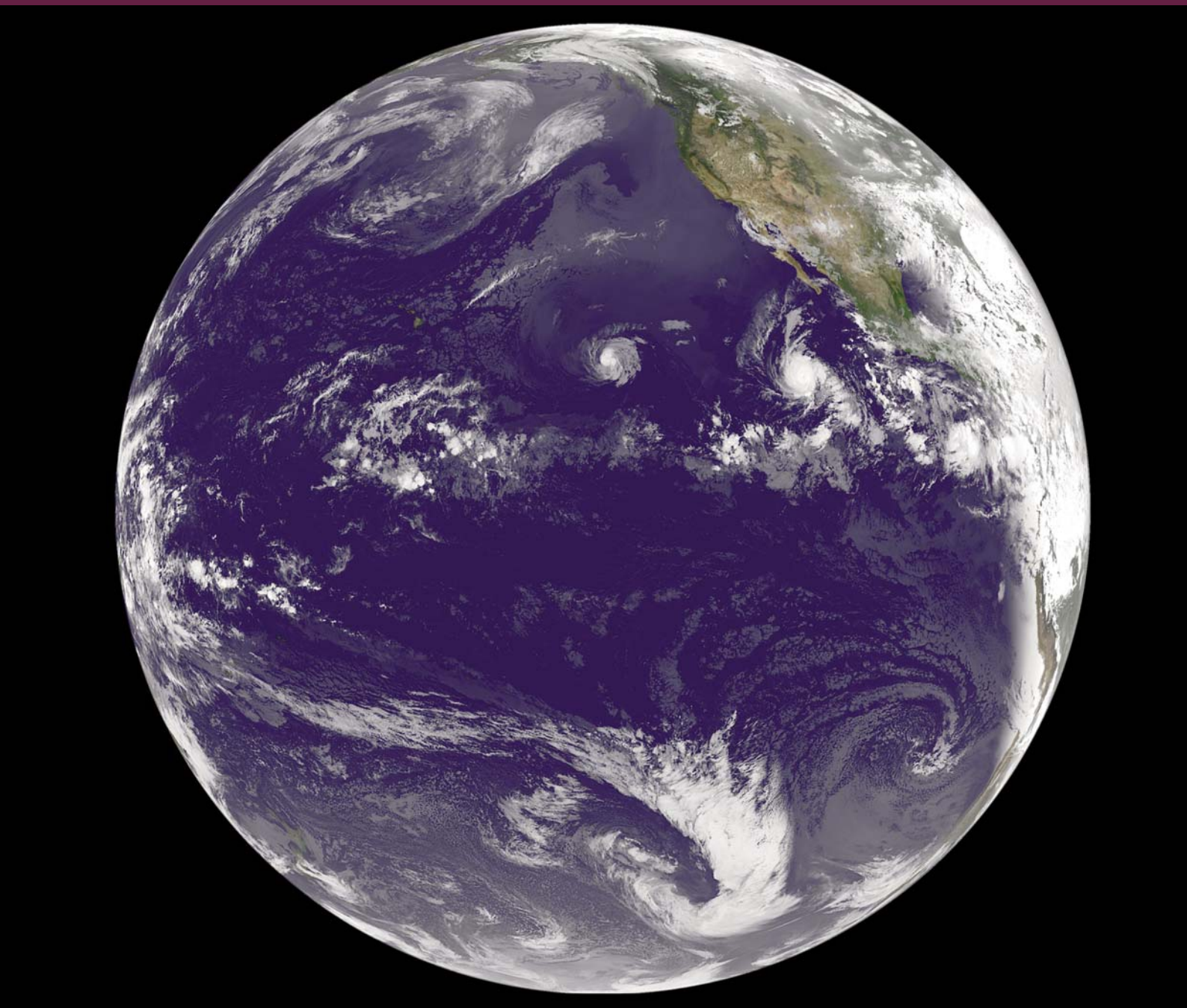
Agriculture *for* Development



Tropical Agriculture Association

Special Issue on Climate Change and Agriculture

The Fifth Assessment Report and agriculture

Climate change and sustainable agricultural technologies

Climate change, agriculture and food security

Climate change from political economy perspectives

Climate change impacts and mitigation

Climate change and livestock in developing countries

No. 22, Summer 2014

Guidelines for Authors
Agriculture for Development

The editors welcome the submission of articles for publication that are directly related to the aims and objectives of the Association. These may be short communications relating to recent developments and other newsworthy items, letters to the editor, especially those relating to previous publications in the journal, and longer papers. It is also our policy to publish papers, or summaries, of the talks given at our meetings.

Only papers written in English are accepted. They must not have been submitted or accepted for publication elsewhere. Where there is more than one author, each author must have approved the final version of the submitted manuscript. Authors must have permission from colleagues to include their work as a personal communication.

Papers should be written in a concise, direct style and should not normally exceed 2000 words using Times New Roman font, 12-point size for the text body, with lines double-spaced and pages numbered. Tables, graphs, and photographs may take a further 1 page plus, but we try to keep the total length of each paper to 3-4 pages of the Journal. Good quality photographs are particularly welcomed, as they add considerably to the appearance of the contents of the Journal. We prefer high resolution digital images.

Format

- An informative title not exceeding 10 words.
- Authors listed, usually with first name and surname.
- A short biographical note about the author(s) is included, preferably with a photograph of the author(s). If still working, indicate your position and email address. If retired, your previous job (*eg formerly Professor of Agriculture, ABC University*).
- For papers longer than 1500 words, a short abstract (summary) of 150-200 words.
- A short introductory paragraph is useful describing, succinctly, the current state of work in the relevant field.
- Système International (SI) units should be used. Others should be related to SI units at the first mention.
- No full stops should be used with abbreviations such as Dr or Prof, or eg, ie, *status quo*, *viz*, and *inter alia*. Acronyms such as GFAR, FAO, IFPRI, and GDP do not have full stops or spaces between the letters. Acronyms should be presented in full at their first mention.
- Thousands should be indicated by a comma and no space eg 12,400.
- Commercial equipment and products referred to should name the product and company, but addresses should be omitted.
- State any statistical methods used eg analysis of variance (ANOVA) and ensure that the analysis method chosen is appropriate for the data. Data tables presenting, for example, mean values should include the appropriate standard errors (SE) and degrees of freedom (DF).
- Results should be presented in an orderly fashion and make use of tables and figures where necessary.
- Discussion should focus on the work presented and its relationship with other relevant published work.
- Sources of funding should be listed in the acknowledgements.

References

- Key references should be quoted, but these should be kept to a minimum.
- Only papers accepted for publication or published may be cited.
- In the text, cite by author's surname and date: (Waller, 2009) or Waller (2009) in chronological order. Use '&' between names of 2 authors; use '*et al*' for 3 or more authors.
- At the end of the paper, give full details of references as per the examples below.
- Personal communications in the text should be cited as: initials, name, brief address, personal communication.

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Journal (online): Osborne K, Dolman AM, Burgess S, Johns KA, 2011. Disturbance and the dynamics of coral cover on the Great Barrier Reef (1995–2009). *PLoS ONE* http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0017516

Book: Brammer H, 2012. *The physical geography of Bangladesh.* Dhaka, Bangladesh: University Press Ltd.

Book (edited): Fuglie KO, Sun Ling Wang, Ball E, eds, 2012. Productivity growth in agriculture: an international perspective. Wallingford. UK: CAB International.

Book (chapter): Warner K, 1997. Patterns of tree growing by farmers in eastern Africa. In: Arnold JEM, Dewees PA, eds. *Farms, trees & farmers: responses to agricultural intensification.* London: Earthscan Publications, 90-137.

Conference proceedings (published): McIntosh RA, 1992. Catalogues of gene symbols for wheat. In: Miller TE, Koebner RM, eds. *Proceedings of the Seventh International Wheat Genetics Symposium*, 1987. Cambridge, UK: IPSR, 1225–323.

Agency publication: Grace D, Jones B, eds, 2011. *Zoonoses (Project 1) Wildlife/domestic livestock interactions*. A final report to the Department for International Development, UK.

Dissertation or thesis: Lenné JM, 1978. *Studies of the biology and taxonomy of Colletotrichum species*. Melbourne, Australia: University of Melbourne, PhD thesis.

Online material: Lu HJ, Kottke R, Martin J, Bai G, Haley S, Rudd J, 2011. Identification and validation of molecular markers for marker assisted selection of Wsm2 in wheat. In: Plant and Animal Genomes XIX Conference, abstract W433. [http://www.intl-pag.org/19/abstracts/W68_PAGXIX_433.html] . Accessed 20 April 2012.

Tables

- Self-explanatory with an appropriate legend above the table, without abbreviations.
- Number with arabic numerals, eg Table 2.
- Refer to tables in the sequence in which they are presented.
- Use lower-case letters, eg a, b and c, for footnotes.

Figures

- Self-explanatory with an appropriate legend below the figure, without abbreviations
- Number in a separate series from the tables.
- Use arabic numerals in the text, eg Figure 2.
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Submission

Your paper should be submitted ready for editing and publication.
Accepted text file types: Word (.DOC or .DOCX), Rich Text Format (.RTF) or Postscript (.PS) only.
Accepted figure file types: .TIF, .EPS or .PDF.
No lecture notes or PowerPoint presentations, please. If the paper is a presentation from a TAA meeting, please let us have this or as soon as possible afterwards so that there is no last minute rush in trying to meet the next publication deadline.

Send submissions via e-mail to coordinator_ag4dev@taa.org.uk preferably in an attached file.

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Cover photograph: Three tropical cyclones spinning over the Eastern Pacific
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Contents

The TAA is a professional association of individuals and corporate bodies concerned with the role of agriculture for development throughout the world. TAA brings together individuals and organisations from both developed and less-developed countries to enable them to contribute to international policies and actions aimed at reducing poverty and improving livelihoods. Its mission is to encourage the efficient and sustainable use of local resources and technologies, to arrest and reverse the degradation of the natural resources base on which agriculture depends and, by raising the productivity of both agriculture and related enterprises, to increase family incomes and commercial investment in the rural sector. Particular emphasis is given to rural areas in the tropics and subtropics and to countries with less-developed economies in temperate areas. TAA recognises the interrelated roles of farmers and other stakeholders living in rural areas, scientists (agriculturists, economists, sociologists etc), government and the private sector in achieving a convergent approach to rural development. This includes recognition of the importance of the role of women, the effect of AIDS and other social and cultural issues on the rural economy and livelihoods.

contact:

coordinator_ag4dev@taa.org.uk

editor_ag4dev@taa.org.uk

Tel: 01298 27957

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Editorial

Special Issue on climate change and agriculture

A former Director of Lumle Agriculture Centre in Nepal, a senior research adviser at DFID and the EC, and Assistant Director General of Bioversity International (previously IPGRI) in Rome, Paul now divides his time between paid work as a consultant and unpaid work as the Coordinating Editor of Ag4Dev.

'Threatened by climate change, Kiribati buys higher ground'; 'Australia and Canada put business ahead of tackling climate change'; 'Obama unveils tough new carbon rules'; 'Antarctic warming will not wait for us'; 'UN report gives stark warning of global threat to life and livelihood'; 'Point of no return for southern glaciers'; 'Averting climate catastrophe is affordable'; 'Climate change could wipe out wildlife and is major threat to UK forests'. These are just a few of the headlines from one newspaper during the last four months – surely there can be no doubt that climate change is happening and now impacts on all aspects of modern life. Indeed, many observers think that climate change will be the defining issue of the 21st century.

This *Agriculture for Development* Special Issue on Climate Change and Agriculture is very timely since the Intergovernmental Panel on Climate Change (IPCC) is in the process of publishing its Fifth Assessment Report (AR5), that is to say the latest update on the current state of climate change knowledge.

Agriculture the world over is already being affected by climate change, sometimes positively, but often negatively. In developing countries many farmers are facing hotter, drier conditions, more extreme weather events, and in some areas, more flooding, and increased problems due to pests and diseases. Appropriate adaptation – 'climate smart agriculture' – can help to reduce these problems. Whilst agriculture contributes to climate change, through greenhouse gas (GHG) emissions, agriculture and agroforestry are also part of the solution if they employ appropriate mitigation activities. I am grateful to the eminent group of international scientists who agreed to contribute to this Special Issue, for their efforts in bringing some clarity to the issue of climate change and agriculture.

The first article, *Climate change and agriculture in the Fifth Assessment Report*, is a summary by the Chair of the IPCC, Dr Raj Pachauri, of what the AR5 says about climate change and agriculture. This sets the scene for this Special Issue. Although some positive impacts of climate change are predicted, they are mainly confined to higher latitudes. Unfortunately, agriculture in the developing countries will be mainly negatively affected, and poor rural people will suffer disproportionately. However, some adaptation is already taking place, and this will continue, especially where supported by appropriate policy environments. Although agriculture, forestry and other land uses (AFOLU) account for about a quarter of man-made GHG emissions, there are many mitigation options such as reafforestation and restoration of organic matter in soils.

In their article *Climate change and sustainable agricultural technologies*, Sir John Beddington, former UK Government Chief Scientific Adviser, and Dr Elizabeth Warham explain how climate smart technologies can contribute to food security, nutrition and sustainable intensification of agriculture in the challenging context of climate change.

The world's largest agricultural research programme on climate change is the CGIAR Research Programme *Climate Change, Agriculture and Food Security (CCAFS)*. This $70 million per year programme is implemented by all 15 CGIAR Centres, with the assistance of more than 700 other partners worldwide. Dr Bruce Campbell is the Director of this comprehensive research programme. In the third article, *Climate change, agriculture*

and food security: from local action to global agreements, Bruce describes how the CCAFS tackles the triple challenges of food security, adapting to climate change and mitigating the effects of climate change. An agreed theory of change links action research with global policy issues, and brings climate smart technologies and practices to scale.

Although science may provide 'climate smart' solutions to the climate change problems of poor rural people in developing countries, Dr Lars Otto Naess, Research Fellow at the Institute of Development Studies, compares the political economy context in four developing countries in his paper *Climate change and agriculture: lessons from political economy perspectives*. He finds that climate change-agriculture debates are often led by powerful, sometimes external, interests; and trade-offs between adaptation, mitigations and development have significant implications for who benefits and who loses.

In the fifth article, *Climate change impacts and mitigation: a review of predictions and reality*, Brian Sims compares the 2011 predictions of Mark Lynas on climate change impacts and mitigation with the latest reality reported by the IPCC in AR5. Brian finds that many of the predictions have already become reality, but that unfortunately Lynas's key 'climate change boundary' of 350ppm CO_2eq has already been passed, and the best we can hope for now is to contain emissions to 450ppm CO_2eq.

In the final article on the climate change theme, *Climate change and livestock in developing countries: possibilities for adaptation*, Dr Philip Thornton, from ILRI and CCAFS, reminds us how relatively understudied are the impacts of climate change on livestock systems in developing countries. It is clear however, that rangeland-based and mixed crop-livestock systems will play critical roles in meeting the growing demand for food in sub-Saharan Africa and South Asia. These can adapt to climate change in various ways, some of which can also provide mitigation co-benefits, but effective adaptation needs an enabling policy, technical, infrastructural and informational environment.

