



INTERNATIONAL FOOD POLICY
RESEARCH INSTITUTE

Supported by the CGIAR

www.ifpri.org

2033 K Street, NW
Washington, D.C. 20006-1002 USA
T +1-202.862.5600 • F +1.202.467.4439

Climate Change

Impact on Agriculture and Costs of Adaptation

Gerald C. Nelson, Mark W. Rosegrant, Jawoo Koo, Richard Robertson, Timothy Sulser, Tingju Zhu,
Claudia Ringler, Siwa Msangi, Amanda Palazzo, Miroslav Batka, Marilia Magalhaes, Rowena
Valmonte-Santos, Mandy Ewing, and David Lee

APPENDIX 2:

RESULTS BY WORLD BANK REGIONAL GROUPING OF COUNTRIES

Washington, D.C.
September 2009

Table A2.1—Yield changes by crop and management system under current climate and two climate change scenarios with and without CO₂ fertilization effects (% change from yields with 2000 climate)

Region	CSIRO NoCF	NCAR NoCF	CSIRO CF	NCAR CF
Maize, irrigated				
East Asia and the Pacific	-1.3	-2.6	-0.8	-1.9
Europe and Central Asia	0.0	-1.3	0.1	-1.2
Latin America and the Caribbean	-2.8	-3.0	-2.3	-2.5
Middle East and North Africa	0.1	-1.0	-0.4	-1.1
South Asia	-6.4	-5.5	-4.4	-3.6
Sub-Saharan Africa	0.3	0.6	0.5	0.8
Developing Countries	-2.0	-2.8	-1.4	-2.1
Developed Countries	-1.2	-8.7	-1.2	-8.6
World	-0.8	-5.6	-0.6	-5.2
Maize, rainfed				
East Asia and the Pacific	1.5	-3.9	3.7	-2.0
Europe and Central Asia	25.0	3.7	32.8	12.4
Latin America and the Caribbean	-0.4	-1.9	2.2	0.4
Middle East and North Africa	58.6	-46.7	61.8	-46.3
South Asia	-2.9	-7.8	0.2	-4.9
Sub-Saharan Africa	-2.4	-4.6	-0.8	-2.7
Developing Countries	0.2	-2.9	2.6	-0.8
Developed Countries	0.6	-5.7	9.5	2.5
World	1.0	-3.4	5.3	0.5
Rice, irrigated				
East Asia and the Pacific	-13.0	-19.8	4.4	-1.1
Europe and Central Asia	-4.1	-15.1	15.0	5.7
Latin America and the Caribbean	-6.4	-0.8	-1.2	7.0
Middle East and North Africa	-13.3	-29.5	1.7	-14.4
South Asia	-15.5	-17.5	2.5	1.4
Sub-Saharan Africa	-11.4	-14.1	5.7	2.4
Developing Countries	-14.4	-18.5	2.4	-0.5
Developed Countries	-3.5	-5.5	10.5	9.0
World	-13.8	-17.8	2.8	-0.0

Region	CSIRO NoCF	NCAR NoCF	CSIRO CF	NCAR CF
Rice, rainfed				
East Asia and the Pacific	-4.5	-5.8	2.5	1.8
Europe and Central Asia	49.8	-1.0	61.3	-6.1
Latin America and the Caribbean	5.3	-1.8	12.7	6.7
Middle East and North Africa	0	0	0	0.0
South Asia	0.1	2.6	8.5	10.2
Sub-Saharan Africa	0.1	-0.5	8.1	7.3
Developing Countries	-1.3	-1.4	6.5	6.4
Developed Countries	17.3	10.3	23.4	17.8
World	-1.3	-1.4	6.5	6.4
Soybean, irrigated				
East Asia and the Pacific	-8.2	-13.4	9.1	3.6
Europe and Central Asia	31.9	30.1	32.9	30.5
Latin America and the Caribbean	-1.2	-2.5	19.5	18.2
Middle East and North Africa	-4.2	-14.0	5.6	-5.0
South Asia	-9.5	-11.5	12.0	10.3
Sub-Saharan Africa	4.6	5.0	17.8	17.8
Developing Countries	-8.0	-12.3	10.3	5.8
Developed Countries	2.5	-2.7	15.0	9.0
World	-0.4	-5.4	13.7	8.0
Soybean, rainfed				
East Asia and the Pacific	-3.6	-8.6	17.0	11.5
Europe and Central Asia	25.5	5.9	37.0	5.9
Latin America and the Caribbean	-2.6	4.2	19.1	19.1
Middle East and North Africa	17.5	-84.2	26.0	-76.4
South Asia	-13.8	-13.6	4.4	7.9
Sub-Saharan Africa	-3.5	-5.8	19.1	17.8
Developing Countries	-2.3	1.7	19.5	18.0
Developed Countries	14.1	6.6	19.5	15.1
World	1.1	2.3	18.0	16.3

