

1 **Changing Climate and Changing Agriculture**

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3 **Report of the Agricultural Sector Assessment Team,**  
4 **US National Assessment**

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7 **Co-Chairs**

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9 **Jeff Graham, US Department of Agriculture (through Sept. 1999)**

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11 **Assessment Team**

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21 **Linda Mearns, National Center for Atmospheric Research**  
22 **Dennis Ojima, Colorado State University**  
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24 **Keith Paustian, Colorado State University**  
25 **Susan Riha, Cornell University**  
26 **Norman Rosenberg, Pacific Northwest National Laboratory**  
27 **Cynthia Rosenzweig, Goddard Institute for Space Studies**  
28 **Francesco Tubiello, Goddard Institute for Space Studies**

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31 Assessment of Climate Variability and Change. The US Department of  
32 Agriculture provided the principal source of funding through the Global Change  
33 Program Office, Office of the Chief Economist. The US Department of Energy  
34 provided substantial funding for participation of the Pacific Northwest National  
35 Laboratory. The Farm Foundation and the Economic Research Service co-  
36 sponsored the initial stakeholder meeting.

1 **Forward**

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3 Assessment efforts of this type offer an opportunity for researchers to  
4 apply their research tools and expertise to issues of National importance. We  
5 came into this effort hoping that the years spent analyzing, modeling, and  
6 studying will provide some measure of useful guidance to those who have  
7 commissioned the assessment. The efforts provide an opportunity to compare  
8 results among colleagues and to deepen one’s understanding of the findings of  
9 other disciplines. I learned much from my colleagues who graciously and  
10 enthusiastically accepted the invitation to serve on the team. The funding  
11 available for the assessment was adequate to support specific modeling tasks and  
12 essential travel. Team members generously contributed time well beyond the  
13 tasks that were specifically funded. For this I am grateful. It is my hope that  
14 members found the experience rewarding and thus found participation  
15 worthwhile.

16 This report represents the combined efforts of the Agriculture Sector  
17 Assessment Team but I would be remiss if I failed to point out the substantial  
18 contributions of the individual team members. Francesco Tubiello coordinated  
19 the crop model scenarios produced by the suite of crop models run by GISS, the  
20 University of Florida, and the Natural Resource Ecology Laboratory at Colorado  
21 State. The protocols and site data developed at GISS by Cynthia Rosensweig for  
22 previous assessments were graciously made available to the teams of crop  
23 modelers. In addition, to Tubiello at GISS, Shrinkant Jagtap, Jim Jones, Keith  
24 Paustian, and Dennis Ojima composed the crop modeling teams that developed  
25 comprehensive and consistent scenarios for the 2 climate scenarios evaluated.  
26 The PNNL team of Cesar Izaurralde and Norman Rosenberg and assisted by  
27 Robert Brown applied a model with more geographically comprehensive  
28 coverage for several crops for one climate scenario. This provided an opportunity  
29 to assess the differences that arose from methodological differences of this  
30 approach compared to the detailed site approach used by the other teams.  
31 Paustian and Ojima organised a crop modeling workshop to compare, in more  
32 depth, the performance of these models at selected sites to further understand the  
33 types of uncertainties that differing model structures could introduce. Linda  
34 Mearns contributed her crop modeling expertise as well as her expertise on  
35 variability and extreme events. A separate study she was leading, and funded by  
36 the National Science Foundation, provided critical coverage for cotton.

37 Bruce McCarl developed national yield changes based on the site results  
38 from the crop studies and simulated economic effects. He with several co-authors  
39 also investigated several other aspects of the problem including the dependence of  
40 pesticide expenditures on climate, economic effects of changes in El Nino, and he  
41 interacted with the Water Sector Assessment to assure that our water supply  
42 assumptions were consistent with their estimates. Roy Darwin provided results on  
43 impacts on trade based on recent analyses he has conducted with his global  
44 model. This large effort was possible within the short time-frame and restricted

1 budget because of the tremendous expertise and experience of these team  
2 members.

3 In other aspects of the assessment, the analytical tools and approaches for  
4 conducting an integrated assessment have not been yet been fully developed.  
5 Here we relied on modeling case studies, creative evaluation of historic data, and  
6 judgement of experts. Steve Hollinger studied data on crop variability over the  
7 past 100 years to provide an historical perspective on adaptation. David Abler  
8 applied a newly developed model of the economics of water quality in the  
9 Chesapeake Bay Region and summarized potential environmental/agro/climatic  
10 interactions. Eldor Paul and John Kimble evaluated potential effects of climate  
11 change on soils. Susan Riha provided a summary of our current understanding of  
12 carbon dioxide effects on plant growth and the potential to develop new crop  
13 varieties as a response to climate change and increased ambient CO<sub>2</sub> levels.  
14 These efforts pushed into some new, but critical territories, lending perspectives  
15 we otherwise would not have.

16 I am also grateful for the time our Steering Committee took from their  
17 busy schedules to guide the effort. I know we have not answered all the questions  
18 they raised but hope that we have answered at least some of them. My thanks  
19 also to Jeff Graham for his help. He left USDA before the report was completed  
20 by left his mark on the effort. Finally, I am grateful to Margot Anderson, Director  
21 of the Global Change Program Office at USDA. She was our initial contact,  
22 secured funding, and did her best to keep us on track and responsive to the goals  
23 of the assessment.

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25 John Reilly  
26 January, 2000

1 **Preface**

2 This report contains the principal findings of the agricultural assessment. Detailed  
3 reports of results and methods are reported in the following working paper reports. All of  
4 these are available at [http://www.nacc.usgcrp.gov/sectors/agriculture/workshop-](http://www.nacc.usgcrp.gov/sectors/agriculture/workshop-report.pdf)  
5 [report.pdf](http://www.nacc.usgcrp.gov/sectors/agriculture/workshop-report.pdf). If you are reading this in electronic form and are connected to the internet you  
6 can access these reports by clicking directly on them. Throughout the report we have  
7 provide direct hot links to WEB available sources.

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9 Agricultural Sector Assessment: Report of a Stakeholder/Sector Assessment Team  
10 Meeting.

11 Chen, C., Gillig, Dhazn, and McCarl, B. 2000. [Effects of Climatic Change on a Water](#)  
12 [Dependent Regional Economy: A Study of the Texas Edwards Aquifer.](#)

13 Chen, C. and McCarl, B. 2000. [Pesticide Usage as Influenced by Climate: A Statistical](#)  
14 [Investigation.](#)

15 Chen, C. and McCarl, B. 2000. [Economic Implications of Potential Climate Change](#)  
16 [Induced ENSO Frequency and Strength Shifts.](#)

17 Chen, C., McCarl, B. and Schimmelpfennig, D. 2000. [Yield Variability as Influenced](#)  
18 [by Climate: A Statistical Investigation.](#)

19 Izaurrealde, R. C., R. A. Brown, and N. J. Rosenberg. 1999. [U.S. regional agricultural](#)  
20 [production in 2030 and 2095: response to CO<sub>2</sub> fertilization and Hadley Climate](#)  
21 [Model \(HADCM2\) projections of greenhouse-forced climatic change.](#) Rep. No.  
22 PNNL-12252. Pacific Northwest National Laboratories, Richland, WA. 42 pp.

23 McCarl, Bruce. 2000. [Results from the National and NCAR Agricultural Climate](#)  
24 [Change Effects Assessments](#)

25 Paul, E. A. and J. Kimble, 2000. [Global Climate Change: Interactions with Soil](#)  
26 [Properties.](#)