Many projects and activities are taking place around the world with the objective of helping developing countries to adapt to, and cope with, climate change. Under *News from the Field*, Karim Hussein and Savis Sadeghian from IFAD describe the *Adaptation for Smallholder Agriculture Programme* (ASAP), the largest such programme in the world. The programme is working in more than thirty developing countries across five continents, financed by eight donor countries with commitments of $353 million. To-date, it has helped eight million smallholder farmers; introduced sustainable and climate-resilient land management practices on 1 million hectares; and avoided or sequestered 80 million tonnes of greenhouse gases.

Anne Radl reports on the success of the *Climate Change and Food Security Marketplace*, which was held at Cambridge recently to exchange ideas and make new connections towards integrating climate change, food security and poverty reduction.

Three of our Corporate Members, Rothamsted Research, Concern Worldwide and UKCDS, tell us about some of the activities they are undertaking linked to climate change and agriculture; and Geoff Hawtin provides news on climate change research at the non-CGIAR international research institutes CABI, IFDC and INBAR.

Bookstack includes reviews of a number of interesting books and reports concerned with climate change. *The Gender Advantage* (IFAD) highlights the crucial contributions of women in finding local solutions to climate change. A number of other publications on climate change from international agencies such as FAO, IFAD and IIED are reviewed; as is Simon Maxwell's *How to win the climate change argument*.

Although almost all scientists now accept that climate change is happening, and that human activity is largely to blame, there are still a small number of sceptics who question these basic assumptions. One such group is the Heartland Institute, funded largely by the tobacco and energy lobbies. Their publication *Climate change reconsidered II: Biological impacts* is from the Nongovernmental International Panel on Climate Change (NIPCC) who aim to parallel the IPCC Working Group Reports and to present contrary evidence. This report is reviewed by Hereward Corley, who recommends that the work of climate sceptics deserves to be read when it is based on scientific evidence.

One way or another, climate change will define the rest of our lives, and probably those of our children as well. It is a global problem, for which we already know many of the solutions, but each solution involves trade-offs, winners and losers. This is as true for agriculture as it is for other sectors, probably even more so. If we can overcome the climate change-agriculture challenge, we will be well placed to overcome the other major issue of the 21st century, the hunger-poverty challenge.

Paul Harding
Guest Editor

Climate change and agriculture in the Fifth Assessment Report

Raj Pachauri, Chairman IPCC

Dr. Rajendra Kumar Pachauri is the Chair of the Nobel Peace Prize-winning Intergovernmental Panel on Climate Change (IPCC), the scientific intergovernmental body that provides decision-makers and the public with an objective source of information about climate change. He is also Director General of TERI (The Energy and Resources Institute) India, a major independent research organisation providing knowledge on energy, environment, forestry, biotechnology, and the conservation of natural resources. Dr Pachauri is a prominent researcher on environmental subjects, recognised internationally for his efforts to build up and disseminate greater knowledge about man-made climate change and to lay the foundations for the measures that are needed to counteract such change. He was appointed as Senior Adviser to Yale Climate and Energy Institute (YCEI) from July 2012 to June 2014 prior to which he was the Founding Director of YCEI (July 2009 – June 2012). He is active in several international fora dealing with the subject of climate change and its policy dimensions. He was awarded the second-highest civilian award in India, the 'Padma Vibhushan' in January 2008 by the President of India and received the 'Officier De La Légion D'Honneur' from the Government of France in 2006. He has been conferred with 'The Order of the Rising Sun, Gold and Silver Star' by His Majesty Akihito, Emperor of Japan, the 'Commander of the Order of the White Rose of Finland' by the Prime Minister of Finland, the 'Commander of the Order of Leopold II' by the King of the Belgians, and Mexican Order of the 'Aztec Eagle' by the President of Mexico in June 2012.

Summary

The key findings of the Fifth Assessment Report (AR5) with regard to agriculture are presented. The impacts of climate change on marine fisheries and agricultural crops are described. These are found to be negative at the global aggregate scale, and will disproportionately impact on poor rural people in developing countries. Adaptation of agricultural systems to climate change has been happening and this will continue, especially when facilitated by appropriate policies. The significant contribution of the Agriculture, Forestry and Other Land Use (AFOLU) sector to global greenhouse gas (GHG) emissions is considered, and is reported to have been decreasing in recent years. Finally, the mitigation options for AFOLU are considered.

Introduction

The Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change. The IPCC was set up in 1988 by the World Meteorological Organisation (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies, and they underlie negotiations at the UN Climate Conference, the United Nations Framework Convention on Climate Change (UNFCCC).

The IPCC provides rigorous and balanced scientific information to decision-makers because of its scientific and intergovernmental nature. Participation in the IPCC is open to all member countries of the WMO and United Nations. It currently has 195 members. The Panel, made up of representatives of the member states, meets in Plenary Sessions to take major decisions.

IPCC assessments are written by hundreds of leading scientists who volunteer their time and expertise as Coordinating Lead Authors and Lead Authors of the reports. They enlist hundreds of other experts as Contributing Authors to provide complementary expertise in specific areas. IPCC reports undergo multiple rounds of drafting and review to ensure that they are comprehensive and objective and are produced in an open and transparent way. Thousands of other experts contribute to the reports by acting as reviewers, ensuring that the reports reflect the full range of views in the scientific community. Teams of Review Editors provide a thorough monitoring mechanism for making sure that review comments are addressed.

IPCC Assessment Reports are produced every 5-7 years and cover the full scientific, technical and socio-economic assessment of climate change, generally in four parts – one for each of three Working Groups, plus a Synthesis Report. The decision to prepare a Fifth Assessment Report was taken by the members of the IPCC at its 28th Session held in Budapest, Hungary, on 9-10 April 2008. The AR5 provides a clear and up-to-date view of the current (2014) state of scientific knowledge relevant to climate change. The three Working Group (WG) reports have already been published, and a Synthesis Report (SYR) which integrates and synthesises material in the WG reports for policymakers, will be finalised by 31 October 2014. The WGI report is entitled *The Physical Science Basis for Climate Change*, and was written by 259 authors from 39 countries, and included 54,677 comments. The WGII report, *Impacts, Adaptation, and Vulnerability*, had 309 authors from 70 countries and incorporated 50,444 comments. The WGIII report, *Mitigation of Climate Change*, was produced by 235 authors

from 57 countries and included 38,315 comments. This paper summarises the key findings of AR5 with regard to climate change and agriculture.

Climate change impact on marine fisheries

Climate change has major implications for food security, since the impacts of climate change are spread across land as well as the oceans. If we consider the impacts on the oceans, the Working Group-II Report of the IPCC, which is a part of the AR5, clearly states that, due to projected climate change by the the mid-21st century and beyond, global marine species' redistribution and marine-biodiversity reduction in sensitive regions will challenge the sustained provision of fisheries productivity and other ecosystem services. Spatial shifts of marine species due to projected warming will cause high-latitude invasions and high local extinction rates in the tropics and semi-enclosed seas. Species richness and fisheries catch potential are projected to increase, on average, at mid- and high-latitudes and decrease at tropical latitudes. The progressive expansion of oxygen minimum zones and anoxic dead zones is projected to further constrain fish habitat.

Open ocean net primary production is projected to redistribute and, by 2100, fall globally under all the scenarios used for future projections by the IPCC. Also, climate change adds to the threats of over-fishing and other non-climatic stressors, thus complicating marine management regimes. This certainly would have implications for global food security. Fisheries are not directly a part of agriculture, but given the fact that a large percentage of the population across the globe relies on marine products as part of their food intake, any changes in production of marine foods would have indirect implications for agriculture. However, there are also direct impacts of climate change on agriculture.

Climate change impact on agricultural crops

Many studies, covering a wide range of regions and crops, find that negative impacts of climate change on crop yields have been more common than positive impacts (Figure 1). Climate change has negatively affected wheat and maize yields for many regions and in the global aggregate. Effects on rice and soybean yields have been smaller in major production regions and globally. Observed impacts relate mainly to production aspects of food security rather than access or other components of food security. Since the Fourth Assessment Report (AR4), several periods of rapid food and cereal price increases following climate extremes in key producing regions have indicated a sensitivity of current markets to climate extremes among other factors.

The IPCC AR5 has found that, for the major crops (wheat, rice and maize) in tropical temperature regions, climate change without adaptation is projected to negatively impact production with local temperature increase of 2°C or more above late 20th century levels, although individual locations may benefit. Projected impacts vary across crops and regions and adaptation

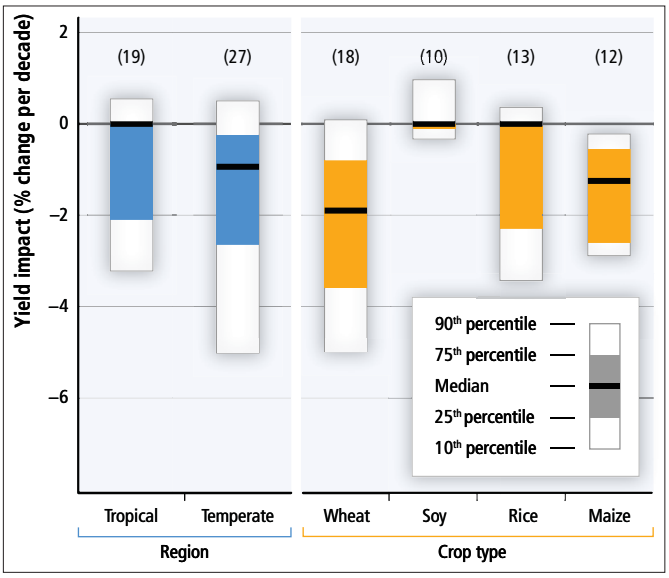

Figure 1. Summary of estimated impacts of observed climate changes on yields over 1960-2013 for four major crops in temperate and tropical regions, with the number of data points analysed given within parentheses for each category.

scenarios, with about 10 percent of projections for the period 2030-2049 showing yield gains of more than 10 percent, and about 10 percent of projections showing yield losses of more than 25 percent, compared to the late 20th century. After 2050, the risk of more severe yield impacts increases, and depends on the level of warming. Climate change is projected to progressively increase inter-annual variability of crop yields in many regions. It should also be noted that these projected impacts will occur against the background of rapidly rising crop demand.

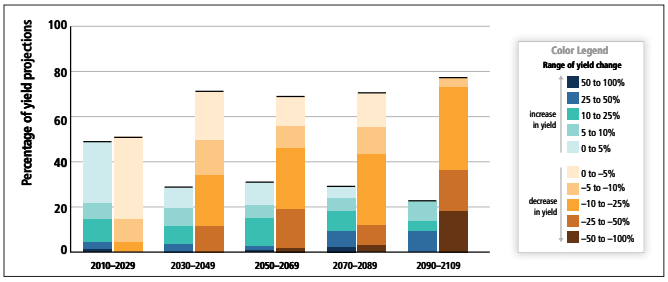

Figure 2. Summary of projected changes in crop yields, due to climate change over the 21st century. The figure includes projections for different emission scenarios, for tropical and temperate regions, and for adaptation and no-adaptation cases combined. Relatively few studies have considered impacts on cropping systems for scenarios where global mean temperatures increase by 4°C or more. For five timeframes in the near-term and long-term, data (n=1090) are plotted in the 20-year period on the horizontal axis that includes the midpoint of each future projection period. Changes in crop yields are relative to late-20th century levels. Data for each timeframe sum to 100 percent.

Another aspect of climate change which has implications for agriculture activity is the increase in frequency and intensity of extreme events. Models project specific warming in temperature extremes by the end of the 21st century. It is virtually certain that increases in the frequency and magnitude of warm daily temperature extremes, and decreases in cold extremes, will occur in the 21st century at the global scale. It is very likely that the length, frequency, and/or intensity of warm spells or heat waves will increase over most land areas. Based on specific IPCC emission scenarios, a one in 20 year hottest day is likely to become a one in 2 year event by the end of the 21st century in most regions, except in the high latitudes and the northern hemisphere where it is likely to become a one in 5 year event.

It is also likely that the frequency of heavy precipitation or the proportion of the total rainfall from heavy fall will increase in the 21st century over many areas of the globe. This is particularly the case in the high latitudes and tropical regions, and in winter in the northern mid-latitudes. Heavy rainfalls associated with tropical cyclones are likely to increase with continued warming. There is also a projection that, in some regions, increase in heavy precipitation will occur despite projected decreases in total precipitation in other regions.

Thus, the AR5 has found all aspects of food security are potentially affected by climate change, including food access, utilisation and price stability. Redistribution of marine fisheries catch potential towards higher latitudes poses risk of reduced supplies, income, and employment in tropical countries, with potential implications for food security. Global temperature increases of 4°C or more above late 20th century levels, combined with increasing food demand, would pose large risks to food security globally and regionally. Risks to food security are generally greater in low latitude areas.

Climate change and poverty

Major future rural impacts are expected in the near-term and beyond through impacts on water availability and supply, food security, and agricultural incomes, including shifts in production areas of food and non-food crops across the world. These impacts are expected to disproportionately affect the welfare of the poor in rural areas, such as female-headed households and those with limited access to land, modern agricultural inputs, infrastructure and education.

Throughout the 21st century, climate-change impacts are also projected to slow down economic growth, make poverty reduction more difficult, and prolong existing poverty traps and create new ones, the latter particularly in urban areas and emerging hotspots of hunger. Climate change impacts are expected to exacerbate poverty in most developing countries and create new poverty pockets in countries, with increasing inequality in both developed and developing countries. In urban and rural areas, wage-labor-dependent poor households who are net buyers of food are expected to be particularly affected due to food price increases, including in regions with high food insecurity and high inequality (particularly in Africa), although the agricultural self-employed could benefit.

Adaptation

Adaptation to weather and climate changes is very much a part of established agricultural practice, and so communities across the globe have found innovative ways by which they have responded to climate variability and changes in weather from year to year. Adaptation measures for agriculture, water, forestry and biodiversity can occur through policies taking account of rural decision-making contexts. Trade reform and investment can improve market access for small-scale farms. In Central and South America, for example, ecosystem-based adaptation including protected areas, conservation agreements, and community management of natural areas is occurring. Resilient crop varieties, climate forecasts and integrated water resources management are being adopted within the agricultural sector in some areas.

Emissions of greenhouse gases

The AR5 has also found that agriculture has an important role to play as a contributor to emissions of greenhouse gases and therefore has contributed to human-induced climate change. The sources of emissions from different sectors of human activity are shown in the figure below which indicates a contribution of 24 percent from agriculture, forestry and other land use (AFOLU).

