



Global Warming and Agriculture

William R. Cline

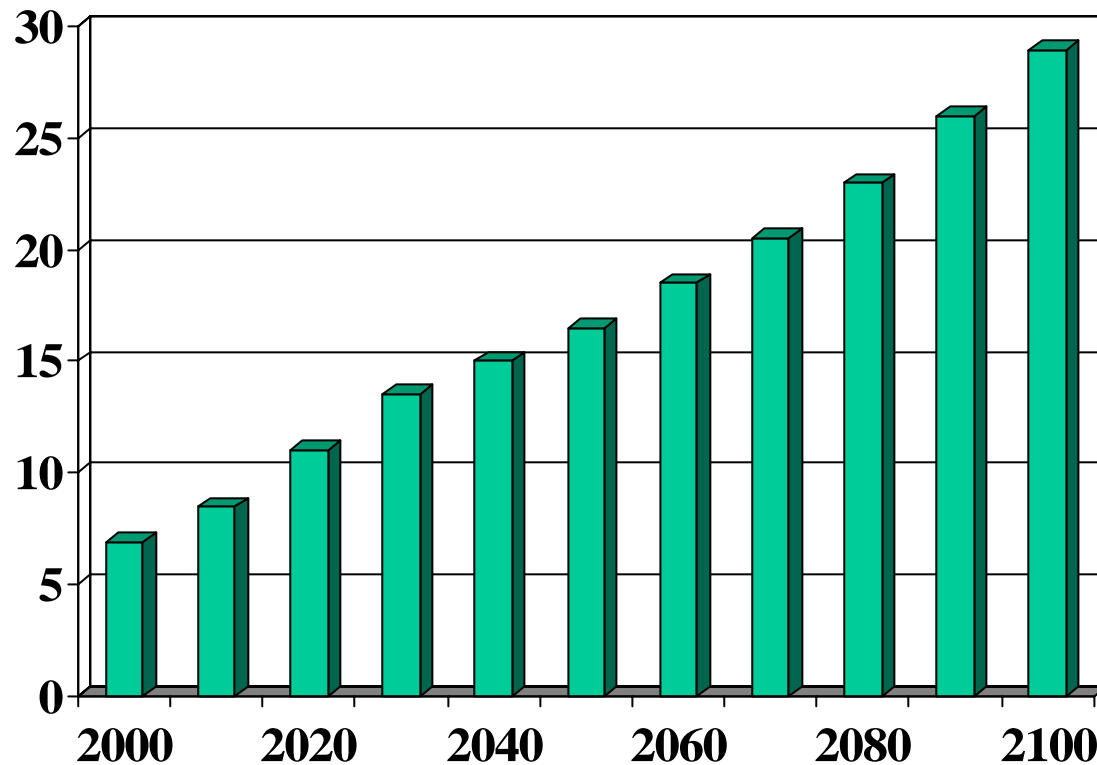
Center for Global Development and

Peterson Institute for International Economics

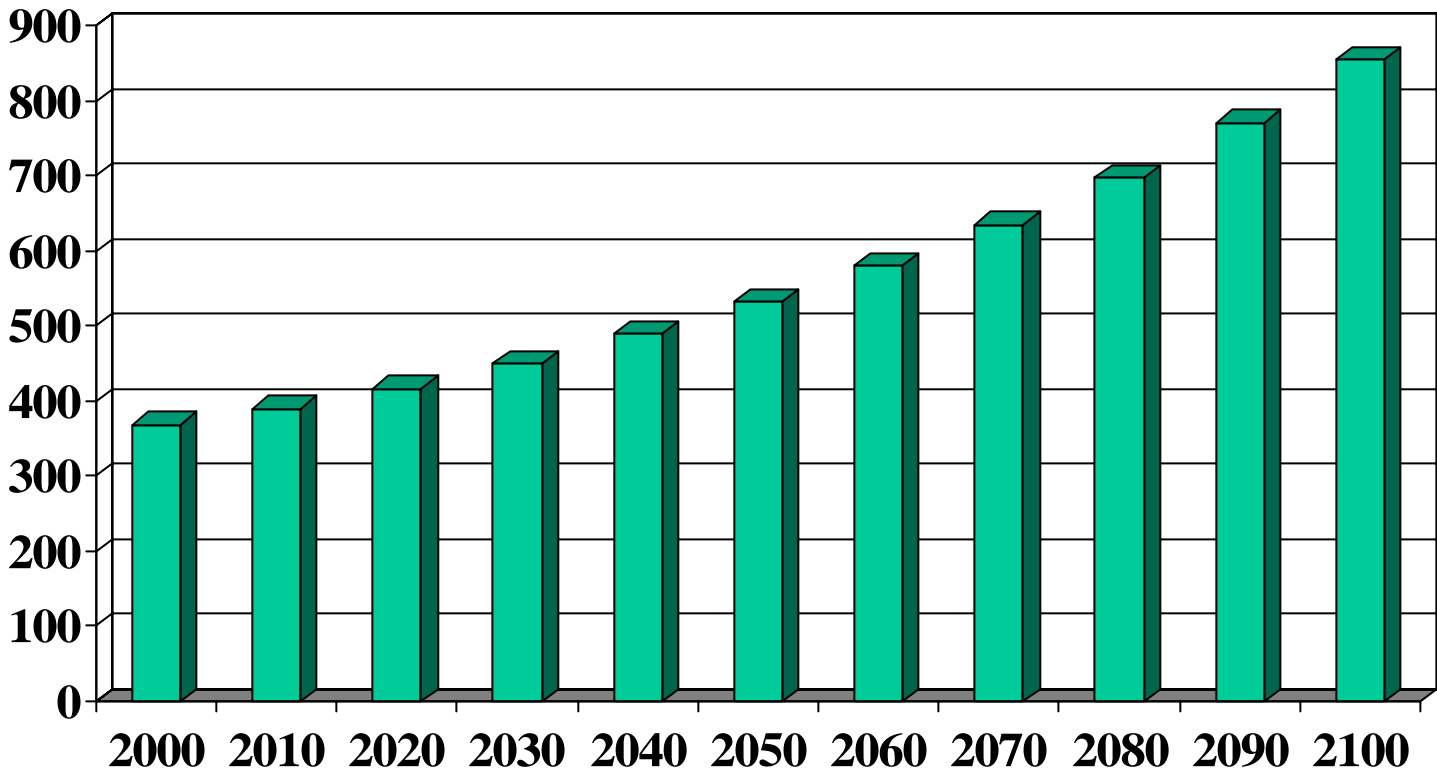
Model	Resolution	Warming for 2xCO ₂ (°C)
German Climate Research Centre	2.8° x 2.8°	2.6
UK Hadley Centre	2.5° x 3.75°	3.0
Australian Commonwealth Scientif. & Indust. Res. Org	3.2° x 5.6°	3.7
Canadian Centre for Climate Modeling	3.7° x 3.7°	3.6
US Geophysical Fluid Dynamics Laboratory	2.25° x 3.75°	3.4
Japanese Centre for Climate Research Studies (f)	5.6° x 5.6°	3.5

Baseline CO2 Emissions (A2)

(billion tons carbon equivalent)



Baseline CO2 atmospheric concentration (parts per million)



Converting Grid Sizes

(resolution and # of land-based cells)

	Resolution	# of cells
IPCC Actuals, 1961-90	1° x 1°	22,156
Typical climate model	3° x 4°	1,836
Standardized grid (this study)	2° x 3°	3,672

