

Climate Change and Agriculture: Change in Yields in a global CGE MIRAGE-CC

Presented by:

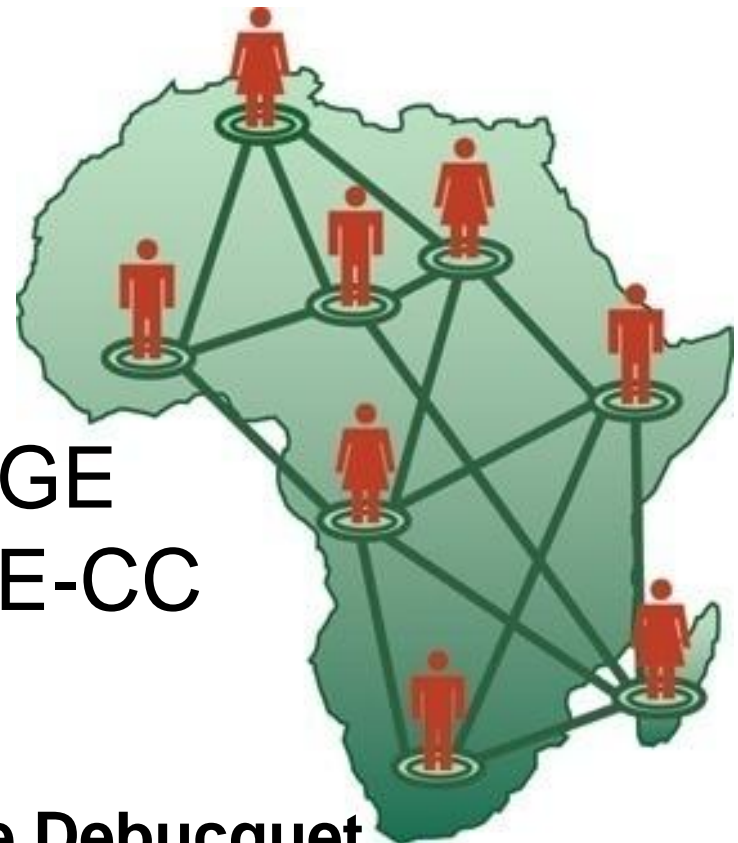
David Laborde Debucquet

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Change Analysis

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Climate Change and Agriculture: Change in Yields in a global CGE MIRAGE-CC

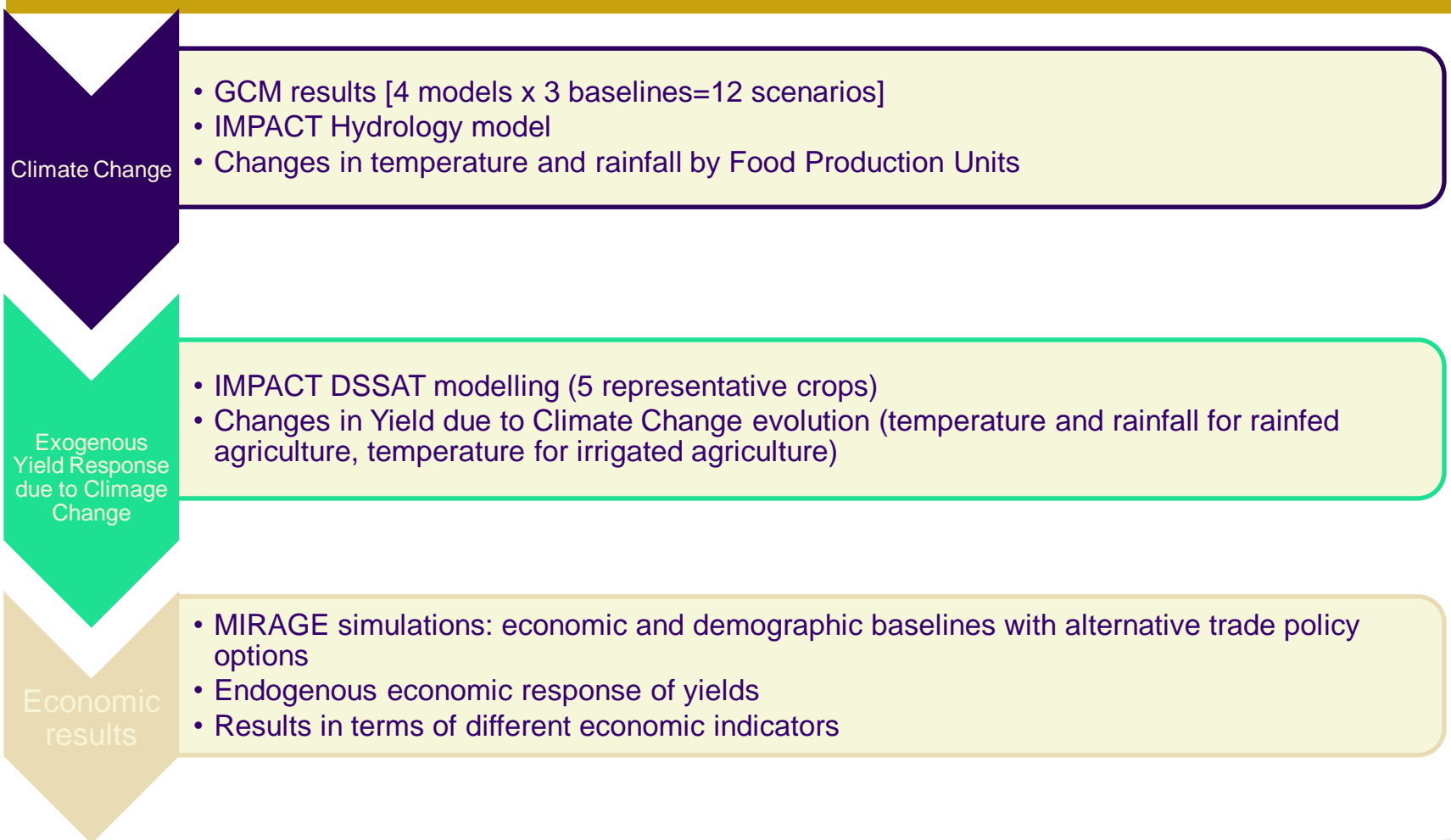
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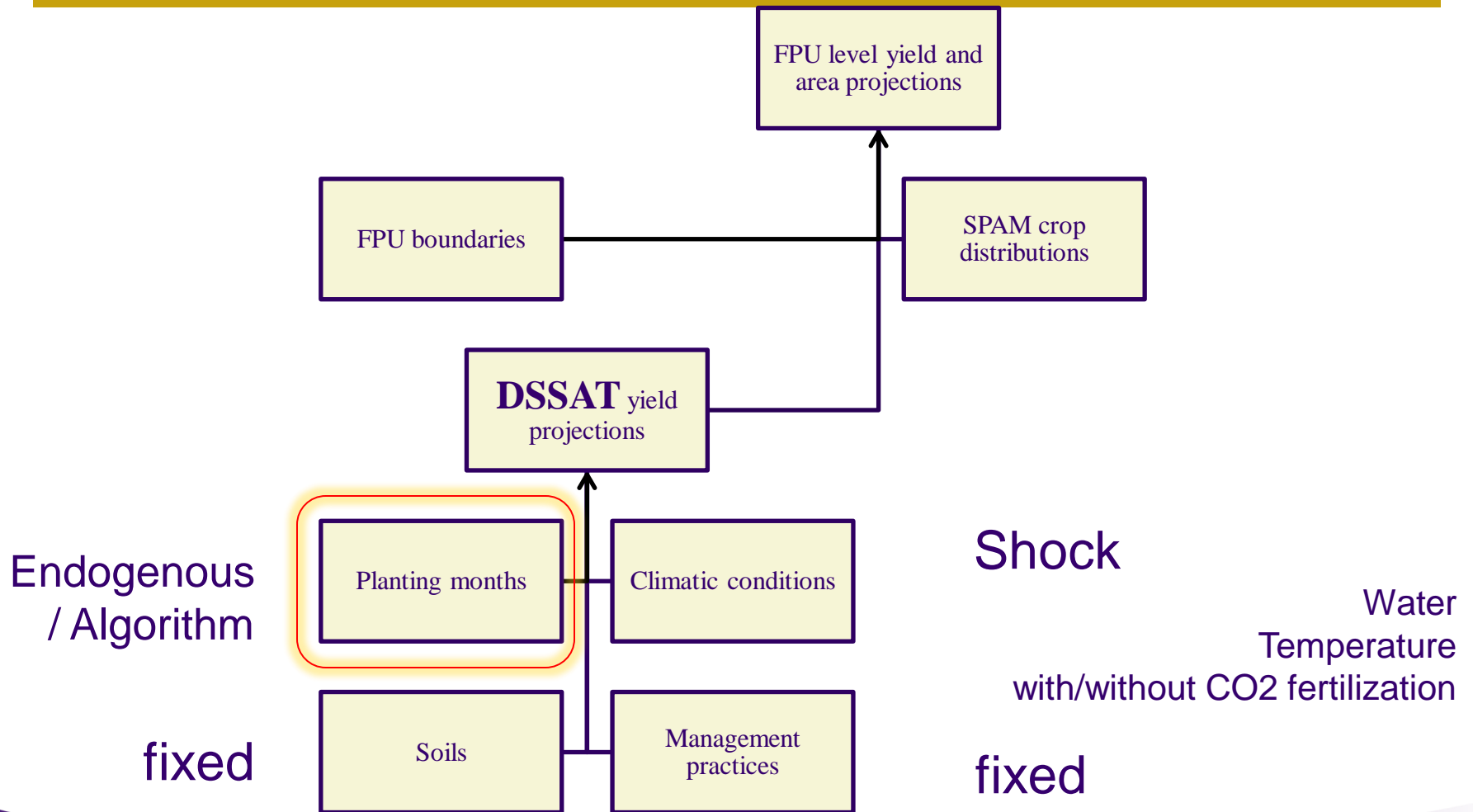
Research Question and Key results

