U.S. Paper

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IPCC WORKING GROUP III
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AGRICULTURE AND FORESTRY - ADAPTIVE RESPONSES TO CLIMATE CHANGE

(Submitted by the co-chairmen of the Resource Use and Management Subgroup of IPCC Working Group III)

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AGRICULTURE AND FORESTRY:
ADAPTIVE RESPONSES TO CLIMATE CHANGE

Draft Working Paper
prepared for the
Resource Use Management Subgroup
of the
Response Strategy Work Group
Intergovernmental Panel on Climate Change

Prepared by an ad hoc Interagency Task Force comprised of members from the following agencies: The Departments of Agriculture, Army (Civil Works), Energy, and the Interior; Agency for International Development; Environmental Protection Agency; and the Bureau of Reclamation.

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1. **Introduction.** Increases in atmospheric concentrations of greenhouse gases and associated increases in temperature and other climatic changes could affect several factors with possibly profound consequences for agriculture and forestry: regional precipitation and soil moisture could change; growing seasons could change; photosynthesis rates could increase for various crops and plant species--as could drought-resistance; frequencies and magnitudes of extreme events (e.g., droughts, heat stress, cold snaps, disease and pest outbreaks) could vary; resistance to disease, pests and other abiotic factors could also change, as could the relative competitiveness between species at a particular location. Moreover, by the time these changes are manifested, new technologies and practices could be available. For all these reasons there may be shifts in regional productivity. Moreover, the crops and vegetation that may be optimal in an area for one atmospheric and climatic regime may not be optimal for another regime. Therefore, there could be shifts in the ranges and compositions of crops and forests which, furthermore, could affect biodiversity.

2. **Rationale for Adaptation Measures.** It is possible that there would be some degree of adaptation even without measures designed specifically to deal with the impacts of changes in atmospheric concentrations and in the climate. It is also conceivable that new technologies and practices could make systems more resilient. Nevertheless, resource managers can facilitate further timely and efficient adaptation measures which could help areas cope with adverse impacts--as well as capitalize on any potential gains--from increasing greenhouse gas concentrations and associated climatic changes. Furthermore, measures taken to better cope with natural variability could be invaluable in helping such adaptation.

3. **Long Term Sustainability.** Adaptive measures should be consistent with long term sustainability of resource use and management. Increased cooperation between government, individuals and other groups will be necessary for both agriculture and forestry. Since forests and agriculture are important sources and sinks of greenhouse gases, adaptation strategies should work in concert with any efforts (e.g., reduced deforestation, reforestation, and reduced methane emissions from crop production and livestock) that may be used to affect the sink or source capacity of these systems. Moreover, because of the importance of these activities, they should be consistent with long term social, environmental and economic goals.

4. **Education and Technology Transfer.** Efforts for educating the people making both the long term planning decisions and the short term planting, growing and harvesting decisions and for providing liaison between the user and research communities must be enhanced. Where it does not already exist, nations could develop an infrastructure (e. g., extension services similar to that existing in the U. S., public education programs) to assist in rapid dissemination of new and appropriate technology, management techniques and practices, and seedlings to help assure sustainable use of forest and agricultural resources. The same infrastructure could also be used to educate farmers and the local public about the role of vegetation in controlling erosion and in modifying the hydrological cycle, as well as appropriate energy conserving practices, techniques and devices relevant to the local population. The international community could strengthen existing institutions that can assist in information exchange and technology transfer.

5. **Production Practices.** Changes in the atmospheric and climatic regimes (e.g., changes in temperature, carbon dioxide concentrations, precipitation and soil moisture~) may require farmers and forest managers to adjust their planting, harvesting, and erosion control techniques. Farmers could shift to more heat and drought resistant crops, change crop rotation and multiple cropping practices, and reduce erosion through terracing, wind breaks, no till, and conservation reserve programs. Forest managers could adapt to climate change through enhanced reforestation programs, planting fast growing and heat and drought resistant species, changing spacing and site preparation, different thinning and rotation schedules, and modified fire control strategies. All such measures should reflect the goal of long term sustainable use and should be consistent with other environmental, social, or economic considerations.

6. **Land Use Management.** Land use plans and practices may need to be adjusted to help cope wit~ anticipated climate induced shifts in regions that will support certain crops or forests and to reflect changes in water demand. Measures that would improve the efficiency of land and water usage for agriculture and commercial forest resources would not only help these sectors adapt more easily but also help preserve biodiversity and unman aged or partially managed ecosystems because such measures could reduce the pressures on them. Specific changes in land use could include increased use of reforestation, agro forestry and conservation reserve programs, and changes in location and density of human settlements. Countries could identify barriers to beneficial changes in use of land for agriculture and forests, and evaluate policies to ensure that land use practices facilitate climate change adaptation, while reflecting other social, environmental, or economic considerations.

7. **Water Conservation and Supply systems.** Climate change could result in greater evaporation and lower soil moisture in many regions of the world. In such areas, this--and other changes --in the availability of water, may require improved water conservation, changes in water delivery systems to meet enhanced demand as well as other changes in water resource management. (A separate paper addresses adaptive responses pertaining to water resources). specific conservation measures could include irrigation application and management based on plant use needs, trickle or drip irrigation, and increased use of drought-resistant crops. Existing and planned future water supply systems could also be adjusted to account for changes in irrigation demands. Reforestation could also serve as a means of improving water retention.

