

Transformation of agricultural input industries and the contemporary agricultural transformation in Africa.

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What are the issues?

- Agricultural productivity growth is an essential component of ag development and research and technology transfer an important component of productivity growth.
- Does the transformation of input industries contribute to innovation from international technology transfer and agricultural R&D?
- Does transformation lead to technology diffusion, access to technology and increased agricultural productivity

Message

- Important transformations of agricultural input industries are taking place in Africa
- There is growth in innovation in sub-Saharan Africa since 2000
- Innovation is having an impact on the productivity of small farmers

Input industry transformation – start with India

Pre-1960s most inputs were produced on farm – seed, fertilizer and animal power

1960s & 70s input production and supply of seed, pesticide formulation, agricultural implements by government corporations, small industry, and coops

- Public sector ventures with Soviet Union and Eastern European in machinery, pesticide manufacturing
- State Seed Corporations and fertilizer industry - USAID and World Bank
- Small scale private sector seeds supported by Rockefeller & USAID
- Small firms in pesticide formulation, seeds, and farm implements protected from competition with big Indian industry or MNCs
- Imports of many inputs except fertilizer banned or high tariffs

Late 1980s and early 1990s rapid private sector growth led by large Indian and foreign firms

2000s India becomes major exporter of technology: generic pesticides and agricultural machinery. Small exporter of plant varieties.

Supply of modern inputs increased

Ag-Inputs	1971	1981	1991	2001	2011
Quality seeds distribution ('000 tons)	52	450	575	918	2773
Consumption of fertilizers (N+P+K) (Million MT)	2	5.3	12	18	28.3
Consumption of pesticides ('000 tons)	25.8	47	72.1	43.6	55.5
Sale of tractors (Million Units)	0.52	0.75	1.4	2.5	5.5

Private R&D expenditure by industry increased 1996-97 & 2008-09

Industry	1984/85 ^a	1994/95 ^a	2008/09 ^b		
			Total	Indian firms	MNCs
Millions of 2005 US\$					
Seed and biotechnology	1.3	4.9	88.6	49.3	39.3
Pesticides	9	17	35.7	24.4	11.3
Fertilizers	6.8	6.7	7.9	4.9	0.0
Agricultural machinery	3.7	6.5	40.5	20.5	20.0
Biofertilizers & biopesticides	0	0	1.3	1.3	0.0
Poultry and feeds	-	3.5	7.8	7.8	0.0
Animal health	0.9	2.7	18.6	3.7	14.9
Sugar	0.9	2.5	10.8	10.8	0.0
Biofuels	0	0	13.1	13.1	0.0
Food, beverages, & plantations	1.3	10.3	27	16.2	10.7
Total	23.9	54.1	251.3	155.0	96.2

India: Market shares of SOEs, Private, and MNCs

	1985			2009		
Industry	Public sector	Indian private firms	MNCs	Public sector	Indian private firms	MNCs
Seed	35% (1991)	65% (1991)	small	20%	54%	26%
Pesticides	8%	72%	20%	<1%	70%	30%
Tractors	16% (1991-2)	84% (1991-2)	Small	1%	89%	10%
Fertilizer production	60% (pub 47, Coop 13)	40%	0%	50%	50%	0%

Internationally competitive Indian firms

- United Phosphorus Ltd becomes a major generic pesticide manufacturer through acquisitions of firms in U.K., U.S. & elsewhere
- United Phosphorus buys Advanta, a Netherlands-based multinational seed firm
- Mahindra and Mahindra tractors grows to 3rd largest tractor producer in world through acquisitions of Indian, American, and Chinese companies
- Jain Irrigation buys firms with drip and micro irrigation technology and then innovates and exports equipment to become first or second biggest firm

Evolution of African Agribusiness 1960 - 1985

- Colonial period
 - Private monopolies of seed sales of major food crops
 - Input supply by commodity boards in cash crops
- Governments nationalize input supply after independence
 - Government monopoly on production and sale of improved seeds
 - Government monopoly or regulated private monopoly on fertilizer imports and sales
 - Government takes over marketing boards in commercial crops and nationalizes sugar and other processing industries

