Discussion on Mark Rosegrant's "Global Perspectives on Food Security and Environmental Sustainability"

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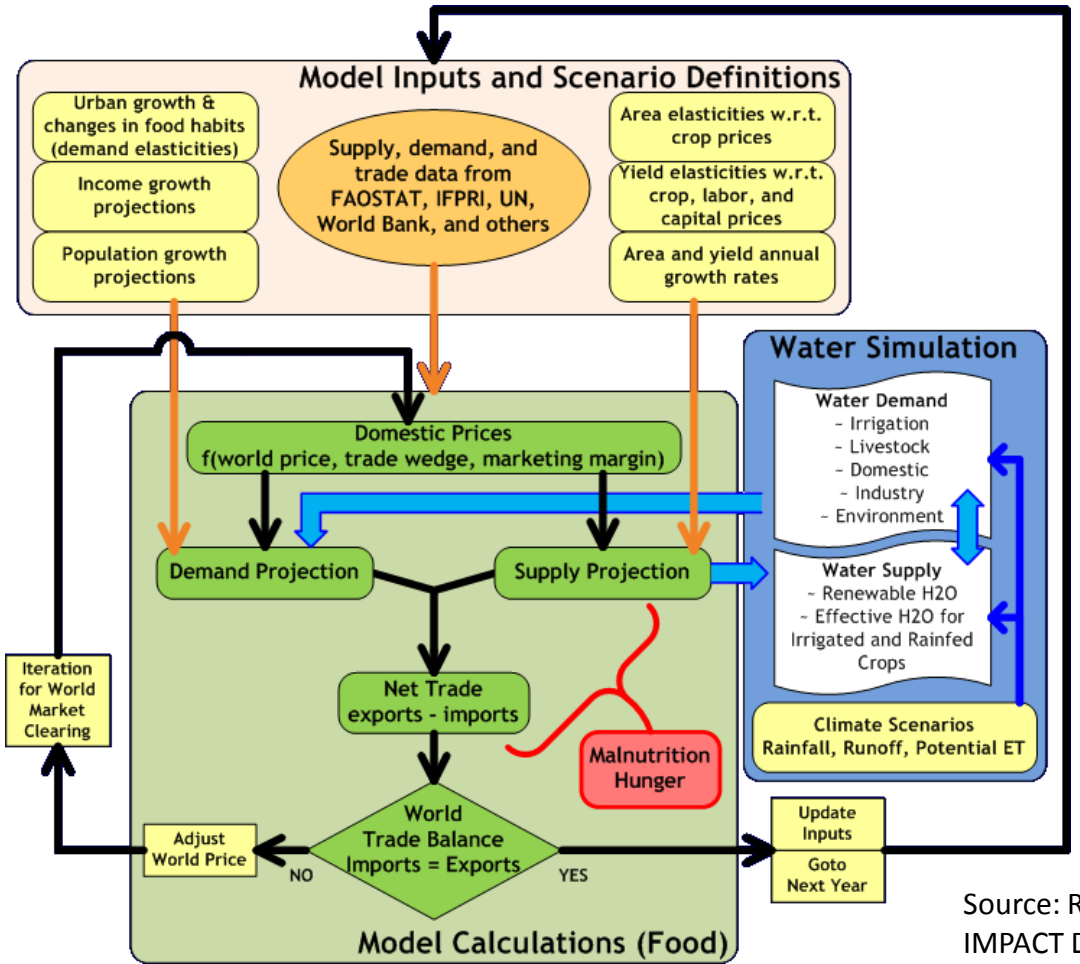
The starting point

IMPACT: A fascinating journey in integrated model building

- 1995: first IMPACT model, only policy and economic component (IFPRI Vision 2020)
- 2002: integration with a water model accounting for CC
- 2009: integration with a crop model accounting for CC
- 2010: major revision to reflect results from the next generation climate models
- 2014: the role of Agr R&D and adoption of innovations on long-term food security and environmental sustainability

The starting point

IMPACT: A fascinating journey in integrated model building



Source: Rosegrant and IMPACT Devt Team, 2012

My discussion

- not focusing on model's projections
- focus on the rationale, hypotheses and implications
  - what is in there?
  - what is not in there?
  - what may be in there?

What is in there?

