TITLE: Benefits of Organic Agriculture as a Climate Change Adaptation and Mitigation Strategy in Developing Countries

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Abstract

Organic Agriculture (OA) as an adaptation strategy (AS) to Climate Change (CC) is a concrete and promising option for adaptation in rural communities. OA has additional potential as a mitigation strategy (MS). This text is a short review note on this topic. Adaptation and mitigation based on OA can build on well-established practice as OA is a sustainable livelihood strategy with decades of experience in several climate zones and under a wide range of specific local conditions. Given the large fraction of rural population living on farming, the potential of this strategy to adapt to the adverse effects of CC and at the same time contribute to the reduction of greenhouse gas emissions and to carbon sequestration is huge. The scope of the approach ranges from local to national – depending on the policy context it is embedded in. Finally, the financial requirements of OA as an AS or MS are low.

Key Words: adaptation, climate change, mitigation, organic agriculture, rural development, sustainable livelihoods, vulnerability

1. Introduction

The Fourth Assessment Report of the IPCC, Working Group II (AR4-WGII), states that "a wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to future climate change. There are barriers, limits and costs, but these are not fully understood." (IPCC 2007). Other important statements of the AR4-WGII include that "vulnerability to climate change can be exacerbated by the presence of other stresses", that "future vulnerability depends not only on climate change but also on development pathway" and that "sustainable development can reduce vulnerability to climate change, and climate change could impede nations' abilities to achieve sustainable development pathways" (IPCC 2007). In general, CC is a considerable threat to agricultural communities, particularly in lower latitudes. This threat includes the likely increase of extreme weather conditions, increased water stress and drought, desertification and increased climate variability as well as adverse health effects (extreme heat and increased spread of diarrhoeal and infectious diseases such as Malaria). Adverse effects are likely to multiply if adaptation fails. This may then overstretch many societies' adaptive capacities, which may lead to destabilization and security risks (loss of livelihoods, malnutrition, forced migration, conflicts) (IPCC 2007, WBGU 2008, Lobell et al. 2008). The Bali Action Plan from the UN Climate Change conference in Bali 2007 (UNFCCC 2007) clearly emphasizes the importance for enhanced action on adaptation.

The following pages outline how organic agriculture (OA) used as an adaptation strategy (AS) has the potential to address these combined threats of climate change (CC) and other stresses. These pages should be read as a compact review of the potential of OA as an AS and also as a mitigation strategy (MS), based on published

literature, including reports and web-references, thus providing ample reference for further details. It combines different strands of literature from both the "organic community" and the "climate community". It also aims at fostering discussion on OA as an AS and MS beyond the "organic community".

Due to adaptation entering the agenda more prominently only recently, while mitigation has been a topic for long time, there is more research available on OA as a mitigation than as an adaptation strategy (e.g. Niggli et al 2008; IFOAM 2006, 2007, 2008; AgroEco 2006 and also Kotschi and Müller-Sämann 2004). OA as an MS faces many technical complexities (carbon sequestration and greenhouse gas emissions avoidance measurement and accounting, assessment of differences in crop rotations and practices, etc.), while the big challenges for OA as an AS are more of a socio-cultural manner. Importantly, however, potential synergies between AS and MS in agriculture should be identified (Rosenzweig and Tubiello 2007). In this text, both are addressed, but a focus is laid on the exposition of OA as an AS, due to its still lower profile in the discussion.

In the following, organic agriculture is shortly introduced. The main challenges posed by climate change that can be addressed by OA as an adaptation and mitigation strategy are outlined. This is followed by a discussion of some institutional and financial requirements. Finally, some key critical points of OA as an AS and MS are presented.

