ECONOMIC IMPACTS OF GM CORN ADOPTION IN BRAZIL

Joaquim Bento de Souza Ferreira Filho

Lucílio Rogério Aparecido Alves

Escola Superior de Agricultura "Luiz de Queiroz".

University of São Paulo, Brazil.

Trabalho apresentado em congresso

- 17th International Consortium on Applied Bioeconomy Research - ICABR Conference. Ravello, Italy. 2013.
- É o principal congresso internacional para temas relacionados à biotecnologia.

MOTIVATION

- A field survey on corn production costs in 2010/2011 showed that the cost of producing GM corn is higher than non GM corn.
- Even then the adoption of GM seeds is spreading very fast in Brazil.
- In this paper we analyze some economic aspects of GM corn adoption in Brazil.
- The research consists of two main parts:
  - A field survey on production costs conducted by CEPEA in 2010/2011 year.
  - A CGE evaluation of the impacts on the economy.

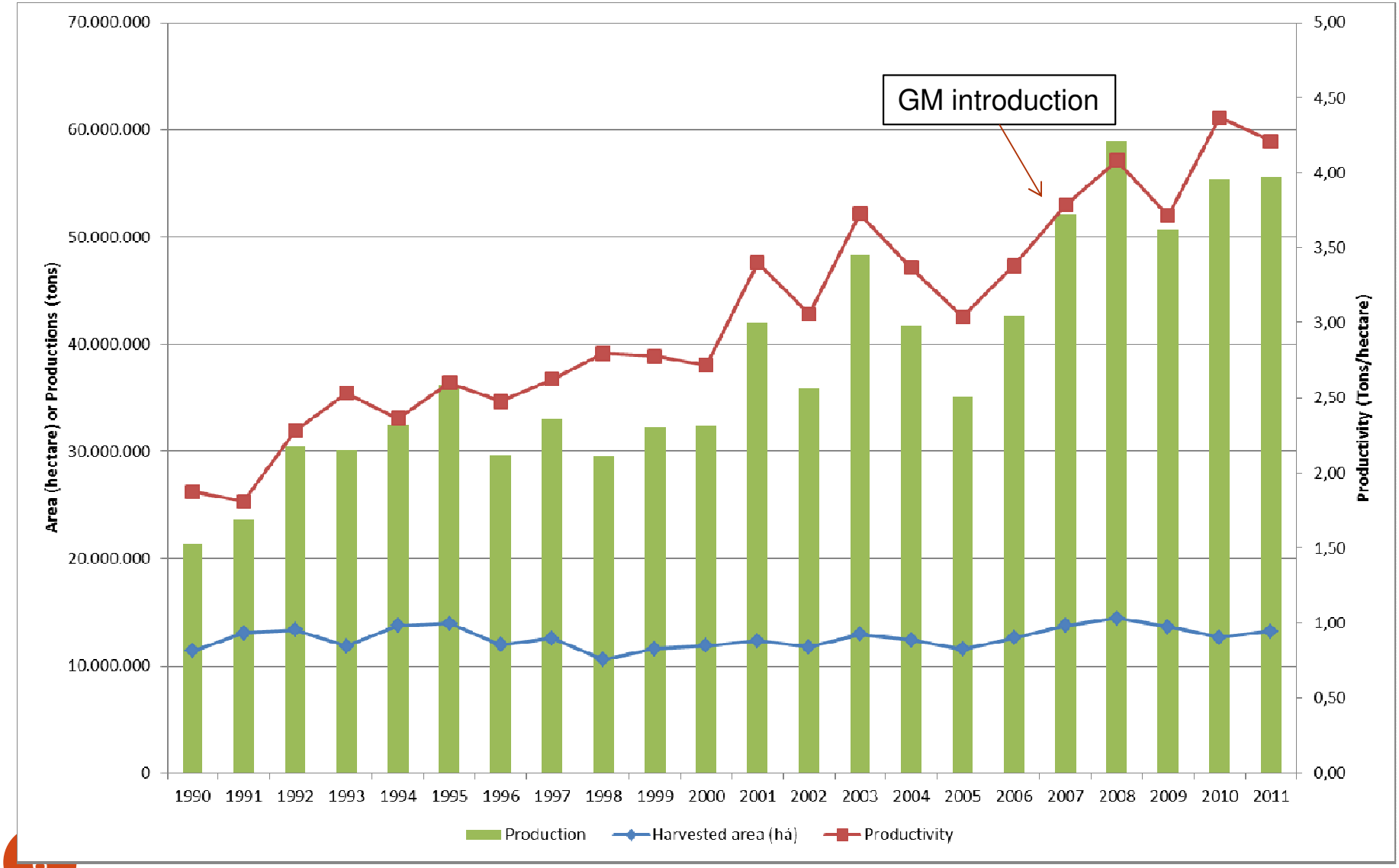
Background: GM corn in Brazil

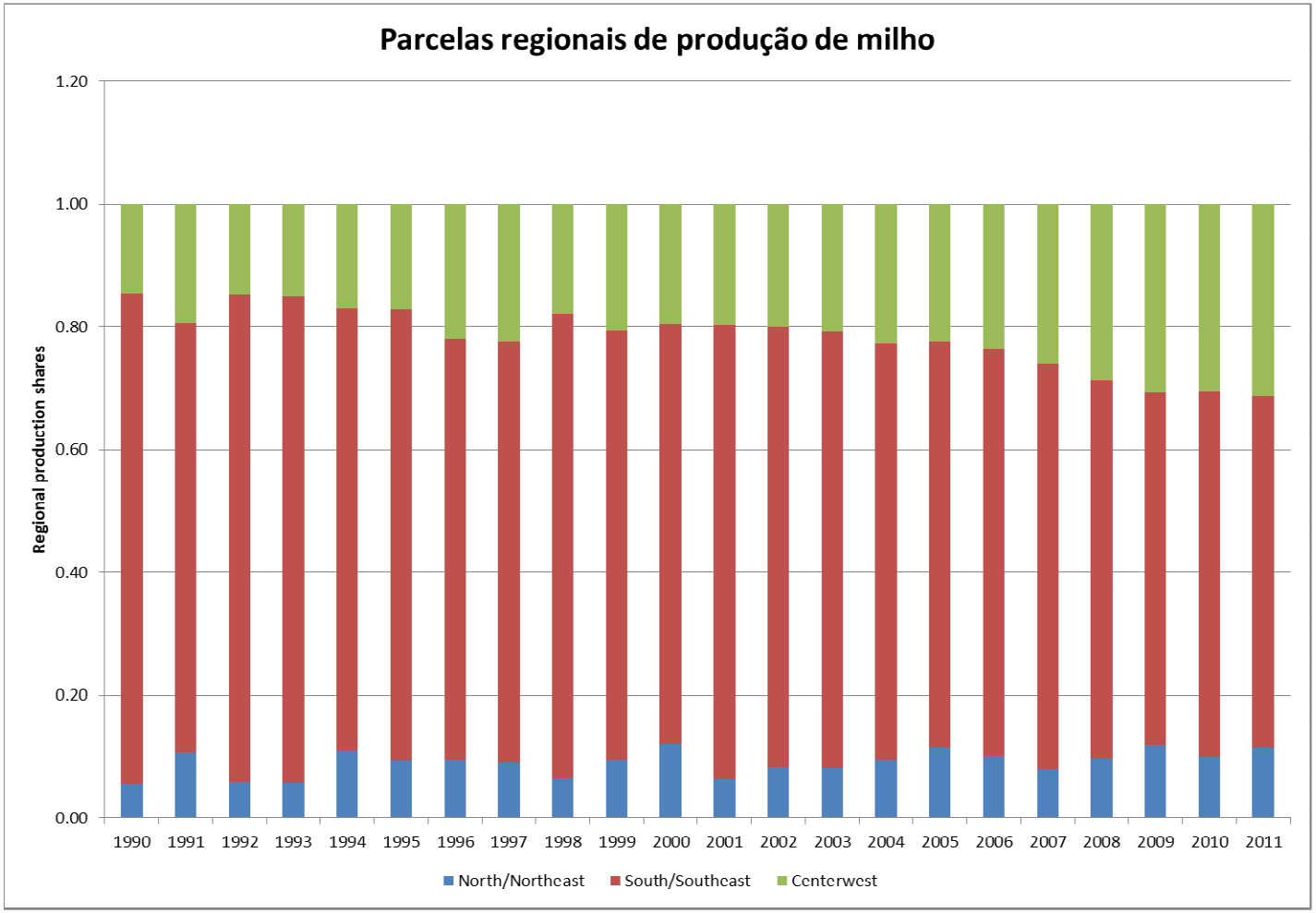
- First authorization: 2007.
- Fourteen events presently:
  - 7 insect resistant (IR).
  - 2 herbicide tolerant (HT).
  - 5 stacked (IR+HT).
- Use of GM corn: widespread in Brazil.
  - Mostly IR (commercial producers).
  - 2010/2011: 55% total area (CEPEA); 58% (CELERES).
  - 2012/2013: CELERES estimates 64.8% (5.3 Mha first crop); 87.8% (6.9 Mha, second crop).