- Which trade policies to deal with Climate Change?
 - Which Climate change effects are we talking about:
 - Change in average yield: the topic of this research
 - But only for effects driven by rainfall and temperature
 - Change in yield volatility: **not** in this research
 - different answers
- Answers:
 - Large uncertainties: one simulation is not enough.
 - How to communicate with policy makers? Are they risk adverse?
 - The role of flexibilities
 - The world will survive and as usual: winners and losers
 - Trade policies will not solve the “average trend” problem. Marginal effects compared to the Climate change. Optimal policies difficult to define: redistribution vs efficiency
 - Role of economic growth
 - Yield in the baseline (and public R&D)

Methodology



Changing Yields in the IMPACT framework



Sectoral Nomenclature: disaggregation of the GTAP database

Code Sector	Description	Code Sector	Description
cattle	Cattle	ffl	Fossil Fuels
coarse	Coarse Grains	Forestry	Forestry
cotton	Cotton	omn	Other Minerals
Maize	Maize	crp	Chemical rubbers and plastics
oagr	Other Ag. Products	mmet	Mineral and metals
oilseed	Oilseeds	moto	Motor vehicles
Pulses	Pulses	ome	Machinery and equipment
rice	Rice	omf	Other manufacture products
sugar	Sugar	p_c	Petroleum & coal products
veget	Vegetables	text	Textiles
wheat	Wheat	wap	Wearing apparel
DairyMeat	Dairy and Meat products	wpp	Wood and paper products
Ofood	Other Processed Food	serv	Services
VegOils	Vegetal Oils	trade	Trade
Fishing	Fishing	trans	Transportation

The MIRAGE CGE for Climate Change

MIRAGE-CC

- Multi sectoral, Multi Country, Recursive Dynamics CGE (used in perfect competition here)
- In GAMS. Input files from DSSAT in .txt
- No FDI allowed in this version (!)
- Irrigation assumption: largely exogenous
 - Leontieff technology within each sector between rainfall and irrigated land
 - No cost
- Armington assumption

New land market representation at an infra-country level

- Critical to avoid composition effect and to see adaptation behaviour: production relocation. Avoid aggregation issue

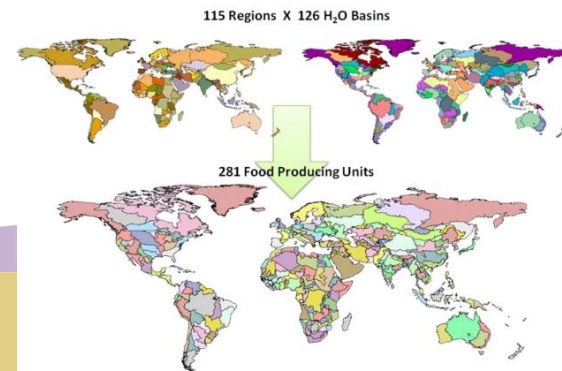
Initial Yield	Maize	Wheat
Region 1	1	2
Region 2	3	5
Country Wide (area weighted)	3	2

Initial Area	Maize	Wheat
Region 1	0	1
Region 2	1	0

Final yield	Maize	Wheat
Region 1	1	2
Region 2	0.5	1.2
Country Wide (area weighted)	0.5 ???	2 ???