2. Organic Agriculture

Organic Agriculture[1] is an agricultural production system that focuses on nutrient cycles, soil protection, crop diversity and bio-control of pest and weeds in organic farms. But OA is not only a specific agricultural production system, it is also a systemic and encompassing approach to sustainable livelihoods in general, where due account is given to climatic conditions and adaptation to changes in these conditions. It does this without neglecting other relevant factors of influence for sustainable development and vulnerability, be this on physical, economic or socio-cultural levels. Eyhorn et al. (2003, p14), for example, paraphrase the principles and aims of OA as follows:

> "Conventional farming puts its focus on achieving maximum yields of a specific crop. It is based on a rather simple understanding: crop yields are increased by nutrient inputs and they get reduced through pests, diseases and weeds, which therefore must be combated. Organic agriculture is a holistic way of farming: besides production of goods of high quality, an important aim is the conservation of the natural resources fertile soil, clean water and rich biodiversity. The art of organic farming is to make the best use of ecological principles and processes."

OA has a long tradition as a farming system and it has been adapted for all climate zones and local conditions. Much and detailed situation specific information on OA is thus available.[2] Furthermore, OA has a recognised potential as a general development strategy for rural communities (see e.g. El-Hage Scialabba and Hattam 2002, Eyhorn 2007).

3. Challenges addressed

Organic agriculture increases soil water absorption and retention capacity, avoids nutrient exploitation and increases soil organic nutrient content (see e.g. the

discussion in Niggli et al. 2008). Production in OA systems is thus less prone to extreme weather conditions like drought, flooding and water logging. OA thus addresses key consequences of CC, namely increased occurrence of extreme weather events, increased water stress and drought and problems related to soil quality (IPCC 2007).

Furthermore, OA reduces the vulnerability of the farmers to the local effects of CC. First, OA comprises highly diverse farming systems and thus increases the diversity of income sources and the flexibility to cope with adverse effects of CC. This leads to higher economic and ecological stability through optimized ecological balance and risk-spreading. Second, OA is a low-risk farming strategy with reduced input costs and therefore lower risks with partial or total crop failure due to extreme weather events or changed conditions in the wake of local CC (see e.g. El-Hage Scialabba and Hattam 2002, Eyhorn 2007). It is thus a viable alternative for poor farmers as well. In addition, higher prices can be realized for the products (due to organic certification). Higher farm incomes are thus possible due to the lower input costs and the higher prices. The coping capacity of the farms is increased and the risk of indebtedness is lowered. Risk management and risk reduction strategies and economic diversification to build resilience are also prominent aspects of adaptation as mentioned in the Bali Action Plan (UNFCCC 2007).

Crops and crop varieties used in OA are usually particularly adapted to the local micro-climatic situation. OA is thus likely to be especially adequate to deal with local effects of CC as the time-scale of those are hypothesized to be similar to the time-scale of breeding crop varieties adapted to local habitats. Duly managed, breeding thus likely provides crop varieties optimally adapted to the effects of CC, which cannot be foreseen in due detail. Climate change models are not very accurate or even not available on the local level. Adaptation in this context thus may need to rely on measures that have a self-adaptive capacity such as local crop-breeding. The systemic character (on farm breeding, etc.) of OA is thus especially adequate to deal with these challenges.

By its nature, organic agriculture is an adaptation strategy that can be targeted at improving the livelihoods of rural populations and parts of societies especially vulnerable to the adverse effects of CC (e.g. the rural population in sub-Saharian Africa). By its systemic character, OA is an integrative approach to adaptation, with potential to also work towards the Millennium Development Goals, in particular 1 ("eradicate extreme poverty") and 7 ("environmental sustainability"). The pivotal role agriculture plays for achievement of these goals and the challenges CC poses to this task are widely acknowledged (see e.g. DFID 2005). It is necessary to develop strategies to achieve these goals under the challenges posed by CC. OA addresses many of the key challenges identified for adaptation to CC and it fulfils many of the criteria, which are seen as important general prerequisites for such strategies, as for example described in FAO (2007a), UNDP (2007), GTZ (2007), Slater et al (2007) and Prowse and Braunholtz-Speight (2007).[3]