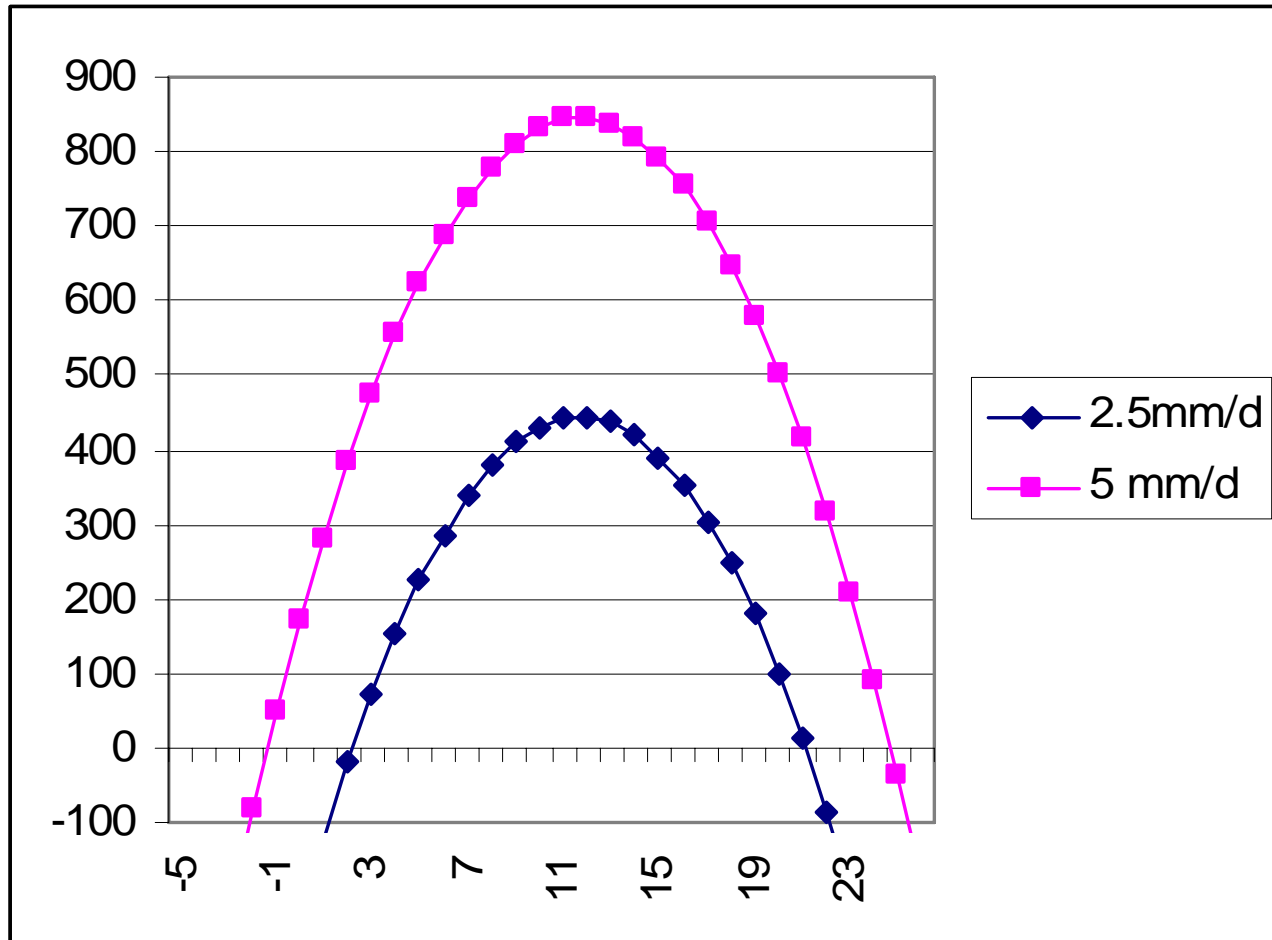
Global Climate Change by 2080s

	Land area weights	Farm area weights
Temperature (°C) (base)	13.15	16.2
Precipitation (mm/d) “	2.20	2.44
Change by 2080s:		
Temperature (°C)	4.95	4.43
Precipitation (mm/d)	0.13	0.07
Precipitation (percent)	5.9%	2.9%

Agricultural Impact Models Used

- Crop Models (18 countries): Rosenzweig-Iglesias
- “Ricardian Models:
 - Mendelsohn-Schlesinger based on US
 - World Bank for Africa, Latin America
 - Mendelsohn-Dinar-Sanghi for India

Output per hectare at alternative average temperatures (\$ and °C)