- **Food Production Unit** (water basin definition) vs AEZ (endogeneity problem)
 - CES across location

Figure A1.9—IMPACT model units of analysis, Food Producing Units (FPUs)



Long term considerations

- **Baseline:**
 - Education equation in the Baseline
 - Dynamic recalibration of the CES-LES
 - Saving rates exogenous
 - Supply of natural resources
 - No Biofuels
 - Role of Leontief technology between intermediate inputs and value added
 - Energy efficiency gains
 - Other sectors and trade
- **Gift of God vs Private-Public Partnership**
 - Exogenous technological change
 - TFP vs agricultural yield

Yield response in the economic model

- At a crop and FPU level
 - DSSAT Yield + Economic response (factors) = final yield response. In the case of the negative yield shock, we have generally
 - If demand elastic: price increase < cost increase = decrease in terms of the capital rate of return → factors leave the sector → yield decrease **more**
 - If demand inelastic: price increase > cost increase = ... → yield decrease **less**
 - DSSAT effects can be magnified or buffered
 - Role of trade liberalization (elasticity of demand for local production) and the relative impacts on other crops (relative yield shocks)
- At a crop and country level: redistribution across FPU.
 - Average country level crop yield can even go in the reverse direction than a “initial weights” average (depending on initial production, yield gaps and yield variations)
- At a country level: redistribution across crops (and FPU).
 - Average agricultural yield can react in very various way

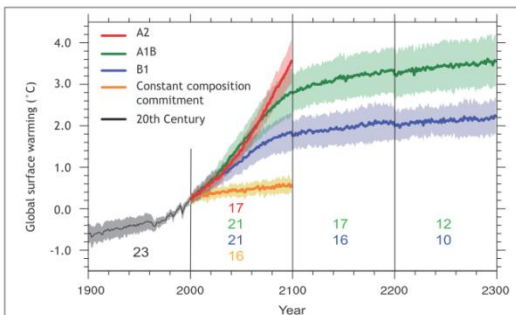
Baselines and Scenarios: Illustrations

- Alternative trade policies = different baselines

Label	Description
BASE	Status quo
SAFTA	Implementation of the post 2007 SAFTA commitments
SAFTAFull	SAFTA + elimination of all remaining tariffs on sensitive products
UNISEN	SAFTAFull + unilateral liberalization with all partners for non sensitive products in SAFTA
UNIAGR	SAFTAFull+ unilateral liberalization in agriculture
UNIALl	Full unilateral liberalization of all SAFTA countries
FTA	Full FTA in Asia and Oceania
MULTI	Full multilateral liberalization

Effects on relative prices
among countries,
among sectors

- Alternative climate change scenarios =



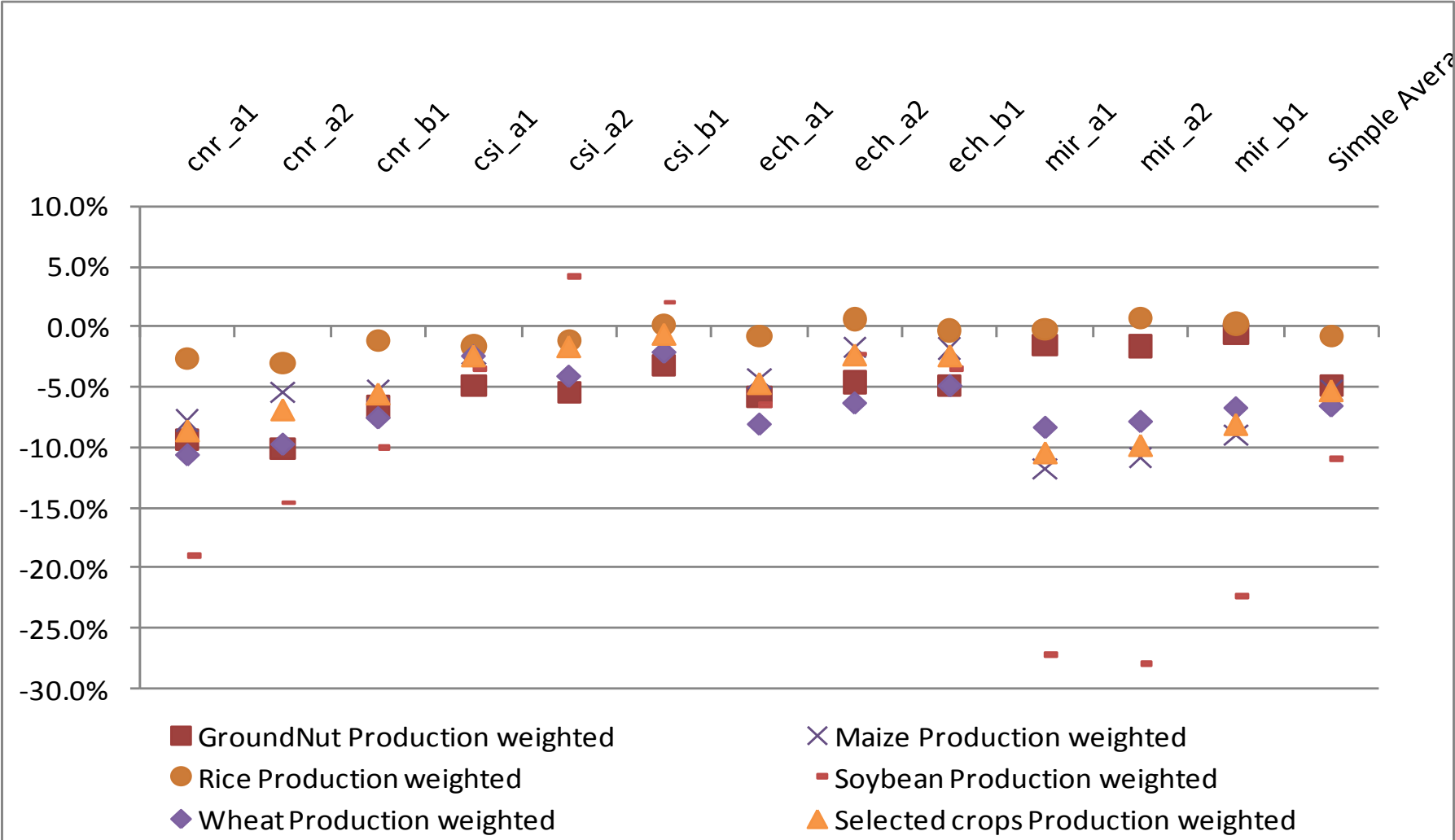
Source: Reprinted with permission from the Intergovernmental Panel on Climate Change (2007).