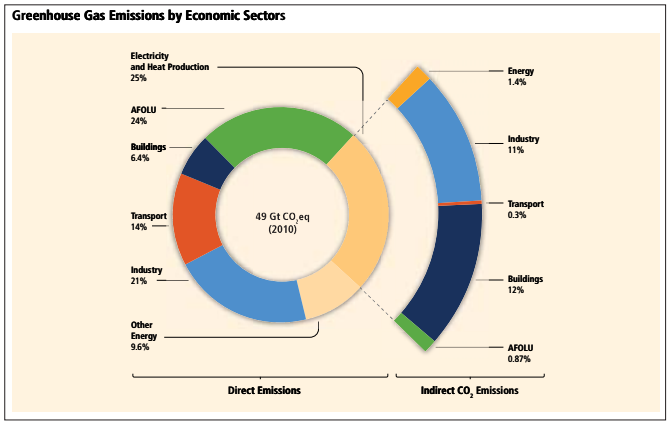

Figure 3. Total anthropogenic GHG emissions ($GtCO_2eq/yr$) by economic sectors. Inner circle shows direct GHG emission shares (in percent of total anthropogenic GHG emissions) of five economic sectors in 2010. Pull-out shows how indirect CO_2 emission shares (in percent of total anthropogenic GHG emissions) from electricity and heat production are attributed to sectors of final energy use. 'Other Energy' refers to all GHG emission sources in the energy sector as defined in Annex II of AR5, other than electricity and heat production. The emissions data from Agriculture, Forestry and Other Land Use (AFOLU) includes land-based CO_2 emissions from forest fires, peat fires and peat decay that approximate to net CO_2 flux from the Forestry and Other Land Use (FOLU) sub-sector. Emissions are converted into CO_2-equivalents based on Global Warming Potential (GWP) from the IPCC Second Assessment Report.

The AFOLU sector accounts for about a quarter (~10–12$GtCO_2eq/yr$) of net anthropogenic GHG emissions mainly from deforestation, agricultural emissions from soil and nutrient management, and livestock. Most recent estimates indicate a decline in AFOLU CO_2 fluxes, largely due to decreasing deforestation rates and increased afforestation. However, the uncertainty in historical net AFOLU emissions is larger than for other sectors, and additional uncertainties in projected baseline net AFOLU emissions exist.

In baseline scenarios, GHG emissions are projected to grow in all sectors, except for net CO_2 emissions in the AFOLU sector. Indeed, in such scenarios, while non CO_2 GHG agricultural emissions are projected to increase, net CO_2 emissions from the AFOLU sector decline over time, with net emissions potentially less than half the 2010 level by 2050 and the possibility of the AFOLU sectors becoming a net CO_2 sink before the end of century.

Mitigation

AFOLU plays a central role in food security and sustainable development. The most cost effective mitigation options in forestry are afforestation, sustainable forest management and reducing deforestation, with large differences in their relative

importance across regions. In agriculture, the most cost effective mitigation options are cropland management, grazing land management and restoration of organic matter in soils. Measures, such as changes in diet and reductions of losses in the food supply chain, have a significant, but uncertain, potential to reduce GHG emissions from food. Estimates vary from roughly 0.76–8.6 $GtCO_2eq/yr$ by 2050.

It is important to note that policies governing agricultural practices and forest conservation and management are more effective when involving both mitigation and adaptation. Some mitigation options in the AFOLU sector (such as soil and forest carbon stocks) may be vulnerable to climate change. When implemented sustainably, activities to reduce emissions from deforestation and forest degradation (REDD+ is an example designed to be sustainable) are cost-effective policy options for mitigating climate change, with potential economic, social and other environmental and adaptation co-benefits (eg, conservation of biodiversity and water resources, and reducing soil erosion).

In addition, bioenergy can play a critical role for mitigation, but there are issues to consider, such as the sustainability of practices and the efficiency of bioenergy systems. Barriers to large scale deployment of bioenergy include concerns about GHG emissions from land, food security, water resources, biodiversity conservation and livelihoods. The scientific debate about the overall climate impact related to land use competition effects of specific bioenergy pathways remains unresolved. Bioenergy technologies are diverse and span a wide range of options and technology pathways. Evidence suggests that options with low life cycle emissions (eg, sugarcane, *Miscanthus*, fast-growing tree species, and sustainable use of biomass residues), some already available, can reduce GHG emissions; outcomes are site specific and rely on efficient integrated 'biomass to bioenergy systems', and sustainable land use management and governance. In some regions, specific bioenergy options, such as improved cooking stoves, and small scale biogas and bio-power production, could reduce GHG emissions and improve livelihoods and health in the context of sustainable development.

Last but not least, behaviour, lifestyle and culture have a considerable influence on energy use and associated emissions, with high mitigation potential in some sectors, in particular when complementing technological and structural change. Emissions can be substantially lowered through changes in consumption patterns (eg, mobility demand and mode, energy use in households, choice of longer lasting products) and dietary change and reduction in food wastes. A number of options, including monetary and non monetary incentives, as well as information measures, may facilitate behavioural changes.

News from the Field

IFAD's Adaptation for Smallholder Agriculture Programme (ASAP)

The International Fund for Agricultural Development (IFAD) is a specialised agency of the United Nations dedicated to eradicating rural poverty and investing in poor rural people, with a special focus on smallholders in developing countries. Since starting operations in 1978, IFAD has invested US$14.9 billion in over 950 projects and programmes that have reached some 430 million poor rural people. These programmes have improved smallholder incomes, food and nutrition security, and resilience to economic and climate shocks. Knowledge generation, studies and analysis on programme experiences, scaling up and strategic thematic issues related to agriculture and rural development are key complements to IFAD's investment programmes.

The ***Adaptation for Smallholder Agriculture Programme*** (ASAP) is a multi-donor-supported financing window launched in 2012 that provides co-financing to scale up and integrate climate change adaptation across IFAD's approximately US$ 1 billion per year of new investments. It channels finance to smallholder farmers so they can access the tools and technologies that help build their resilience to climate change. The programme is working in more than thirty developing countries across five continents combining relevant adaptation know-how, practices and technologies with tried-and-tested approaches to rural development. ASAP has been financed to-date with the generous support of eight donor countries (United Kingdom, Netherlands, Canada, Belgium, Finland, Norway, Sweden, Switzerland) with total pledges and commitments of US$ 353 million.

ASAP is the world's largest climate change adaptation programme focused on poor smallholder farmers, channelling climate finance to eight million smallholder farmers. ASAP funds are used to enhance the resilience of smallholder farming systems, rural value chains and agricultural landscapes to climate-related shocks and stresses; introduce sustainable and climate-resilient land management practices on 1 million hectares of agricultural lands; avoid or sequester 80 million tonnes of greenhouse gas emissions; and increase human capacities for adaptation, climate risk management and hydro-meteorological disaster preparedness in over 1,200 rural communities. ASAP promotes the scaling up of successful 'multiple-benefit' approaches to smallholder agriculture, which improve production while reducing and diversifying climate-related risks.

On the ground, ASAP has co-financed one-third of IFAD's new programme designs at country level in 2013. This has led to additional features being incorporated in project designs to directly address climate risk analysis and climate risk management actions. For example: a flash flood early warning system to improve crop management in **Bangladesh**; the development of a real-time salinity monitoring and forecasting system and data platform to help cope with rising sea levels in the Mekong Delta, **Vietnam**; more robust building codes for agricultural processing and storage hubs to withstand heavier rainfall and storm events in **Rwanda**; an inventory of indigenous climate risk management techniques in **Bolivia**, supporting families to avoid climate-related losses and damage to production; to cope with extreme rainfall events, adding water runoff capture and storage to rural roads being built in **Yemen**; identification of hot spots for erosion to guide infrastructure investments and pasture management in **Kyrgyzstan**; and crowd-sourcing of weather information to improve meteorological forecasts in **Mali**.

The ASAP is financing integrated approaches to climate change adaptation which bundle well-known, 'no regrets' technologies for agricultural intensification (such as agroforestry, rotational grazing, conservation agriculture or intercropping with fertiliser plants) with more innovative measures such as the promotion of heat-, drought- or salt-tolerant crop varieties; the use of Geographic Information Systems (GIS); and the analysis of meteorological observations and soil survey data.

For example, in **Yemen**, a vulnerability analysis was undertaken in the ASAP-supported Rural Growth Programme which has focused on community empowerment, livelihood diversification and agricultural development. Using a GIS data base, a number of climate risks have been identified (soil erosion, droughts, and flash floods) and suitable locations for cropping, terracing and appropriate adaptation investments have been identified. In these priority areas, adaptation interventions include the use of drought-resistant wild varieties of endemic species, agroforestry schemes, and priority zones for crop-livestock integration. The GIS modelling applied by the programme has added critical value to investment design, but also helped to build a platform which involves all key government agencies and partners in the design of complementary development initiatives.

ASAP also aims to develop policy and strategic planning tools to promote climate-resilient agriculture and increase the resilience of productive value chains. One example is the *Adapting to Changing Markets and the Effects of Climate Change Project (NICADAPTA)* in **Nicaragua**. This project seeks to contribute to the improvement of the competitiveness of coffee and cocoa cooperatives and associated small-scale producers through increased productivity and the adoption of practices that facilitate adaptation to climate change and changing market conditions. It will introduce water efficiency and crop diversification measures such as coffee-cocoa intercropping in coffee plantations to buffer the effects of rising temperatures. Moreover, it will strengthen the availability of weather information through improved dissemination of agro-climatic information. This will be complemented by efforts to strengthen producer organisations and public institutions through capacity building and the design of policies and incentives to facilitate private sector investments in coffee and cocoa value chains.

ASAP pays particular attention to gender equality and women's empowerment, responding to the differentiated vulnerabilities of women and men in relation to climate change, and harnessing the role of women as agents of change to strengthen the resilience of the households, communities and ecosystems in which they live and work. IFAD's experience shows that gender-sensitive adaptation results in more diversified livelihood options and income sources, enhanced food security and reduced workloads for women and their families. Examples of gender-inclusive initiatives under ASAP include the offsetting of the strenuous collection of firewood, which can increase with a drier climate, through innovative biogas technology. Apart from providing a clean source of energy that is independent from national grids, this source of energy reduces the time women have to spend collecting firewood. A valuable side effect is the countering of deforestation in sensitive ecosystems and the creation of a cleaner and safer energy source that is less prone to accidents **(Mali)**. Another example of gender-sensitive adaptation is piloting the implementation of a Gender Action Learning System (GALS) in **Mozambique**, which is a participatory approach enhancing the inclusion of women and the poor in value chains, and reflecting gender dimensions in Annual Value Chain Development Action Plans and the Project Learning System.

Further reading

IFAD, *Adaptation for Smallholder Agriculture Programme: ASAP* (www.ifad.org/climate/asap)

IFAD, 2012, *ASAP Programme Description* (http://www.ifad.org/climate/asap/note.pdf)

IFAD, 2014, *ASAP Newsletter: Issue 3 – February 2014* (http://www.ifad.org/climate/asap/newsletter/3.htm)

IFAD (2013), *What are ASAP funds being spent on?* (July) http://www.ifad.org/climate/asap/asap-spending.pdf

Karim Hussein and Savis Sadeghian
IFAD, Rome

Climate change and sustainable agricultural technologies

John Beddington and Elizabeth Warham

John Beddington was UK Government Chief Scientific Adviser (GCSA) from 2008-2013. During his tenure he highlighted the linked problems of food, water and energy security in the context of mitigating and adapting to climate change. He supervised the development of the Foresight report on the Future of Food and Farming which was widely quoted. In 2011 he chaired an International Commission on Agriculture and Climate Change and for the last year has Co-Chaired an International Commission on Agriculture and Nutrition. He is an adviser to the Oxford Martin School and, amongst other activities, is a Non-Executive Director of the UK Meteorological Office.

Elizabeth Warham is Head of the UKTI Agri-Tech Organisation, promoting the investment and trade of innovative agricultural businesses, products and services, to gain the very best of agriculture through the cutting edge of innovation. She provided advice and support on food and water security issues to John during his tenure as GCSA in the Government Office for Science. In the UK Department for International Development she managed research programmes to develop appropriate technologies for different agricultural production systems in low- and middle-income countries (Africa, Asia, Latin America and the Caribbean). She worked for 10 years at the International Centre for Wheat and Maize Improvement (CIMMYT) in Mexico, in the maize breeding, wheat pathology and seed health programmes.

Summary

Throughout the world, agriculture is at the nexus of achieving food security, climate adaptation and mitigation, and sustainable use of critical resources such as water, energy and land. Yet individual countries vary in their vulnerability to climate change and the opportunities to improve food security, while ensuring agriculture is more resource efficient. Sustainable intensification of agriculture will be key to bringing people out of poverty, but also to improving the nutrition of people with an inadequate diet at present. Many exciting technologies drawing on new developments in science offer new approaches to agricultural production systems. These new technologies will require investment so they can be translated into use, integrated with other technologies in on-farm practice, and the benefits (economic/social/environmental) demonstrated to farmers and growers. In turn, these new production systems must manage natural resources in the landscapes to ensure the resilience of ecosystems and their services.

Sustainable agriculture

Agriculture is at the nexus of the three greatest challenges of the 21st Century – achieving food security, climate change adaptation and mitigation, and sustainable use of critical resources such as water, energy and land. Global trends in population growth, changing diets, resource degradation and climate change impacts on agricultural productivity mean there is a real risk of food shortfalls as the century progresses. Dietary changes are highly significant for future demands on agriculture as, per calorie, some food items such as meat require considerably more resources (such as land, water and energy) to produce than others.

Throughout the world, food insecurity and climate change already inhibit human well-being and economic growth, and are likely to accelerate. Individual countries vary in their vulnerability to climate change, the amount and type of greenhouse gases (GHG) they emit and their opportunities to reduce GHG emissions and improve agricultural productivity. The control of GHG to reduce the rate of global warming to avoid major ecosystem and economic disruption will require tough and well-guided action to cut GHG emissions in agricultural production. The low-emissions world of agriculture is therefore not a possible option, but a necessity.

Sustainable agriculture simultaneously increases production and income, adapts to climate change and reduces greenhouse gas emissions, while balancing crop, livestock, fisheries and agro-forestry systems, increasing resource use efficiency (including land and water), protecting the environment and maintaining ecosystem services (Foresight, 2011).

Climate change adaptation and mitigation

The balance of evidence indicates the world is likely to become warmer, especially at higher latitudes; patterns of precipitation will change, with lower latitudes and equatorial regions likely to become drier, and high latitudes wetter; and there will be more frequent extreme weather events such as droughts and floods. Food production will be directly affected by these changes in various ways. Warmer and more humid conditions may favour the increased incidence and activity of pests and diseases, or crops may become stressed by more extreme environmental conditions and have lower resistance (Newman, 2004; Cheke & Tratalos, 2007; Gregory *et al*, 2009; Evans *et al*,

2008). It has been estimated that even a 2°C average temperature rise in Africa will have more negative consequences than originally thought as a result of the continent's relatively greater sensitivity to more frequent extreme weather events (FAO, 2011).