OA as an MS addresses both emission avoidance and carbon sequestration. The first is achieved through lower N2O emissions (due to lower nitrogen input; 1-2% of the nitrogen applied to farming systems is emitted as N2O, irrespective of the form of the N input), less CO2 emissions through erosion (as, due to the better soil structure and more plant cover, less erosion usually occurs in organic farming systems than in conventional ones) and lower CO2 emissions from farming system inputs (this mainly refers to pesticides and fertilizers that are currently and for the foreseeable future mainly produced employing fossil fuel). Sequestration (both temporary and

long-term) takes place through differences in cultivation practices (such as increased application of organic manures, use of intercrops and green manures, higher share of perennial grasslands and trees or hedges etc.) and changed soil characteristics (higher soil organic matter content and thus higher organic carbon content, better soil structure) (see e.g. Niggli et al 2008; IFOAM 2006, 2007, 2008; AgroEco 2006 and also Kotschi and Müller-Sämann 2004). Given the size of the agricultural sector on a global scale, the potential for mitigation via OA is huge. Of course more detailed assessment of the concrete potential duly differentiated according to climatic zones, local climatic conditions, variations in crops and cultivation practices, etc. is till needed.

4. Institutional and Financial Aspects

Regarding the institutional framework, OA can in principle build on the existing general agricultural institutions present in any country and internationally. However, a main hindrance is the fact that OA is not yet broadly recognised for its potential as a development strategy and even less as an adaptation or mitigation strategy. In particular, its capability to produce yields high enough to replace conventional agriculture to a significant amount is often questioned. In developing countries, yields are however not necessarily lower, as recent research points out.[4] In OA, prospects for long-term sustained productivity are given, different to many intensive conventional farming systems, where, after some decades, decreasing yields are observed.[5] Specialised institutions for OA, such as IFOAM (International Federation of Organic Agriculture Movements, www.ifoam.org), FiBL (Research Institute of Organic Agriculture - Forschungsinstitut für biologischen Landbau, www.fibl.org) or topical sections in larger organisations such as the FAO (Food and Agriculture Organization of the United Nations, www.fao.org/organicag/) or FAL (Federal Agricultural Research Centre – Bundesforschungsanstalt für Landwirtschaft, www.fal.de) have the crucial task to spread the knowledge on OA, in particular if a more positive attitude towards OA as an AS and MS develops widely. Fastest dissemination of OA as an AS and MS could be reached if it would become part of national agricultural policies and the international agricultural policy discourse. Detailed information on some national OA policies is contained in Rundgren (2008), for example.

OA as an AS or MS does not hinge on large additional financing for the OA farming system itself (additional costs come from certification, extension services and the general provision of information). However, it is crucial to have access to international markets and to develop local markets for the products. In the transition phase to OA, additional financing to the farms may be necessary: training and extension services need to be provided, and lower yields for the 2-3 years of the transition period may necessitate some additional support. Hereby, emphasis should be given to knowledge transfer and infrastructure building (including access to markets, etc.), rather than to direct monetary transfers only, although such may be necessary in certain cases. The economic viability of organic farming is also likely to increase with increasing energy prices (which makes conventional farming more expensive, due to the energy costs for production of fertilizers and pesticides) and with decreasing levels of subsidies for conventional agriculture.

Several options to meet these financial requirements exist. Microfinance strategies would certainly be adequate for the situation in many rural communities, given no larger governmental budget would be reserved for this strategy. Another option could be financial support from biodiversity conservation initiatives, such as biodiversity banking (see e.g. Carroll et al 2007). If OA would however be widely

recognised as an AS and MS, financial aid could be granted by the existing agricultural support and research programmes from the governments and by some of the targeted financing programs for CC adaptation and mitigation. In particular, OA as an MS could in principle be framed under the CDM, expectedly most adequately as programmatic or sectoral CDM activities (on those, see e.g. Hinostroza, et al 2007, Sutter 2007 or Baron and Ellis 2006). Finally, to establish a level playing field, distorting subsidies for conventional agriculture (e.g. on fertilizers) should be abolished.

5. Key critical points

Although promising, OA clearly is no panacea and several critical issues remain to be resolved.