GCM	SRES scenario	Change between 2000 and 2050 in the annual averages			
		Precipitation (percent)	Precipitation (mm)	Minimum temperature (°C)	Maximum temperature (°C)
CSIRO	B1	0.0	0.1	1.2	1.0
CSIRO	A1B	0.7	4.8	1.6	1.4
CSIRO	A2	0.9	6.5	1.9	1.8
ECH	B1	1.6	11.6	2.1	1.9
CNR	B1	1.9	14.0	1.9	1.7
ECH	A2	2.1	15.0	2.4	2.2
CNR	A2	2.7	19.5	2.5	2.2
ECH	A1B	3.2	23.4	2.7	2.5
MIROC	A2	3.2	23.4	2.8	2.6
CNR	A1B	3.3	23.8	2.6	2.3
MIROC	B1	3.6	25.7	2.4	2.3
MIROC	A1B	4.7	33.8	3.0	2.8
Multi-model ensemble mean					
	A1B	1.51		1.75	
	A2	1.33		1.65	
	B1	1.65		1.29	

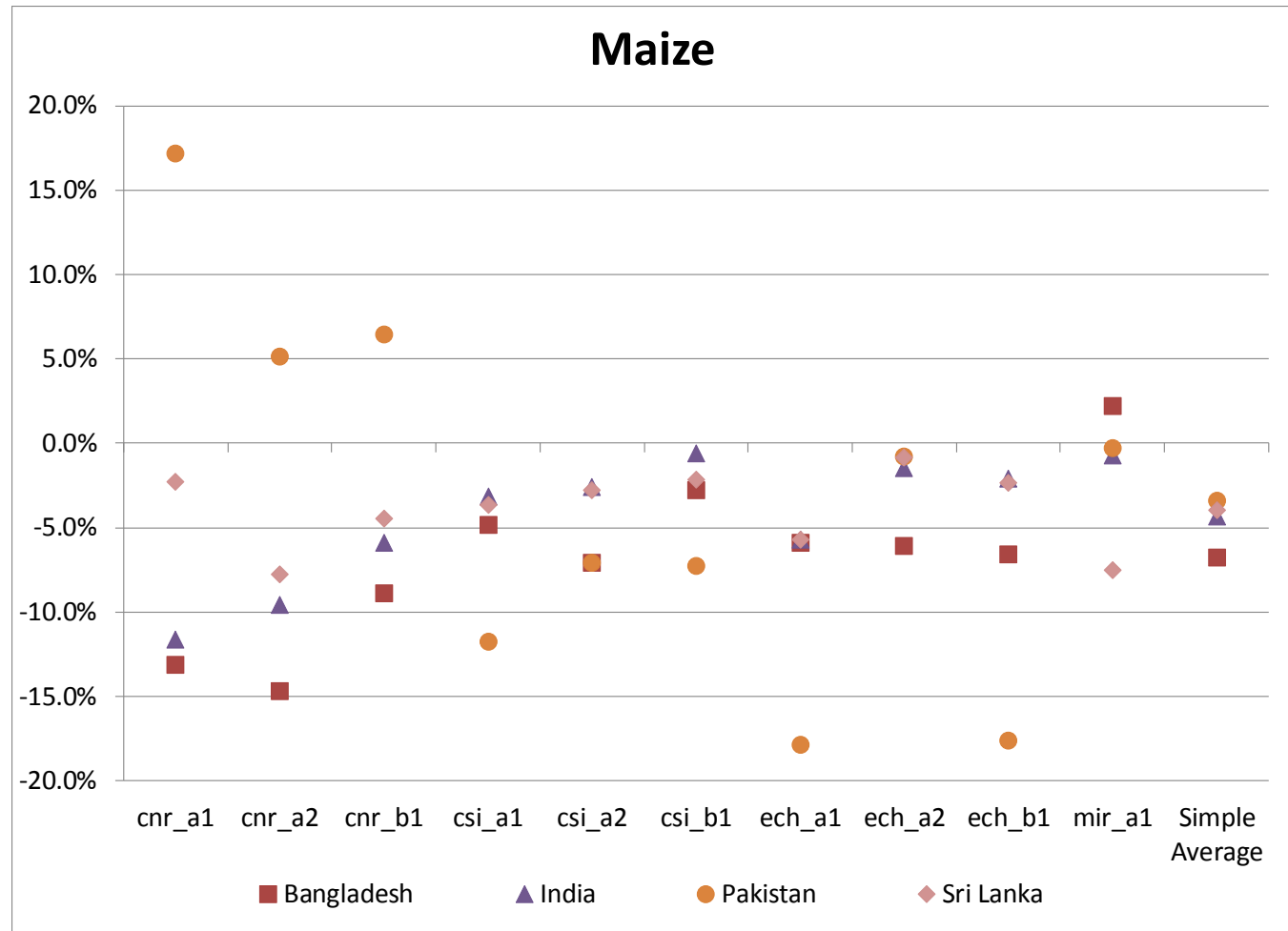
150 dynamic simulations...

CROP MODEL RESULTS

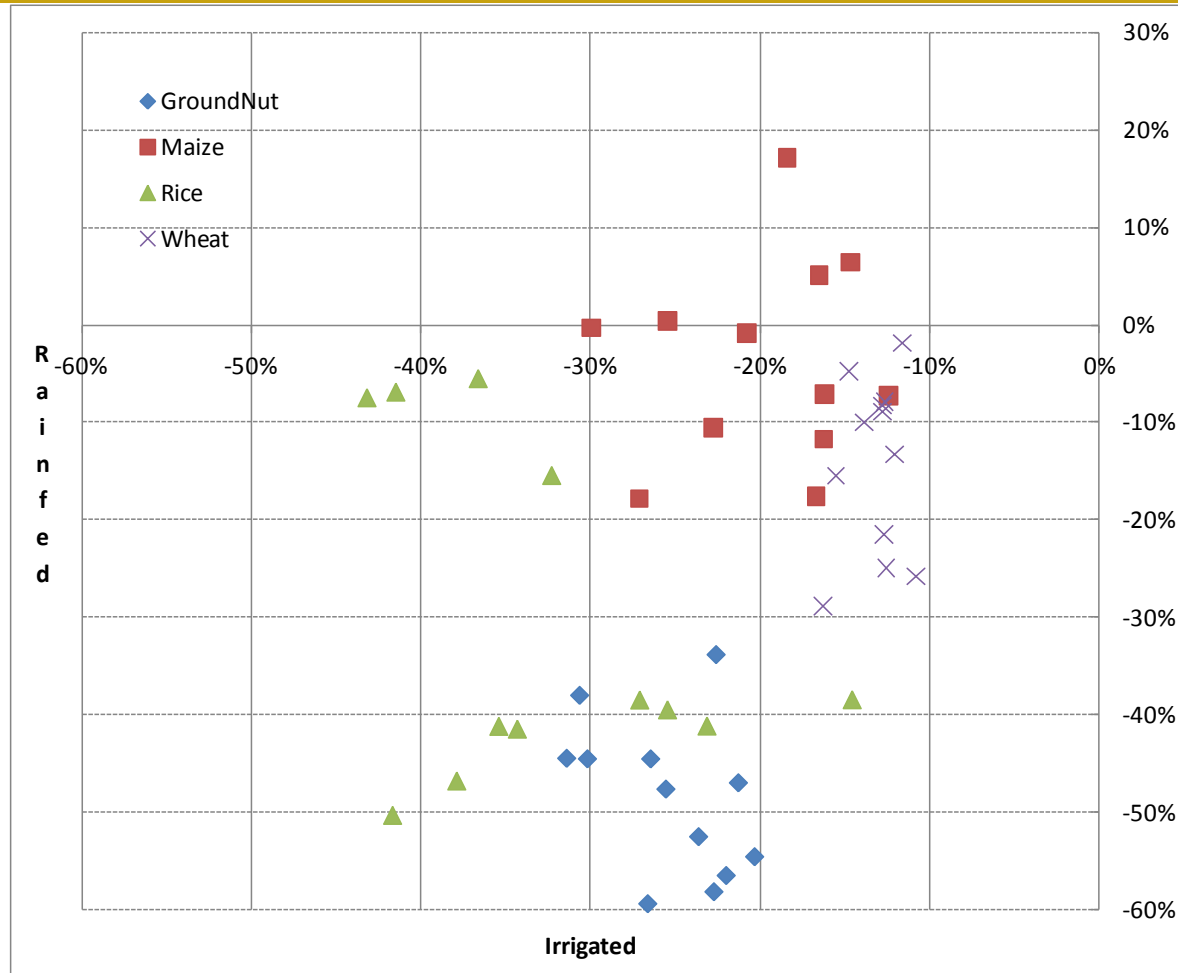
Climate Change effects yields (World)