Wheat, irrigated				
East Asia and the Pacific	-2.7	-7.1	3.7	-0.6
Europe and Central Asia	-9.4	-19.8	-3.3	-14.7
Latin America and the Caribbean	0.3	-5.6	6.5	0.9
Middle East and North Africa	-12.8	-19.7	-5.8	-13.4
South Asia	-47.1	-53.9	-38.3	-45.8
Sub-Saharan Africa	0.7	1.4	7.3	9.7
Developing Countries	-28.3	-34.3	-20.8	-27.2
Developed Countries	-5.7	-4.9	-1.3	-0.1
World	-25.6	-31.1	-18.5	-24.4
Wheat, rainfed				
East Asia and the Pacific	-14.8	-16.1	-5.4	-9.2
Europe and Central Asia	-0.3	-1.8	8.5	8.0
Latin America and the Caribbean	2.3	4.2	12.2	11.8
Middle East and North Africa	-2.6	-8.1	8.8	2.0
South Asia	-44.4	-43.7	-28.9	-28.0
Sub-Saharan Africa	-19.3	-21.9	-11.2	-15.9
Developing Countries	-1.4	-1.1	9.3	8.5
Developed Countries	3.1	2.4	9.7	9.5
World	1.0	0.8	9.7	9.1
Groundnut, irrigated				
East Asia and the Pacific	-11.1	-13.7	3.6	1.2
Europe and Central Asia	-34.4	-50.3	-22.6	-41.5
Latin America and the Caribbean	0.0	0.0	0.0	0.0
Middle East and North Africa	-11.6	-28.5	4.3	-15.6
South Asia	-6.7	-10.6	9.4	5.0
Sub-Saharan Africa	-11.5	-11.3	3.9	4.2
Developing Countries	-10.0	-13.1	5.2	2.0
Developed Countries	-4.6	-10.7	12.1	5.0
World	-9.2	-12.7	6.2	2.5

Groundnut, rainfed				
East Asia and the Pacific	-5.1	-6.5	11.3	9.7
Europe and Central Asia	0.0	0.0	0.0	0.0
Latin America and the Caribbean	0.9	7.1	18.1	17.9
Middle East and North Africa	-20.5	23.6	-11.8	23.6
South Asia	-8.1	-8.9	9.1	6.7
Sub-Saharan Africa	-4.1	-8.6	14.2	8.8
Developing Countries	-4.7	-7.9	12.9	8.6
Developed Countries	-18.3	-5.0	2.7	11.6
World	-4.9	-7.9	12.7	8.7

Source: Compiled by authors. The results in this table are derived by “growing” a crop at 0.5 degree intervals around the world. At each location, the yield is calculated with 2000 climate, existing soil conditions, and rates of nitrogen application assumed relevant for that country. Then 2050 climate data replace the 2000 climate data and the crop is grown again.

Table A2.2—Production changes between 2000 and 2050 by crop and management system for two GCMS with and without CO₂ fertilization effects (% change)

Region	NCAR NoCF	CSIRO NoCF	NCAR CF	CSIRO CF
Maize, irrigated				
East Asia and the Pacific	-9.3	-8.1	-8.7	-7.7
Europe and Central Asia	-13.7	-12.6	-13.6	-12.6
Latin America and the Caribbean	-24.0	-23.9	-23.6	-23.5
Middle East and North Africa	-31.2	-30.5	-31.3	-30.9
South Asia	-25.3	-26.0	-23.8	-24.4
Sub-Saharan Africa	-39.5	-39.7	-39.4	-39.5
Developing Countries	-16.4	-15.7	-15.8	-15.2
Developed Countries	-13.0	-6.3	-12.9	-6.4
World	-15.4	-13.0	-15.0	-12.7

Maize, rainfed				
East Asia and the Pacific	-13.9	-19.2	-12.5	-17.5
Europe and Central Asia	-74.8	-24.4	-72.7	-19.4
Latin America and the Caribbean	-13.0	-11.2	-11.0	-8.9
Middle East and North Africa	-57.4	-24.5	-57.1	-23.0
South Asia	-25.5	-36.8	-22.9	-34.8
Sub-Saharan Africa	-17.9	-17.8	-16.3	-16.3
Developing Countries	-17.3	-16.5	-15.5	-14.5
Developed Countries	-14.2	-5.5	-6.5	3.0
World	-16.2	-12.5	-12.2	-8.1
Rice, irrigated				
East Asia and the Pacific	-28.4	-22.0	-11.8	-6.5
Europe and Central Asia	-40.6	-33.0	-26.1	-19.8
Latin America and the Caribbean	-20.1	-24.9	-13.8	-20.7
Middle East and North Africa	-56.7	-46.5	-47.5	-37.2
South Asia	-23.7	-19.8	-6.2	-3.1
Sub-Saharan Africa	-41.3	-39.4	-30.0	-27.7
Developing Countries	-27.3	-22.6	-11.3	-7.6
Developed Countries	-19.3	-17.7	-7.2	-5.4
World	-26.8	-22.3	-11.1	-7.5
Rice, rainfed				
East Asia and the Pacific	-11.0	-8.5	-2.7	-0.9
Europe and Central Asia	-36.9	-31.0	-6.3	-25.7
Latin America and the Caribbean	-25.8	-20.7	-19.6	-15.1
Middle East and North Africa	-100.0	-100.0	-100.0	-100.0
South Asia	-12.6	-16.4	-8.5	-11.3
Sub-Saharan Africa	-15.5	-15.3	-8.9	-8.6
Developing Countries	-13.2	-13.5	-7.0	-7.2
Developed Countries	-34.9	-30.7	-30.8	-27.1
World	-13.3	-13.5	-7.1	-7.2