8. **Fertilizer Use Rates.** Increased carbon dioxide concentrations and changes in temperature and water availability may require adjustments in fertilization practices. Ideally fertilization rates would be determined by a cost/benefit analysis which could take into consideration several factors including fertilizer cost and marginal improvement in yield, as well as factors such as surface and ground water degradation and the effects, if any, on greenhouse gas concentrations. Alternative management practices, such as multiple cropping, which reduce demand for fertilization, could also be considered.

9. **Insect and Disease Control.** Atmospheric and related climatic changes may change the susceptibilities of plants to pest and disease outbreaks and may require adjustments in strategies for controlling these disturbances. Pest control techniques could include changes in pesticide application, greater use of biological control, and use of a meteorology/climatology to reduce pesticide consumption. Innovative disease control techniques could include changes in crop rotation and greater use of meteorological data to predict disease occurrences. For example, simple crop row orientation change eliminated the need for fungicides in one area. In another instance, use of meteorological data to determine potential for disease development reduced fungicide use by 30 to 70 percent for peanut leaf spot in a 3-year test.

10. **Programs to Facilitate Species Miqration[1].** Plant and animal migration rates and the availability of new habitats for dispersed species would have a significant impact on forest response to climate change. Natural resource management agencies could establish research, evaluation and development programs to aid species migration. Programs that could be researched and evaluated include methods of establishing new habitat, protection of migration pathways, preservation of large forest and biosphere reserves, reforestation, and

[1] More applicable to forests than agriculture

changes in fire suppression policies. These programs may have other recreational, ecological, and climate related benefits.

11. **Reducing Economic and Institutional Barriers.** Nations could consider reducing economic and institutional barriers to more rapid and efficient responses to climate change consistent with other social, economic and environmental goals.

12. **Research Needs.** To help develop adequate response strategies dealing with agriculture and forestry, more research could reduce current uncertainties with respect to temperature, soil moisture and the hydrological cycle in the event of climate change, and their effects on vegetation and crops in a world with higher greenhouse gas concentrations. Such research should be location- and species-specific. More research is needed on techniques to assure sustainable use and to optimize the rate of removal of CC2 from the atmosphere consistent with other social, environmental and economic objectives. The techniques deserving further research include (1) maintaining genetic diversity and selecting, breeding, and planting new crop species for agriculture, reforestation, and fuelwood and industrial wood plantations which are fast growing and heat and drought resistant; (2) changes in forest planting, thinning and rotation, harvesting, fertilization, and fire and pest control; (3) modified agricultural cropping, irrigation, erosion control, and reforestation techniques; and (4) methods for facilitating migration of forest species and protecting the diversity of forest species. Several recent developments, including biotechnology, show promise in our ability to develop the types of plants that will be responsive to the possible environmental changes that could occur by the middle of the next century.

13. **Broadening Participation in Research.** The diversity and complexity of the research needs make it critical that there is a commitment to cooperative research ventures that encourage public and private sector participation. Active participation from both sectors will be essential to the ultimate success of this research. Nations could examine and, if necessary, adopt measures to strengthen support of, and reduce barriers to, broad participation in research. For example, hurdles to the development and marketing of new technologies (including species) could be reduced.

14. **Conclusion.** Global warming could cause significant changes in world-wide agriculture and forests. However, the uncertainty associated with global warming and its impact on agriculture and forests may argue for. pursuing only those adaptive measures that are not very costly or have other direct benefits, while deferring

more expensive responses until reductions in the uncertainties indicate their need. Adaptive responses that also slow global warming, such as reduced deforestation, increased reforestation, and agro forestry could be especially appealing. Consideration also needs to be given to the lead time necessary to change agriculture and forestry practices. Shorter plant life and more intensive management may make rapid adjustments more feasible for agricultural systems than for forests. For now, priority should be given to measures which would make systems more adaptable to the inherent natural variability in the climatic system.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

APR 7 1989

Dear Colleague:

Attached is a draft working paper on agriculture and forestry produced for the Resource Use and Management Subgroup of the Intergovernmental Panel on Climate Change's Response Strategy Work Group. This paper identifies various measures for adapting to the effects of climate change on water resources. Over the next few months, with the help of your comments, we hope to add information on each measure's cost and effectiveness; its social, environmental and economic consequences; and legal and institutional hurdles to its adoption as well as methods to reduce these hurdles.

The measures identified in this draft paper seem reasonable options for further evaluation in the context of the U.S. However, they may be much less suitable for other nations because of a variety of institutional, legal, cultural, social and financial considerations. Even for the U.S., some of them may be appropriate for one area but not another. Your comments would be invaluable in helping address the issue of whether these options are suitable for further evaluation in your situation.

I hope you received our paper on water resource adaptation strategies which was mailed to you earlier.

Please send your comments to me at the Department of the Interior, Mail Stop 4412, 18th and C Streets, NW, Washington, DC 20240 (phone no. 202-343-4951; fax no. 202-343-~~8950~~ 4867).

Sincerely,

Indur M. Goklany,
Executive Director,
Departmental Working Group
on Climate Change

Attachment
List of Addressees