Improved Seeds and Profitability: An Analysis of Maize Production in Mexico

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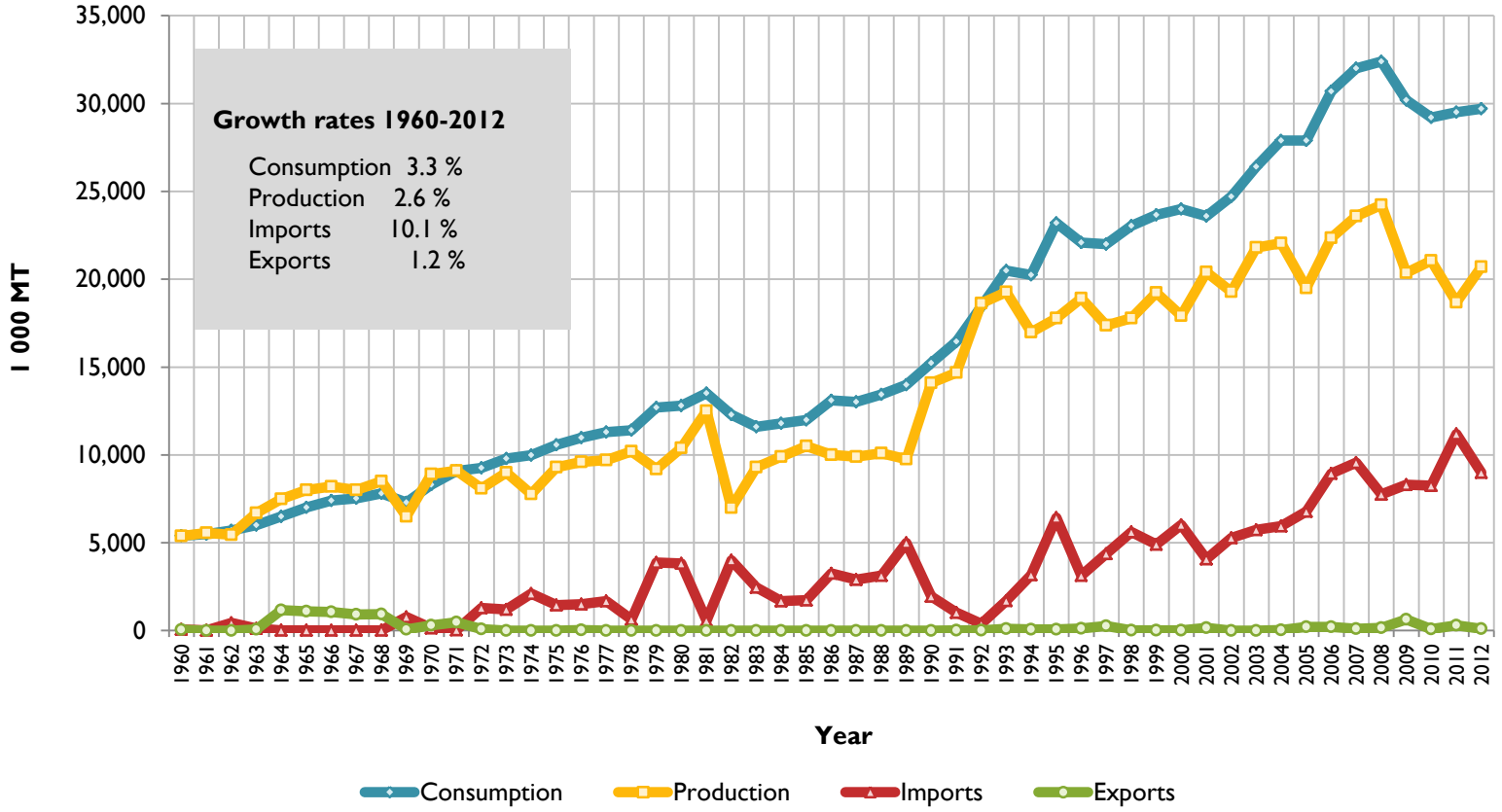
Diversity of Maize Production in Mexico

- Diversity of production environments
  - Geographies
  - Altitude
  - Rainfall
  - Temperature
  - Daylength
- Diversity of maize varieties
  - Tuxpeño in the humid tropical lowlands
  - Celaya, Bolita, and Cónico Norteño in the mid-altitude lands
  - Cónico and Chalqueño in the highlands of Mexico
  - Comiteco and Olotón in Chiapas
- Other production inputs and practices
  - Tillage system
  - Planting density
  - Water system
- Producers' characteristics
  - Farm size
- Maize uses and markets:
  - Flour industry, dough and tortilla industry, animal production, maize starch, subsistence consumption and differentiated maize uses
  - Commodity and specialty, retail and local, via intermediary and direct to consumer,
- Scale–related "profitability crossover" (Kelleman et al 2013)

Need for Maize Productivity Growth

- Mexico Maize Consumption, Production, Exports and Imports by Year 1960 – 2012. Source: USDA, FAS, 2013.