(basic) IMPACT: policy and trade simulations

- **partial equilibrium** global agricultural sector model: world market prices for all commodities that satisfy market-clearing conditions
- **multi-commodity**: 46 crops and livestock commodities
- **multi-country**: 115 countries/regions, linked to the rest of the world through trade

IWSM: water systems and water stress

- **water scenarios**: downscaled and calibrated to GCMs (future climates in the different IPCC SRES scenarios)
- **food producing units**: 281 combination of 126 water basins with 115 country/regions

What is in there?

DSSAT: process-based crop model

- **crop modeling suite**: simulate the responses of crops to changing biophysical conditions
- **technology adoption**: adoption pathways, link between IMPACT and DSSAT

Outputs

- **demand**: function of prices, income, and population growth
- **crop production**: determined by crop and input prices, the rate of productivity growth, and water availability
- **projections**: global food supply, demand, trade, and prices

What is in there?

Rationale

- rising resource scarcity (water, land) → constraints on food production growth
- increasing bioenergy demand → increased food-fuel competition for land and water
- greater food production from higher productivity rather than from a net increase in cropland area
- role of agricultural R&D activities and technology adoption

What is in there?

Source: von Lampe et al., 2014

Model (References)	Institution	Type	Economy coverage	Agric. sectors†	Regions‡	Agric. policies	Agric. supply	Final demand	Trade
AIM (Fujimori et al., 2012)	NIES, Japan	CGE	Full economy	8/1	89/17	Implicitly assumed unchanged	Nested CES	LES utility	Nonspatial; Armington gross-trade
ENVISAGE (van der Mens-brugghe, 2013)	FAO/World Bank	CGE	Full economy	10/5	11/9§	Price wedges (based on GTAP)	Nested CES	LES utility (w/ dynamic shifters)	Armington spatial equilibrium
EPPA (Paltsev et al., 2005)	MIT, USA	CGE	Full economy	2/0	7/9	Subsidies, taxes, tariff equivalents	Nested CES	Nested CES utility	Armington spatial equilibrium
FARM (Sands et al., 2013)	USDA, USA	CGE	Full economy	12/8	5/8§	Price wedges (based on GTAP)	Nested CES	LES utility	Armington spatial equilibrium
GTEM (Pant, 2007)	ABARES, Australia	CGE	Full economy	7/7	5/8§	Implicitly assumed unchanged	Nested Leontief and CES	CDE utility	Armington spatial equilibrium
MAGNET (Woltjer et al., 2011)	LEI-WUR, The Netherlands	CGE	Full economy	10/9	29/16	Price wedges (adjusted from GTAP); milk quotas	Nested CES	CDE private demand¶ and Cobb-Douglas utility	Armington spatial equilibrium
GCAM (Wise and Calvin, 2011)	PNNL, USA	PE	Agriculture, Energy	18/0	7/9§	Implicitly assumed unchanged	Leontief	Iso-elastic¶	Heckscher-Ohlin nonspatial, net-trade
GLOBIOM (Havlik et al., 2013)	IIASA, Austria	PE	Agriculture, forestry, Bioenergy	31/6	10/20	Implicitly assumed unchanged	Leontief	Iso-elastic¶	Enke-Samuelson-Takayama-Judge spatial equilibrium
IMPACT (Rosegrant et al., 2012)	IFPRI, USA	PE	Agriculture	32/14	101/14	Price wedges (based on PSE/CSE)	Iso-elastic¶	Iso-elastic¶	Heckscher-Ohlin nonspatial, net-trade
MAgPIE (Lotze-Campen et al., 2008)	PIK, Germany	PE	Agriculture	21/0	0/10	Implicitly assumed unchanged	Leontief	exogenous	Based on historical self-sufficiency rates

