Does adoption of improved agricultural inputs improve food and nutrition security?

A study of maize-growing farm households in Tanzania

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EAAE

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Background

The situation in Tanzania

- High prevalence of undernourishment (34.6%) vs 19.5 average of SSA
- Incomes depend on agriculture
- Low agricultural productivity (8% use improved seed and 3% use fertilizer)
- Lack of credit, information and access to natural resources holds smallholders from innovation

Agricultural productivity of smallholders is key to poverty alleviation and improved nutrition

Background

National Agricultural Input Voucher Scheme (NAIVS)

- Response to the food crisis of the late 2000s
- Objective: improve agricultural productivity of the smallholders
- Targeted to smallholder maize- and rice farmers

- 50% subsidy on the price of fertiliser and seed
- Participation is limited to 3 years; smallholders are expected to invest themselves after 3 years

Background – research question

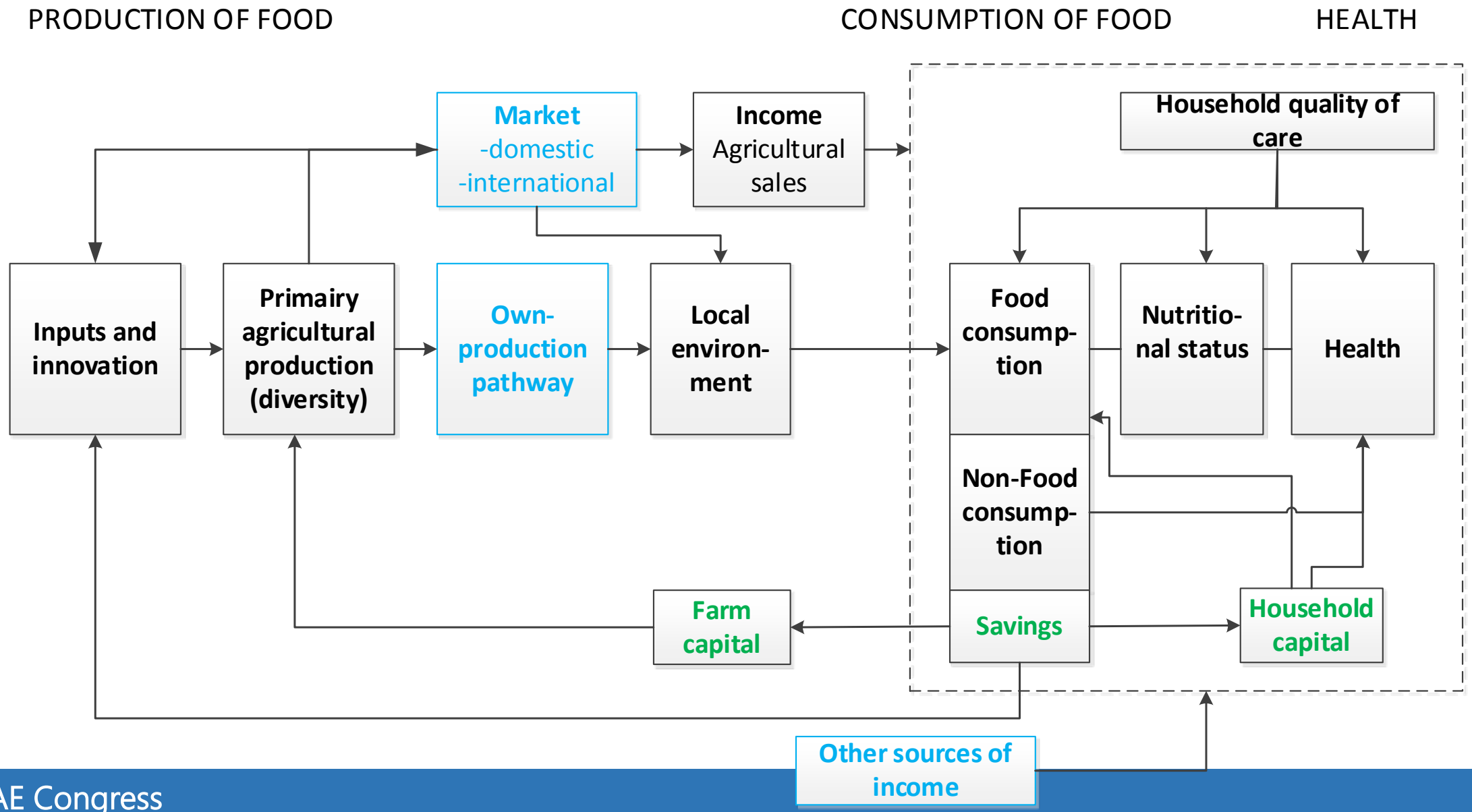
Does farm-level adoption of improved maize seed and fertiliser use affect food security for households in rural Tanzania?

