Overseas Development Institute

# Natural Resource Perspectives 109

**September 2007**

# Climate change, agricultural policy and poverty reduction – how much do we know?

**Rachel Slater, Leo Peskett, Eva Ludi and David Brown[1]**

*Projections suggest that, by the end of the 21st century, climate change could have had substantial impact on agricultural production and thence on the scope for reducing poverty. This paper seeks to trace the likely impacts through changes in the quality of the physical asset base, access to assets, and impacts on grain production and on agricultural growth more generally. At moderate degrees of warming, impacts are likely to be negative in some regions, but positive in others, making it important to understand the possible implications for trade between the regions. The short term impacts of climate change, particularly changes in the frequency and severity of adverse weather events, remain uncertain, but their impacts on many developing countries are likely to be negative. There is likely to be time to make appropriate policy responses to some of the longer-term impacts.*

**Policy conclusions**

- Considerable uncertainty surrounds long-term patterns of climate change and their likely[2] impacts on agriculture. The prospects are that policy will have time to respond to some impacts, such as possible global decreases in crop production.
- Shorter term shocks from increased climate variability might be experienced much sooner and are likely to be severe for tropical areas.
- Both long- and short-term changes imply an increased need for more food trade between the OECD and rest of the world. Without this, food security in some regions may diminish.
- Agricultural practices need to be incorporated into mitigation policies and programmes such as the Clean Development Mechanism (CDM). This will promote the measurement of carbon balances in agriculture and the search for synergies between mitigation and adaptation in the sector.
- Increased scope for carbon trading may in some measure compensate for lost agricultural production potential in developing countries if these countries can access the carbon markets.
- Conversely, if not carefully designed, mitigation policies such as biofuels and carbon markets are likely to further restrict access by the poor to productive resources, access which is already under threat from numerous development pressures on resources
- Donors can help in mainstreaming policy responses to climate change into poverty reduction strategies and into other national development policies and programmes.
- The "mainstreaming" of responses to climatic change into wider government policy will help in identifying which rights of the poor are under threat and in strengthening them.
- Donor assistance may usefully support developing country interests in international climate negotiations, and help governments to support both regulated and voluntary carbon markets.
- Specific international funds for agricultural adaptation need to be identified that are additional to existing development assistance, possibly targeted towards viable export options, and if necessary earmarked for access by developing countries.

DFID Department for International Development

Sida

This series is published by ODI, an independent non-profit policy research institute, with financial support from the Swedish International Development Cooperation Agency, Sida. Opinions expressed do not necessarily reflect the views of either ODI or Sida.

**Overseas Development Institute**

ODI is the UK's leading independent think tank on international development and humanitarian issues.

## Introduction

For present purposes, climate change is defined as a process of global warming, in part attributable to the 'greenhouse gases' generated by human activity. Accompanying changes are likely to be both global, as with rising sea levels attributable to ice-melt, and local, such as changes in rainfall patterns. Responses to climate change can either seek to reduce the level or rate of change (*mitigation*) or manage its consequences (*adaptation*). We are concerned here with both types of response.

Agriculture currently accounts for 24% of world output, and uses 40% of land area (FAO 2003). It is highly dependent on the climate and human dependence on agricultural livelihoods, particularly by the poor, is high, and so agriculture has been a focus of those modelling the impact of climate change on poverty.

This paper reviews current knowledge about the relationships between agriculture and climate change, focusing on:

- cereal crops – rice, wheat and maize make up 85% of world cereal exports, and are thought to be particularly sensitive to climate change (FAO 2003)
- four scenarios of future climate change derived from models of the Intergovernmental Panel on Climate Change (IPCC) and modelling studies used in the recent IPCC Working Group II Report (particularly Fischer et al 2002; Fischer et al 2005; Parry et al 2004; Parry et al 2005).
- *global* climate changes, as these have more coverage in modelling studies, rather than regional or local changes.

Most models suggest that climate change will slow or reverse the poverty reducing impact of agriculture, with, by one estimate, some 600 million additional people at risk of hunger if temperature increases by over 3°C (Warren et al. 2006). But this has to be set against other changes in agriculture such as improvements in technology and changes in farming systems. Also, assumptions about population growth and food demand have a large influence on future projections (IPCC 2007).