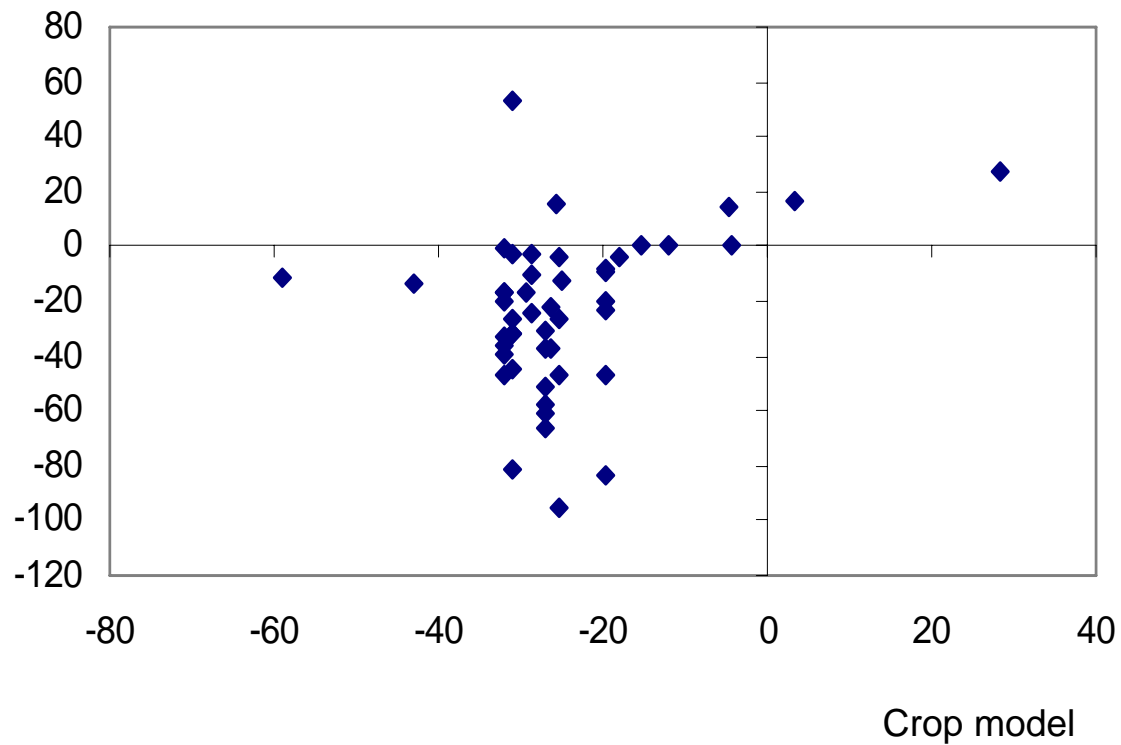


How Much Carbon Fertilization?

- Carbon dioxide is an input into photosynthesis
- Wheat, rice, soybeans, cotton (C3): more response; corn, sugarcane (C4): less
- Early laboratory experiments overstated effect. Open field (FACE) results now show lower impact.
- Estimate: 15% yield boost for 735 ppm

Figure 5.4 Percentage change in agricultural capacity by the 2080s in 47 countries and regions (without carbon fertilization)