Situação em 2017

- 69 eventos autorizados em 2018:
  - 12 resistentes a insetos;
  - 21 tolerantes a herbicidas;
  - 31 com genes combinados (stacked).
- Milho safrinha: GM corresponde a 91% da área (10.4 milhões hectares).
- Milho safra: GM corresponde a 82,4% área (5,3 milhões hectares).
- Média Brasil: 88.4% taxa de adoção.

Corn production, area and productivity in Brazil




Parcelas regionais de produção de milho
Regional production shares
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
North/Northeast
South/Southeast
Centerwest

Survey: meetings with stakeholders in crop production, 28 cost structures, GM x non-GM.

Region	State	Crop	GM use reported
Rio Verde (RVD)	Goias	First crop	Yes (IR)
		Second crop	Yes (IR)
Mineiros (MNR)	Goias	First crop	Yes (IR)
		Second crop	Yes (IR)
Uberaba (UBR)	Minas Gerais	First crop	Yes (IR)
Unaí (UNAI)	Minas Gerais	First crop	Yes (IR)
		Second crop	Yes (IR)
Xanxerê (XNX)	Santa Catarina	First crop	Yes (IR)
Campos Novos (CNV)	Santa Catarina	First crop	Yes (IR)
Castro (CST)	Paraná	First crop	Yes (IR)
Guarapuava (GPVA)	Paraná	First crop	Yes (IR)
Cascavel (CVEL)	Paraná	First crop	Yes (IR)
		Second crop	Yes (IR)
Londrina (LDN)	Paraná	First crop	Yes (IR)
		Second crop	Yes (IR)

Source: CEPEA field survey.

CORN, FIRST CROP. BRAZIL. (% variation in relation to non-GM)