First, there is a need for more research. OA is often criticised for lower yields in comparison to conventional agriculture. Recent research invalidates this prejudice, especially in the context of extensive farming systems, which characterize much of agricultural production in developing countries.[4] Further research on this is however still needed. Furthermore, the hypothesized similarity of time-scales of the local effects of climate change and breeding new varieties adapted to those needs to be investigated in detail. For OA as an MS and for its eligibility as a CDM, detailed carbon accounting measurements, both regarding avoided emissions in input production and fertilizer application, and regarding the sequestration potential due to higher soil organic contents and specific cultivation practices have to be provided.

Second, OA is a complex strategy. Widespread implementation of OA must be managed wisely. Enough time for the transition, the learning processes and the general acceptance needs to be given. But duly managed, there are no principal reasons against a transition of agricultural production to OA and on the time-scale of adaptation to CC. The time to soundly design and implement corresponding policies is available.

Third, in the current situation, access to and increased development of (local) markets for the products, local processing possibilities and export infrastructure are of particular importance for OA. For this, the role of international institutions and trade policies (WTO, FAO, UNDP, UNEP, etc.) has to be discussed. The institutional environment for OA as an AS or MS also has to be identified, in particular on a global level. Knowledge transfer has to be institutionalised. There is a wealth of knowledge available on OA, especially in the north (e.g. in various EU countries). Clearly, this knowledge is tied to specific climatic circumstances and cannot be transferred to other regions without due caution and modification.

To be successful, wider recognition of the potential of OA is needed among bodies currently mainly promoting conventional agriculture. An important step could be that (national) agricultural policy begins to prominently support Organic Agriculture as an adaptation and mitigation strategy.

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Notes:

1 For completeness, I mention that there are several approaches of "sustainable agriculture" besides OA (cf. e.g. Eyhorn et al. 2003). These capture important aspects (such as improved pest management, improved water management, crop rotations, etc.). The advantage of OA is that it comprises a bundle of mutually adapted and optimised practices and in this a whole operational farming system with a proven record of good performance, and that the certification available for products of OA allows realising higher prices.

2 For general information on OA in several contexts, see e.g. publications by IFOAM (www.ifoam.org), FiBL (www.fibl.org) or ICROFS (www.darcof.dk), such as the training manual for OA in the tropics: Eyhorn et al. 2003, the Principles of Organic Farming (DARCOF 2000) or the edited volume Halberg et al. (2006). See also the database "Organic eprints" (http://www.orgprints.org/).

3 The OA community is aware of the potential of OA for CC adaptation (see e.g. IFOAM 2007, 2008, FAO 2007b, AgroEco 2006, Borron 2006), but this discussion is not linked to the discussion on adaptation in the "climate community" and its content is hardly known beyond the "organic community". OA is linked to other proposals for adaptation, as it is, for example, an "adaptive social protection" strategy as recently promoted by the IDS (2007), or a "community-based adaptation" strategy, as promoted by the IIED (2007). It is also an answer to the third crucial question addressed in the special issue of the journal "Climate Policy" on how to integrate adaptation and mitigation in a development context (Climate Policy 7 (2007): "What methodological approaches exist that would help to achieve both mitigation and adaptation responses to climate change embedded in the context of local sustainable development?"; it also scores well regarding the several key points identified for this challenge in the editorial to this special issue (Bizikova 2007). In particular, OA has best premises to utilize local and indigenous farmer knowledge and adaptive learning which is seen as an important source for adaptation in farming communities (Tengö and Belfrage 2004, Nyong et al. 2007, Niggli et al 2008). OA also has all the aspects of optimal strategies as identified in Rosenzweig and Tubiello (2007). For a recent overview on a wealth of concrete adaptation projects (not in OA), see e.g. McGray et al. 2007 and also Eldis (2008) and UNFCCC (2008).