Transformation starting mid -1990s debt and structural adjustment policies

- Seeds
 - Eliminated government seed supply monopolies
 - Closed government seed corporations (e.g. Tanzania & Zambia)
 - Closed government seed corps but retain government control (Ghana)
 - Modernized government distribution (Kenya and Ethiopia)
- Fertilizer - wide variety of structural changes (Rashid, Jayne & colleagues)
 - Kenya monopoly ends and competition starts
 - Zambia and Tanzania – monopoly ends but government keeps control
 - Ethiopia government corporations continue to distribute all fertilizer

Seed and fertilizer industry since 2000

- Seed
 - Corn in SSA 2007 (Langyintuo et al. 2010)
 - 46% of sales by African multinationals, e.g. SeedCo, Pannar and East Africa Seed Company
 - 36% sales by national private companies, e.g., FICA and Victoria Seeds in Uganda; Western Seed & East African Seeds in Kenya
 - 18% sales by Global MNCs – Pioneer, Monsanto and Syngenta
 - 2010 to present: Global MNCs expand in Africa
 - Pioneer/DuPont buys Pannar, Limagrain buys Link Seeds (South Africa) and share of Seedco, Syngenta buys MRI (Zambia)
 - Monsanto expands in South Africa and East Africa
- Fertilizer
 - Global MNCs expand – Yara expands in Ghana and buys Greenbelt in Zambia, Malawi and Mozambique

Causes: Demand for modern inputs

- Rapid increase in demand for food and fiber due to higher incomes, changing tastes and population growth
- Growth of commercial farmers
 - Large farmers and farm management companies
 - Demand from modern processing industry for large commercial growers
 - Contract farming with small farmers and coops of farmers where processors buy and provide inputs
- Government programs
 - input subsidies and subsidized credit for modern inputs that increase actual demand for modern inputs
 - Extension programs which educate farmers about value of modern inputs and then help farmers determine the best inputs for their conditions

Causes: Supply side

- 1970s - 80s: Government investments in input production distribution
 - Protection of local industry from foreign investments and from large companies in India
 - Government companies and extension programs to sell inputs
 - Donor investments
- 1980-90s: Structural adjustment, internal financial crises & new governments lead to policies that allow private sector
 - Eliminated government input supply monopolies
 - Liberalization of trade and foreign direct investment
 - Privatization of some government corporations
 - Policies to improve business climate for private investment
 - Donor investments in seed