Subregional heterogeneity

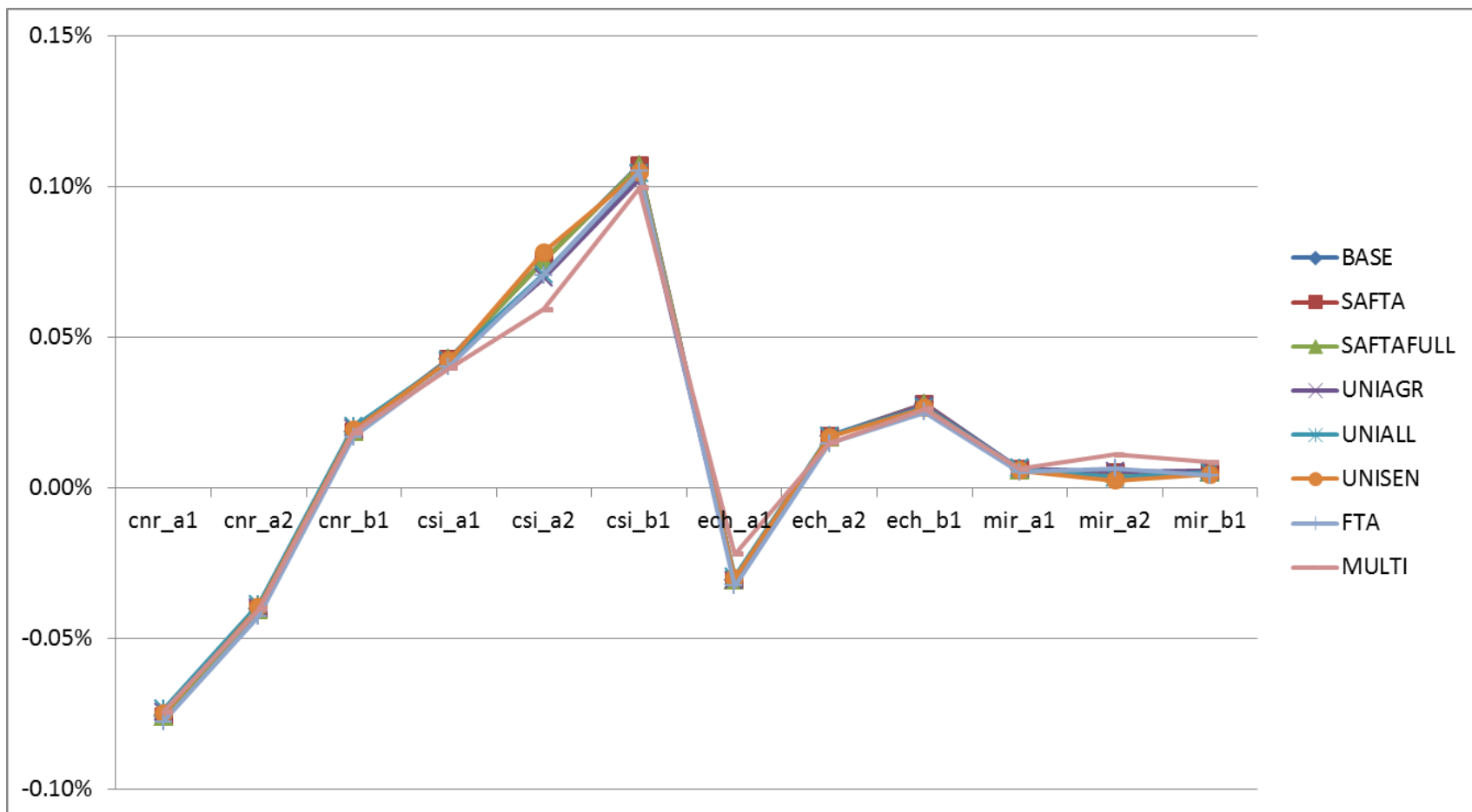


Rainfed vs Irrigation: Illustration Pakistan



CGE RESULTS

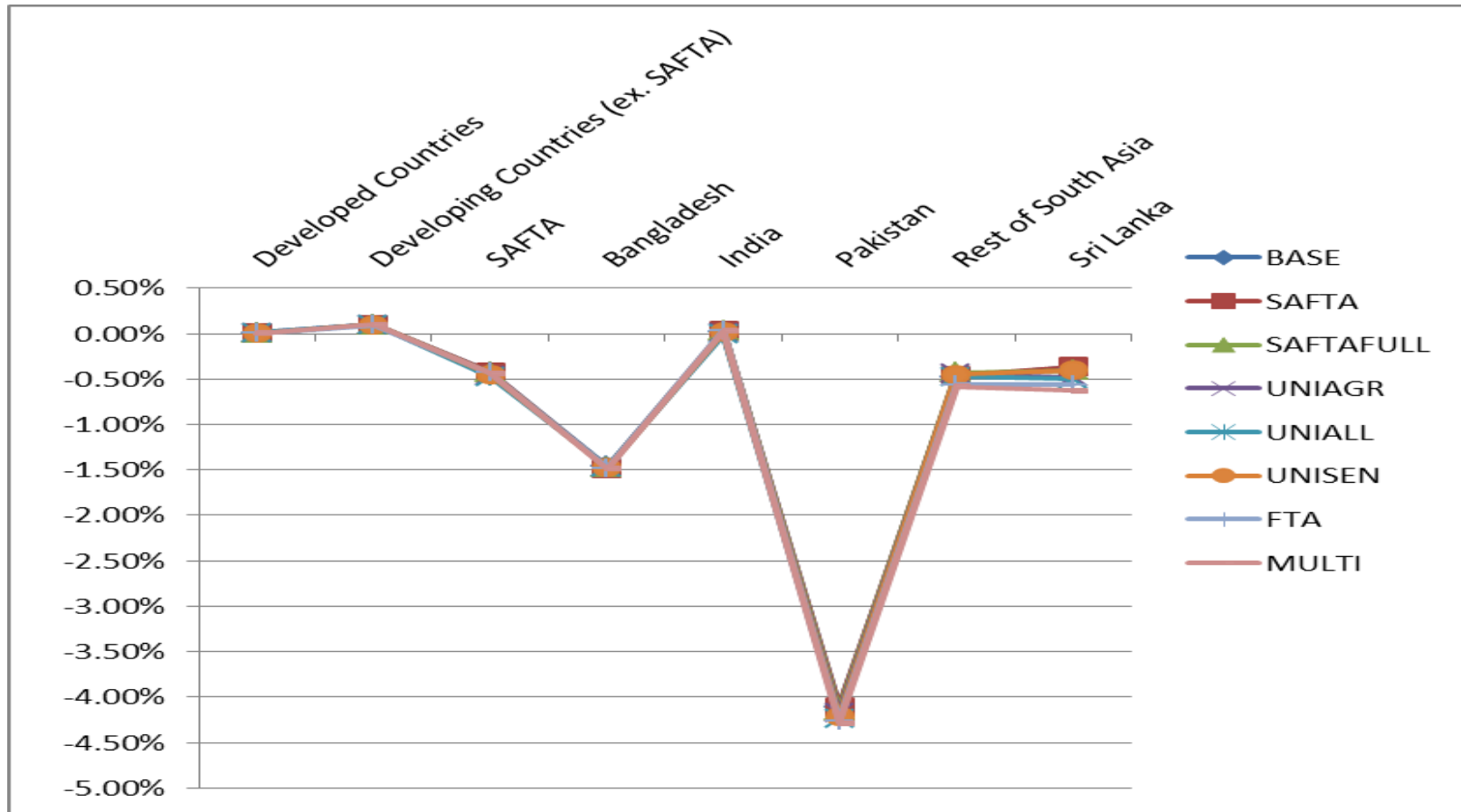
Changes in real income (world level)



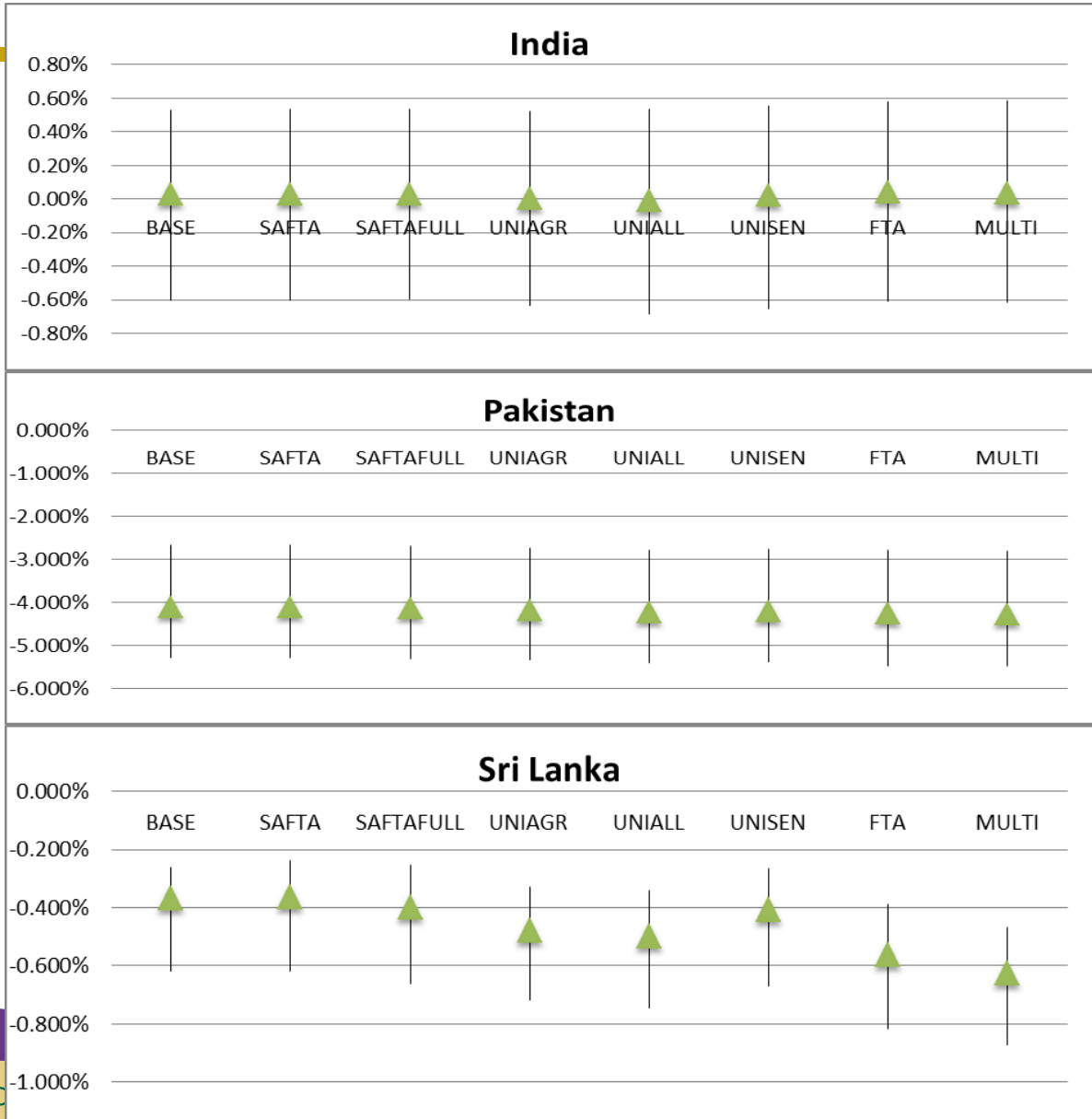
Changes in world trade (staples)



SAFTA – Real Income



Real Income



Agricultural and Agrifood production

India

Agro-food

Average	4.6%	4.6%	4.6%	4.6%	4.3%	4.3%	4.6%	3.7%
Maximum	5.8%	5.7%	5.7%	5.3%	5.1%	5.5%	5.4%	4.2%
Minimum	4.0%	3.9%	4.0%	4.1%	3.8%	3.7%	4.2%	3.3%

Staple

Average	-1.2%	-1.2%	-1.2%	-1.3%	-1.3%	-1.2%	-1.2%	-1.3%
Maximum	0.3%	0.3%	0.3%	0.2%	0.2%	0.3%	0.2%	0.1%
Minimum	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%