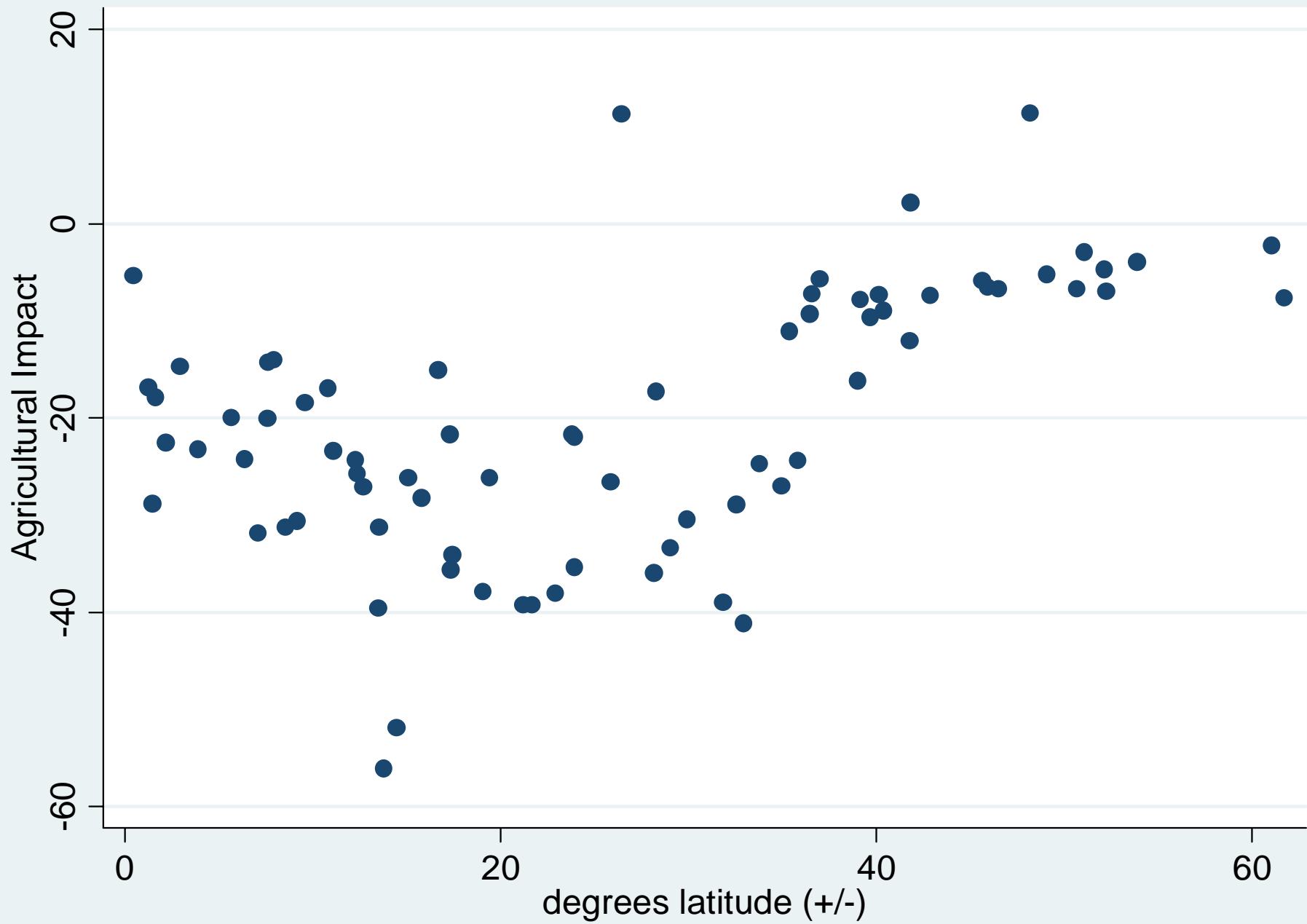
Ricardian model



Results, selected countries

(percent change in agricultural productivity)

	Ricardian	Crop Model	Weighted Avg	
			w/oCF	w/CF
Argentina	-4	-18.1	-11.1	2.2
Brazil	-5.1	-28.7	-16.9	-4.4
US	4.7	-16.5	-5.9	8.0
SW plains	-11.1	-59.0	-35.1	-25.0
India	-49.2	-27.0	-38.1	-28.8
China	3.8	-12.6	-7.2	6.8
S. central	-18.8	-12.6	-14.6	-1.8