Given the complex relationships between crops, atmospheric composition and temperature, combined with the complexities of world agricultural policies and trade, to make predictions about the future impacts of climate change on agriculture is fraught with difficulties. However, models based on the scenarios in Table 1 all suggest an increase in extreme events such as floods and droughts, even in the short term.

## Global climate models

These seek to link predictions of future climates to potential impacts on crops. There are five main elements to these processes:

- Scenarios of greenhouse gas and aerosol emissions
- Scenarios of greenhouse gas concentrations
- Projections of temperature changes
- Impacts on agriculture generated through, for example, crop response models
- Impacts on agricultural trade investigated by linking these models with agricultural production, demand and trade models

Table 1 outlines four sets of scenarios used widely in modelling the above kinds of impact, along with examples of outputs from different modelling studies. These results are discussed in the following sections which are concerned with, respectively, the physical asset base, access to assets, impacts on cereal production, and on trade and food security, and impacts on growth and poverty reduction. Box 1 summarises much of the discussion.

## Impacts of climate change on the physical asset base

Modelling of environmental constraints in relation to agriculture starts with a current situation in which two-thirds of the global land surface – some 8.9 billion hectares – suffers severe constraints for crop cultivation: 13.2% is too cold, 26.5% is too dry, 4.6% is too steep, 2.0% is too wet, and 19.8% has poor soils. For e.g. southern Africa by 2080, climate change could have made an additional 11% of the total land area severely constrained for crop cultivation (constraints were in relation to soils, terrain, cold temperatures and moisture). Increased carbon dioxide concentrations can have a positive impact on plant growth, although the effects are very uncertain (e.g. at one extreme the projected number of people at risk of hunger in 2080 are at levels similar to 2000, at the other, almost twice that number). Increased frequency of extreme weather events could also depress yield by damaging crops at key growth stages (Rosenzweig et al. 2002). However, agricultural land suitable for cereal crop cultivation could expand significantly in North America (40%), northern Europe (16%), the Russian Federation (64%), and East Asia (10%), due to longer planting periods and generally more favourable growing conditions under warming (Fischer et al, 2005; IPCC 2007).

**Table 1: Impacts on cereal yields and imports, and undernourished people using four IPCC Special Report on Emissions Scenarios**

| **IPCC Scenario** | *A1F1* | *A2* | *B1* | *B2* |
|---|---|---|---|---|
| **Population in 2100 (a)** | 7 billion | 15 billion | 7 billion | 10 billion |
| **Economic growth (a)** | 3.5% p.a. | 2% p.a. | 2.75% p.a. | 2% p.a. |
| **Emission levels (a)** | High | Medium high | Low | Medium low |
| **Temperature increases (°C) (a)** | 2020: 0.7<br>2050: 1.96<br>2080: 3.67 | 2020: 0.59<br>2050: 1.59<br>2080: 2.9 | 2020: 0.54<br>2050:1.15<br>2080: 1.76 | 2020: 0.61<br>2050: 1.31<br>2080: 2.08 |
| **Cereal yields (without beneficial $CO_2$ effects (b)** | decreases 10 to 18% by 2050, up to 30% by 2080 in Africa and parts of Asia | similar to A1F1<br>largest contrast between developing and developed countries | | |
| **Cereal imports in developing countries in 2080 (c)** | | 430 million tonnes | 170 million tonnes | |
| **Number of people at risk of hunger in 2080 with and without $CO_2$ fertilisation (million) (d)** | 136<br>370 | 742-885<br>950-1320 | 99-102<br>125 | 221-244<br>257-384 |

Sources: (a) Stern, 2006; (b) Parry et al., 2004; (c) Fischer et al. 2005) (d) IPCC 2007
Note: many different models are used to process the basic scenario inputs, each using different assumptions.

**Box 1: Six things we know about the science of climate change and agriculture**

- There is high uncertainty in projections of impacts on agriculture, due to the global nature of models, 'scaling' problems in linking global models to local crop models and the large impact that the basic socio-economic scenario assumptions have on outcome of the models.
- Yield changes are expected due to climate change, but with complex relationships among the effects of $CO_2$ fertilisation, temperature, type of crop and impacts of extreme events on key stages in the growth cycle of plants. The $CO_2$ fertilisation effect, in particular, can have a very large impact on crop yields.
- Potential agricultural land available for agriculture is likely to increase at high latitudes and decrease at low latitudes.
- Related to this, most models project that tropical developing countries (especially Africa) will increase cereal imports from developed countries and temperate areas by the 2080s.
- Extreme events such as floods and droughts are likely to become more severe and frequent over the next century under all scenarios and for most land areas.
- Cereal price changes are generally modest under all but the most extreme scenarios.