In many parts of the world, the challenges faced in adapting agriculture to climate change are enormous. In practice, they involve a collection of coping strategies, with each strategy focused on a particular threat. For example, through changing water temperatures and circulation patterns, climate change is likely to influence aquatic ecosystems and the movements of fish stocks, potentially raising fishing costs, and increasing conflicts over harvesting rights and management arrangements. There is already evidence of the movement of some species, and the need for more mobile fishing operations to adapt to these changes. However, poorer communities near transition zones (eg Angola, Senegal) or in shallow water areas (eg deltas), with fewer market or technical options, may be less able to adapt. Similar issues could arise in inland lakes and seas, and where stocks migrate from salt to fresh water or vice versa (Foresight, 2011).

Agriculture accounts for about 10-12 percent of total anthropogenic GHG emissions (Smith *et al*, 2007), reaching 30 percent if fuel, fertiliser, and land use change are included, the last accounting for 6-17 percent of total emissions (Bellarby *et al*, 2008). Livestock production is estimated to be responsible for 18 percent of total emissions (FAO, 2009). Moreover, agriculture contributes a disproportionate amount of high-impact GHGs: approximately 58 percent of nitrous oxide (N_2O) from the action of soil bacteria on ammonium and nitrate, originating from chemical fertilisers, manure, crop residues or nitrogen-fixing plants; and 47 percent of methane (CH_4) from ruminant digestion (cattle, sheep and goats), rice cultivation, and anaerobic soils and sediments, including small quantities from some aquaculture sites (Smith *et al*, 2007; Wreford *et al*, 2010). Livestock production is estimated to be responsible for 37 percent of global CH_4, and 65 percent of global N_2O emissions, and 18 percent of total GHG inputs (Steinfeld *et al*, 2008). Managing GHGs linked with agriculture will require consideration of a range of strategic and local land use decisions, including land clearing and restoration, reforestation, agro-forestry, wetland management and biofuel production.

Investing in sustainable agriculture technology

Many examples of successful technologies exist to reduce GHG emissions in agriculture within different environments, while maintaining or improving yields and adapting to more extreme weather (Pretty *et al*, 2011).

Better management of farm inputs such as fertilisers, herbicides, seed, fuel (used during tillage, planting, spraying etc) can be achieved by application of the right practice, at the right place and the right time through mechanised precision agriculture. Whereas large farm fields under conventional management receive uniform applications of fertilisers, irrigation, seed, etc, with precision agriculture, these fields can be divided into management zones that each receive customised management inputs based on varying soil types, landscape position, and management history.

Utilising agronomic approaches with integrated pest management solutions can reduce the risk of attack by pests, weeds and diseases. Crop rotation can mitigate the build-up of pathogens and pests that often occurs when one species is continuously cropped, and can also replenish nitrogen through the use of green manure in sequence with cereals and other crops; and improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants.

Looking to the future, there are many exciting technologies drawing on new developments in science, that need much more investment to bring about their use. For example:

- Precision farming will help allow minimum tillage and potentially intercropping, including better fertiliser placement and application of crop protection products, thus minimising their use and contributing to environmental protection.
- 'Omic' technologies and advanced molecular diagnostics to characterise pests, weeds and diseases, linked to smartphones, will help realise the potential of bringing information to field applications of new control strategies.
- More effective use of existing agricultural data systems and predictive computer modelling of plant, soil and water interactions will help design new crop regimes, for more efficient use of water and nutrients.
- The application of modern genetic and breeding approaches will help to improve the quality, sustainability, resilience and yield-led profitability of crops and farm animals.
- Ensuring a wide biodiversity of crops and animals will be critical in adapting agriculture to climate change.

The impact of new, innovative approaches for sustainable intensification of agriculture will only come to bear through the application of research, integration with on-farm practice, and demonstration of the benefits (economic/social/environmental) to farmers and growers. A challenge for farmers and growers is access to the available technologies, and the opportunity to adapt new technologies in a step-wise manner. Practices for sustainable intensification will require packages of technologies working together and will involve complex mixes of plant and animal species and associated management techniques building on new skills and knowledge developed by farmers and outside organisations. This will involve overcoming previous expectations about what works and what does not, what to expect from new technologies, how to share and adapt new techniques, and how to strike a balance between risk-aversion and risk-taking. Training and adoption will need to be long term and supported by participatory approaches. These practices will have increased yields, and contribute resilience, while at the same time improving the environment through increased carbon sequestration in soils, nitrogen fixation, reductions in the use of synthetic pesticides, reduced run-off and soil erosion, increased groundwater, and greater diversity of habitats and species.

When farmers are aware of new practices and products, they must be able to access the credit, inputs, technologies and markets required to capitalise on new developments. The Foresight case studies (Pretty *et al*, 2014) demonstrate the importance of a strong network of partnerships, helping to develop innovations, disseminate them, support their spread and add value through

additional processing and commercialisation. Partnerships involve linkages across institutions, sectors and scales. NGOs and other civil-society organisations, research organisations, farmer groups, businesses, banks, government agencies and policy bodies have all had a contribution to make in each case of sustainable intensification. Two important aspects of these partnerships are the central role played by various forms and levels of social capital, and the role of the private sector.

Agricultural production systems in the future

Intensification - climate-smart?

Many rural communities are already successfully making the transition to new forms of farming better suited to the rigours of a warmer world. A shift to climate-smart agriculture will not only help shield farmers from the adverse effects of climate change and offer a way to reduce GHG emissions, but can also improve farm yields and household incomes, leading to stronger, more resilient communities.

For example, the planting of fertiliser trees can yield several social, economic and environmental benefits. Increased availability and proximity of firewood has reduced the foraging time for women, and greater availability of fodder has increased their ability to keep livestock and therefore boosted their income. Environmental gains include increases to the water table, decreased soil erosion, significant carbon sequestration and increased soil nitrogen. Fertiliser trees are being adopted as a result of participatory trials and on-farm testing. As a result of direct stakeholder involvement, many innovations have come from farmers themselves (Pretty *et al*, 2014). In the highlands of Mount Kilimanjaro, farmers are returning to an 800 year-old agroforestry system known as *Kihamba*, which supports one of the highest rural population densities in Africa and provides livelihoods for an estimated one million people. An agro-ecosystem similar to a virgin tropical mountain forest, *Kihamba* maximises the use of limited land, provides a large variety of foods all year round and maintains groundwater health, among other environmental services (FAO, 2013).

Nutrition

Globally, around 1 billion people experience hunger, lacking access to sufficient of the major macronutrients (carbohydrates, fats, and protein). An additional 1 billion suffer from 'hidden hunger', in which important micronutrients (such as vitamins and minerals) are missing from their diet, with consequent risks of physical and mental impairment. In contrast, a billion people are substantially over-consuming, spawning a new public health epidemic involving chronic conditions such as type-2 diabetes and cardiovascular disease (Foresight, 2011).

The Global Panel on Agriculture and Food Systems for Nutrition is an independent group of influential experts with a commitment to tackling global challenges in food and nutrition security. The aim of the Global Panel is to provide effective guidance to decision-makers, particularly government, on generating nutrition-enhancing agricultural and food policy and investment in low and middle income countries.[1]

Nutrition-specific interventions include supplementation and food fortification. One example of a biofortified crop is the new orange-fleshed cultivars, which combine high resistance to pathogens and high concentrations of nutrients, developed by the Ugandan Sweet Potato Programme through a highly

[1] http://www.glopan.org/about

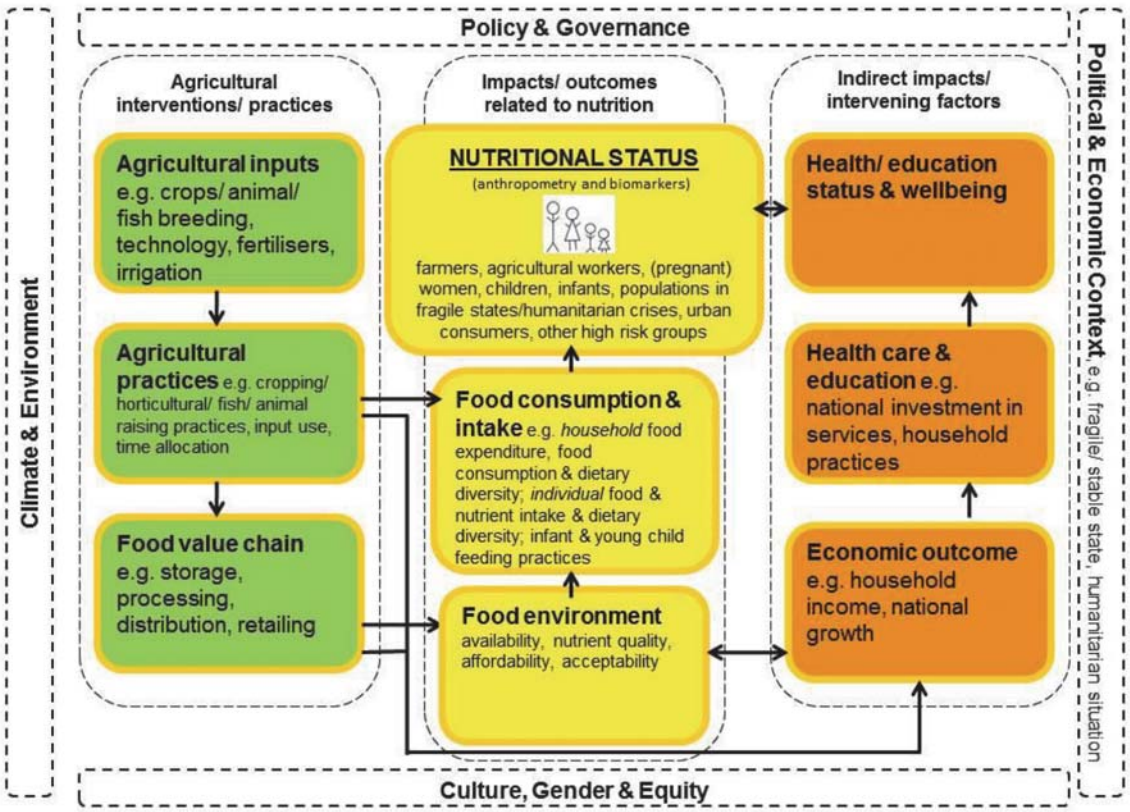

Figure 1: Pathways that link agricultural practices or interventions with nutrition-related outcomes.

collaborative, international research and development effort, well-supported by international and national donors. Households adopting the new cultivars have been able to boost income and nutritional security, with farmers in Eastern and Central Uganda able to earn about US$400 per month from the sale of planting materials and sweet potato products (Mwanga & Ssemakula, 2011). The new cultivars have contributed to improving the vitamin A status of children and can generate superior levels of food per unit area per unit time during relatively short rainy periods, giving them an advantage over major staples.

These biofortified crops can only provide a part of the solution, and there is a need to engage agriculture and food systems more broadly in efforts to reduce under-nutrition. The agriculture sector will in future need to improve nutrition and health outcomes, either directly through the production and consumption by small-scale farmers of an energy-sufficient and nutritionally diverse diet, or indirectly, for example by changing the price of foods through increased market supply, or through enhanced household and national income by means of increased agricultural productivity.

The links between agriculture and health are complicated (Dangour *et al*, 2012). One of the latest frameworks, (Hawkes *et al*, 2012), identified the principal pathways that link agricultural practices or interventions with nutrition-related outcomes, either directly or indirectly (Figure 1).

The pathways start with changes relating to inputs such as new crop varieties, practices such as home gardening, or the mechanisms by which nutritious food products reach the consumer via storage, processing, distribution and retail systems. The direct effects of these changes are captured in the central (yellow) boxes linking changes in the food environment and food consumption and intake, to nutrition and health outcomes in populations. The indirect effects in the right hand (orange) boxes identify the impact of changes in agricultural practices and the food environment on agricultural employment and farm incomes, and the knock-on effect of changes in livelihoods on the ability to purchase foods and services that can be both beneficial and harmful to health. The role of agricultural growth in contributing to national economic growth which might improve population-wide access to health care and education is also identified. Macro-level factors that can influence agricultural practices and nutritional outcomes are presented in the borders of the framework and include: policy and governance; culture, gender and equity; climate and environment; and the political and economic context.

Conclusions

Sustainable intensification of agriculture is not a single specific agricultural technology or practice that can be universally applied, but a holistic approach to a given production system that requires site-specific assessments to identify suitable agricultural production technologies and practices. This integrated approach will need to ensure greater efficiency in the use of resources and more sustainable management of natural and human-created processes in the landscape. Production systems must be incorporated into landscapes in ways that capitalise on natural biological processes, recycle waste and residues, and create integrated and diversified farming systems. This integration can greatly reduce the pressure on the natural resources and minimise the need for external inputs (eg energy, chemical fertilisers and pesticides) and other management interventions.

Managing natural resources in a way that ensures the resilience of ecosystems will reverse natural resource degradation, safeguard agricultural productivity and maintain ecosystem services (eg the provision of water, pests and disease control, pollination and climate regulation). Healthy ecosystems are the basis for sustainable agriculture, forestry and fisheries. To achieve healthy ecosystems, participatory and people-centred approaches and management structures are needed. This approach will simultaneously improve the resilience of production systems and people's livelihoods in the face of climate change.

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News from the Field

The Climate Change and Food Security Marketplace, Cambridge

On Friday 13 June 2014, the Humanitarian Centre[1] held a *Climate Change and Food Security Marketplace*, generously hosted at Murray Edwards College, University of Cambridge. Over 60 people attended, all of them open to exchanging ideas and making new connections, to forge new paths towards integrating climate change, food security and poverty reduction work.

The event was designed by Humanitarian Centre members (with backgrounds as diverse as tropical agriculture, conservation, and climate smart financing) to:

- showcase innovative thinking and projects;
- engage participants in open dialogue and focused networking;
- and foster connections that could lead to new collaborations to increase resilience in food security and combat poverty and inequality.

The day opened with a conversation with Dame Barbara Stocking, President of Murray Edwards College and former CEO of Oxfam GB, and Sir Jonathon Porritt, founder of the Forum for the Future and author of *The World We Made*. Their dialogue with the audience raised several key points:

- Food security and climate change are the most important challenges of our time, and **many of the apparent short-term solutions only exacerbate the long-term problems**.
- **Food security encompasses other kinds of securities too – like energy security and social protections**, and political will is essential to guarantee these securities for all – especially the poorest.
- **We need to question the 'productionist fantasy' of food security:** that focusing on simply producing food enough for 9 billion by 2050 belies other key issues such as food waste, food distribution, and family planning.
- **It is possible for smallholders to organise** to engage with companies and markets on a population level, to generate livelihoods for themselves and future generations, and to use local, less-carbon-intensive inputs.
- **Smart businesses realise that sustainable practices are the only way to stay in the game** in the long run, but being 'smart' means thinking about social and economic sustainability as well as environmental sustainability.
- **It's critical that young people, in the UK and globally, get involved** and take action – the generation of 'millennials' is geared towards looking for solutions!

Their keynote address was followed by a 'marketplace': four rounds of short presentations from a host of individuals and organisations doing innovative work in the field, including:

DFID, Oxfam, The Strategic Climate Institutions Programme Fund (SCIP), Cambridge Institute of Sustainability Leadership (CISL), IIED, Barefoot Lightning, NIAB, SOWTech, Value in Enterprise Ltd., Mott MacDonald and Population Matters.