4 See e.g. Badgley, et al. 2007, Drinkwater et al. (1998), Maeder et al. (2002). Parrott and Marsden (2002) (contains a review of some case studies); Eyhorn (2007), contains details on yields of organic Cotton in Madhya Pradesh, India.
It has also to be emphasised that OA is a multi-output farming system, for which yields in single outputs may not be an adequate indicator without consideration of the other outputs.
For the advantageous environmental and yield performance of many "sustainable farming systems" (not only certified organic), see Pretty et al. 2006. OA seems also to perform better than conventional agriculture under water constraints (Badgley, et al. 2007; Hepperly et al. 2006)

5 On the adverse effects of the green revolution, see e.g. Matson et al 1997, or DFID 2004. Despite these adverse effects, the immense successes of the Green Revolution regarding crop yields and food security and poverty reduction between 1965 and 1990 clearly has to be acknowledged to avoid a biased picture (see e.g. Evenson and Gollin 2003; IFAD 2001). See also the discussion of adverse effects in the wider context of conventional agricultural (world-)markets, e.g. in Sachs and Santarius (2007), Murphy and Santarius (2007).

References

AgroEco (2006) Carbon Fixation and Organic Agriculture, presented at the Climate Conference in Montreal, 2005 http://www.agroeco.nl/project.php?i=63, or at Biofach 2006 (.../project.php?i=65). Cited 29 July 2008

Badgley C, Moghtader J, Quintero E, Zakem E, Chappell M, Avilez-Vazquez K, Samulon A, Perfecto I (2007) Organic agriculture and the global food supply, Renewable Agriculture and Food Systems 22(2):86–108

Baron R, Ellis J (2006) Sectoral Crediting Mechanisms for Greenhouse Gas Mitigation: Institutional and Operational Issues., OECD and IEA, COM/ENV/EPOC/IEA/SLT(2006)4,
http://www.iea.org/textbase/papers/2006/greenhouse.pdf. Cited 29 July 2008

Bizikova L, Robinson J, Cohen S (2007) Linking climate change and sustainable development at the local level. Climate Policy 7:271-277

Borron S (2006) Building resilience for an unpredictable future: how organic agriculture can help farmers adapt to climate change. Food and Agriculture Organization of the United Nations FAO

Carroll N, Fox J, Bayon R (2007) Conservation and Biodiversity Banking - A Guide to Setting Up and Running Biodiversity Credit Trading Systems. Earthscan.

DARCOF (2000) Principles of Organic Farming. International Centre for Research in Organic Food Systems (ICROFS, extends DARCOF).
http://www.darcof.dk/discuss/princip.pdf. Cited 1 Sept 2008

DFID (2004) Agricultural Sustainability. Working Paper Nr. 12, UK Department of International Development (DFID), London.
http://dfid-agriculture-consultation.nri.org/summaries/wp12.pdf. Cited 29 July 2008

DFID (2005) Growth and poverty reduction: the role of agriculture. DFID Policy Paper, Department for International Development UK
http://www.dfid.gov.uk/pubs/files/growth-poverty-agriculture.pdf. Cited 29 July 2008

Drinkwater LE, Wagoner P, Sarrantonio M (1998) Legume-based Cropping Systems Have Reduced Carbon And Nitrogen Losses. Nature 396:262-265

Eldis (2008) Eldis Database Dossier on Climate Change Adaptation, Institute of Development Studies Sussex (IDS),
http://www.eldis.org/go/topics/dossiers/climate-change-adaptation. Cited 29 July 2008

El-Hage Scialabba N, Hattam C (eds) (2002) Organic Agriculture, Environment and Food Security. Food and Agriculture Organisation of the United Nations FAO, http://www.fao.org/docrep/005/y4137e/y4137e00.htm. Cited 29 July 2008

Evenson RE, Gollin D (2003) Assessing the Impact of the Green Revolution, 1960-2000. Science 300:758-762

Eyhorn F, Heeb M, Weidmann G (2003) IFOAM Training Manual for Organic Agriculture in the Tropics. International Federation of Organic AgricultureMovements (IFOAM)