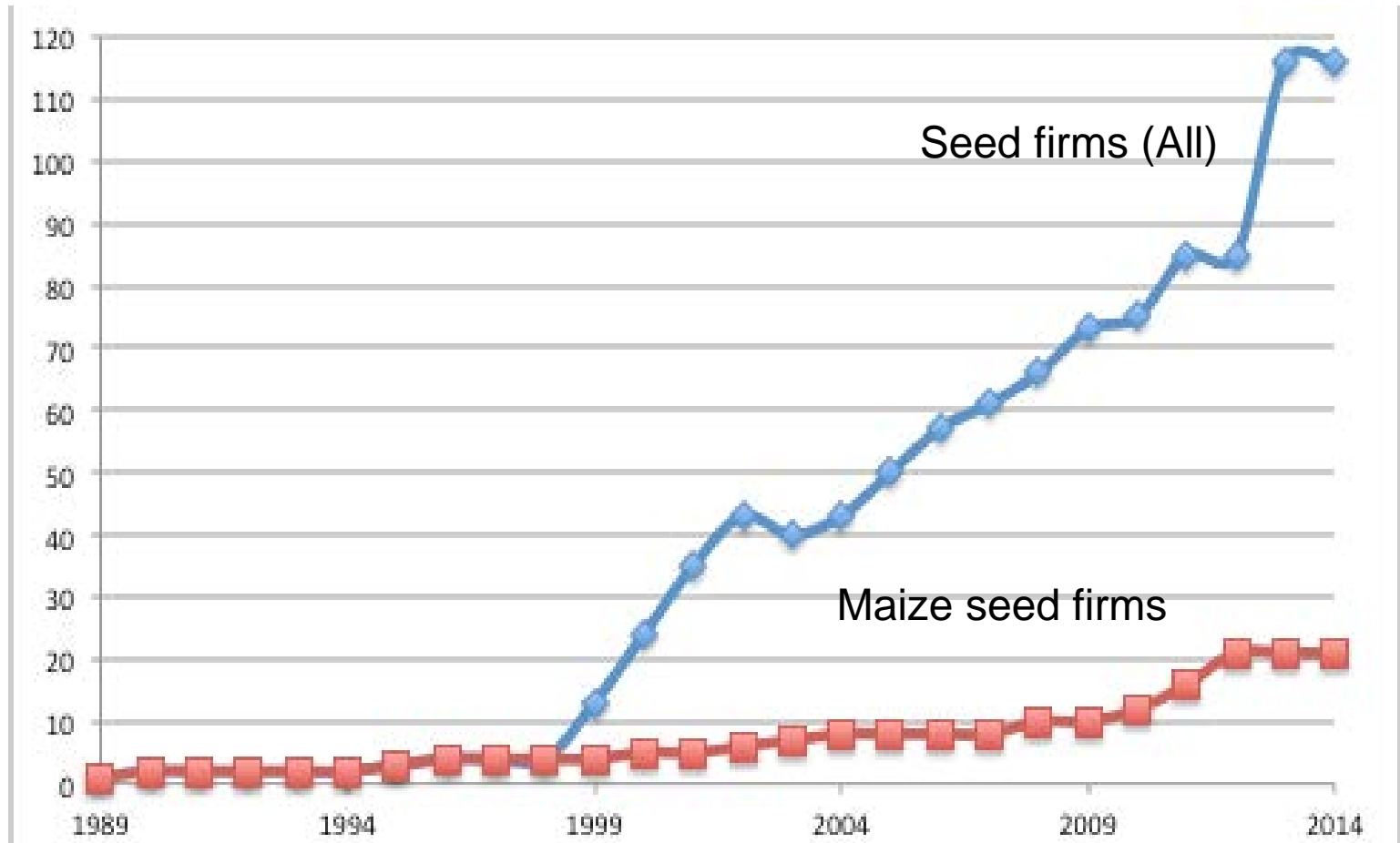
Impact on Innovations: Own R&D contributes 1/3rd, 1/2 imported, 10% public R&D in SSA

Activities	# of organizations reporting innovations	Source of innovations (number of organizations with each source; organizations may have >1 one source)			
		Developed in-country		Imported from	
		Own R&D	Other R&D*	Parent firm	Other source
A. Inputs supply					
Seeds	31	12	4	12	10
Fertilizers	4	2	1		1
Pesticides	12	3		6	5
Ag Machinery	7	3	3	3	1
Livestock	9	4		3	4
B. Large scale production					
Crops	6	2	2	3	2
Livestock					
Fisheries					
C. Processing					
Crops	5	3			2
Livestock	3	2	1		
Fisheries	3	3		1	
Total	89	34	11	28	25