## Impacts of climate change on access to assets

The claims made by non-agricultural development on scarce land and water are set to increase. These will tend to exacerbate the insecurity of tenure which the poor already face in relation to land and water resources. This trend is likely to worsen as claims on resources shift with e.g. the increased financial flows associated with mitigation instruments (CDM and emissions trading, Reduced Emissions from Deforestation and Degradation (REDD), biofuels and voluntary carbon schemes outside Kyoto's market mechanisms).

An appropriate balance needs to be struck between governments' international mandates and the pro-poor dimensions of national policies. This can be done by:

⇒ Mainstreaming climate change into development policy via Poverty Reduction Strategy Papers (PRSPs), the United Nations Framework Convention on Climate Change (UNFCCC), National Adaptation Programmes of Action (NAPAS); and Sector Wide Approaches (SWAps).

⇒ Adopting a rights-based approach in order to:
- o Strengthen the negotiating position of the poor
- o Reinforce their assets base

Case studies of land tenure/management and water resources (Brown et al, 2007) indicate the significant challenges that remain to pro-poor development, challenges which derive as much from the political economy of resource exploitation as from the nature of the climatic constraints. However, one positive message is that a rights-based approach, coupled with improved understanding of likely patterns of climate change, offers a valuable opportunity to pursue longer term policies than are normally evident in conventional mechanisms such as PRSPs and SWAps. Only when the rights of the poor are more fully established and acknowledged will there be some prospect of tailoring the impacts of climate change to the wider benefit by 'mainstreaming' it within development policy. This is also likely to enhance the capacity of communities to cope through more robust 'adaptation' options, as well as addressing the wider international interests that are likely to arise with increasing international investment in climate change adaptation and mitigation.

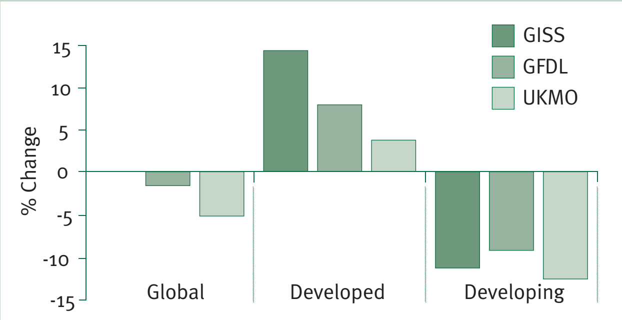
## Impacts of climate change on global cereal production

Fischer et al (2005) project that global cereal production could continue to increase up to 3.7-4.8bn tonnes by 2080 without climate change. When it is factored in, global cereal production could be within 2% of reference scenarios, but with potentially large regional variations. In general, decreases are expected in low latitudes and developing countries, reflecting both declining potential land available for crop cultivation reported above and changes in productivity. Sub-regional variations are masked by these figures, with some short term increases possible in areas of overall decrease (e.g. Africa). For example, in tropical highlands where current low temperatures prevent planting of certain crops, new land could become suitable for agriculture.

### *Prices and agricultural GDP*

At high degrees of warming (>5°C) some models project price increases of up to 30% on average, though most projections are generally more modest, and in the short and medium term real prices could fall owing to higher outputs from slight temperature increases. Also, the impacts of climate change on agricultural GDP until 2080 are likely to be small at global level, and range between -1.5 to +2.6%, depending on the scenario, but with decreases in most developing regions (Fischer et al., 2002).

**Figure 1: Change in cereal production in developed and developing countries for a doubling of $CO_2$ levels**




Note: Percentage changes for a 3°C warming in the three models used, are relative to what they would have been without climate change. Assumptions: mostly farm level adaptation; some economy wide adaptation; strong $CO_2$ fertilisation effect.