Approach – definitions

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (FAO)

The FAO definition of nutrition security is “a situation that exists when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, in order to ensure a healthy and active life for all household members”

Approach – conceptual framework



Approach – indicators

Food Variety Score (FVS) – count of food items consumed in week before interview

Food Consumption Score (FCS) – weighted (frequency) count of food items (frequency) in week before interview

(reduced) Coping Strategy Index (CSI) – subjective food insecurity based on predefined questions on food availability

Model

Based on the Agricultural Household model the regression model will relate improved seed- and fertiliser use to the FVS, FCS and CSI:

$$\mathrm{FS_i} = \beta_0 + \beta_1 V_i + \beta_2 h_i + \beta_3 f_i + \varepsilon_i \quad i = 1, \ldots, N \quad (1)$$

$\mathrm{FS_i}$: Food security indicators in operational terms

V_i : Vector of household, farm and region characteristics

h_i: hybrid seed use

f_i : fertiliser use

might be endogenous!

Model IV-approach

First stage

$$h_i = \alpha_0 + \alpha_1 V_i + \alpha_i M_i + u_i \quad i = 1, \ldots, N \qquad (2)$$

$$f_i = \gamma_0 + \gamma_1 V_i + \gamma_i M_i + v_i \quad i = 1, \ldots, N \qquad (3)$$

Second stage

$$FS_i = \beta_0 + \beta_1 V_i + \beta_2 \hat{h}_i + \beta_3 \hat{f}_i + w_i \quad i = 1, \ldots, N \qquad (4)$$

M_i: vector of instrumental variables

$\hat{h}$ and $\hat{f}_i$: predicted values from first stage

Data

Living Standard Measurement Survey (LSMS) collected by Tanzania National Bureau of Statistics (NBS)
Integrated Survey on Agriculture (ISA)

- Agricultural production section
- Food consumption section

Waves for 2008/2009, 2010/2011 and 2012/2013 with 3,280, 3,924 and 5,015 households respectively (12,219 respondents in total)

Data - characteristics

- 37,9% of all respondents are maize farmers, i.e. 4,632 respondents
- 20.4% of maize farmers use hybrid seeds
- 14.4% of maize farmers uses fertiliser
- Households have on average 5.6 members
- Average land size is 3.9 acres
- Households consume on average 12.8 different food items a week, and 7.8 different food groups

Data - characteristics

	Non-maize-growing farmers			Maize farmers								
				All			Adaptors hybrid seed			Fertilizer adaptors		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
DDS	8.13	2.66	7567	7.87	2.07	4632	8.63	2.00	946	8.68	1.84	665
FVS	14.17	6.08	7567	12.83	4.94	4632	14.58	5.45	946	14.62	4.93	665
FCS	54.47	21.50	5609	49.51	17.87	3321	55.25	19.04	677	51.79	18.02	507
CSI	4.19	8.08	5609	3.47	7.12	3322	2.65	5.98	678	1.96	4.73	507

Results - OLS

Determinants	FVS	FCS	CSI
Hybrid see use	**0.769**	0.806	-0.363
Fertilizer use	**0.895**	**1.548**	-0.620
Female-headed household	-0.015	-0.614	**1.250**
Education	**1.622**	**3.468**	**-1.167**
Household size	0.012	0.141	**0.159**
Household wealth/income			
Household quality index	**2.200**	**6.131**	**-1.269**
Off-farm income (log)	**0.090**	**0.182**	-0.001
Farm characteristics (land, assets, livestock, membership credit org.)	yes	yes	yes
Regional dummies	yes	yes	yes
Climatic factors (rainfall & temp.)	yes	yes	yes
Distance to nearest town (km)	**-0.006**	0.010	0.003
Distance to nearest market (km)	0.002	-0.002	**-0.013**
Dummy for year 2012	**1.382**	**5.260**	-0.553
Intercept	**-7.002**	**-9.210**	**11.584**
Number of observations	2,728	2,727	2,728
Adjusted R^2	0.257	0.244	0.073
F Statistic	**40.283**	**37.723**	**9.987**