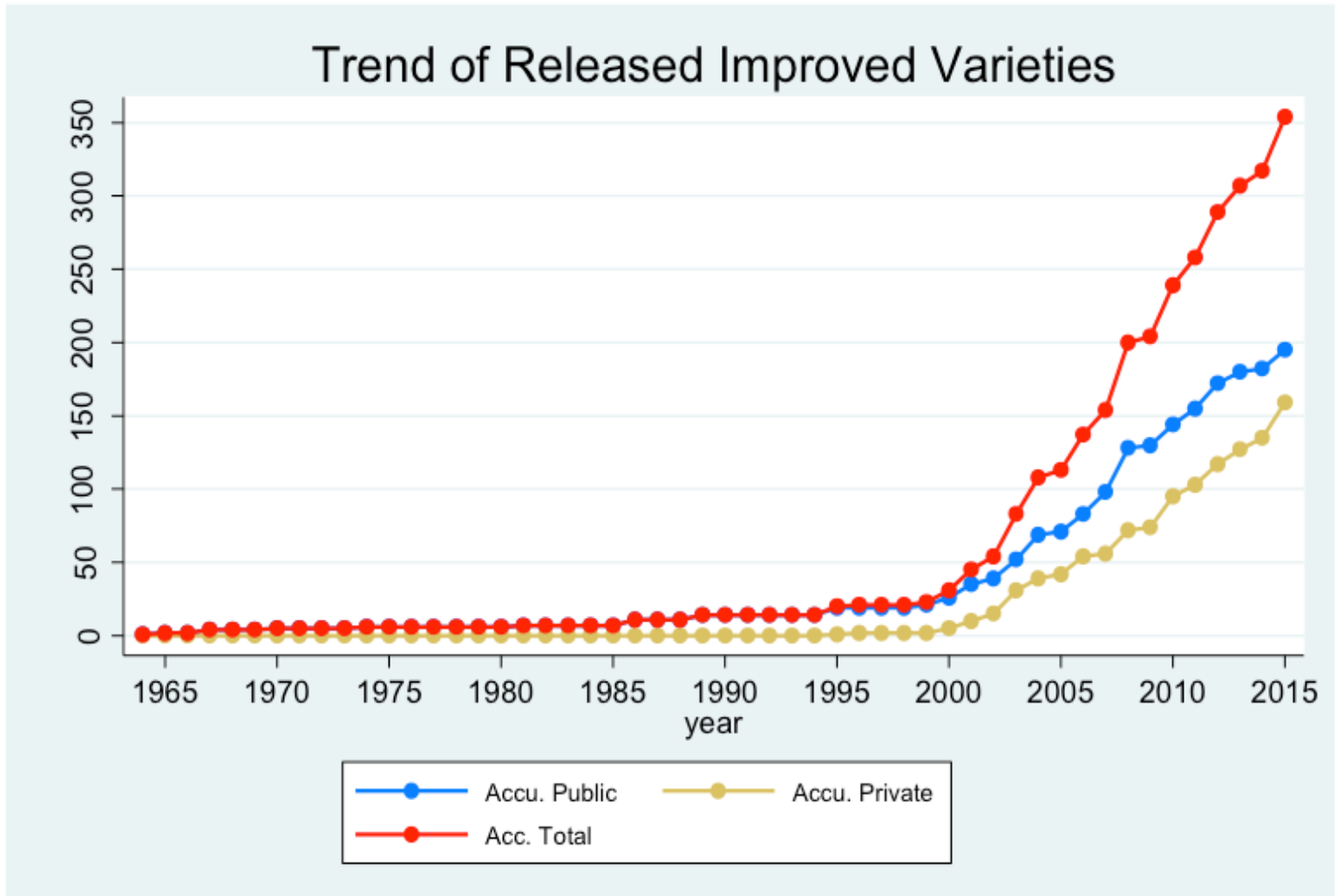
Kenya case study – Maize Seed

- Structural change
- Measurement of innovations
- Yields and innovations
 - Graphs
 - Regression results