Pakistan

Agro-food

Average	-6.5%	-6.1%	-6.0%	-6.2%	-6.1%	-6.1%	-5.4%	-5.4%
Maximum	-4.6%	-4.3%	-4.4%	-4.4%	-4.3%	-4.5%	-4.0%	-3.9%
Minimum	-9.4%	-8.9%	-8.7%	-9.0%	-8.9%	-8.8%	-7.6%	-8.0%

Staple

Average	-8.5%	-8.4%	-8.6%	-8.5%	-8.6%	-8.6%	-8.7%	-8.7%
Maximum	-5.3%	-5.2%	-5.3%	-5.3%	-5.3%	-5.3%	-5.4%	-5.4%
Minimum	-10.6%	-10.6%	-10.7%	-10.6%	-10.7%	-10.7%	-10.9%	-10.9%

Agricultural and Agrifood production

India

Agro-food

Average	4.6%	4.6%	4.6%	4.6%	4.3%	4.3%	4.6%	3.7%
Maximum	5.8%	5.7%	5.7%	5.3%	5.1%	5.5%	5.4%	4.2%
Minimum	4.0%	3.9%	4.0%	4.1%	3.8%	3.7%	4.2%	3.3%

Staple

Average	-1.2%	-1.2%	-1.2%	-1.3%	-1.3%	-1.2%	-1.2%	-1.3%
Maximum	0.3%	0.3%	0.3%	0.2%	0.2%	0.3%	0.2%	0.1%
Minimum	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%

Pakistan

Agro-food

Average	-6.5%	-6.1%	-6.0%	-6.2%	-6.1%	-6.1%	-5.4%	-5.4%
Maximum	-4.6%	-4.3%	-4.4%	-4.4%	-4.3%	-4.5%	-4.0%	-3.9%
Minimum	-9.4%	-8.9%	-8.7%	-9.0%	-8.9%	-8.8%	-7.6%	-8.0%

Staple

Average	-8.5%	-8.4%	-8.6%	-8.5%	-8.6%	-8.6%	-8.7%	-8.7%
Maximum	-5.3%	-5.2%	-5.3%	-5.3%	-5.3%	-5.3%	-5.4%	-5.4%
Minimum	-10.6%	-10.6%	-10.7%	-10.6%	-10.7%	-10.7%	-10.9%	-10.9%

Agricultural production

India

Wheat	-7.2%	-7.2%	-7.2%	-7.3%	-7.3%	-7.2%	-7.4%	-7.5%
Vegetal Oils	-4.6%	-4.7%	-5.0%	-6.3%	-6.6%	-5.2%	-7.2%	-4.8%
Rice	-4.8%	-4.8%	-4.8%	-4.8%	-4.9%	-4.8%	-4.9%	-5.3%
Cotton	-3.5%	-3.5%	-3.5%	-3.6%	-3.6%	-3.5%	-3.6%	-3.6%
Oilseeds	-2.0%	-2.0%	-2.0%	-2.1%	-2.1%	-2.1%	-2.0%	-2.1%

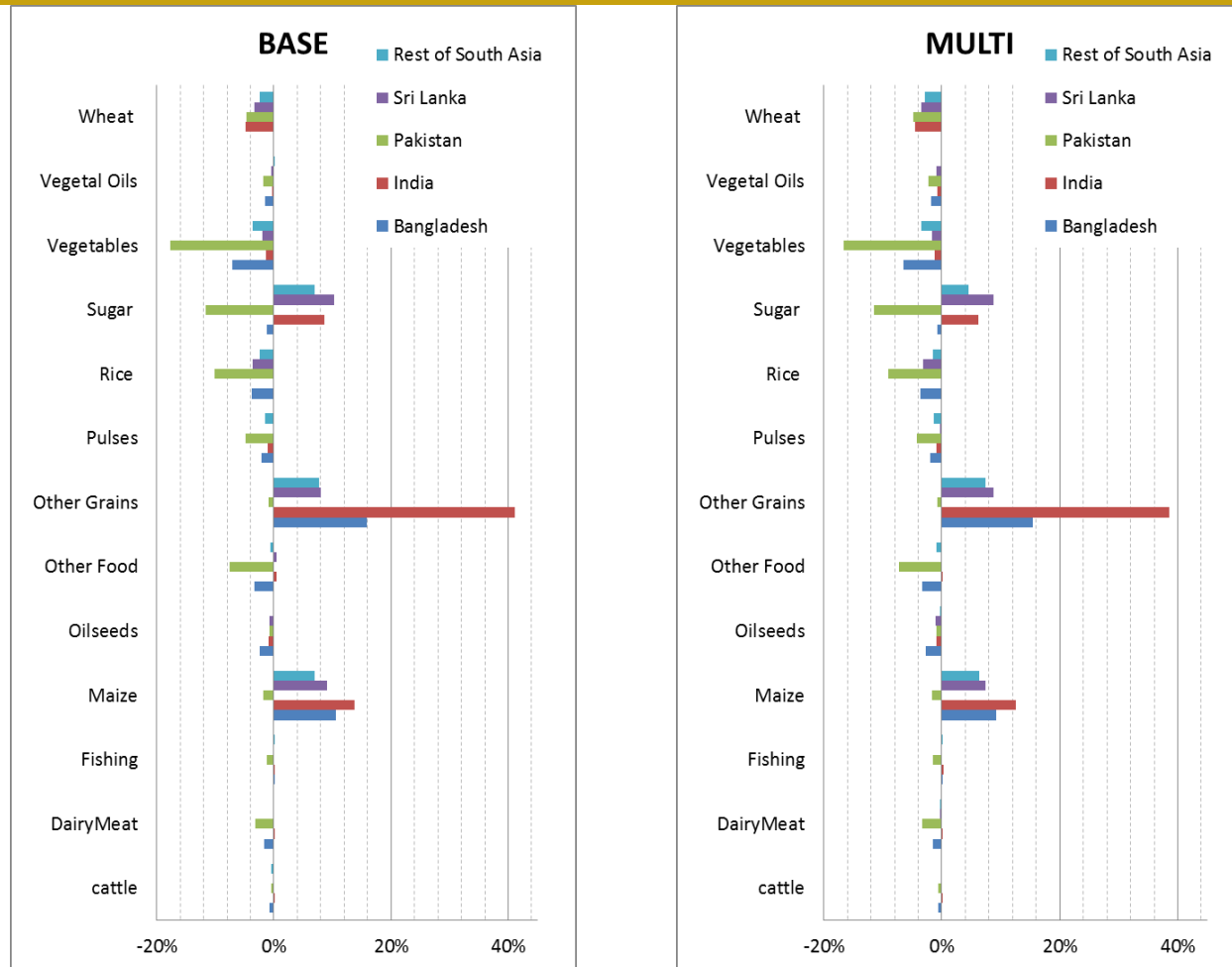
Pakistan

Oilseeds	-35.1%	-35.1%	-35.0%	-34.8%	-34.8%	-35.1%	-34.7%	-34.6%
Rice	-32.7%	-32.6%	-32.6%	-32.6%	-32.6%	-32.6%	-33.2%	-33.5%
Cotton	-27.6%	-27.6%	-27.6%	-27.6%	-27.7%	-27.7%	-27.6%	-27.6%
Pulses	-27.2%	-27.1%	-27.4%	-27.4%	-27.3%	-27.3%	-27.4%	-27.3%
Vegetables and Fruits	-22.2%	-22.2%	-22.2%	-22.3%	-22.3%	-22.2%	-22.6%	-22.6%

