



AGRICULTURE FOR DEVELOPMENT POLICY BRIEF

Adaptation and Mitigation of Climate Change in Agriculture

Climate change will have far-reaching consequences for agriculture that will disproportionately affect the poor. Greater numbers of crop failures and livestock deaths are already imposing economic losses and undermining food security. Effects on crops and livestock are likely to get far more severe as global warming continues. Adaptation measures, facilitated by concerted international action to mobilize financing globally and long-term strategic planning in developing countries, are urgently needed to reduce the adverse effects of climate change. As a major source of greenhouse gas emissions (GHGs), agriculture has much untapped potential to reduce emissions through reduced deforestation and changes in land use and agricultural practices.

Climate change has caused farmers to adapt.

Scientific evidence about the seriousness of the climate threat to agriculture is now unambiguous, although the exact magnitude is uncertain because of the complex interactions and feedback processes in the ecosystem and in the economy. Under moderate to medium estimates of rising global temperatures (1–3°C) over the next 50 years, crop climate models predict a small impact on global agricultural production because the negative impacts on tropical and mostly developing countries will be offset by gains in temperate and largely industrial countries. But in tropical countries, even moderate warming (1°C for wheat and maize and 2°C for rice) can significantly reduce yields. For temperature increases above 3°C, the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC) that has just been released expects yield losses to occur everywhere and be particularly severe in tropical regions. Many regions already feel the negative effect of climate change, and impacts will get progressively worse as mean temperatures rise and the climate becomes more variable.

In addition to higher average temperatures, other factors—more intense droughts, floods, and greater temperature variability—will result in productivity losses to crops and livestock. In some developing countries, agriculture will be damaged by flooding and salinization of surface water and groundwater aquifers as sea level rises. Less precipitation will reduce the availability of water for irrigation and livestock production, particularly in semiarid regions. In Africa, between 75 million and 250 million people are expected to experience increased water stress. Many irrigation systems may become obsolete in areas of glacial melt. In the longer term, global warming is expected to reduce seasonal water flows used for irrigation.

The poor will be disproportionately vulnerable to the effects of climate change because of their greater dependence on agriculture and their lower ability to adapt. In countries with severe resource constraints, farmers will not be able to adapt to climate change without outside help. According to recent survey data of thousands of farmers from 11 African countries, farmers are already planting different crop varieties,

changing planting dates, and adapting practices to a shorter growing season. But in some countries, more than a third of all households that perceive greater climate variability or higher temperatures report no change in their agricultural practices. Barriers to adaptation vary by country, but for many the main reported barrier is the lack of credit or savings, and some also point to the lack of access to water as the main obstacle to adaptation.

Adaptation can substantially reduce adverse economic impact but requires an urgent policy response.

The greater uncertainty from climate change can be best addressed through contingency planning across sectors. Many of the least developed countries are preparing national adaptation plans of action to identify immediate priorities to improve preparedness for climate change. Mainstreaming climate change in the broader economic agenda, rather than taking a narrow agricultural perspective, will be crucial in implementing those plans.

The public sector can facilitate adaptation through such measures as crop and livestock insurance, social safety nets, and research on and dissemination of flood-, heat-, and drought-resistant crops, including conservation of traditional plant varieties with those characteristics. New irrigation schemes in dryland farming areas are likely to be particularly effective, especially when combined with complementary reforms and better market access for high-value products. But greater variability of rainfall and surface flows needs to be taken into account in the design of new irrigation schemes and the retrofitting of existing ones. The cost of modifying irrigation schemes, especially those that depend on glacial melt (as in the Andes, in Nepal and in parts of China), could run into millions or even billions of dollars. Better climate information such as provision of long-term weather forecast is another potentially cost-effective way of adapting to climate change.

Global support for adaptation urgently needs to be scaled up. Without significant investments in adaptation, climate change will undermine



progress in attainment of the Millennium Development Goals in the developing countries that are most vulnerable to the effects of climate change. Although no specific estimates are available for the funding needs for adaptation in the agricultural sector—a sector especially sensitive to climate change—the need is likely to be large in relation to the total current aid to the sector. Contributions from three adaptation funds, that have been created within the framework of the UN Framework Convention on Climate Change (UNFCCC), are expected to be between US\$150 million to US\$300 million a year. The costs of adapting to climate change—estimated at tens of billions of dollars in developing countries—far exceed the resources available, requiring significant transfers from industrial countries through both public and private sources of financing. Carbon taxes based on the polluter pays principle could become a major new source of revenues to fund adaptation programs.

The international community needs to devise new mechanisms to provide a range of global public goods, including climate information and forecasting, research, conservation and development of crops adapted to new weather patterns, and techniques to reduce land degradation. Because of the long time lag between the development of technologies and information systems and their adoption in the field, investments to support adaptation need to be initiated now.