The events of the day closed with three rounds of 'speed dating' networking, where participants had the opportunity to have one-on-one conversations with each other. Of 30 participants surveyed, 27 suggested they had met three or more people who they planned to continue a conversation with, moving towards potential collaboration.

All of the presentations from the marketplace are available to view at: http://www.slideshare.net/HumCentre/tag/climate-change

The conversation with Barbara Stocking and Jonathon Porritt will be available by podcast and will also be captured in our 2014 *Cambridge International Development Report*, which will be released in October 2014, at Cambridge's Liberated Feast.

[1]The Humanitarian Centre's aim is to identify and solve problems that tackle the root causes of poverty and inequality and to alleviate their enduring symptoms. For more information about our work, visit us on the web at: www.humanitariancentre.org

Anne Radl
Programmes Manager
The Humanitarian Centre

Climate change, agriculture and food security: from local action to global agreements

Bruce Campbell

Dr Bruce Campbell has a PhD in Ecology from Utrecht, but has increasingly moved into inter-disciplinary work, championing new approaches to applied research on natural resource management. He is Director of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), and a staff member of the International Centre for Tropical Agriculture (CIAT). He operates out of the CCAFS office at the University of Copenhagen, Denmark. He was previously based in Zimbabwe, Indonesia and Australia, where he has worked in agricultural and forestry research for development. He has published over 120 peer-reviewed articles and more than a dozen books.

Summary

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) focuses on climate-smart agriculture, which is designed to address three major global challenges: achieving food security, adapting to climate change and mitigating climate change. To achieve impacts in as short a time as possible, the programme has adopted a number of principles, including having a focus on a theory of change, facilitating action research, building strong partnerships from farm to global policy levels with actors that help along the impact pathway, and focusing on gender and social differentiation. Various technologies and practices are climate-smart – the challenge is to bring these to scale. Getting information to farmers through television, radio and mobile phones is one of the scaling options.

Climate challenges for agriculture

Agriculture stands at the interface of three of the greatest challenges facing humankind in the 21st century: achieving food and nutrition security; adapting to climate change; and contributing to reducing greenhouse gasses (GHGs) (Vermeulen *et al*, 2012). Climate change is an unprecedented threat to the food security of hundreds of millions of households who depend on small-scale agriculture for their livelihoods. The complex and dynamic relationships among agriculture, food security, natural resource management and climate systems are also shaped by economic policies, local governance arrangements, political conflict and other factors such as the spread of infectious diseases. The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is designed to tackle these challenges.

CCAFS aims to capitalise on the growing political imperative for solutions in agriculture under climate change, as epitomised by the movement towards 'climate-smart agriculture' (CSA). This involves stakeholders from government, civil society, farmers' organisations, the private sector, and international and regional agencies. CSA is defined as agriculture that *'sustainably increases productivity, enhances adaptive capacity, reduces/removes greenhouse gas emissions, and enhances achievement of national food security and development goals'* (FAO, 2013).

Theories of change

Given the complexity of the issues and the urgent challenges, CCAFS advocates research approaches centred on action research, multi-level research from farmers' fields to global policy arenas, deep engagement in partnerships across the research-action divide, and considerable focus on gender and social differentiation. A key focus is on theories of change (TOCs), so that research leads to impact over as short time horizons as possible. We draw on sustainability science and integrated natural resource management (Sayer & Campbell, 2004) and place a major emphasis on social learning (Kristjanson *et al*, 2014). Social learning approaches provide ways to address complex socio-ecological problems – so-called 'wicked problems'. Social learning includes joint learning, reflection on successes and failures, adaptive management and spreading lessons through social networks.

It is easy to get lost in the complexity. Thus, having a clear TOC is crucial. It should clarify key leverage points while at the same time being comprehensive enough to tackle the multi-faceted nature of the problems. The TOC is, in fact, a set of interacting and nested TOCs, with national/regional TOCs linked to global thematic TOCs, and site-level TOCs embedded in national processes. Work at different levels, from farmers' fields to global engagement, must interact seamlessly. The TOC evolves over time as evidence emerges as to better ways of achieving impact. Opportunism must also be fostered, given that unforseen opportunities for significant impact may suddenly appear.

The over-arching CCAFS TOC involves work with partners on three inter-dependent areas (Figure 1):

- Generating evidence from action research, through exploring what works at farm and landscape level (eg climate-smart practices, climate information services, index-based insurance, local adaptation planning).
- Effecting policy and institutional change to support CSA, using the evidence generated from farm to policy levels, combined with engagement and communication.
- Implementing and scaling up CSA. Working with national and global agencies to improve prioritisation and maximise scaling-up.

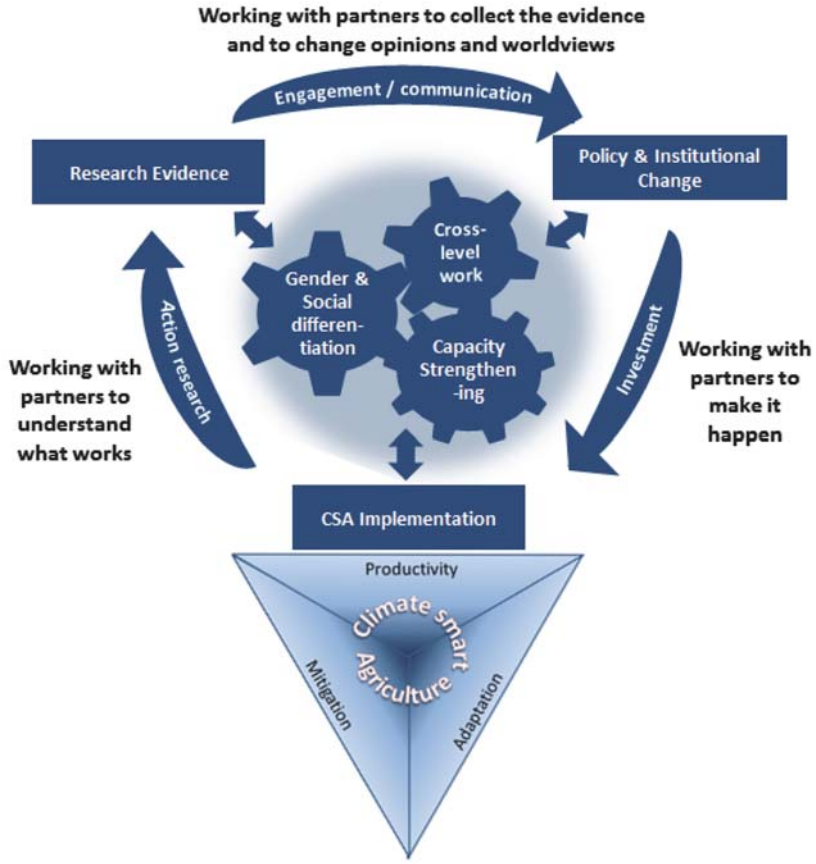

Figure 1. The over-arching theory of change for the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Local action: climate-smart villages

CCAFS implemented fifteen climate-smart villages (CSVs) in South Asia, West Africa and East Africa in 2011, and is now establishing them in South East Asia and Latin America. These are research sites where technologies and practices are trialled in an integrated manner, learning-by-doing is promoted, best practices are distilled, local adaptation planning is promoted, capacity is enhanced, and policy options are identified and discussed. Stakeholders prioritise which interventions they will test. All site work is set within a TOC so as to limit the problem of burgeoning pilots that never go to scale. Partners have now taken up the concept: for example, in Maharashtra State, India, the government will support the development of 1,000 villages in poverty-prone regions.

Farmers trial and evaluate diverse options that have included: weather forecasts and associated agricultural advisories; index-based insurance; seed and fodder banks; irrigation strategies; rainwater harvesting; drainage techniques to remove flood waters; adapted cultivars and breeds; conservation agriculture; management of soil carbon; precision application of fertilisers; vegetable cultivation and marketing; and energy-efficient machinery. The primary goal of such interventions is to enhance resilience and food security. In addition, there are often gains for mitigation, as many of the chosen technologies and practices decrease GHG emissions per unit output of food.

A 'climate analogue tool' has been developed to facilitate farmer-to-farmer exchange (Ramírez-Villegas *et al*, 2011). For example, farmers from Lawra-Jirapa, a CSV in Ghana, visited Yatenga, a CSV in Burkina Faso, because the analogue tool indicated that Yatenga farmers were experiencing conditions today that the Ghanaian farmers could expect in the future. The Ghanaians were able to learn first-hand about the crops and techniques that their Burkinabè colleagues currently use.

Engaging in policy processes

An over-arching objective when dealing with climate change and food security is to facilitate the inclusion of agriculture in climate change policies, and the inclusion of climate issues in agricultural policies, in a way that brings benefits to the rural poor. CCAFS is deeply involved in policy analysis and in policy dialogue from sub-national to global levels.

Agriculture is finally being considered by the United Nations Framework Convention for Climate Change (UNFCCC). The Durban Agreement of 2011 called for the technical body (SBSTA) to discuss agriculture, but a two-year series of submissions and workshops on agriculture was only agreed in June 2014. One sticking point has been the dichotomy between those focusing on adaptation and those focusing on mitigation. While this dichotomy may be valid for other sectors, it is less an issue in agriculture. A key challenge to researchers is to demonstrate that, in agriculture, sustainable intensification can raise incomes (and thus enhance adaptive capacity), increase food security, and reduce GHG emissions per unit of production.

Policy progress at country level has been faster, with national adaptation planning well advanced. In Nicaragua, for example, CCAFS research indicated that, by 2050, coffee will have to shift to areas around 300 metres above where it is currently grown. This shift will push farmers at lower altitudes out of coffee production. Cocoa is a promising alternative to coffee

at low altitudes because it requires high temperatures and fetches higher prices. Scientists engaged with government, the private sector and civil society in Nicaragua to raise awareness of the threats and develop adaptation options. Nicaragua subsequently launched a National Adaptation Plan for agriculture, which attracted some US$ 24 million to adapt the coffee and cocoa sectors.

Research-action partnerships

Partnerships are central to the TOC. No single research institution alone can address the critically important issues. For that reason, CCAFS is a partnership with Future Earth – a major initiative devoted to global change research – and many national and regional research agencies. CCAFS also involves all 15 CGIAR Centres.

Most important are partnerships with partners that help leverage impact. These range from local farmers' organisations to major global actors. To illustrate the partnership model at local level, the partners at the Nyando CSV in Kenya include NGOs (eg World Neighbours), local organisations (eg FOKODEP community), private sector (eg MAGOS Farm Enterprises), national agencies (eg Kenya Agricultural Research Institute), and Universities (eg Maseno University). At national level, many science-policy platforms are being facilitated, so that lessons inform policy processes and key actors help set the direction of research.

There is also interaction with many agencies at regional level, for example through a scenario process (Vervoort *et al*, accepted). As a multidisciplinary programme looking to enhance food security, CCAFS spans a huge range of interests and experiences in climate change. The scenario approach is a planning tool for addressing complexity and finding common ground among disparate groups. Scenarios – plausible descriptions of the future – are developed collectively. By 2013, national and regional stakeholders in all five CCAFS regions were setting up processes to use CCAFS scenarios to develop adaptation and mitigation policies. For instance, in northern Vietnam, stakeholders used scenarios to develop investment proposals for CSA. Nearly 250 organisations – local to multinational – have helped formulate the regional scenarios.

Gender and social differentation

Gender and other inequalities undermine innovation and food security, and women and marginalised people are often more vulnerable to climate change. CCAFS allocates about 10 percent of its budget to addressing gender and social differentiation, and many of its partnership and capacity strengthening initiatives focus on women and marginalised groups. In Kenya, for example, more than 70–85 percent of the 1,100 households in the self-help groups of CSVs are women. In CSVs, women farmers are encouraged to weigh-in on all the discussions and take the lead in prioritising what activities should be implemented in their villages. Research has shown that information access is often worse for women than men. In Nepal, this was addressed by a major capacity enhancing programme together with the Youth and Small Entrepreneur Self-Employment Fund, Ministry of Finance. Elected female leaders received training based on a tailor-made manual that identified climate change impacts and described possible adaptation options. Trainers then ran workshops in all 75 districts. Distribution of the Nepali version of the manual reached almost 10,000 copies.

Can agriculture be climate smart?

In many developing country situations, the focus for CSA has to be on productivity and adaptation, but, fortunately, mitigation is often a co-benefit. Three examples illustrate this. Climate change will particularly affect arabica coffee, which is grown at higher altitudes where temperatures are lower. Many public authorities have promoted high-input monocropping systems, but research in East Africa shows that banana intercropping can increase plot revenue by more than 50 percent, reduce the impacts of droughts and add additional carbon in the system (Van Asten *et al*, 2011).

Livestock production can be intensified, eg through using leaves of *Leucaena leucocephala* as feed. Adding a small amount of *Leucaena* to dairy cattle feed can treble milk yield and quadruple weight gain, thereby increasing income considerably, and reduce methane produced per kg of meat and milk by factors of 2 and 4, respectively (Thornton & Herrero, 2010).

Improved land management in Burkina Faso involves the construction of stone bunds along contours and *zaï* pits (shallow in-field pits filled with compost or manure in which crops are planted) (Bayala *et al*, 2012). Yields of millet or sorghum can double as compared with unimproved land. There is often increased tree cover, and improved soil fertility and groundwater levels. The system allows farmers to cope with changing weather and adds carbon to the system.

Scaling up climate-smart agriculture

Crucial to enhancing adaptive capacity is information that reaches farmers on technologies, practices and approaches. Given the pace of climate change and its negative impacts in the tropics (Vermeulen, 2014), adaptation information has to reach about a billion farmers by 2030. The information explosion, even in rural areas of Africa, gives hope that reaching such numbers will be feasible. But R&D therefore needs to connect to the private and public actors involved in information delivery.

CCAFS and the Nepal Development Research Institute showed that more than 90 percent of households in the surveyed rural areas in Nepal have mobile phones. Numbers are lower in many of the African study sites but are rising rapidly. CCAFS therefore has many activities involving mobile phones. But radio remains a crucial medium. In Senegal, CCAFS has worked with 15 community-based radio stations in four administrative regions to deliver seasonal forecasts to an estimated 2 million farmers, using communication approaches developed by CCAFS and the Senegal Meteorological Agency (ANACIM). This was preceded by detailed work in Kaffrine District, exploring the kinds of information wanted by farmers, gender inequities, and the results of receiving forecasts. This work has stimulated the agricultural agencies and ANACIM to integrate activities for the benefit of farmers.

Television is also a medium for agricultural advisories. In East Africa, Mediae produces the TV show *Shamba Shape-Up*, similar in concept to popular home-renovation TV shows. This TV show helps smallholders 'make-over' their farms and has an audience of some 11 million, the majority of whom are rural. CCAFS partners with the TV show to provide information on climate-smart approaches. Surveys show that at least 36 percent of *Shamba Shape-Up* viewers have changed their farming practices as a result of the show – including choosing different seed varieties, intercropping maize and beans, and storing maize. Farmers can submit questions via SMS and Mediae connects them with experts. Over 170,000 farmers have already tapped into the service.