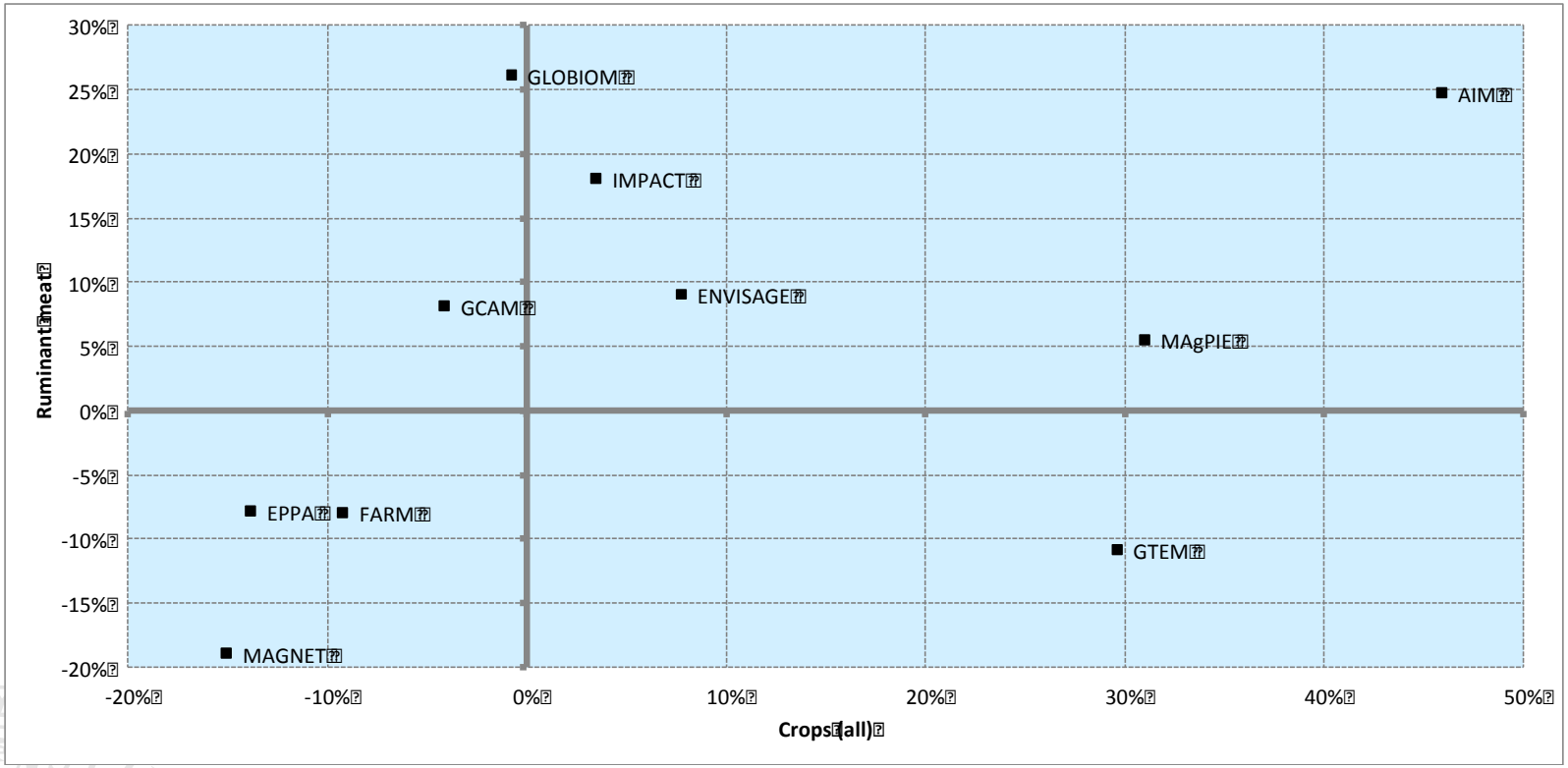
What is in there?

- **comparative advantage**: analysis of global agricultural production along with detailed regional disaggregation
- **objective**: providing long-term projections (i.e. model simulations, not predictions of the future), "to address a lack of long-term vision and consensus among policy-makers and researchers" → looking for trends/estimates not necessarily accuracy
- Questions
  - Q1: baseline based on reasonably assumptions, but how robust is it and what are the most sensitive assumptions?
  - Q2: how robust are the results obtained wrt technology adoption?

What is in there?