	VARIATION [(GM-Non GM)/non GM]							
Item	LDN	CVEL	GPVA	CST	XNX	CNV	RVD	UBR
	% variation	% variation	% variation	% variation	% variation	% variation	% variation	% variation
Fertilizers	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Chemical inputs	-32,17	-20,90	-1,85	-31,08	-15,87	-14,66	-33,24	-24,96
Herbicides	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Insecticides	-85,78	-82,45	-50,76	-79,38	-51,60	-37,04	-97,18	-100,00
Fungicides	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Seed treatment	0,00	0,00	0,00	0,00	0,00	-26,67	0,00	0,00
Seeds	26,67	40,00	40,00	30,43	12,13	29,63	50,00	56,25
Emulsionable oil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Mechanical operations	-1,89	-7,29	0,00	-4,36	0,00	-3,10	-0,63	0,00
Transportation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Labor	-1,59	-4,73	0,00	-6,39	0,00	-3,91	-2,48	0,00
Trade/Storage	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Taxes	0,00	0,00	0,00	0,00	6,25	11,11	0,00	14,29
Insurance	-3,35	-3,47	0,00	-2,26	0,00	-1,31	-0,54	0,00
Technical assistance	0,11	4,01	7,09	-0,01	0,72	4,01	0,85	6,38
Interest over capital	0,09	3,57	6,51	-0,01	0,66	3,77	0,77	5,80
CO	0,09	3,72	6,64	-0,03	0,90	4,28	0,80	6,62
COT	0,18	2,79	6,02	-0,32	0,83	3,66	0,71	6,12
CT	-0,01	1,78	4,86	-0,44	0,67	2,75	0,56	4,84

CORN, SECOND CROP. (% variation in relation to non-GM)

	Variation [(GM-Non GM)/non GM]				
Item	RVD	MNR	CVEL	LDN	UNAI
	% variation	% variation	% variation	% variation	% variation
Fertilizers	0,00	0,00	0,00	0,00	0,00
Chemical inputs	-18,88	-25,37	-11,67	-36,52	-27,37
Herbicides	0,00	0,00	0,00	0,00	0,00
Insecticides	-100,00	-71,84	-43,57	-85,78	-96,91
Fungicides	0,00	0,00	0,00	0,00	0,00
Seed treatment	0,00	0,00	0,00	0,00	0.00
Seeds	75,31	55,56	43,48	35,71	20,00
Emulsionable oil	0	0,00	0,00	0,00	0,00
Mechanical operations	-0,62	-2,33	-14,01	-3,53	-8,28
Transportation	0,00	0,00	0,00	0,00	0,00
Labor	-2,62	-0,73	-3,06	-10,44	-2,59
Trade/Storage	0,00	0,00	0,00	0,00	0,00
Taxes	0,00	0,00	0,00	0,00	0,00
Insurance	0,10	-1,18	0,00	-7,03	-5,91
Technical assistance	7,40	3,62	4,77	1,19	-2,33
Interest over capital	7,40	3,62	4,77	1,19	-2,33
CO	7,15	3,47	4,56	1,12	-2,29
COT	6,57	2,89	4,11	0,41	-2,95
CT	5,66	2,32	3,37	-0,10	-3,32

Observation from field survey

- No consistent increase in productivity (2010/2011).
- GM technology (Insect Resistant) is cost increasing in average: consistent with the fast increase in GM technology in corn in Brazil?
- Reason for GM technology adoption: question asked in the survey.
- Predominant answer: risk reduction. Control of worms in the initial stages of corn can be very hard in Brazilian conditions, especially in large areas.
- Producers accept a reduction in their rate of return in exchange for risk reduction: which size??

Simulating this effect with the aid of a CGE model

- Static, inter-regional, bottom-up.
- 42 sectors.
- 42 products (11 agricultural products)
- 10 types of workers (wage classes)
- 27 regions inside Brazil
- 10 household types (income classes)
- Linearized, solved with GEMPACK.

Simulation strategy

- Make corn cost itens exogenous.
- Impose to the model the change in corn cost structure (which was turned exogenous for the shocks).
- This triggers changes in corn profitability:
  - Competition for land.
- Agricultural production:
  - Endogenous for other crops, GRET exogenous (LONG RUN).
  - Exogenous for corn, GRET endogenous (producers accept fall in GRET in Exchange for risk reduction).