Source: Stern 2006

### *Impacts on trade*

Simulations based on the SRES scenarios outlined above project an approximate 25% increase in developing countries' net cereal imports, totalling between 170 million tonnes and 430 million tonnes in 2080, depending on the scenario (Fischer et al 2005; Parry et al 2004).

Some support within developing countries to sustainable resource management may make soil and water more resilient against climate change impacts and so help towards diversification. Public expenditure on agricultural research and advisory services, market development, and rural infrastructure can be shifted in favour of small farm export promotion. Help in diversifying out of agriculture, and more social protection, will be necessary in those areas, or for those farms, without successful farming futures.

The private sector potentially also offers new market opportunities, for example through carbon trading, the value of which could exceed official development assistance (ODA). Donors can help to build

**Table 2: Policies relating to production/trade scenarios**

| Scenario | Policies making this scenario more likely | Policies making a better outcome more likely |
|---|---|---|
| 1. Export agriculture declines | • Neglect of "climate change proofing" technology for export agriculture;<br>• Transport and related policies that discriminate against sub-Saharan African transport modes;<br>• Subsidies to domestic producers;<br>• Restrictions on global trade in biofuels. | • Early shift in emphasis for technical support from doomed crops to more climate change-proof ones;<br>• Tackling the (large) domestic footprint of food consumption before the (small) external one;<br>• Taxes on domestic use of climate change-adverse inputs (e.g. artificial fertilisers);<br>• Removal of all import restrictions (and subsidies limited to domestic suppliers) of biofuels. |
| 2. Capital-intensive (hi-tech) agricultural exports increase | • Failure of public provision of support for smallholders and labour-intensive, climate-change-proof production methods;<br>• SPS and other regulations that are more difficult for smallholders to meet. | • Early and marked shift in public support to R&D, extension, market development, rural infrastructure and services so as to benefit directly smaller farmers able to produce for export. |

Source: Ludi et al 2007

developing country capacity in international carbon negotiations as well as helping them to support both regulated and voluntary carbon markets.

Trade will impact on poverty by:

- altering the total supply of food within a country (from the combined effects of changes to domestic supply, to the volume of exports and to the relative price of imports and exports);
- altering the balance of production between those currently net producers and those who are net consumers, between those producing for the domestic market and for export, and between those who source their consumption domestically or from imports;
- altering the structure of production between small and large farmers and between landed and landless labour.

Specific technical features of production will influence how agricultural production and trade evolve under climate change. But it is possible to identify policies – both national and international – that would tend to facilitate a particular outcome or the reverse. Table 2 illustrates these for sub-Saharan Africa. A third scenario – the expansion of labour-intensive exports, which offers the best prospects for poverty reduction – would be achieved by avoiding everything in column 2 and undertaking everything in column 3.

### *Impacts on food security*

Climate change may slow rates of improvement in food security, although the projections are highly uncertain due to limitations in the number of crop and economic models available and simplification of the definition of food *security* to food *availability*. It is projected that in 2080 around 1300 million people (around 600 million more than 1999) could be at risk of hunger under the most extreme scenarios (Parry et al 2004), with the poorest countries worse affected. In these, a large portion of the population will continue to depend on agriculture and capacities to adapt to climate change (e.g. technologies, finances, investments, etc.), both at national and farm level are lowest. Within sub-Saharan Africa the negative impacts are likely to be strongest in north and south, possibly with some positive impacts in central African countries. General modelling studies on food security rarely consider how it could be disrupted by more extreme weather events. Under more moderate scenarios, climate change appears to have a negligible effect on the numbers of people at risk of hunger.

## Climate change, growth and poverty reduction

Against a resurgence of donor interest in the contribution of agricultural growth to poverty reduction, there are three critical areas of debate, yet concerns over climate change have been articulated into these only to a limited extent:

### *Are optimal combinations of growth and poverty reduction more likely to come from small rather than large farms?*

One emerging view is that small farms have proven to be "good adapters" by e.g. responding to weather as crops are planted and mature. But they cannot adapt in the longer-term unless they can access micro-insurance, credit, new technology and market information. In reality, larger farmers are better able to take risks, and to support small farmer adaptation through longer-term policies is likely to be difficult.