A serious redistribution concern: Changes in unskilled worker wages

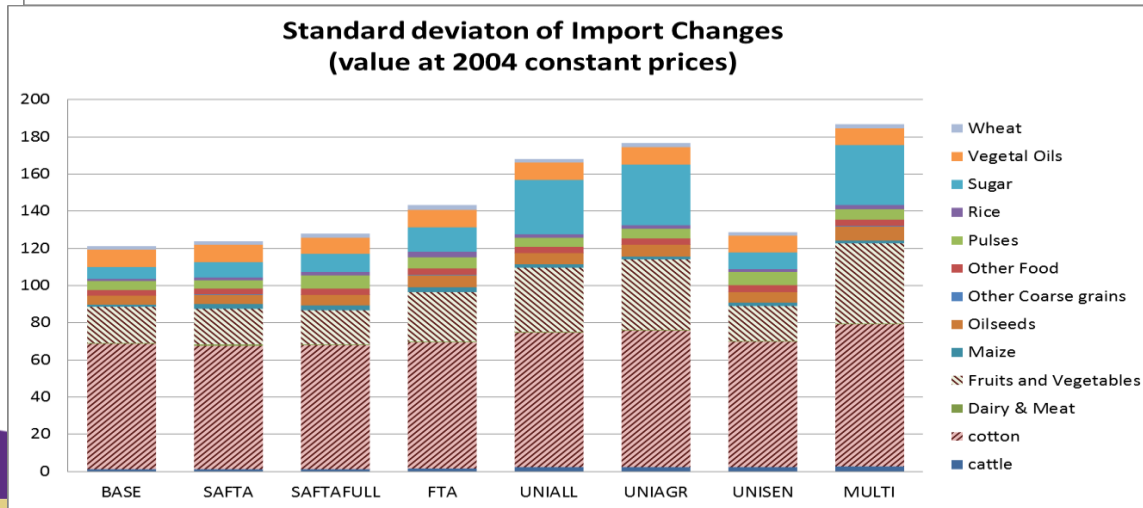
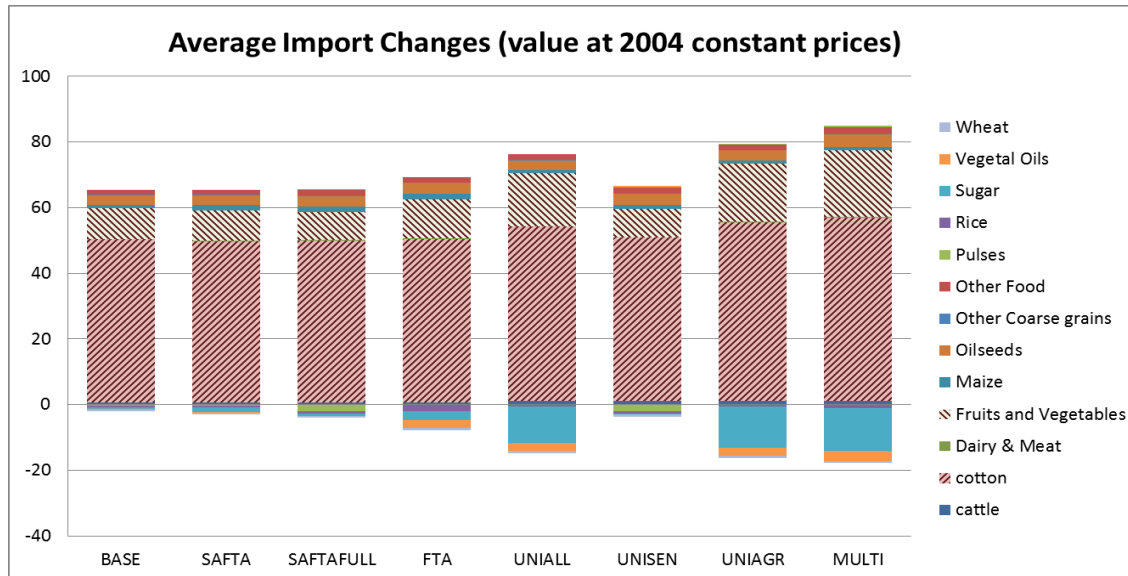
	BASE	SAFTA	SAFTAFULL	UNIAGR	UNIALI	UNISEN	FTA	MULTI
Bangladesh								
Average	-2.1%	-2.1%	-2.0%	-2.0%	-1.9%	-2.0%	-1.9%	-1.9%
Maximum	-0.4%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
Minimum	-3.6%	-3.5%	-3.4%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%
India								
Average	1.6%	1.5%	1.4%	0.8%	0.4%	0.8%	1.0%	0.8%
Maximum	8.2%	8.1%	8.0%	6.1%	3.9%	4.9%	5.4%	4.3%
Minimum	-9.1%	-9.1%	-9.1%	-7.8%	-5.4%	-6.0%	-6.0%	-4.7%
Pakistan								
Average	-5.9%	-5.8%	-5.7%	-5.7%	-5.3%	-5.3%	-5.4%	-5.2%
Maximum	-3.3%	-3.2%	-3.1%	-3.3%	-2.8%	-2.8%	-2.8%	-2.7%
Minimum	-8.2%	-8.1%	-8.0%	-7.9%	-7.4%	-7.5%	-7.5%	-7.3%
Sri Lanka								
Average	-1.9%	-1.9%	-1.9%	-2.0%	-2.1%	-1.9%	-2.3%	-2.3%
Maximum	-1.2%	-1.2%	-1.2%	-1.3%	-1.4%	-1.2%	-1.6%	-1.6%
Minimum	-2.4%	-2.4%	-2.4%	-2.5%	-2.6%	-2.4%	-2.9%	-2.8%

(too) Large Substitution effects on the consumption side?



Changes in consumption

Level of Imports



Concluding remarks

- The Trade policy landscape has limited macroeconomic effects of Climate Change consequences on average yield
 - Larger role on distribution (poor people): needs to investigate the issue deeper, in particular with better demand modeling: integration of the MIRAGE-Climate Change and the MIRAGE-Household disaggregation modele
- Large Uncertainties
 - Promote economic growth (endogenous investments) and role of FDI?
 - Flexibilities for farmers to change crops
 - Flexibilities to relocate production: infrastructure
 - Caution with any large sunk costs (R&D in one crop...)
- Improved work on irrigation