Agriculture can help mitigate climate change.

Livestock and crops emit carbon dioxide, methane, and nitrous oxide, making agriculture a major source of GHGs. According to the emissions inventories that governments submit to the UNFCCC, agriculture accounts for about 15 percent of global GHGs. Its global contribution goes up to between a quarter and a third of total GHGs with the addition of the estimated emissions from deforestation in developing countries (agriculture is the leading cause of deforestation) (figure 1). About 80 percent of total emissions from agriculture, including deforestation, are from developing countries.

Agriculture contributes about half of the global emissions of two of the most potent non-carbon dioxide greenhouse gases—nitrous oxide and methane. Nitrous oxide emissions from soils (from fertilizer appli-

cation and manures) and methane from livestock production each account for about a third of agriculture's total non-carbon dioxide emissions and are projected to rise. The rest of non-carbon dioxide emissions are from biomass burning, rice production and manure management. Agriculture is also a major contributor of reduced carbon sequestration (storage) through land use change (e.g., the loss of soil organic matter in cropland and pastures, and forest conversion to agriculture), although quantitative estimates are uncertain.

Agriculture offers great opportunities for reducing GHGs.

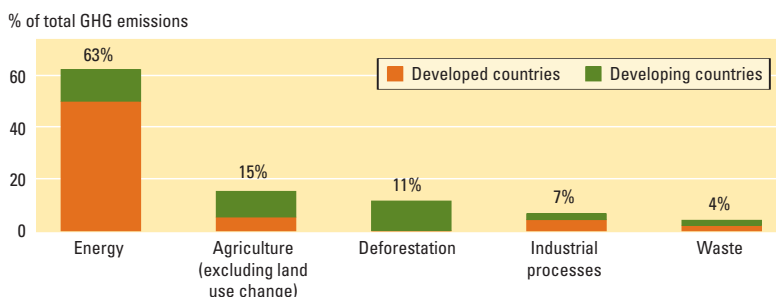
GHGs can be dramatically reduced through carbon trading. The emerging market for trading carbon emissions offers new possibilities for agriculture to benefit from land uses that sequester carbon, thereby enhancing carbon storage in soils and avoiding deforestation. Opportunities for this reduction through carbon trading are in principle quite large because of generally low returns from forest conversion to agricultural land.

Greenhouse gas mitigation projects in developing countries are funded through the Clean Development Mechanism (CDM) of the Kyoto Protocol—the main carbon trading mechanism available to developing countries. However, the CDM has limited coverage of afforestation and reforestation projects. Negotiations for the period after 2012 should correct this major flaw. They could also explore credits for sequestration of carbon in soils (for example, through conservation tillage) and for agroforestry in agricultural landscapes. Incentives are also needed for investment in science and technology for low-emission technologies, such as cattle breeds that emit less methane.

Many GHG mitigation measures can have win-win outcomes for poverty and the environment. Other promising approaches are changes in agricultural land management (conservation tillage, agroforestry, and rehabilitation of degraded crop and pasture land); overall improvement of nutrition and genetics of ruminant livestock; storage and capture technologies for manure; and conversions of emissions into biogas. Many of those approaches

have win-win outcomes in higher productivity, better management of natural resources, or the production of valuable by-products, such as bioenergy. Others require substantial investment at the global level, such as the development of low-emission rice varieties and livestock breeds. The “public good” nature of research in this area warrants international support for innovative, cost-effective solutions that will reduce emissions from livestock and rice paddy fields through advances in breeding and through the use of advanced biotechnologies.

Figure 1. Agriculture: The Second Largest Source of GHG Emissions



Source: WDR 2008 team, based on data from the United Nations Framework Convention on Climate Change, www.unfccc.int.

Note: These are the latest available data for developing countries as a group, and consistent comparisons using UNFCCC data are possible only for 1994 dates. There is a large range of uncertainty about gross emissions from land use change (mainly from deforestation). The best estimate of the contribution of emissions from land use change to total emissions is 20 percent (with a range from 10 to 30 percent) of total global emissions during the 1990s (Watson and others 2000). The UNFCCC estimate of total emissions from deforestation based on emissions inventories as reported by developing countries (11.4 percent) is a low-range estimate.

This policy brief has been extracted from the World Bank's 2008 World Development Report, *Agriculture for Development*. Further information and detailed sources are available in the Report. The Report uses a simple typology of countries based on the contribution of agriculture to overall growth, 1990-2005 and the share of rural poor in the total number of poor (2002 US\$2-a-day level). In agriculture-based countries (mostly Africa), agriculture contributes a significant (>20%) share of overall growth. In transforming countries (mostly in Asia), nonagricultural sectors dominate growth but a great majority of the poor are in rural areas. In urbanized countries (mostly in Latin America and Europe and Central Asia), the largest number of poor people are in urban areas, although poverty rates are often highest in rural areas.