IMPACT projections close to the average of models'

Crop vs. ruminant prices in 2050

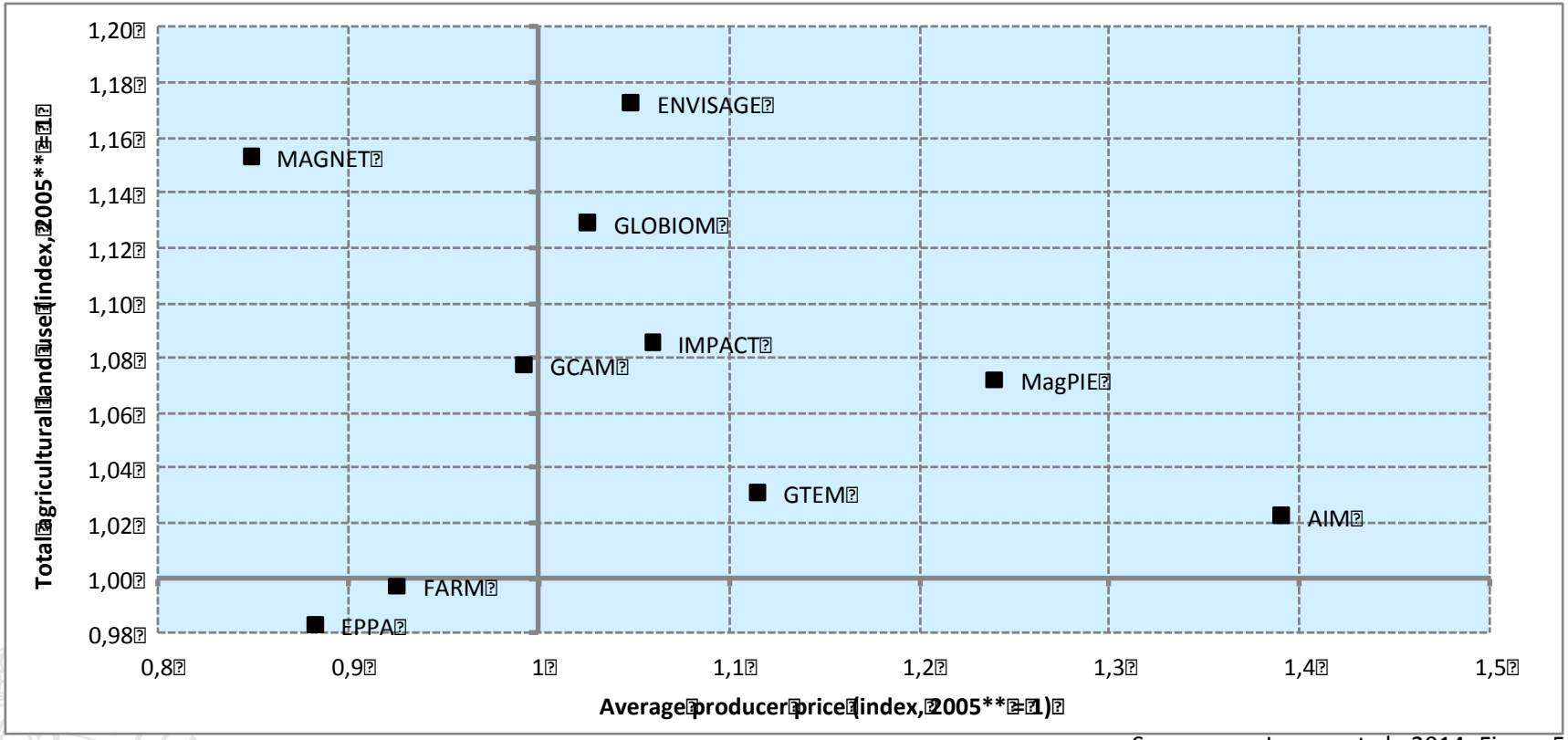


Source: von Lampe et al., 2014: Figure 4

What is in there?

IMPACT projections close to the average of models'