### *Will a focus on cash or food crops offer the best prospects for growth and poverty reduction?*

The evidence is scant, but, where cash crops are perennial, producers find it difficult to adapt. To reduce risk, food crop producers adapt by diversifying their range of crops, switching to drought-resistant crops and possibly even withdrawing from markets. Carbon sequestration may generate new "cash crop" opportunities – i.e. selling for income from carbon markets, as may crops for generating biofuels. This may imply a shift towards tree crops and/or agroforestry, or possibly new cropping systems, such as reduced tillage.

### *Will investments in high or low potential areas offer the best prospects for growth and poverty reduction in agriculture?*

The prevalent view is that low potential areas are highly vulnerable to climate change and significant investments will be needed to maintain production there. An alternative to this type of investment is to support diversification into the rural non-farm economy and/or to enable outmigration. In some zones, high potential areas which are double or triple cropped will be most under threat. Where food security or export earnings are threatened, governments may choose to protect these high potential areas rather than invest in marginal areas.

**Table 3: Climate change and the challenges to increasing productivity in agriculture**

| | Challenge | Possible Impact of Climate Change |
|---|---|---|
| Natural resources | • In semi-arid and arid developing world, precipitation highly variable<br>• Irrigation: Water critical to increasing productivity in Asia but opportunities are far more limited in Africa, where agriculture will rely heavily on rain-fed systems in the future.<br>• Degradation of the natural resource base | • Increased variability of precipitation<br>• Increased competition for water, particularly between productive agriculture utilisation and domestic / non-agricultural use. Agriculture will have to use less water and / or irrigate far more efficiently.<br>• Increased degradation, especially in Africa |
| Population | • Agricultural development limited where low population densities and small markets<br>• HIV/AIDS reducing agricultural productivity in agriculture (Slater and Wiggins, 2005) | • Increased migration and changing population densities in different parts of the world - changing markets<br>• Adaptation hindered as coping / adaptive strategies and local knowledge not passed between generations |
| Transportation / Infrastructure | • Poor transport infrastructure limits market access for many farmers (Dorward and Kydd, 2003).<br>• Transport costs account for high proportion of export costs in many African countries (von Braun et al 2002) | • Infrastructure threatened by disasters e.g. floods.<br>• Transport costs likely to rise as a result of (shipping and airfreight) mitigation measures – implications for global and local competitiveness |
| Commodity prices | • Commodity prices have fallen steady since the 1960s (UNCTAD 2003)<br>• Volatility of input and output prices discourages investment in increasing productivity (World Bank 2006) | • Global prices for commodities may increase but there will be significant inter-regional differences<br>• Volatility of prices will increase under climate change scenarios |
| Access to markets | • Product standards imposed by supermarkets are a barrier to market entry by small producers (Page and Slater 2003)<br>• High value cash crops (e.g. horticulture and floriculture) provide opportunities for growth though small farmers receive small share of market value | • Phytosanitary standards may increase due to concerns about new disease corridors resulting from climate change<br>• Changing consumption patterns and increased transport costs reduce access to supermarkets in developed countries |
| Agriculture growth linkages | • Links between agriculture and wider growth may not be as strong today as during the Green Revolution (Ellis et al 2000) | • Increased costs of global shipping and changing consumer demands regarding food miles may stimulate local diversification and linkages |
| Role of the state | • In many developing countries, fiscal unsustainability has forced states to reduce / withdraw support to agriculture with only rarely successful private substitution.<br>• Public expenditure on agriculture has fallen over the last 3-4 decades, especially in research (e.g. Fan et al 2004) | • Climate change suggests an increased role for the state to ensure successful adaptation and mitigation but whether this will result in a rejuvenation of Ministries of Agriculture or 'more of the same' is not clear<br>• Different and increased public expenditure in agriculture is required under climate change scenarios. |

Source: Slater 2007

## Knowledge gaps

There are large uncertainties in current projections. These result from gaps in the science of climate change, in uncertainties over crop responses, in complex socio-economic relationships and in the lack of detail in current models. For instance, in relation to rainfall prediction in Africa, there are several things we do not know which are important for agriculture, including the time of onset of seasonal rainfall and the prevalence of dry spells within seasons. Even in 15 years' time, models are unlikely to be able to project the impacts of climate change at scales of less than 50km. If this is the case, policymakers might best proceed via more 'flexible' policy approaches to cope with increased uncertainty about possible futures.