Results - OLS

- Effect of input use:
  - Hybrid seed use increases FVS
  - Fertilizer use increases FVS and FCS
  - No effect on CSI
- Education and housing quality have positive effects on fs
- Total land size, value of farm assets and saving groups increase food security
- Rainfall and temperature have positive effects
- If everything else is constant, 2012 scores higher than 2010

Results – endogeneity of inputs

- Subsidy for improved seed
- Subsidy for fertiliser
- Average hybrid seed use in the previous period at district level
- Average fertiliser use in the previous period at district level

=>data from 2008/2009 excluded from the regressions

Results – endogeneity of inputs

Food and nutrition indicators for farm households with and without a subsidy for hybrid maize seed and/or fertilizer

	Not subsidised			Subsidised		
	Mean	SD	N	Mean	SD	N
	Seed					
FVS	14.575	5.445	946	14.369	5.289	295
FCS	55.246	19.037	677	52.973	17.997	277
CSI	2.650	5.984	678	3.489	7.181	278
	Fertiliser					
FVS	14.623	4.926	665	14.778	5.280	54
FCS	51.786	18.022	507	46.870	17.535	23
CSI	1.959	4.728	507	0.609	1.644	23

Results – IV-results

Determinants	IV-first stage		IV- second stage		
	Hybrid seed	Fertilizer	FVS	FCS	CSI
Hybrid see use#			0.974	3.751	1.125
Fertilizer use#			-0.026	-1.783	-1.228
Subsidy for hybrid see use	**0.388**	0.02			
Hybrid seed use at district level (t-1)	**0.257**	-0.005			
Subsidy for fertilizer use	**0.159**	**0.423**			
Fertilizer use at district level (t-1)	0.020	**0.544**			
Household characteristics	yes	yes	yes	yes	yes
Household wealth/income	yes	yes	yes	yes	yes
Farm characteristics (land, assets, livestock, membership credit org.)	yes	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes	yes
Climatic factors (rainfall & temp.)	yes	yes	yes	yes	yes
Distance to nearest town	-0.0002	0.00002	**-0.006**	0.008	0.003
Distance to nearest market (km)	-0.0004	-0.0001	0.003	-0.0002	**-0.013**
Dummy for year 2012	0.364	0.046	**1.360**	**4.470**	-1.003
Intercept	**-0.613**	**-0.114**	**-6.277**	-6.257	**12.620**
Number of observations	2,703	2,703	2,703	2,702	2,703
Adjusted R^2	0.268	0.322	0.255	0.237	0.067
F Statistic	**39.10**	**50.40**			

Results – diagnostic test for instruments

Test	FVS	FCS	CSI
Weak instruments (hybrid seed)[#]	85.76 ***	85.76 ***	85.76 ***
Weak instruments (fertilizer) [#]	112.54 ***	112.54 ***	112.54 ***
Wu-Hausman	0.94	1.31	1.03
Sargan	2.64	0.03	2.90
Wald	38.94 ***	36.68 ***	9.72 ***

[#] First stage regression is similar for all distinguished food and nutrition security indicators

Results

- Instruments have significant impacts on hybrid seed use and fertilizer use (first stage)
- Diagnostic test suggest OLS results are preferred
  - F-test: instruments are not weak
  - Sargan test: overidentification test is not rejected
  - Wu-Hausman test: exogeneity is not rejected
- Impact of instruments take away the impact of hybrid seed use and fertilizer use on food and nutrition security

- Discussion: were our instruments good enough?

Conclusions

- Agricultural input use is a way to improve food security although our models showed mixed results: countable indicators showed impact but subjective measure did not
- However, the pathway is unclear
- Fieldwork revealed that promotion of input use is best combined with
  - education on production and nutrition diversity and
  - investments in market access and transport
- Further research – disentangle the pathway in the analyses to target productivity increasing policies