Links to private sector actors are crucial. The Agricultural Insurance Company of India insures about 20 million farmers, more than half of whom are covered by weather-index insurance. Some insurance companies now include agricultural advisories as part of their package, and so can be a means for scaling up. Another example, just as important, is to link farmers with local input suppliers.

Conclusions

Given the urgency of implementing CSA, agricultural R&D has to make rapid progress, embracing new ways of doing business through action research with close partnerships to users of research. Research must link seamlessly across scales, from farms to global policy arenas. While the detailed technical, socio-economic and policy research skills are still crucial, we also need researchers with the ability to foster partnerships and facilitate progress along impact pathways.

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News from the Field

The Africa Congress on Conservation Agriculture: some of the technical issues raised

The Congress was held in Lusaka, Zambia, in March 2014 and attracted about 350 participants from every region of the continent. It was organised by a range of African-based research and development organisations as well as CIMMYT, ICARDA, ICRAF and CIRAD. Among the delegates were a number of practising farmers from a wide geographical spread and, although lack of fluency in French or English precluded smallholders, they provided a welcome practical leaven to the proceedings. There was a general concern at the lack of rapid and widespread adoption of the technology across the continent despite intensive extension efforts in a number of countries. This report will focus on the technical issues raised which were considered to contribute to the lack of rapid uptake by the continent's millions of small-scale farmers.

Weed control was a major issue for the moister areas. Few farmers are able to produce a sufficiently dense mulch of crop residues to effectively control weed growth over their whole farm. There were no reports of African smallholders using smother crops to deal with weeds. In fact, most of the successful examples cited of CA in more humid areas depended on the use of herbicides. Wider uptake of these is limited by the cost of equipment and inputs for poor smallholders and, perhaps more importantly, by the widespread lack of intensive extension coverage to ensure the effective use of the herbicide. Such advice becomes even more important in systems which mix cereals and leguminous crops.

Following on from the above was the issue of the availability of mulch for soil protection which is a fundamental feature of CA. Delegates from areas with mono-modal rainfall, and seven or eight months of dry season, reported on how difficult it was to maintain crop residues in the face of livestock, termites and months of natural weathering. The farm visits in Zambia to the fields of leading practitioners of CA revealed that none of these had any mulch. The same was true of the excellent CA research and extension station (established in 1996) by the national Conservation Farming Unit where none of the plots carried any significant mulch. Heavily fertilised maize on farmers' fields provided reasonable protection from heavy rain. The same was not true of groundnuts which are planted in the same lines as the previous maize crop. This leaves a significant proportion of the land devoid of cover and serious crusting was clearly evident. This is not just a Zambian problem and was reported by a number of delegates.

Soil fertility issues were well aired and stimulated considerable debate between a committed 'organic' section of the meeting who decried the use of fertiliser in CA, and the majority of research and technical participants who saw the provision of adequate nutrient supply as being crucial to the success of the system. There were useful research reports highlighting the fact that worked-out soils low in plant nutrients will not benefit from a switch to CA in the absence of any complementary improvement in the availability of plant nutrients. Several speakers highlighted how essential was adequate fertiliser application to the successful implementation of CA. This provided a healthy reminder to those who would promote CA as a universal panacea to overcome the challenges facing poor smallholder farmers.

Related to the above was the issue of agro-forestry in CA systems. A quarter of a century of promoting alley cropping, *Tephrosia, Calliandra* and *Gliricidia* hedges by ICRAF and local extension systems has not resulted in a spread of these technologies beyond the confines of intensively supervised projects. There has been more success with *Faidherbia albida* but, in East and southern Africa, the spread is still slow and the stands of uneven quality. The focus of the agro-forestry presentations at the Congress was to encourage farmers to preserve indigenous tree seedlings growing on their farms so as to foster a natural tree population which would provide nutrient recycling but without a specific goal of nitrogen fixation.

The Zambian experience was appreciated by delegates and attracted a lot of interest. Under the leadership of the Farmers' Union, the Conservation Farming Unit in Zambia has the most farmers in the region who are practising CA. The system is built on the use of herbicides to control weeds and adequate fertiliser application to ensure strong plant growth. The key to their success is the intensity of the extension coverage, with one paid lead farmer helping about 25 of his or her neighbours. This is particularly necessary with the calibration of crop sprayers and the choice of herbicides for different crop combinations. All farmers use two herbicide sprays and the wealthier ones use an application of Paraquat later in the growing season to suppress seeding weeds. As mentioned earlier, there is little mulch, but soil erosion is largely avoided because so much of the land is completely flat.

Figure 1. Land preparation using an ox-drawn ripper (Photo: Conservation Farming Unit, Zambia)

Figure 2. Emergence on basins compared to ridges (Photo: Conservation Farming Unit, Zambia)

The use of oxen for cultivation is widespread in Zambia and ox-drawn ploughs are modified into rippers (Figure 1), while direct seeders have been designed locally and are readily available. The Unit encourages farmers who do not have access to oxen to hire tractor-drawn rippers which provide two deep furrows three feet apart into which fertiliser and seed can be placed directly. This opens up the soil for rapid moisture penetration and compensates for the lack of mulch. Those who cannot afford either of these alternatives use shallow basins prepared with a hoe, with crops being planted in the same basin each year (Figure 2).

As with any such gathering, much of its value lay in the sharing of experiences, the development of a new range of contacts and the realisation that others were sharing the same challenges and frustrations in the promotion of Conservation Agriculture.

Stephen Carr

Climate change and agriculture: lessons from political economy perspectives

Lars Otto Naess

Lars Otto Naess is Research Fellow at the Institute of Development Studies, University of Sussex, UK, and Visiting Associate Professor at the Department of International Environment and Development Studies (Noragric), Norwegian University of Life Sciences. He is a social scientist with a doctorate from the University of East Anglia, and has been a Research Fellow at IDS since 2008. He has 19 years' experience of research on climate change, development and agriculture. His research interests centre on social and institutional dimensions of adaptation to climate change, policy processes on climate change and agriculture at national and sub-national levels, the role of local knowledge for adaptation to climate change, and adaptation planning in the context of international development. Much of his recent work has focused on Africa, in particular Tanzania, Kenya, Malawi and Ethiopia.

Summary

An increasing attention to climate change and agriculture over recent years has been accompanied by a concern over whether the increased attention will translate into benefits for the poorest and most vulnerable. This paper examines this concern through a political economy analysis of climate change-agriculture debates in Ethiopia, Ghana, Kenya, and Malawi. The paper makes three key points. First, that a lack (so far) of integration of climate change and agriculture policy areas has left the policy areas open to being led by powerful, often external, interests. Second, the seemingly broad consensus on the need for 'climate smart agriculture' hides competing visions and power struggles over what it should look like in practice. And third, trade-offs between adaptation, mitigation and development often remain implicit, yet have significant implications for who benefits and who loses from funding. The increased risks posed by climate change to agriculture make it imperative that policy conflicts and trade-offs are brought out more explicitly.

Introduction[1]

Debates on climate change and agriculture have brought with them a new optimism and expectations of funding in the agriculture sector, to a large extent embodied in the concept of 'climate smart' agriculture (CSA)[2]. With CSA becoming more popular, it can take many shapes and forms. It may involve large commercial farms, pastoral systems, agroforestry, and, more recently, landscape-focused approaches that involve considerations of forests and water resources as well (Scherr *et al*, 2012).

At the same time, we still know relatively little about whether and how the increased attention to climate change and agriculture and CSA will benefit the poorest and most vulnerable groups, and claims of benefits to the poor have been challenged by some (eg Sharma & Suppan, 2011). There have been concerns around whether the goals are too optimistic with regard to the 'triple wins' of mitigation, adaptation and development; whether interventions tackle the root causes or bring any new solutions; whether it will draw resources away from smallholders;

[1] Acknowledgements: Contributions to the analysis from Professor Pete Newell, University of Sussex, are gratefully acknowledged. The paper draws on research under the DFID-funded Future Agricultures Consortium (FAC) as well as the DFID and Dutch Government-funded Climate Development and Knowledge Network (CDKN).

[2] Climate smart agriculture is 'agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals' (FAO, 2010).

and whether there is a risk of elite capture. Arguably, many activities could qualify as 'climate smart agriculture' by this understanding, without being equitable or socially just.

This paper examines the implications of climate change-agriculture debates through applying a political economy framework[3]. The approach is based on the view that policy processes are best described as incremental, complex and 'messy' (Keeley & Scoones, 2003), involving actors with competing goals and interests, and where policy decisions are shaped by those who are able to mobilise coalitions and networks around particular solutions gaining political traction. This is in contrast to a traditional, linear and stylised view of policy processes, in which evidence is weighed and decisions are made, and policies implemented, on the basis of the best available knowledge.

First, the *Context* examines actors and policies driving the agenda. It finds that the climate change-agriculture policy area in the four countries involves a large number of actors with very diverse backgrounds and goals, and a lack (so far) of coherent policy frameworks has given opportunities for strong groups to define policy priorities. Second, *Competition*, focuses on how actors are organised around (often) competing claims, and their alliances. Third, *Consequences* reviews the outcomes from particular processes and how they give raise to synergies or trade-offs, and ultimately the winners and losers from such processes. The paper applies this framework to four country case studies, in Ethiopia (Yirgu *et al*, 2013), Ghana (Sarpong & Anyidoho, 2013), Kenya (Maina *et al*, 2013), and Malawi (Chinsinga *et al*, 2013). The case studies were carried out under the Future Agricultures Consortium (FAC)[4].

Context: key drivers of climate change-agriculture debates

Climate change and agriculture debates across the four countries were characterised by a large number of very diverse actors (in government, civil society, international donors and organisations, and local organisations) with different visions of what agriculture should look like under climate change.

The studies show that a lack of coherent policy frameworks balancing priorities within and across sectors has left considerable space for powerful actors, such as those linked to large agribusiness or carbon trading companies, to shape the way in which countries are responding to challenges and opportunities, and how they manage policy conflicts and trade-offs. One concern that was raised across several cases was the extent to which the debates were driven by foreign interests rather than domestic priorities. Although adaptation to climate impacts is the major concern for the governments (as indeed it is for all African governments), mitigation is surprisingly high on the agenda in discussions over climate change and agriculture. Many of the activities appear more aligned to international priorities, typically mitigation concerns, than to a national policy agenda.

Policies and strategies on climate change and agriculture have been developed largely independent of agriculture sector policies, with stronger linkages to environment and development policies. The most complete formal framework is in Kenya through its National Climate Change Action Plan (Gov of Kenya, 2013), but the strategy is lacking an action plan that relates the suggested activities to the broader Kenyan policy framework. Agriculture sector policies tend typically not to mention climate change.

In Ghana, the current sectoral policy of the Ministry of Food and Agriculture (FASDEP II), which was launched in 2009, makes no mention of climate change in either its discussion of constraints to agricultural production and sustainability (including natural resource management, food insecurity, irrigation), nor in any of the preferred solutions. In the few cases where climate change is mentioned, the focus tends to be on adaptation. This can partly be attributed to the separate groups of actors involved, climate change being dominated by Ministries of Environment, separate from agriculture ministries (Sarpong & Anyidoho, 2013).

Competition: contested views and priority areas

National level debates over climate change and agriculture reflect political struggles to set priorities and control expected funding, within and between government departments, non-government organisations and other actors. For example, in the case of Malawi, three key government departments all have claims to leadership on climate change and agriculture (Chinsinga *et al*, 2012).

With donor funding driving local priorities, and with the potential for existing aid funds to be relabelled as climate funds (rather than as additional sources of finance), many actors have relabelled themselves as 'climate change champions'. Much of this can be considered a response to real and expected external funding opportunities from donors. In Kenya, for example, the study showed the promotion of carbon sequestration as agencies and organisations re-package their work programmes to align them with the latest donor priorities.

This has, in turn, reinforced a framing of climate change as an external and 'foreign' problem. At the same time, dominant narratives are heavily shaped by domestic actors and politics, including patronage and individual interests. In Ethiopia, the research suggested that there are concerns over the effect of external priorities on the national debates, including that *'a rush for climate finance may crowd out important local knowledge and experience from below that can better inform policy responses'* (Yirgu *et al*, 2013). In Malawi, strategies such as conservation agriculture, drought resistant varieties, hybrid seeds and agroforestry are being promoted by particular players – NGOs and donors – in support of 'climate smart agriculture'. Yet the state clearly also has a strong political commitment to the maize subsidy programme.

This is not a trivial concern: who leads policy processes determines which strategies are prioritised at national levels and ultimately who gains and who loses on the ground. Concern remains that the external discourse on mitigation might also constitute a backdoor route to sneaking in mitigation obligations. Questions remain about how much policy autonomy countries have. Can they determine their own 'climate

[3] For an elaboration of the framework, see Quan *et al* (2014).

[4] www.future-agricultures.org

resilient' agricultural futures and resist interventions proposed by funders? It is clear that some countries are better able to protect or project their interests than others, which often depends on economic might and levels of aid dependence.

Consequences: potential for synergies and trade-offs

Third, the debate reveals trade-offs across climate change and agriculture goals. For example, Yirgu *et al* (2013) found a 'substantial contradiction' in Ethiopia between, on the one hand, seeking to improve productivity and prevent soil erosion among smallholders, and on the other, the bigger structural changes hindering land access which undermines livelihoods and adaptation. The authors also point to the trade-offs between support to large-scale mechanised farming, and their negative impact on pastoralist rangelands.

Questions have also been raised about the sustainability of the various scenarios and pathways for 'climate smart' agriculture, which has prompted reflections over the input side of agriculture in terms of energy and water, and how climate change might affect these; or how future demand for food and visions for agricultural development will affect and compete with choices of energy and water pathways. This is one of the rationales for conservation agriculture and water conservation in Kenya, for example. While there is broad agreement that the increased focus on climate change and agriculture provides important opportunities, the case studies suggest that it is too early to say whether these opportunities translate into benefits for the poorest and most vulnerable groups and how this should happen in practice.

Conclusions

This paper has discussed climate change and agriculture debates based on case studies in Ethiopia, Ghana, Kenya and Malawi through the lens of a political economy framework, focusing on the actor and policy context in which decisions are made, the cooperation, competition and conflict between different actors and narratives, and the consequences for different social groups. These four countries share a high exposure to climate risks and a reliance on agriculture for economic development.

The studies suggest, first, that country level debates involve a range of actors with very different interests, and a lack of coherence in agriculture and climate change policy areas. Second, a seemingly broad consensus around the need for 'climate smart agriculture' hides competing visions of what it is, and struggles over leadership and control over the climate change and agriculture agenda. Third, there are clear trade-offs between adaptation, mitigation and development concerns, and a lack of coherent policy frameworks balancing priorities across sectors has left considerable space for powerful actors to shape the way in which countries are responding to challenges and opportunities.

With climate change posing increased risks to agriculture and food security, it is imperative that such trade-offs and policy conflicts are made explicit.