## Conclusions

Shock events driven by climate chance are likely to start occurring in the near term and will require increased disaster preparedness as well as increased flexibility in e.g. trade policies. At a global scale, more gradual impacts on yields are unlikely to be felt – if at all – for several decades. This allows time for agriculture-focused policies to adapt.

Thus, in places where climate change will mean new markets and productive opportunities, to increase productivity now and make small farmers more efficient will place them on a strong footing to take advantage of climate change.

Elsewhere, climate change may provide a short-term window of opportunity for specific activities in the agricultural sector (for example making the most of regional and domestic grain trade opportunities whilst they still exist).

Most importantly, countries that have both diversified economies and strong agricultural sectors will fare better under climate change scenarios. Thus, development assistance for the next few decades should be focused on investing in countries in the earliest stages of development. Getting an enabling environment in place, getting markets working, putting social protection in place, and strengthening R&D will enable the agriculture sector and agricultural livelihoods to be more resilient, as well as stimulating wider economic growth.

There is a need for improved coordination between climate change modellers, agricultural economists and agricultural policy-makers, in order to integrate issues of climate change into existing agricultural policies and programmes.

In the future, there will be a need to incorporate agricultural practices into mitigation policies and programmes such as the Clean Development Mechanism (CDM). This will lead to measurement of the carbon balances of both agricultural and wider development activities and the search for synergies between mitigation and adaptation in the agriculture sector.

At the international level, the proportion of funds available to agriculture in new funding mechanisms created to address climate change is unclear. Specific funding for agricultural adaptation needs to be identified and if necessary earmarked for access by developing countries. There are strong arguments for targeting funds for adaptation towards areas that promote the development of a viable agricultural export sector.

## Further Reading

The following papers can all be found at:
**www.odi.org.uk/climatechange/**

Brown, D., Slaymaker, T. and Mann, N. K. (2007) Access to assets: Implications of climate change for land and water policies and management. Paper prepared for DFID Renewable Natural Resources and Agriculture Team. London: ODI

Ludi, E., Stevens, C., Peskett, L., and Cabral, L. (2007) Climate Change and Agriculture: Agricultural trade, markets and investment. Paper prepared for DFID Renewable Natural Resources and Agriculture Team. London: ODI

Peskett, L (2007) A rough guide to climate change and agriculture. Paper prepared for DFID Renewable Natural Resources and Agriculture Team. London: ODI

Slater, R., (2007) Climate Change: Implications for DFID's Agriculture Policy. Paper prepared for DFID Renewable Natural Resources and Agriculture Team. London: ODI

Slater, R. and Peskett, L. (2007) Climate Change, Agricultural Growth and Poverty Reduction. Paper prepared for DFID Renewable Natural Resources and Agriculture Team. London: ODI

## References

Dorward, A. and Kydd, J. (2003) 'Implications of Market and Coordination Failures for Rural Development in Least Developed Countries' Paper presented at the Development Studies Association Annual Conference, Strathclyde University, Glasgow, 10-12 September 2003.

Ellis, F. (2000) Rural Livelihoods and Diversity in Developing Countries, Oxford University Press, Oxford.

Fan, S., Zhang, X., and Rao, N. (2004) 'Public Expenditure, Growth and Poverty Reduction in Rural Uganda' DSGD Discussion Paper No. 4, IFPRI, Washington, DC.

FAO (2003) 'World Agriculture towards 2015/2030: An FAO Perspective'. Rome: Food and Agriculture Organisation of the United Nations.

Fischer G., M. Shah, F.N. Tubiello, and H. van Velhuizen (2005): 'Socio-economic and climate change impacts on agriculture', Philosophical Transactions of the Royal Society B 360: 2067 – 2083

Fischer G, Mahendra Shah and H.V. Velthuizen (2002) 'Climate Change and Agricultural Vulnerability. A special report prepared by the International Institute for Applied Systems Analysis as a contribution to the World Summit on Sustainable Development, Johannesburg 2002.

IPCC (2007a) 'Climate Change 2007: Climate Impacts, Adaptation and Vulnerability', Working Group II to the Intergovernmental Panel on Climate Change Fourth Assessment Report, DRAFT technical summary 2006, Geneva: Intergovernmental Panel on Climate Change.