Closure: environment in which model reaches a new equilibrium

- Capital stock is endogenous by industry, while the Gross Rate of Return (GRET) in each production sector is exogenous. The exception to this rule is the corn production activity, where:
  - Production is fixed at base year level;
  - the GRET fall necessary to ratify the fixed production level in the presence of cost increase is calculated endogenously: SHADOW VALUE OF RISK REDUCTION.
- Land stocks are fixed in each region, mobile between activities.
- Real wages endogenous, aggregate employment fixed. Labor can migrate between regions and activities, driven by real wages.
- Total (aggregated) investment in the economy is endogenous, and follows aggregated capital stock.

Scenarios

- Model shocked with the change in cost structure (weighted average): increase in costs (1.86% in operational costs).
- GRET variation: SHADOW VALUE of risk reduction.
- Run Term.exe (sti condensation): term.sti

Description in cost spreadsheet	Description in CGE model	Shocks (%)
Chemical inputs	Inorganic Chemicals	-13.6
Seeds	Seeds	29.5
Mechanical operations	Machines and vehicles	-1.75
Insurance + Technical assistance	Services	1.0
Labor	Labor	-1.65

Seeds shocks

- In the CGE database classification, corn seeds are agricultural product. (MilhoLAC.har)
- The increase in the price of GM seeds:
  - simulated through an increase of a tax on seeds, to avoid this extra income being directed to agriculture.
  - This gives the desired increase in costs, without biasing agricultural incomes. Government spending fixed. Slight change in government budget surplus (or, conversely, a reduction in deficit).
- Term.tab
- Milholr3.cmf

Results: aggregated (% change)

	Land use	Production
Agricultural sector		
Rice	0,07	0,02
Corn	-1,26	0,00 (fixed)
Other	0,08	0,01
Sugar cane	0,07	0,01
Soybean	0,10	0,03
Cotton	0,06	0,02
Forestry	0,08	0,01
Livestock	0,09	0,03
Milk	0,11	0,02

Results: regional GRET variation. % change.

	GRET % variation
State	
Bahia	-48,3
Minas Gerais	-46,6
São Paulo	-32,9
Parana	-30,0
Santa Catarina	-30,5
Rio Grande do Sul	-30,9
Mato Grosso do Sul	-38,2
Mato Grosso	-46,0
Goias	-46,6
Brazil	-38,2

Results: labor demand by occupation and region (% change)

Unskilled labor

State	OCC1	OCC2	OCC3	OCC4	OCC5	OCC6	OCC7	OCC8	OCC9	OCC10
Bahia	-0,07	-0,02	0,00	-0,01	0,00	0,01	0,01	0,01	0,00	0,00
Minas Gerais	-0,27	-0,09	-0,01	-0,01	-0,01	0,01	0,00	0,01	0,01	0,01
São Paulo	-0,03	-0,02	-0,01	-0,01	-0,01	0,00	0,00	0,00	0,00	0,00
Parana	-0,33	-0,15	-0,02	-0,01	0,02	-0,01	0,00	-0,01	-0,01	0,00
Santa Catarina	-0,36	-0,06	-0,03	-0,03	0,02	0,00	0,01	0,01	0,01	0,00
Rio Grande do Sul	-0,14	-0,03	0,00	-0,01	0,00	0,00	0,00	0,01	0,00	0,00
Mato Grosso Sul	-0,14	-0,10	0,02	-0,10	-0,09	-0,01	0,02	0,02	0,01	0,01
Mato Grosso	-0,65	-0,24	-0,06	0,03	-0,01	0,01	0,01	-0,03	0,02	0,02
Goias	-0,09	-0,03	-0,03	0,00	-0,04	-0,04	-0,01	0,00	0,00	0,01

Fall in unskilled labor demand.

Final remarks

- LIMITATION: observations based in just one year. More field surveys needed to assess the impacts on:
  - Productivity
  - Costs.
- The reduction in GRET (Shadow value of risk reduction) is calculated on a "ex post" basis: not really a measure of the "willingness to pay" for risk, what is probably determined based on a probability distribution of pests infestation.

- Thank you.

- Email: jbsferre@usp.br