Agr area expansion vs. avg agr prices in 2050

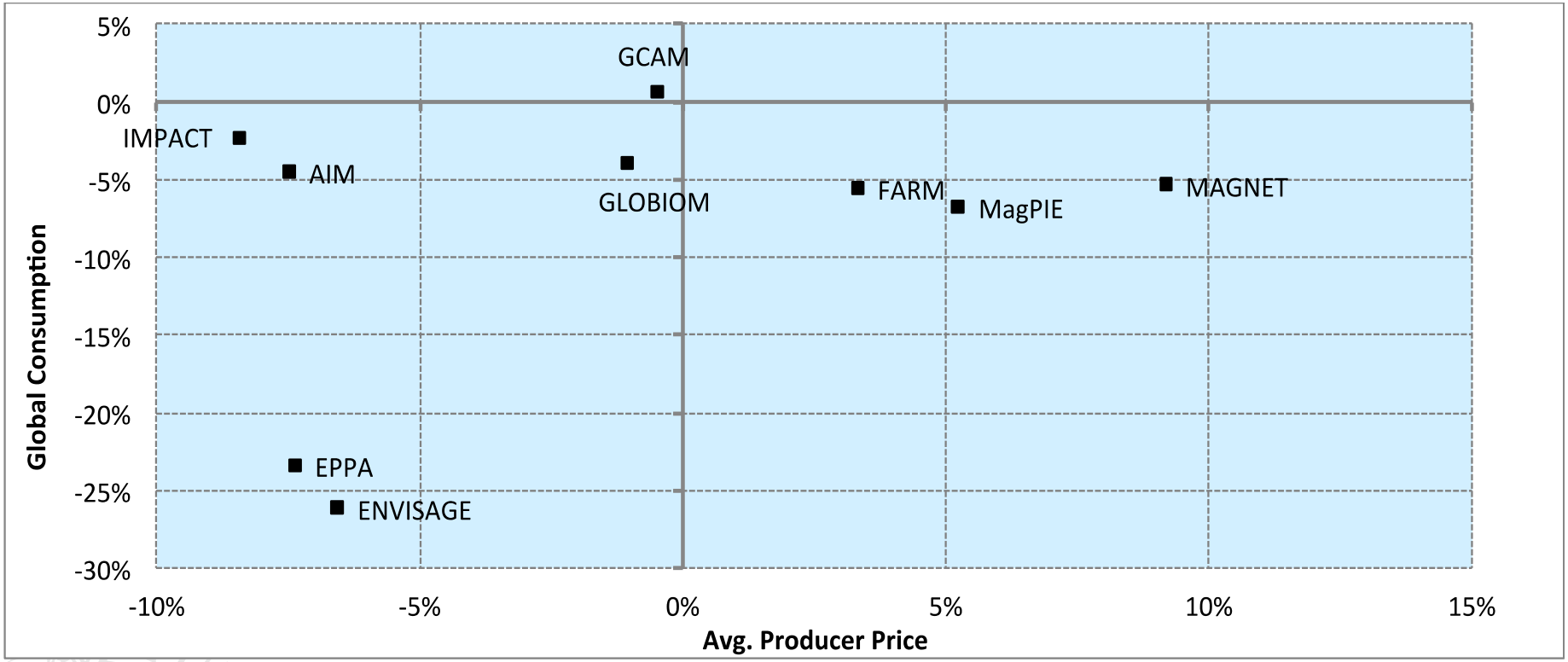


Source: von Lampe et al., 2014: Figure 5

What is in there?

IMPACT projections close to the average of models'

Global consumption vs. avg agr prices in 2050



Source: von Lampe et al., 2014: Figure 6

What is in there?

- **agreements**:
  - relative importance of productivity progress as compared to area expansions
  - hotspots for future growth in agricultural demand (e.g. SSA, MENA) and production (eg. SSA, LAC)
  - increasingly important role for international trade (e.g. import SSA, MENA, veg exp NAM, OCE, an exp BRA)
- **disagreements**:
  - estimating future demand over a long-term horizon (small differences in income elasticities add to substantial differences in projected food consumption)
  - accounting for technical progress in agriculture: assumptions about yield growth, but also factor deepening
  - bioenergy: endogenous vs exogenous, 1st vs. 2nd gener.

What is not in there?

- CGE vs. PE
  - prices: CGE models usually smoother price path
  - institutions: CGE agents' behavioral rules, income distribution

  Q3: is there any chance to incorporate some of these features through empirical relations/components feeding into the PE model?
- Land dynamics

  Q4: is it already in DSSAT? Or is an additional module (e.g. LPJmL) needed?

  Q5: only land use switching or also new land conversion to agriculture

What may be in there?

- Improvements:
  - more economic research and better economic data
  - more bio-physical research and better linkage to the economic module

Q6: what are the most promising research areas in the short, medium and longer run?

A couple of concluding remarks on policy implications

- Differences in results across regions and within regions:
  - diversified policy packages
  - prioritization
- Many technology options:
  - single vs. multiple technology packages
  - sequencing of technology adoptions