Eyhorn F (2007) Organic Farming for Sustainable Livelihoods in Developing Countries: The Case of Cotton in India.
http://www.vdf.ethz.ch/loadAllFrames.asp?showArtDetail=3111
http://www.zb.unibe.ch/download/eldiss/06eyhorn_f.pdf. Cited 29 July 2008

FAO (2007a) Climate Change and Food Security. A Framework Document, FAO, http://www.fao.org/clim/docs/climatechange_foodsecurity.pdf. Cited 29 July 2008

FAO (2007b) International Conference on OA and Food Security
http://www.fao.org/organicag/ofs/index_en.htm
see also in general: http://www.fao.org/organicag. Cited 29 July 2008

GTZ (2007) Economic Approaches to climate change adaptation. Deutsche Gesellschaft für Technische Zusammenarbeit GTZ
http://www.gtz.de/de/dokumente/en-climate-adaptation-economic-approaches.pdf. Cited 29 July 2008

Halberg N, Alroe HF, Knudsen MT, Kristensen ES (eds) (2006) Global Development of Organic Agriculture: Challenges and Prospects. CABI Publishing

Hepperly P, Douds Jr D, Seidel R (2006) The Rodale farming systems trial 1981 to 2005: long-term analysis of organic and conventional maize and soybean cropping systems. In: Long-term field experiments in organic farming. Raupp J, Pekrun C, Oltmanns M, Köpke U (eds) pp 15-32. International Society of Organic Agriculture Research (ISOFAR), Bonn.

Hinostroza ML, Cheng C-C, Zhu X, Fenhann J, Figueres C, Avendano F (2007) Potentials and barriers for end-use energy efficiency under programmatic CDM. UNEP Risoe Centre, Working Paper Series 3
cd4cdm.org/Publications/pCDM&EE.pdf Cited 29 July 2008

IDS (2007) Climate Change Adaptation. IDS in Focus Issue 2, Nov 2007
http://www.ids.ac.uk/index.cfm?objectId=61C5E34F-0C47-6CC1-C9C8484E86231263. Cited 29 July 2008

IFAD (2001) Rural Poverty Report 2001: The challenge of ending rural poverty. International Fund for Agricultural Development (IFAD),
http://www.ifad.org/poverty. Cited 29 July 2008

IFOAM (2006) the IFOAM-Side Event to the 24th session of the Subsidiary Bodies, 24th May 2006
http://regserver.unfccc.int/seors/reports/archive.html?session_id=SB24
http://regserver.unfccc.int/seors/file_storage/nz4xyif4q78v67j.pdf. Cited 29 July 2008

IFOAM (2007) OA's Role in Countering CC
http://www.ifoam.org/organic_facts/benefits/pdfs/climate_change_english.pdf. Cited 29 July 2008

IFOAM (2008) FAO Workshop on Organic Agriculture and Climate Change at the IFOAM 2008 conference;
http://www.ifoam.org/events/ifoam_conferences/owc/modules/wed_workshop_climate_changes.html. Cited 19 August 2008

IIED (2007) COP 13 Briefings and Opinion Papers, Dec 2007, http://www.iied.org/pubs/pdfs/17028IIED.pdf. Cited 19 August 2008

IPCC (2007) IPCC Fourth Assessment Report, WG II (http://www.ipcc.ch/ipccreports/ar4-wg2.htm), Summary for Policy Makers (http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf); specifically on adaptation: chapter 17, on vulnerability: chapter 19. Cited 29 July 2008

Kotschi J, Müller-Sämann K (2004) The Role of Organic Agriculture in Mitigating Climate Change – A Scoping Study, IFOAM.
http://www.ifoam.org/press/positions/Climate_study_green_house-gasses.html.
Cited 29 July 2008

Lobell DB, Burke MB, Tebaldi C, Mastrandrea MD, Falcon WP, Naylon RL (2008) Prioritizing Climate Change Adaptation Needs for Food Security in 2030, Science 319:607-610

