0441)	(0.056)	(0.0546)	(0.065)	(0.0638)
Observations	2,810	2,810	2,810	2,810	2,809	2,809
R-squared	0.656	0.653	0.398	0.396	0.75	0.748
Number of fixed-effects	1,803	1,803	1,805	1,805	1,805	1,805

A short season dummy & a constant term are included.

Table 3. Effects of the intensification index on agriculture production per year (household fixed effects model, household level data)

	Log of value of crop & milk production (KSh/ha)	Log of net crop & milk income (KSh/ha)	Log of net non-farm income per capita (KSh)	Log of net total income per capita (KSh)
Intensification index	0.293***	0.277***	0.0787	0.168***
	(0.030)	(0.038)	(0.082)	(0.0386)
Observations	1,195	1,195	1,189	1,190
R-squared	0.389	0.524	0.184	0.287
Number of households	619	619	617	617

Household & sub-location covariates, a year dummy, division dummy, year & division interaction terms, & a constant term are included.

Summary of Main Results

- Increase in population density and decrease in land-labor ratio accelerate farming intensification.
- Adoption of hybrid maize seed, organic fertilizer application, chemical fertilizer application, and other chemical inputs application have positive and significant effects on land productivity.
- These findings are supported by the significant positive impacts of the agriculture intensification index on land productivity and income.

Conclusions

- Population pressure on land accelerates farming intensification.
- New maize farming system seems to facilitate small farmers to improve efficiency of agricultural production in Kenya.
- The establishment of the “optimum” mix of technologies and their dissemination are required.

Further Information

- Please contact muraokarie@gmail.com for more information. The views expressed are those of the authors and all errors are our own.

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