Soybean, irrigated				
East Asia and the Pacific	-15.0	-10.1	1.6	6.9
Europe and Central Asia	7.2	7.3	7.5	7.7
Latin America and the Caribbean	-53.4	-52.7	-43.4	-42.8
Middle East and North Africa	-43.4	-37.1	-37.5	-30.6
South Asia	-16.4	-12.2	4.2	8.6
Sub-Saharan Africa	-11.6	-12.0	-0.8	-0.9
Developing Countries	-16.2	-11.5	1.1	6.1
Developed Countries	-15.0	-6.1	-2.9	7.2
World	-15.6	-8.8	-0.9	6.6
Soybean, rainfed				
East Asia and the Pacific	-19.6	-25.5	-1.7	-11.1
Europe and Central Asia	-40.3	-20.8	-40.3	-11.3
Latin America and the Caribbean	-3.3	-9.5	10.5	10.8
Middle East and North Africa	-84.7	10.9	-77.0	18.9
South Asia	-32.7	-56.1	-13.8	-46.8
Sub-Saharan Africa	-38.2	-36.2	-22.8	-21.3
Developing Countries	-8.9	-16.0	5.9	2.4
Developed Countries	2.9	12.5	11.6	16.9
World	-4.9	-6.5	7.8	7.3
Wheat, irrigated				
East Asia and the Pacific	-24.4	-19.2	-19.2	-13.9
Europe and Central Asia	-53.4	-46.8	-50.4	-43.2
Latin America and the Caribbean	-26.0	-21.4	-20.8	-16.5
Middle East and North Africa	-35.5	-30.1	-30.5	-24.6
South Asia	-57.7	-50.1	-50.3	-41.8
Sub-Saharan Africa	-34.0	-34.4	-28.6	-30.1
Developing Countries	-43.8	-37.5	-37.8	-31.0
Developed Countries	-32.5	-29.3	-28.7	-25.5
World	-43.1	-36.9	-37.2	-30.6

Wheat, rainfed				
East Asia and the Pacific	-39.2	-34.5	-34.2	-27.3
Europe and Central Asia	-51.3	-46.6	-46.5	-41.7
Latin America and the Caribbean	-3.1	-4.9	4.0	4.3
Middle East and North Africa	-24.3	-20.3	-16.0	-10.9
South Asia	-57.7	-54.7	-46.0	-42.1
Sub-Saharan Africa	-34.4	-32.2	-29.4	-25.4
Developing Countries	-33.7	-31.0	-27.4	-23.4
Developed Countries	-21.4	-15.4	-15.7	-10.1
World	-27.7	-23.4	-21.7	-16.9
Groundnut, irrigated				
East Asia and the Pacific	-19.6	-18.1	-5.7	-4.5
Europe and Central Asia	-66.6	-55.9	-60.6	-47.9
Latin America and the Caribbean	0.0	0.0	0.0	0.0
Middle East and North Africa	-53.3	-42.3	-44.9	-31.9
South Asia	-23.7	-19.6	-10.5	-5.8
Sub-Saharan Africa	-54.0	-54.1	-46.0	-46.1
Developing Countries	-27.0	-24.6	-14.4	-11.8
Developed Countries	-21.1	-15.4	-7.3	-0.6
World	-26.6	-23.9	-13.9	-11.0
Groundnut, rainfed				
East Asia and the Pacific	-25.6	-32.4	-11.2	-21.2
Europe and Central Asia	-100.0	-100.0	-100.0	-100.0
Latin America and the Caribbean	-17.7	-21.7	-9.4	-8.3
Middle East and North Africa	7.5	-82.1	7.5	-80.1
South Asia	-21.9	-43.9	-9.6	-30.3
Sub-Saharan Africa	-34.9	-34.8	-22.5	-22.3
Developing Countries	-30.1	-34.9	-17.3	-22.6
Developed Countries	-13.0	-25.2	2.2	-6.0
World	-29.7	-34.7	-16.8	-22.2

Source: Compiled by authors.

Copyright © 2009 International Food Policy Research Institute. All rights reserved. For permission to republish, contact ifpri-copyright@cgiar.org.