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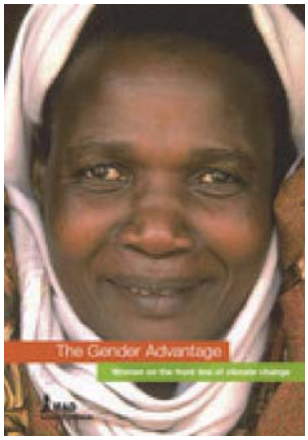


The Gender Advantage: Women on the Front Line of Climate Change, International Fund for Agricultural Development (IFAD), 2014

Available on http://www.ifad.org/climate/asap/resources.htm, 21pp.

Through the extensive experience of the International Fund for Agricultural Development (IFAD), this report highlights the importance of people-centred solutions and the active engagement and inclusion of women to promote more effective and sustainable development programmes that benefit entire communities in the face of climate change.

Until recently, it has been assumed that climate change and other incidents associated with climate change do not respect traditional boundaries and should therefore affect the lives of women and men equally. The welfare of our planet is of global concern and, as such, requires a collective input in its management and sustainability. Nevertheless, the developed world, and principally men, have dominated climate negotiations and adaptation programmes, whilst poorer nations and women have been left powerless to influence climate change policy and adaptation strategies.

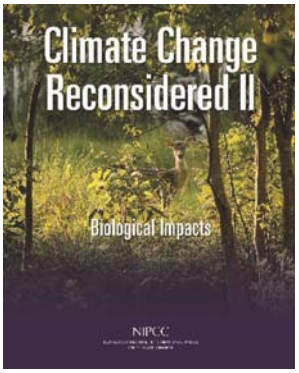
Despite this, in recent years, the gender dimensions of climate change have begun to come to light, with the recognition that women and men do not, and will not, experience the effects of climate change in the same way. This is particularly true of developing countries, where economic constraints and cultural norms tend to inhibit women's ability to find paid employment, thus causing their livelihoods to be particularly dependent on sectors prone to the effects of climate change, such as rain-fed subsistence agriculture. Furthermore, women's engagement in agriculture is more common in regions likely to be most affected by the impacts of climate change. In these contexts, the responsibility for adaptation is likely to fall on their shoulders – including finding alternative ways to feed their families. However, both statutory and customary laws in developing countries tend to restrict women's property and land rights, a normative male claim, making it difficult for them to access credit and extension services, resulting in a reduced incentive to carry out environmentally sustainable farming practices.

Landlessness and the commercialisation of agriculture are forcing women to adopt other income-generating activities in order to survive. However, a lack of education and access to appropriate knowledge inhibits women from accessing credit facilities and employment opportunities and, in the end, communal resources may be all they have at their disposal. Thus, small-scale agriculture and environmental management are highly gendered activities and require that conservation mechanisms take into account the gendered divisions of labour to attain greater equity. This equity is about ensuring that discussions reflect a cross-section of society, ensuring that the voices of the vulnerable and less resilient are not drowned out and that they are equipped with the necessary tools to adapt and sustain themselves. Already, women are paying a huge price for globalisation, economic depression and environmental degradation, and climate change is likely to worsen their already precarious situations, thus leaving them, their households and their communities more vulnerable.

In order to address these disparities, IFAD launched its pioneering Adaptation for Smallholder Agriculture Programme (ASAP) in 2012 , with gender equality and women's empowerment central to the programme, to generate a more holistic resilience for entire communities (see page 7 of this journal). This report, through ten case studies from across the developing world, demonstrates the work that has been done through ASAP to close the gender gap and encourage the 'gender advantage'. It recognises that women are not only the victims of climate change, but can be effective agents of positive change by harnessing their knowledge, experience and expertise in adaptation and disaster risk reduction.

The case studies illustrate the value of gender-sensitive adaptation programmes that recognise the importance of women's knowledge and experience, provide women with equitable access to adaptation knowledge and result in improved yields, incomes and food security. Additionally, the case studies demonstrate how alternative livelihood opportunities can be created that are less susceptible to the effects of climate change and that benefit not only women, but also their households and communities. A case study from India, in which 13,000 women's self-help groups were developed under an IFAD initiative provided a platform for women's voices to be heard and allowed them to contribute to a climate policy forum. What is more, the case studies show that, through the encouragement of gender equality, sharing of knowledge between women and men improves and they are able to make more equitable and informed decisions about their livelihoods, including how best to take advantage of natural resources in a sustainable manner. Ultimately, through sharing their experiences around the globe, IFAD shows that the active engagement of both women and men results in more effective development programmes and climate change policies.

Gareth Horsfield
Doctoral Candidate, School of Agriculture, Policy and Development, University of Reading



Climate change reconsidered II - Biological impacts. Idso CD, Idso SB, Carter RM, Singer SF eds, 2014.
The Heartland Institute, Chicago, 1,062 pp. Free download (donations requested) from http://www.nipccreport.org/reports/ccr2b/ccr2biologicalimpacts.html

This publication is from the Nongovernmental International Panel on Climate Change (NIPCC), which *'seeks to understand the causes and consequences of climate change, without conforming to any specific agenda'. This is claimed to contrast with the IPCC, which is 'government-sponsored, politically motivated, and predisposed to believing that climate change is a problem in need of a UN solution'*. The publishers, the Heartland Institute, are a right-wing think tank, with dubious views on topics such as tobacco (see, for example, http://en.wikipedia.org/wiki/The_Heartland_Institute). The Institute does not disclose its sources of funds, but these apparently include the tobacco industry and Exxon, as well as pharmaceutical companies and Microsoft. Despite its background, though, I suggest that this publication should be judged by the quality of the science reviewed. With over 5,000 references, the great majority from peer-reviewed journals, this is a real review, not a right wing polemic.

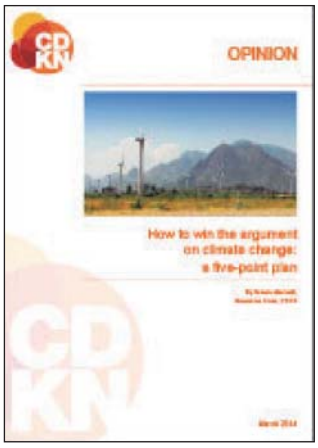
The first volume in this series, *Climate change reconsidered I – Physical science* (2013), showed that neither the rate nor magnitude of late-20th Century warming lay outside the range of natural variability, and that there is no unambiguous evidence for dangerous interference in global climate caused by CO_2 emissions. With four main authors, and 32 other contributors, reviewers and editors, this second volume provides an alternative view to that of the IPCC Working Group II. WG II has listed a number of risks from climate change, including the biological impacts shown in the following table. The NIPCC report provides detailed counter-arguments to all of these.

Seven chapters cover effects of CO_2 and rising temperature on plants, plant characteristics, plants under stress, Earth's vegetative future (including agriculture, biodiversity and extinction), terrestrial animals, aquatic life and human health. Each chapter is subdivided into self-contained reviews, covering a total of nearly 80 topics, most of them further subdivided. For example, the chapter on plant characteristics has 34 sub-sections, covering subjects such as leaves, roots, flowers, fruit and seeds, acclimation, phenology, starch, sugars, storage proteins, nitrogen fixation, nitrogen use efficiency, transpiration and water use efficiency. Appendices list plant dry weight responses to atmospheric CO_2 enrichment for 549 species, and photosynthesis responses for 472 species. There is no index, a serious deficiency in a book of over 1,000 pages. In summary, the authors state *'We find no net harm to the global environment or to human health, and often find the opposite: net benefits to plants, including important food crops, and to animals and human health'*.

This book is an important source of information on the observed effects of climate change. Much of the work quoted has been ignored by the IPCC, which is accused of *'selectively reporting data to present an alarmist view of the impacts of climate change'*. The authors may be guilty of selective reporting to present a contrary view, but anyone seriously interested in the possible effects of climate change should certainly look at this work as well as the IPCC reports.

Hereward Corley

Risks listed by IPCC Working Group II	NIPCC conclusions
Loss of rural livelihoods and income, and food insecurity due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists with minimal capital in semi-arid regions.	There is abundant evidence that rising temperature and CO_2 levels are contributing to rising agricultural productivity throughout the World. Water use efficiency is greater at high CO_2 levels, which will enhance agricultural productivity in Africa and elsewhere.
Loss of marine ecosystems and the services they provide for coastal livelihoods, especially for fishing communities in the tropics and the Arctic.	Many aquatic species have shown tolerance to rising temperature and CO_2, and any adverse impacts will be mitigated through adaptation and evolution over the centuries it will take for pH levels to fall significantly.
Loss of terrestrial ecosystems and the services they provide for terrestrial livelihoods.	Numerous studies show that global warming fosters the expansion of animal habitats, ranges and populations. Animal species are adapting and evolving to cope with climate change. Global vegetation cover is increasing.
Human mortality, morbidity, and other harms during periods of extreme heat, particularly for vulnerable urban populations.	Rising temperature reduces cold-related deaths by much more than any increase caused by excessive heat. Climate change has had minimal impact on vector-borne diseases; social factors are much more important.



How to win the argument on climate change: a five-point plan.
Simon Maxwell, 2014.

Climate and Development Knowledge Network (CDKN), 20 pp.
Available on: http://cdkn.org/2014/03/news

Simon Maxwell uses his long field and academic experience of international development to illustrate the many obstacles that governments face in seeking to promote policies for tackling climate change and to outline a five-point plan to win public and policy support for necessary action.

The first need, he states, is to simplify the message: eg by rounding numbers, avoiding ranges and probabilities, using simple examples and good images; and making messages understandable in personal and emotional terms. Two figures respectively relate North European capitals to Mediterranean sites whose climates they might experience by 2050 and illustrate the drastic reduction in the area suitable for Robusta coffee in Uganda that a 2^0C temperature increase could cause.

His second point is to emphasise the positive: for example, by illustrating the economic and utilitarian benefits from avoiding natural disasters; using new technology to reduce carbon emissions; and opportunities to generate new employment by research and development of such technology. His third point is that, in order to facilitate transition to carbon reducing policies, countries should recognise and take active measures to minimise the disruptive effects of climate change and design industrial policies that minimise development costs and maximise development benefits.

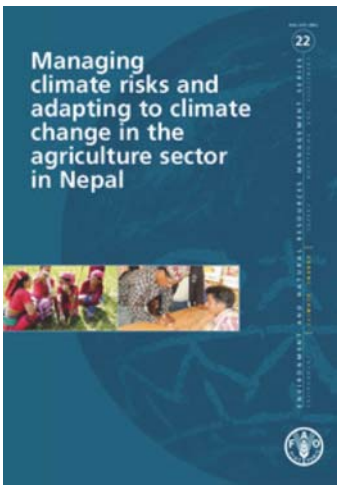
The author's fourth point is to build a leadership group that will deliver a long-term consensus on climate change policy, either outside the political arena or via a sustainable consensus across political parties. He gives examples of how this has been approached or achieved in different developing countries. His final point is to focus relentlessly on implementation despite the many obstacles to persuading governments, officials, commercial interests and the public to make necessary policy, technical and behavioural changes. He provides a positive example of how 15 Caribbean Community members have developed a plan to integrate climate risk management in every-day policy and planning processes.

The author concludes by acknowledging that tackling climate change is a big task that places huge demands on political leadership. He aspires to a tipping point where the need for change suddenly becomes obvious, but in the meantime urges the need to continue thinking about leadership and change management.

Hugh Brammer

New publications on climate change by international development agencies

FAO
Available on
http://www.fao.org.publications/en/



Managing climate risks and adapting to climate change in the agriculture sector in Nepal, Selvaraju R, 2014. 143 pp.

(Abstract). Projected future scenarios of climate change suggest that climatic conditions in Nepal will worsen, which may imply even more frequent occurrences of climate-related extremes and negative impacts on food production. However, by adopting the right measures, it is possible to manage the climate risks and adapt to the challenges. Efforts to promote such measures require a comprehensive approach that includes strengthening the capacities of institutions and delivering need-based services to farming communities. This report provides detailed information about climate and its variability in Nepal, including past trends, future climate change projections and likely impacts on the agriculture sector. The report elaborates the institutional context for managing climate risks and adaptation, and reiterates the need to strengthen the collection and analysis of data and information. A comprehensive typology of coping and adaptation strategies for managing current climate risks, and building the necessary knowledge and good practices for advancing adaptation over the longer term, is presented. The report also examines the issues and opportunities for mainstreaming climate change concerns into broader agriculture and food security policies, plans and strategies.

International Fund for Agricultural Development (IFAD)
Available on
http://www.ifad.org/climate/asap/resources.htm

Increasing adaptive capacity through participatory mapping, Piccolella A, 2013. 28pp.

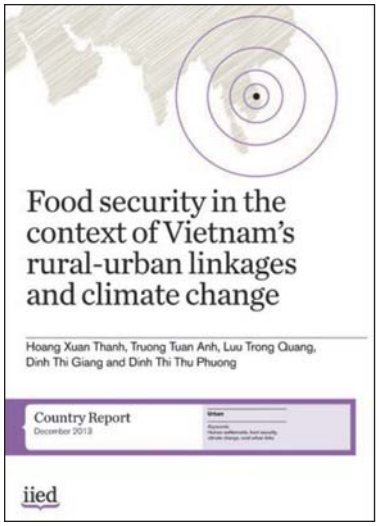
Participatory maps display geographical features plus information such as household characteristics and vulnerability, traditional agricultural and environmental knowledge, and cultural and historical heritage. Case studies in five countries illustrate how participatory mapping contributed to reducing vulnerability, strengthening resilience and building adaptive capacity in areas prone to climate hazards. Lessons learnt included that participatory mapping helps to mitigate conflicts over climate-sensitive resources, helps to better understand complex relationships between natural and human systems, gives voice to the most marginalised members of communities who

are most vulnerable to climate and environmental change, and provides an invaluable tool to strengthen community resilience.

The adaptation advantage: the economic benefits of preparing small-scale farmers for climate change, IFAD, 2013. 35pp.

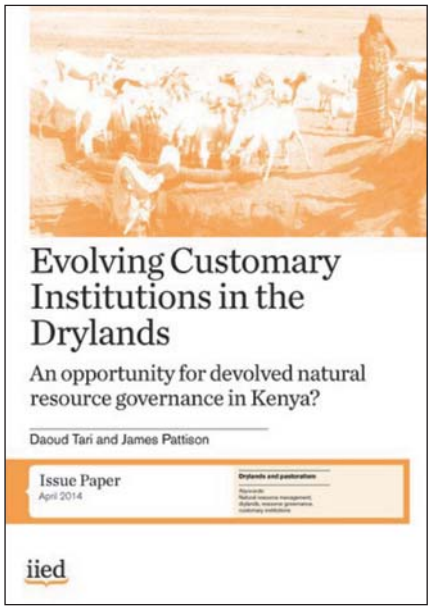
This report states that the climate debate often overlooks how adaptation can result in economic and financial opportunities for smallholder farmers. It describes how, by taking both long-term climate changes and market forces into account, farmers can capitalise on opportunities to diversify their production and spread climate risk across different income streams, or they can sustainably intensify to maintain stable harvests in a more resilient natural environment. Economic benefits of adaptation include sustained or increased agricultural production, higher household incomes, enhanced environmental services, protection of the asset base and reduced vulnerability to extreme weather events. Five country case studies illustrate the diverse situations in which environmental or climate-related problems pose a challenge to human development and demonstrate that it is possible to quantify the benefits that arise from adaptation investments in economic and financial terms.