IPCC (2007b) 'Climate Change 2007: The Physical Science Basis: Summary for Policymakers' Working Group I to the Intergovernmental Panel on Climate Change Fourth Assessment Report, Geneva: Intergovernmental Panel on Climate Change.

Page, S. and Slater, R. (2003) 'Small producer participation in global food systems: policy opportunities and constraints' Development Policy Review 21 (5-6): 641-654

Parry M.L, C. Rosenzweig, and M. Livermore (2005): 'Climate change, global food supply and risk of hunger', Philosophical Transactions of the Royal Society B 360: 2125 – 2136

Parry M.L, C. Rosenzweig, A. Iglesias et al. (2004): 'Effects of climate change on global food production under SRES emissions and socio-economic scenarios', Global Environmental Change 14: 53 – 67

Rosenzweig, C.E., Tubiello, F., Goldberg,R., and Bloomfield, J. (2002) Increased crop damage in the US from excess precipitation under climate change. Global Environmental Change 12, 197-202.

Slater, R. and Wiggins, S. (2005) 'Responding to HIV/AIDS in agriculture and related activities' Natural Resource Perspectives No. 98, March, Overseas Development Institute.

Stern, N. (2006) 'Stern Review on the Economics of Climate Change', London: Her Majesty's Treasury and the Cabinet Office, available from http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

UNCTAD (2003) Economic Development in Africa: Trade performance and commodity dependence, United Nations, New York, NY.

Von Braun, J., Wobst, P. and Grote, U. (2002) 'Development Box' and Special and Differential Treatment for Food Security of Developing Countries: Potentials, Limitations and Implementation Issues', ZEF Discussion Papers on Development Policy, Bonn.

Warren, R., N. Arnell, R. Nicholls, P. Levy, and J. Price (2006): 'Understanding the regional impacts of climate change', Research report prepared for the Stern Review, Tyndall Centre Working Paper 90, Norwich: Tyndall Centre, available from http://www.tyndall.ac.uk/publications/working_papers/twp90.pdf

Washington, R. (2007) Presentation at 'Climate change and development in Africa Policy frameworks and development interventions for effective adaptation to climate change', 12 March 2007, Oxford: Oxford Centre for the Environment, University of Oxford, available at: http://african-environments.ouce.ox.ac.uk/events/2007/070312workshop.php

World Bank (2006) Managing Food Price Risks and Instability in an Environment of Market Liberalisation, World Bank Agriculture and Rural Development Department Report No 34499-GLB, Washington, DC.

## Endnotes

1. This paper draws on a suite of 5 papers (see Further Reading) prepared by ODI for DFID. The authors are indebted to the co-authors of these papers, namely Lidia Cabral, Nanki Mann Kaur, Tom Slaymaker and Chris Stevens, and to the editor of the Natural Resource Perspectives Series. The authors are indebted to DFID for funding the work on which this paper is based, but the views expressed are those of the authors alone.
2. Note that the use of the term 'likely' is not linked to the formal IPCC definitions related to probabilities

***Rachel Slater** is a Research Fellow at the Overseas Development Institute. Email: r.slater@odi.org.uk*

***Leo Peskett** is a Research Officer at the Overseas Development Institute and focuses on climate change issues. Email: l.peskett@odi.org.uk*

***Eva Ludi** is a Research Fellow at the Overseas Development Institute. Email: e.ludi@odi.org.uk*

***David Brown** heads the Forestry Policy Programme at the Overseas Development Institute. Email: d.brown@odi.org.uk*

**Acknowledgements**: The research on which this paper is based was funded by the Renewable Natural Resources and Agriculture Team of the UK Department for International Development (DFID). The arguments made in this paper are those of the authors alone and are not necessarily those of DFID.

odi

**Overseas Development Institute**

**111 Westminster Bridge Road, London SE1 7JD**

**Tel: +44 (0)20 7922 0300**

**Fax: +44 (0)20 7922 0399**

**Email: nrp@odi.org.uk**

**Natural Resource Perspectives** present accessible information on current development issues. Readers are encouraged to quote from them or duplicate them, but as copyright holder, ODI requests due acknowledgement. The Editor welcomes manuscripts for this series.

www.odi.org.uk/nrp

Series Editor: John Farrington

Administrative Editor: Jojoh Faal

© Overseas Development Institute 2007

ISSN 1356–9228