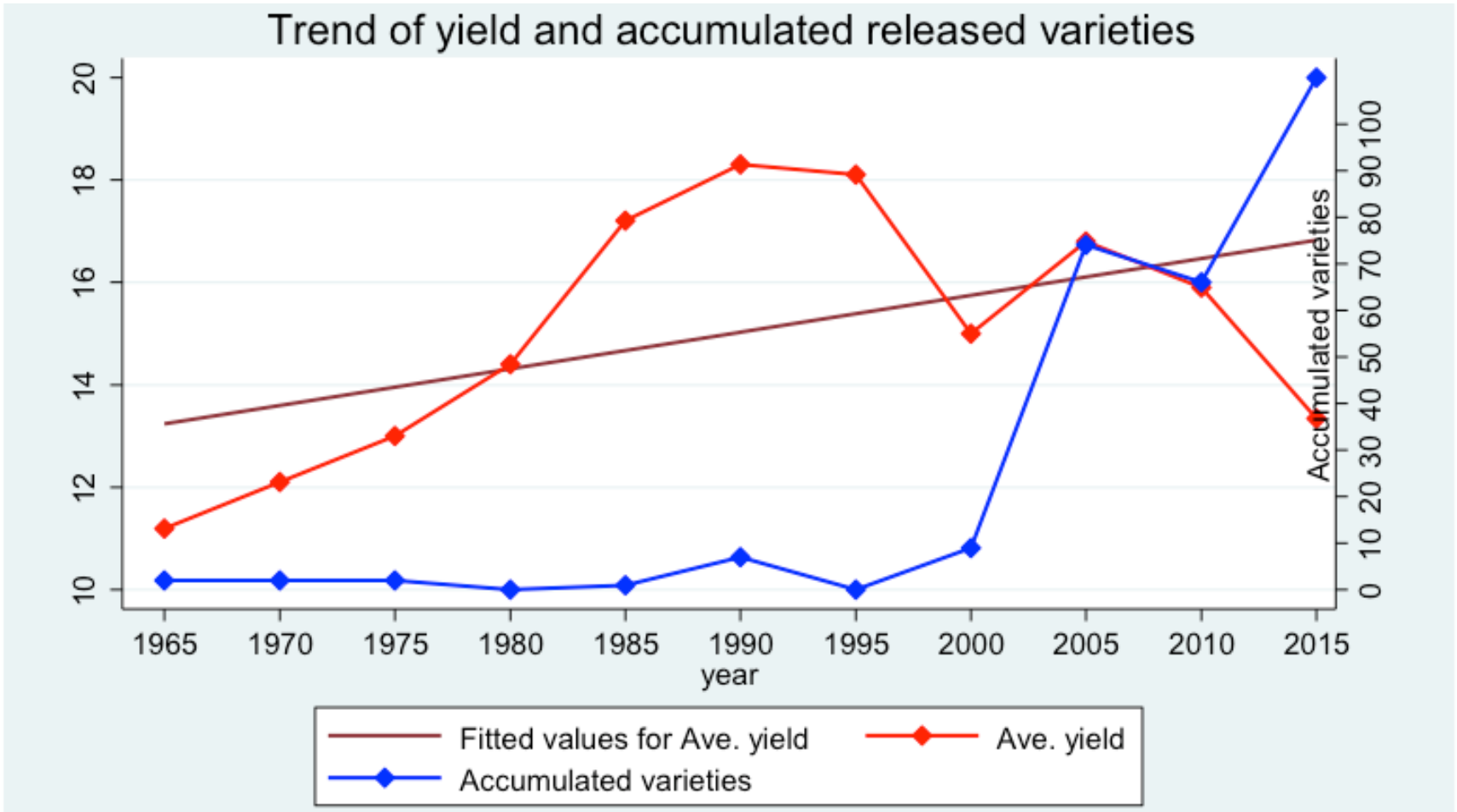
Number of Seed firms in Kenya. Govt. monopoly ends in 1995



Innovations, measured by accumulated, improved maize varieties release(s) – Kenya (1964-2015)