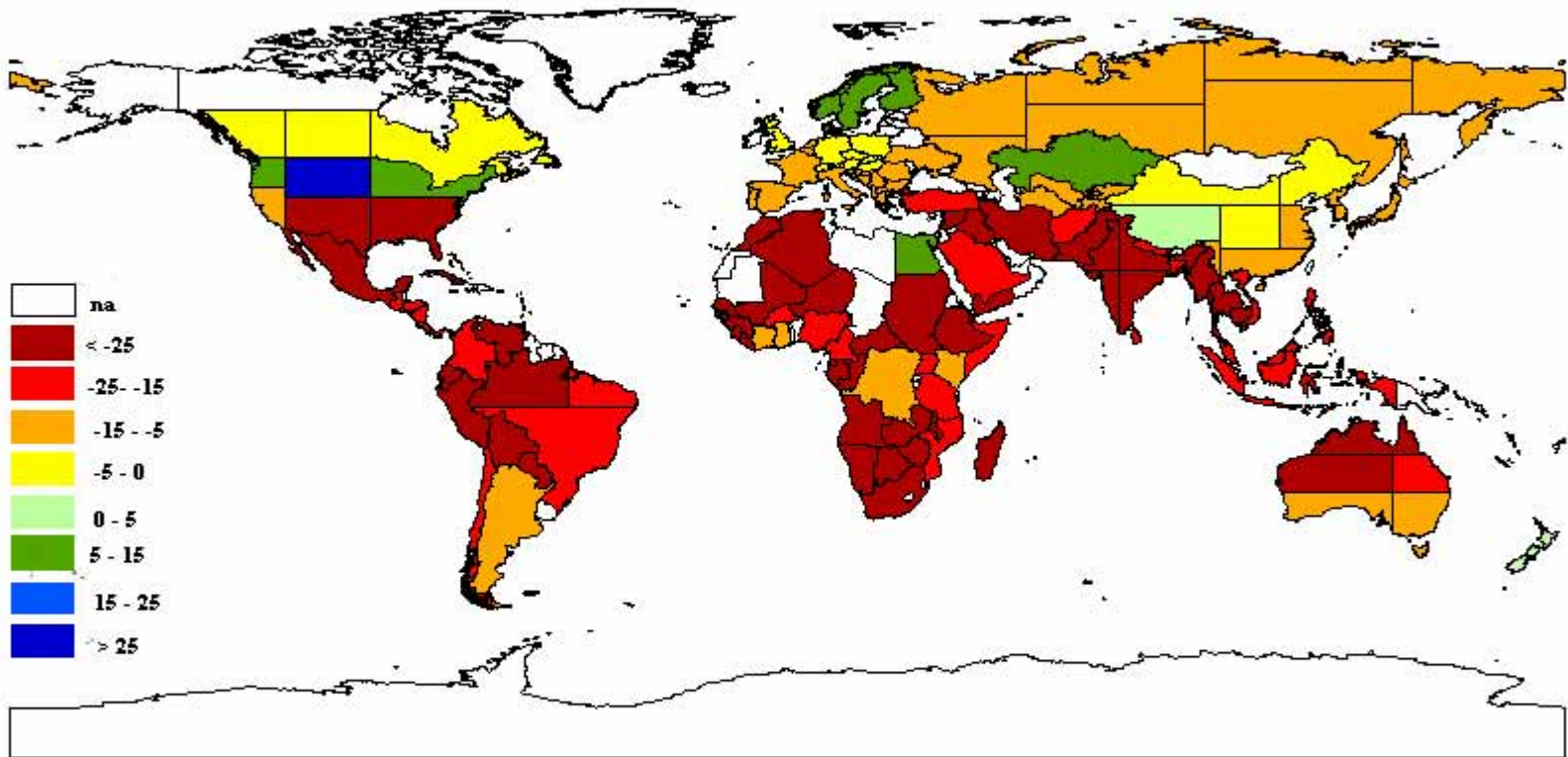


Results, selected countries

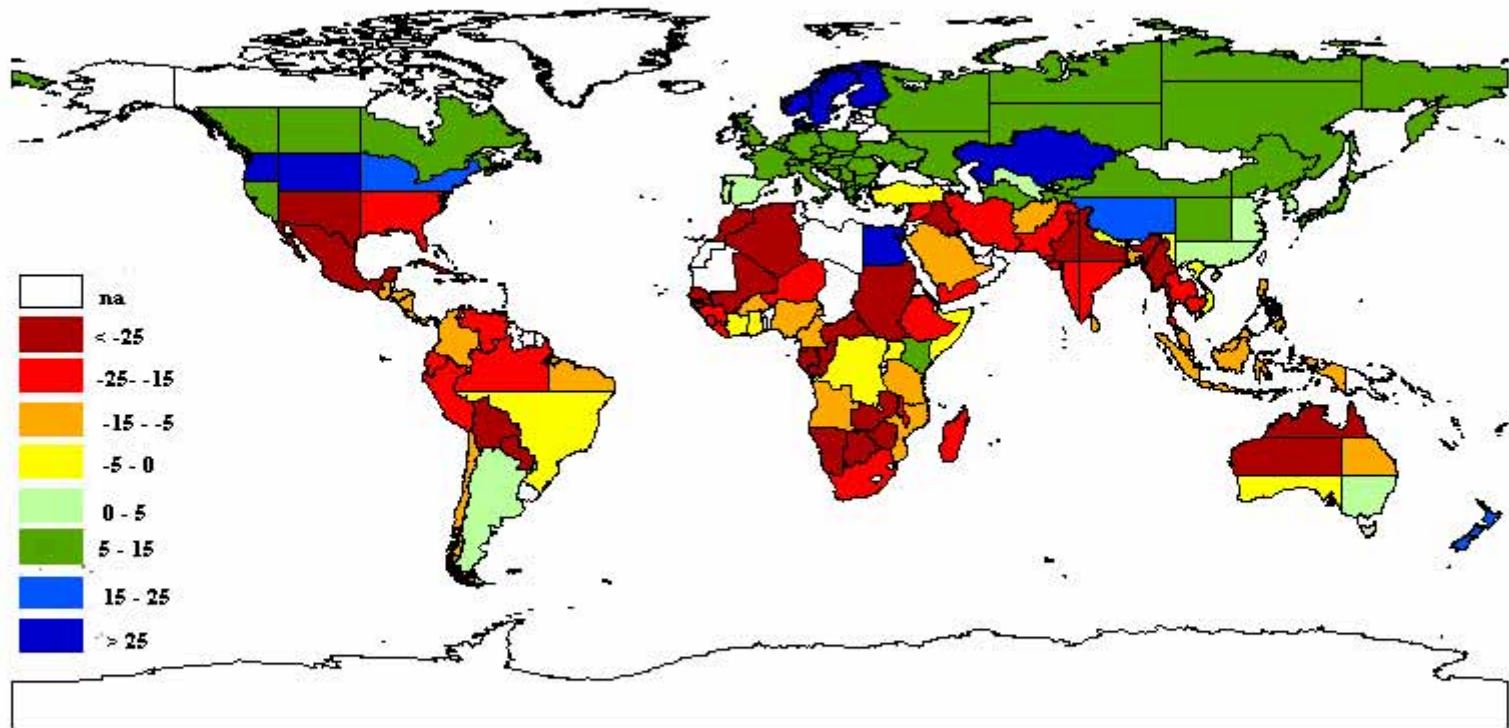
(percent change in agricultural productivity)

	Ricardian	Crop Model	Wtd Average	
			w/oCF	w/CF
Mexico	-35.9	-35.1	-35.4	-25.7
Nigeria	-12.1	-24.9	-18.5	-6.3
South Africa	-47.0	-19.8	-33.4	-23.4
Ethiopia	-31.4	-31.1	-31.3	-20.9
Canada	0	-4.3	-2.2	12.5
Spain	-4.5	-11.1	-8.9	4.8
Germany	13.8	-11.1	-2.9	11.7

Impact on Agricultural Productivity without Carbon Fertilization (percent)



Impact on Agricultural Productivity with Carbon Fertilization (percent)



Results by Region

(% change in agricultural productivity)

	w/o CF	w/ CF
World	-15.9	-3.2
Industrial countries	-6.3	7.7
Developing countries exc. Eur.	-21.0	-9.1
Median	-25.8	-14.7
Africa	-27.5	-16.6
Middle East –North Africa	-21.2	-9.4
Asia	-19.3	-7.2
Latin America	-24.3	-12.9

Technological Change is No Panacea

		2004	2085
Population (billion)	medium	6.5	10.5
	high	6.5	14.7
Per capita ppp income (\$)		6,330	14,000
Per capita food consumption (index)		100	163
Food demand (index)		100	260-370
Food supply: technology (index)		100	350
Diversion to energy crops (%)		1	30
Food supply: combined (index)		100	245



GLOBAL WARMING and AGRICULTURE

Impact Estimates by Country

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