Maeder P, Fliessbach A, Dubois D, Gunst L, Fried P, Niggli U (2002) Soil Fertility and Biodiversity in Organic Farming, Science 296:1694-1697

Matson PA, Parton WJ, Power AG, Swift MJ (1997) Agricultural Intensification and Ecosystem Properties, Science 277:504-509

McGray H, Hammill A, Bradley R (2007) Weathering the Storm: Options for Framing Adaptation and Development, World Resources Institute WRI, http://www.wri.org/publication/weathering-the-storm. Cited 29 July 2008

Murphy S, Santarius T (2007) The World Bank's WDR 2008: Agriculture for Development. The Ecofair Trade Dialogue, Discussion Paper No. 10, http://www.ecofair-trade.org/en/web/Discussion_Papers.html. Cited 29 July 2008

Niggli U, Fliessbach A, Hepperly P, Scialabba N (2008) Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems, FAO (similar: Niggli U, Fliessbach A, Schmid H, Kasterine A (2007) Organic Farming and Climate Change, International Trade Center UNCTAD/WTO, Geneva).

Nyong A, Adesina F, Osman Elasha B (2007) The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel, Mitigation and Adaptation Strategies for Global Change 12:787-797

Parrott N, Marsden T (2002) The Real Green Revolution. Organic and Agroecological Farming in the South. Greenpeace Environmental Trust, London. http://www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/4526.pdf. Cited 29 July 2008

Pretty JN, Noble AD, Bossio D, Dixon J, Hine RE, Penning de Vries F, Morison J (2006) Resource-Conserving Agriculture Increases Yields in Developing Countries, Environmental Science and Technology 40(4):1114-1119

Prowse M, Braunholtz-Speight T (2007) The first Millennium Development Goal, agriculture and climate change. ODI Opinion Paper October 2007, http://www.odi.org.uk/publications/opinions/85_MDGs_and_agriculture_oct07.pdf. Cited 29 July 2008

Rosenzweig C, Tubiello FN (2007) Adaptation and mitigation strategies in agriculture: an analysis of potential synergies. Mitigation and Adaption Strategies for Global Change 12:855–873

Rundgren G (2008) Best Practices for Organic Policy, Report prepared under the CBTF Project "Promoting Production and Trading Opportunities for Organic Agricultural Products in East Africa", UNEP-UNCTAD

Sachs W, Santarius T (2007) Slow Trade – Sound Farming. The Ecofair Trade Dialogue, http://www.ecofair-trade.org/en/web/Reform_Proposal.html. Cited 29 July 2008

Slater R, Peskett L, Ludi E, Brown D (2007) Climate change, agricultural policy and poverty reduction – how much do we know? ODI Natural Resources Perspective 109, http://www.odi.org.uk/publications/nrp/NRP109.pdf. Cited 29 July 2008

Sutter C (2007) Will it fly? Carbon Finance July 2007: 16. http://www.carbon-financeonline.com/index.cfm?section=features&action= view&id=10675. Cited 29 July 2008

Tengö M, Belfrage K (2004) Local management practices for dealing with change and uncertainty: a cross-scale comparison of cases in Sweden and Tanzania. Ecology and Society 9(3); www.ecologyandsociety.org/vol9/iss3/art4. Cited 29 July 2008

UNDP (2007). Human Development Report 2007/2008 – fighting climate change: human solidarity in a divided world, United Nations Development Programme UNDP, http://hdr.undp.org/en/ Cited 29 July 2008

UNFCCC (2007) The Bali Action Plan, United Nations Framework Convention on Climate Change (UNFCCC).
http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf. Cited 1 Sept 2008

UNFCCC (2008) Web-Sites on Adaptation, United Nations Framework Convention on Climate Change (UNFCCC). http://unfccc.int/adaptation/items/4159.php. Cited 1 Sept 2008

WBGU (2008) World in Transition – Climate Change as a Security Risk .Report of the German Advisory Council on Global Change (WBGU), Earthscan, London. http://www.wbgu.de/wbgu_jg2007_engl.html. Cited 29 July 2008