Kenya maize yields vs. varietal releases



Transformation leads to innovation & innovation to productivity change

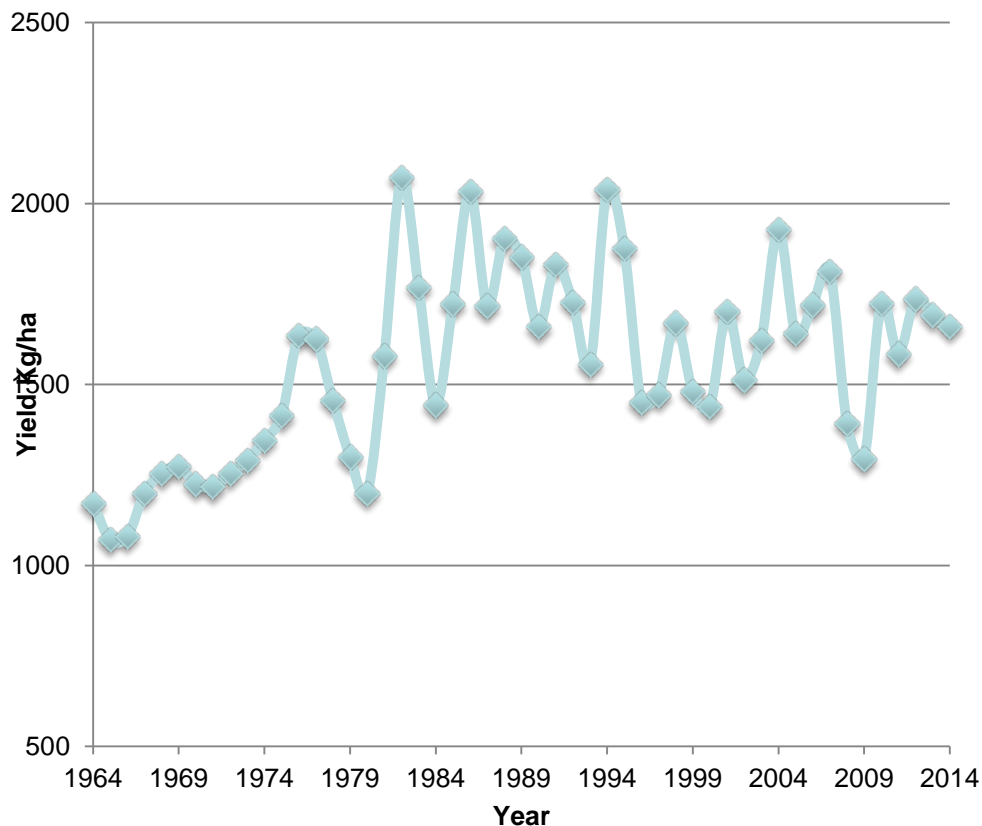
- Innovation = $f(\text{end of KSC monopoly, public research, PVPs, fertilizer imports, seed market size})$
- Yield = $g(\text{Innovation, public research, share of private maize varieties, maize prices, weather})$

Yield regression preliminary results using instrumental variables

Maize yield	Coef.	z
No. of maize varieties	16.516	2.190
Private varieties share	-433.864	-2.230
Maize producer prices	-2.347	-2.520
Public R&D investments	7.238	3.600
Annual Rainfall	6.986	1.700

Note: No. of maize varieties endogenously determined thru' seed market size, fertilizer imports, PVPs issued for maize

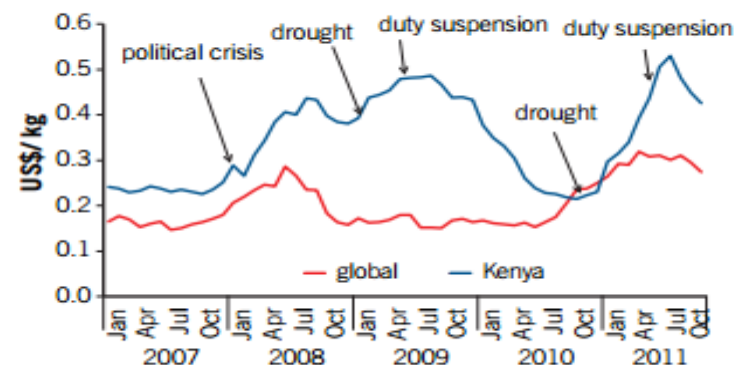
Maize yields and prices in Kenya (1964-2014)



Unpredictable government intervention in maize markets

- Discretionary policy tools used by the government to influence market prices and supplies
- Decisions on import tariff rates
- NCPB (National cereal and produce board) pricing and marketing operations
- Export bans

Figure 1. Kenya Maize Prices are Higher Than Global Prices



Source: Kenya National Bureau of Statistics; World Bank estimates.

