POLITECNICO MILANO 1863 | DEPARTMENT OF MANAGEMENT ECONOMICS AND INDUSTRIAL ENGINEERING

Agri-tech innovation: a poverty trap for African countries?

12th December 2025

OEET Workshop

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Outline

1. Relevance
2. Literature
3. Research hypotheses
4. Methodology
5. Results
6. Discussion of results
7. Way forward and open issues

Background and literature

Need to increase agricultural labour productivity to fight hunger and allow agricultural transformation

Modern input use not uniformly low across African countries, especially for inorganic fertilizer and agro-chemicals (Sheahan and Barrett, 2017), but most growth is extensive (Fuglie et al., 2019).

African countries that are relatively poor adopt a pathway to **innovation that is internationally oriented** (based on import); African countries with higher income adopt a pathway that is nationally oriented (based **on local R&D)** (Allard and Williams, 2020)

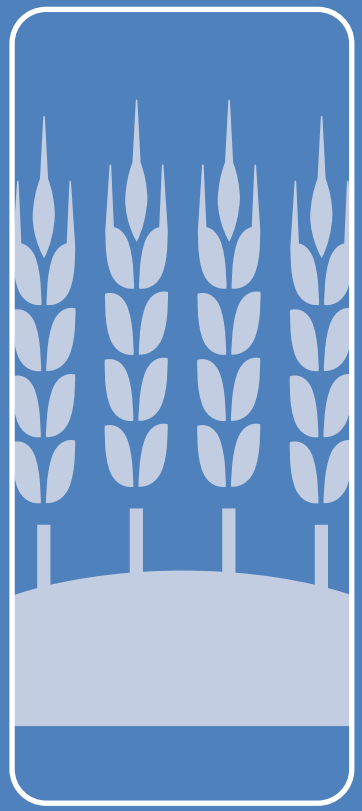
Transfer of agricultural innovations across agroecological and climatic zones is subject to agronomic constraints. **Downstream research in developing countries** is needed to solve location-specific problems and develop varieties suitable for local conditions (Lybbert and Sumner, 2012; Jayne and Sanchez, 2022)

Donors and policy-makers prefer **low-hanging fruits**, largely relying on imported technologies (Resnick et al., 2018)

There are now more than 100 **African-owned seed companies** that sell improved seeds and many **small fertilizer blending facilities** that produce appropriate nutrient compositions for specific areas (Ciceri and Allanore, 2019)

Potential poverty trap: African countries that only rely on international trade for innovation might fail to benefit from foreign agricultural technologies because they are not adapted to the local agro-ecological conditions

Research hypotheses



a) An increase in external inputs used in agriculture will increase agricultural productivity.

b) An increase in the number of local patents on agriculture will increase agricultural productivity.

c) The combination between external inputs (imported technologies) and local innovations will lead to an additional increase in agricultural productivity

Methodology

We model the effect of innovation in African agriculture from 1994 to 2022 on productivity and we distinguish between:

- innovation resulting from imported technologies
- and innovation resulting from local technologies.

and

- we model the interaction between the two to test how the effectiveness of imported technologies changes when there is local capacity to adapt them.

Our model specification is a linear with country fixed effects (η_i) and cluster robust standard errors (ε_{it}):

$$\delta \boldsymbol{P_{it}} = \boldsymbol{\alpha} + \sum_{s=1}^{2} \boldsymbol{\beta} \boldsymbol{EI_{it}^{s}} + \sum_{s=1}^{2} \boldsymbol{\gamma} \boldsymbol{LI_{it}^{s}} + \sum_{s=1}^{2} \boldsymbol{\delta} \boldsymbol{LI_{it}^{s}} \# \boldsymbol{EI_{it_{it}}^{s}} + \boldsymbol{\zeta} \boldsymbol{X_{it}} + \eta_i + \varepsilon_{it}$$

P_{it} is agricultural productivity of country i in year t

LI_{it} is local innovation, EI_{it} is external innovation, X_{it} are control variables

For both EI_{it} and LI_{it} we distinguish two technologies t (seeds and agro chemicals)

Variables	Source
Agriculture, forestry, and fishing, value added per worker (constant 2015 US$)	FAOSTAT
Cunulated number of patents (IPC code A01) filed by applicants from the country (ANA), cumulated and logged	WIPO
Number of papers about seed and chemicals by authors affiliation country	SCOPUS
Number of startups in seed and agrochemicals	CRUNCHBASE
Stock of agricultural capital per worker	FAOSTAT
Urban population %	WDI
GDP growth	WDI
Agri share GDP	FAOSTAT
Imported seeds and fertilizer as percentage of total	*EORA*

Provisional results (based on a preliminary specification)

- Before classificaton of local innovation into chemicals and seeds
- Before introduction of alternative dependent variable papers and startups
- Before inclusion of stock of capital per capita in the agricultural sector

change in agricultural productivity

	Total sample			Middle-income countries			Low-income countries		
Patents	18.79**	16.87*	15.62	25.49**	21.81*	19.53	0.14	2.50	2.29
	(9.11)	(8.69)	(9.49)	(11.82)	(11.93)	(13.10)	(1.59)	(1.46)	(1.75)
Share imported inputs	276.19			378.96			8.72		
	(240.97)			(355.74)			(99.34)		
Share imported inputs from agriculture		14120.36***	12221.10***		13217.63**	11320.04**		9077.71*	7328.48*
		(3851.84)	(3965.09)		(4884.70)	(4897.30)		(5119.25)	(3726.33)
Share imported inputs from chemistry		-3636.81**	-2961.81*		-3120.48	-2428.31		-2713.58**	-2490.14**
		(1610.03)	(1567.42)		(2645.19)	(2569.99)		(1169.95)	(927.36)
Patents x imported inputs from agriculture			2087.23***			2028.93**			-6210.87
			(775.41)			(942.68)			(4430.04)
Patents x imported inputs from chemistry			-899.30*			-888.45			1132.00
			(468.99)			(561.99)			(826.52)
GDP growth	8.96***	9.02***	9.04***	8.82**	8.95**	8.97**	8.98***	9.08***	9.01***
	(2.50)	(2.37)	(2.36)	(3.68)	(3.37)	(3.34)	(2.15)	(2.15)	(2.16)
Num.Obs.	1207	1207	1207	651	651	651	556	556	556
R2	0.188	0.196	0.197	0.179	0.185	0.186	0.224	0.235	0.239
R2 Within	0.027	0.036	0.037	0.025	0.032	0.033	0.187	0.199	0.203

Discussion of provisional results based on preliminary specification

a: An increase in the percentage of external inputs used in agriculture will increase agricultural productivity is **partially supported (for seeds but not for chemicals)**

b: An increase in the number of local patents on agriculture will increase agricultural productivity is **supported (but not for LIC)**

c: The combination between external inputs (imported technologies) and local innovations will lead to an additional increase in agricultural productivity is **partially supported (for seeds but not chemicals and not when only LICs are considered)**

Way forward and open issues

- Run models with the new specification
- Include spillover effects from neighbouring countries
- Using PLUTO data for seeds varieties (normal patents from WIPO only partially cover them)
- Addressing potential endogeneity?
- Add control variables?
- …

Main references

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