Seed Profitability and Productivity Growth

1. In a market based economy, profitability is the measure to look at for sustainable productivity growth
2. Seed is the core of the technical and business package
3. **Our approach in this study:**
   1. Understand what determines and modifies profitability
   2. In our case, profitability of improved seeds
4. Empirical studies on profitability of productivity increase technologies
   - Profitability of fertilizer use on maize in Zambia (Xu et al. , 2009): effects of production inputs, producers' household characteristics and government programs
5. Adoption literature:
   - Assumes profitability
   - Empirical results:
     - Profitability is found to be major a determinant in adoption (Kafle et al 2010)
     - Mixed findings: positive effect of technology on yield but negative on profitability

Research Question

- What factors influence profitability of improved seed use on maize in Mexico?
  - Focus on the main factors of variation of the impact of improved seeds on profitability.
  - Estimate main and interaction effects of production environment, production inputs, producers' characteristics and maize regions variables
  - Present results of separate and joint maize profitability regressions for producers using improved and own seed.

Maize production regions

- Capture a combination of various sources of heterogeneity

Maize Production Budgets Database

- Source: Maize and Beans Program. PROMAF. 2007. N = 2,059

Variable	Unit	All	Own Seed	Improved Seed
Yield	t/ha	4.5	2.9	6.3
Price	MXN$/t	2,754	2,956	2,527
Revenue	MXN$/ha	11,808	8,366	15,688
Production Cost	MXN$/ha	6,391	5,087	7,862
Profit Margin	MXN$/ha	5,417	3,279	7,826
Farm Size	ha	3.4	2.2	4.9
Maize regions				
Highlands Mexico		28	41	14
Highlands Oaxaca		6	10	1
Bajio		14	6	22
Center North		10	6	14
North		3	5	0
West		20	9	33
South East		20	23	16
10.90 MXN$= 1 US$ in 2007				

Maize Production Budgets Database, cont'

Variable	Unit	All	Own Seed	Improved Seed
Altitude	masl	1,606	1,807	1,380
Production potential				
Low productivity		33	36	29
Medium productivity		37	38	35
High productivity		31	26	36
Planting de	plants/ha	46,278	40,313	53,001
Tillage system				
Conventional		70	76	63
Minimal		21	16	27
Conservation		9	8	10
Water				
Rainfed		85	94	74
Irrigation		15	6	26

Maize Profitability Model

- The profit margin of the *i*-th maize producer is a function of the environment, producer, production and region independent variables *Xj and their interactions Zj* (*j*=1,…,*m*):

$$\mathrm{PM_i} = \beta_0 + \sum\nolimits_j \beta_j X_{ij} + \sum\nolimits_j \partial_j Z_{ij} + \varepsilon_{ij}$$

- where *Xj* are the *j*-th main effect variables:

  Improved seed, Tillage Systems, Irrigation, Planting density, Altitude, Production Potential, Size and Maize Region, and
- *Zj* are the *j*-th interaction terms:

  Improved Seed×Irrigation, Improved Seed×Highlands Mexico, Improved Seed×Highlands Oaxaca, Improved Seed×Center North, Improved Seed×North, Improved Seed×West, Improved Seed×South East

Results: Statistical Significance

Effect	Unit	All		Own Seed		Improved Seed	
Improved Seed[1]		1,360	*				
Tillage system: base group Conventiona							
Minimal		-135		-1,880	***	954	**
Conservation		349		-208		346	
Irrigation		-703		-351		3,103	***
Interactions Improved seed Irrigation		4,106	***				
Planting density	plants/ha	0.13	***	0.07	***	0.17	***
Altitude	masl	-1.46	***	-0.76	**	-2.15	***
Production potential: base group Low							
Medium productivity		1,812	***	2,098	***	1,235	***
High productivity		3,196	***	2,866	***	3,251	***
Size	ha	25		109		13	

Results: Statistical Significance, cont'

Effect	Unit	All		Own Seed		Improved Seed	
Maize region: base group Ba							
Highlands Mexico		2,282	***	1,747	***	3,222	***
Highlands Oaxaca		-1,452	**	-950		-6,103	***
Center North		24		-971		1,173	*
North		-4,734	***	-4,307	***	-1,163	
West		1,133		616		1,706	***
South East		665		1,533	**	-1,773	**
Interactions Improved seeds & Maize regions							
Highlands Mexico		-25					
Highlands Oaxaca		-5,270	**				
Center North		-493					
North		1,775					
West		553					
South East		-2,496	***				
Constant		-1,656	**	-548		-2,034	**
Adj R2		0.4096		0.1787		0.4567	
Observations		2,059		1,091		968	

Results: Economic Significance

1. Controlling for all factors the effect of improved seeds on profitability is MXN$ 1,360
2. The margin differential of improved seeds crucially depends on regions, capturing market and cultural issues:
    1. Oaxaca: - MXN$ 5,270
    2. South East: - MXN$ 2,496
3. Maize production is most profitable in the Highlands:
    1. On average: MXN$ 2,282
    2. With own seed: MXN$ 1,747
    3. With improved seed: MXN$ 3,222

Results: Economic Significance, cont'

4. Production environment:
    1. Own seed perform better in medium productivity and improved seeds in high productivity
    2. Profitability degreases with altitude, at a lower rate with own than with improved seeds
5. Production inputs and practices:
    1. Increase planting density with improved seeds
    2. Improved seeds outperform own seed under irrigation by MXN$ 4,106
6. Size is not important but the scale-related profitability cross-over is important

Managerial Implications

- Strategies for expanding the benefits of improved seeds to broader sets of producers $\Rightarrow$ target breeding and commercial efforts more specifically :
  - Market segmentation of maize producers
  - Needs assessment of each segment
  - New seed products with new traits and multiple traits, including adaptation and output / quality traits for specialty markets
- Strategies for enhancing the benefits of producers' own seeds

Thank you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