Kenya is leading up to cross country studies

- Results suggest structural change leads to innovation
 - Growth of seed market
 - PVPs issued
 - Fertilizer imports (fertilizer subsidy)
- Also innovation is an important contributor to yields as is public sector research expenditure...
-

Current research: do changes in policy and industry structure lead to more adoption of innovation & productivity change?

We base our current model on Fuglie's diffusion model adding policy variables

- timing of liberalization,
- increase in private sector activity in seed production
- type of private sector activity and
- donor or subsidies effect.

Data set 34 SSA countries, 1990 to 2014/14, maize and other crops.

1. Policy variables

- Time of liberalization
- Private share of seed production
- Private share of seed sales
- MNC branches
- Subsidies

2. Economic forces

- Commodity prices or government revenue

3. Control variables

The background of the slide is a solid red color. In the upper left corner, the word "RUTGERS" is written in a white, serif font. Below it, in a smaller, white, sans-serif font, are the words "THE STATE UNIVERSITY OF NEW JERSEY". A large, faint, circular seal of Rutgers University is visible in the background, centered behind the text. The seal features a sunburst design and the text "RUTGERS THE STATE UNIVERSITY OF NEW JERSEY" around the perimeter.

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Thanks....Questions?

Brazil industry evolution

- **Import-substitution Industrialization period 1960-1980**
 - Imports of modern inputs but high tariffs
 - State owned fertilizer companies other input industries private
 - Policies to support local manufacturing until 1980s.
 - Major public research corporation (EMBRAPA) 1973 which worked with small firms, coops and large farmers to sell technology
- **Transition decades: 1980-2000**
 - Privatization of SOEs like fertilizer
 - Structural adjustment – market exchange rates, reduced taxation of exports, foreign direct investments encouraged in input industries
- **Agribusiness structure today**
 - MNCs dominate biotech traits, corn seed but not soy seed, pesticides, and machinery
 - Big foreign investments in sugar and biofuel since 2000
 - Brazilian input industries not exporters or globally competitive but Brazilian food and process industries are.

Brazilian Private R&D up, led by MNCs in seed

(Millions of 2012 US \$s)

	1996	2012	MNCs % of RD
Chem	na	45	50%
Seed	na	280	80%
Machinery	na	48	50%
Animal health	na	4	0%
Total	50	377	72%

Source: Jose' Maria da Silveira & and Jaim da Silva

China

- Before 1980s agricultural inputs provided by the government
- Gradual liberalization started in the early 1980s.
 - Commercial enterprises were allowed to enter the livestock, fisheries, crop, and food industries.
 - Input industries:
 - Pesticide and farm machinery industries were liberalized first.
 - The seed industry was one of the last that private firms were allowed to enter in 2000
- Large, state-owned enterprises still have a dominant role in fertilizer manufacturing and play a significant role in seed, pesticide, and machinery production.
- MNCs have about 40% of market of the pesticide industry and about 5% of maize seed and nothing in rice and other major crops
- Large exports of ag machinery and generic pesticides

Chinese private R&D 2000 – 2006 by industry

	2000		2006	
	Mil 2006 US\$s	% total	Mil 2006 US\$s	% total
Crop	19	18	76	17
Livestock & veterinary	39	37	133	30
Fisheries	13	13	44	10
Processing	34	32	185	42
Total	105	100	438	100

No data from ag pesticide and ag machinery

Missing data from most MNCs, their role have been restricted

Source:Hu et al 2011

Firm R&D Modelling Results in India (Pray and Nagarajan 2014) and China (Hu et al 2011)

- Transformation of input industries important
 - Growth of firm size (entry of large firms, growth of current firms)
 - Competition increased private R&D
- Appropriability in form of ability to patent is important in India
- Technological opportunity - particularly important in seed industry –
 - India: biotechnology and public sector plant breeding stimulate private research
 - China: Total public sector R&D has negative impact but If separated
 - applied research has a positive impact
 - developmental research has negative impact (crowding out)

Factors influencing Chinese firms' R&D 2000 to 2006 regressions (Hu et al 2011)

- Transformation –
 - privatization of firms
 - firm size
 - age of firm
- Crop firms higher R&D than other industry – particularly processing firms