International Institute for Environment and Development (IIED)
Available on http://www.iied.org/publications



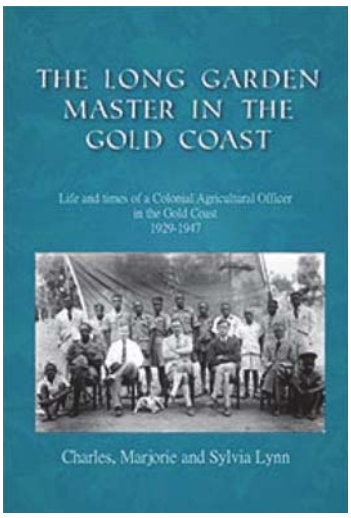
Food security in the context of Vietnam's rural-urban linkages and climate change, Hoang Xuan Thanh and four other authors, 2013. 44 pp.

(Abstract). Despite its modest contribution to climate change, Vietnam is expected to be heavily affected by its impacts. Although at the national level the country is self-sufficient in rice, the main staple and one of the main global exporters, environmental change has a disproportionate impact on the food security of the most vulnerable groups, thus slowing Vietnam's progress to poverty reduction. Environmental conditions have also become an important contributing factor in migration. Stronger rural-urban links, including the development of small towns that ensure access to urban markets, often through small-scale traders and remittances from migrants to the cities, contribute to food security by supporting both production and access. However, high food prices have affected the growing number of net food buyers in both rural and urban areas, and the financial crisis has reduced migrants' ability to send money home. This suggests that food security in Vietnam should be seen as a key element of development and adaptation to climate change.



Evolving customary institutions in the drylands: an opportunity for devolved natural resource governance in Kenya? Daouad Tari and James Pattison. 2014.

(Abstract). Improved governance of natural resources is crucial for building climate resilient livelihoods and economies in Africa's drylands. This paper looks at why the authority and capacity of customary natural resource management institutions has been weakened, and how this impacts on resource governance and climate resilience. [The] case study looks at a new hybrid form of customary/formal institution that is emerging as a response to the stagnation of development and increasing conflict around resource access. The paper demonstrates that legitimising and supporting customary institutions can be a more successful and sustainable approach to addressing the 'drylands development deficit' than projects that focus on technical fixes or work in parallel to customary institutions.



The Long Garden Master in the Gold Coast: Life and times of a Colonial Agricultural Officer in the Gold Coast 1929-1947, Charles, Marjorie and Sylvia Lynn, 2013.

Published and available from Authors Online Ltd, 19 The Cinques, Gamlingay, Sandy, Beds SG19 3NU, 322pp.
Price £9.99 + p&p £2.90 (UK); £3.62 (Europe); £6.25 (ROW)
e-book format, price £4.74,
www.authorsonline.co.uk
ISBN 978 0 7552 0710 7

Charles Lynn followed the common course of colonial Agricultural Officers: Wye College; Cambridge; ICTA (the Imperial College of Tropical Agriculture) in Trinidad; and then - after waiting for his 21st birthday to arrive in December 1929 - the seeming lottery selection of a posting to a colony and to a station within that territory. For Charles, the colony that came out of the hat was the Gold Coast and, after some temporary postings in the south - including the Aburi botanic gardens where Agricultural Officers were still known as Garden Masters; his title was later unofficially enhanced to 'long' because of his height - an eventual posting of 17 years in the Northern Territories of which 15 years were at one station, Zuarungu, in the far north. Today, such a career would be impossible, except possibly for some missionaries. International agencies, DFID and NGOs move staff on after a maximum of five - sometimes only three - years, in the supposed interest of

career development, oblivious of the interests of the country and the job in hand. That would not have worked in the pioneering days of administration and development described in this book.

The book provides a highly personal, sometimes day-to-day account comprising a reminiscence that the principal author had started to draft himself, combined with lengthy extracts from letters written to his mother, compiled into a single, free-flowing text by his daughter Sylvia who also provides a lengthy, context-setting Preface. The developing story is augmented by lengthy comments, mainly given in endnotes, by two socio-anthropologists who worked with a neighbouring small tribal group for three years, providing insights and comments that were often contrary to official administration policy. Both they and the author make interesting commentaries on the implementation of the policy of indirect rule then being introduced in what was then still socio-politically virtually *terra incognita*. One is left wondering, however, if the anthropologists had had their way, if tribal society would have been preserved in aspic as it were and modern 'development' - for all its faults and problems, but also its eventual social and economic benefits - prevented.

Charles spent his first tour of 18 months based on the agricultural station at Tamale, the headquarters of the Northern Territories administration, but he was almost immediately seconded to control a locust invasion in areas further north which lasted throughout the rainy season of 1930. This provided his first experience of trekking on foot in areas then beyond the limits of motor transport, with 25 or more men head-carrying his loads, including camping and cooking equipment, all walking 10-15 miles in a day. At Tamale, he enjoyed leisure activities including polo and game-shooting in the neighbouring countryside. Of the 30 European residents in Tamale at that time, he reported that five died in the six months that he was on his first six months home-leave, and he describes further deaths of several young colleagues and friends in subsequent years: the Gold Coast was still 'the white man's grave'.

On returning from leave in December 1931, he was posted to Zuarungu, 98 miles north of Tamale, the first Agricultural Officer to be posted to this densely-settled, food-short area where he was to remain for almost the remainder of his service in the Gold Coast. This is where he did his pioneering work carrying out statistically-designed agricultural surveys and introducing mixed farming, bullock ploughing and soil conservation together with the training of farmers and teaching of agriculture in schools, all under the severe budget limitations of the 1930's depression years. The work involved nearly continuous trekking throughout an extensive District, mainly on foot or on horseback.

Doing the same job in the same places over a long period of years, his tour-by-tour account inevitably includes much repetition of his tasks, places visited, people met, the weather and problems experienced. Yet that's how life was for him and for many of his generation: progress was slow in a region of still-primitive tribal culture, and it took much personal effort and dedication to achieve. That was not always appreciated at high official levels in his first few years: colonial policy was to develop export crops that would generate revenue, not simply improve farming methods and food security. The value of his work was eventually recognised: he was awarded the MBE in 1943 and eventually transferred to ICTA in 1948 to pass on his knowledge of extension methods.

Periodically, Charles returned to Tamale to write his reports or to take over as officer-in-charge while the incumbent was on leave. He also describes enjoyable and refreshing local leaves taken mainly on the coast. While on his way back to the UK after his fourth tour of duty in 1937, he met and soon married his wife (joint author Marjorie), who returned to Tamale and Zuarungu with him. World War II broke out while they were on home-leave in 1939, so their next long leave was taken in South Africa in 1941 where Marjorie remained for the birth of their first child - Sylvia, joint author of this book - whom Charles did not see for the first time until she was 19 months old on his next long leave in South Africa in 1943. Eventually, after the end of the war, they were both allowed to return to live with him in Tamale where he spent the last few months of his Gold Coast career.

I enjoyed reading this book, with a growing sense of nostalgia, in part because I later spent ten years soil surveying in the Gold Coast/Ghana myself and so recognised many of the places and landscapes described and knew some of the people named. The book deserves to be read by both policy makers and practitioners (including NGOs) involved in agricultural development in tropical Africa as a cautionary tale against the setting of over-ambitious, short-term, achievement targets: local knowledge, sympathetic understanding, tongue-biting patience and sustained personal involvement are as much needed now, even with modern communications, as they were in Charles Lynn's day.

Hugh Brammer
(Soil surveyor Gold Coast/Ghana 1951-61)
(Reprinted with permission from *The Overseas Pensioner*, No 107, April 2014)

News from the Field

TAA Sustainable Agriculture Seminar, Cambridge

Introduction

Held in Hughes Hall, Cambridge on 12 May 2014, the seminar was led by the TAA, with enthusiastic support from the Humanitarian Centre (Cambridge), Cambridge University's Strategic Initiative in 'Global Food Security' (GFS), and the Cambridge Conservation Forum (CCF). There was an amazing turn-out of some 50 people from a wide range of institutions and individuals from Cambridge and beyond. The high attendance was much to do with the TAA's partner organisations. Following brief descriptions of the partner organisations by their representatives, Keith Virgo, of the TAA, introduced the topics of the seminar. He recalled how, since the mid-1980s, people have lost interest in 'soil'; there are now few people who can call themselves soil scientists. Likewise, donor interest in agriculture itself waned from the 1990s onwards, and largely disappeared from the funding agencies' radars. He expressed satisfaction that two new approaches to agriculture have emerged over the last 15 to 20 years, both of which recognised the crucial importance of 'soil' and the need to ensure environmentally sustainable methods of food production.

Figure 1. Keith Virgo sets the scene for the seminar

These two new approaches were the subjects of this seminar:

- System of Rice Intensification (SRI)
- Conservation Agriculture (CA)

These methods enable producers to raise production with lower cost, less dependence on agro-chemical inputs, and lower energy and water requirements. Moreover, they optimise conditions for crop growth, both above and below ground.

Presentations were made by two TAA members, outlining the principles of these agro-ecological concepts and practices, with evidence that the approaches can re-orientate agriculture in developed and less-developed countries to achieve greater productivity with sustainability.

Presentation 1. From field observation to agricultural science: the case of the System of Rice Intensification (SRI), by Willem A Stoop.

Willem was trained as an agronomist/soil scientist at Wageningen and the University of Hawaii. He had a career with the international agricultural research centres. Since 1998, when doing research at WARDA, he became increasingly involved in rice research and particularly SRI (System of Rice Intensification). He was co-author with Norman Uphoff of the first formal/peer reviewed publication on SRI in 2002. Presently, he is involved in advising three Indian PhD candidates doing their research on socio-economic aspects of SRI in India.

Willem traced the post-WWII emphasis on high-input high yield cropping but noted the missing elements of soils, root systems, organic matter and soil biota. The empirical nature of SRI (*labelled* as an agro-ecological method) developed progressively on the basis of field practices (*bottom-up* orientation). This compared with the scientific theory and/or fundamental research (*top-down* orientation).

He outlined the SRI package of practices as compared with conventional, *best* practices: very low seed rates; very young transplants (8 to 15 days old); single transplants/hill; wide spacing (20x20 to 50x50 cm); no flooding; moist soil; use of compost; thorough weed control with 3 to 4 passes by manually-pushed rotary hoe. Figures in Table 1 showed a potential for doubling yields under SRI, with fewer inputs.

Most crop varieties (local and improved) respond positively to SRI practices. This is accompanied by drastically reduced (1/5th to 1/10th) seed rates that lead to more efficient phenotypes, because the expanded root development per plant will permit an increased efficiency in moisture and nutrient uptake from the soil. Willem supported this by numerous illustrations of SRI cropping from around the world (see Figure 2).

Figure 2. Root development with SRI rice (on the right) compared with conventionally transplanted rice.

Table 1: Comparisons of yields under conventional and SRI systems

Rice systems	Hills/m^2	Plants/m^2	Root dry weight (g) per hill	Root dry weight (g) per m^2	Rice grain yield (t/ha)
Conventional rainfed rice	50	150	4.1 d	206 c	2.9 d
Rainfed SRI rice	25	25	7.5 c	187 c	4.4 c
Rainfed SRI rice with suppl. irrigation from groundwater	25	25	10.2 b	254 b	5.7 b
Rainfed SRI rice with suppl. irrigation from stored run-off water	25	25	12.3 a	308 a	6.2 a

Note: In each column, values with different letters differ significantly (p=0.05)

In conclusion, he cited the overall effects as increased yields and reduced costs (savings on seeds; on chemicals: mineral fertilisers and plant protection; and on labour). Conventional (science-steered) intensification has seriously overshot its target, thereby endangering sustainability!

Key points were noted that *diversity* and *variability* in production systems and in socio-economic conditions require *flexible* implementation strategies. SRI is not a *fixed* blueprint package. It involves a grassroots *learning* exercise: adaptation and timing are essential requirements. Grassroots farmer organisations and local development agencies need to guide integration into actual systems.

Presentation 2. Conservation Agriculture: sustainable production with environmental protection, by Brian Sims.

Brian has agriculture and engineering degrees from Reading University and the National College of Agricultural Engineering in the UK, and a Diploma in Tropical Agriculture from the University of the West Indies. He was leader of the International Development Group at Silsoe Research Institute (SRI) in the UK. He is now an independent consultant working in tropical agriculture and agricultural engineering, focusing on the development of smallholder farming-systems with an emphasis on farm mechanisation. More recently, he has focused on the mechanisation of Conservation Agriculture (CA), principally for FAO.

Brian introduced CA as a key component of Sustainable Crop Production Intensification as promoted by FAO. The aim is to strengthen natural processes to underpin increased production, boost ecosystem services and avoid losses, by only using the inputs that the system can utilise. The basic features of CA were explained as:

- Minimum movement of soil (no-till or direct sowing - every season);
- Permanent soil cover, with crops, cover crops, crop residues or mulch;
- Rotations and/or associations of crops, through crop sequences, associations, relay crops and mixed cropping.

He described the ways that CA works in practice, especially in encouraging better soil health, higher soil fertility, improved infiltration and soil water availability. The benefits were cited as reductions in:

- Fertiliser requirements (30-50 percent);
- Water requirements (30 percent);
- Fuel consumption (60 percent);
- Pesticide applications (20 percent).

Figure 3. A no-till planter for two-wheel tractors, developed for smallholders with support from the Australian Centre for International Agricultural Research, and now manufactured by a Chinese company.

Reduction in these production costs is the key to improved profitability under CA. He cited figures to show that, globally, CA-farmed areas increased from about 2 million to 5 million ha from 1974 to 1990, and then expanded to 125 million ha by 2010. Globally, the area under CA is increasing by 6 million ha per year.

He concluded with a comprehensive description and illustrations of mechanisation systems appropriate to CA under small-scale and large-scale farming (see Figure 3). Overall, the principles of CA are **universal**, the applications are **local**. We have the

technology already developed. What is now needed are supportive policies and mutual support groups.

Conclusions

Following the formal presentations there were many relevant questions and valuable discussions. These included:

- Lack of recognition of SRI as a viable husbandry system by international agencies, such as IRRI, and the difficulties in scientific comparison between conventional and SRI results.
- SRI provides a set of flexible techniques that can be adapted and used to suit local needs.
- SRI is beneficial in areas where arsenic toxicity is a risk (like Bangladesh) because arsenic is less prone to uptake in the predominantly aerobic soil conditions under SRI.
- CA was seen as a micro-scale change for macro-scale impact.
- Integrating CA with free-grazing livestock in semi-arid areas was seen as a big challenge in terms of maintaining year-round soil cover.
- Conversion to CA from conventional tillage farming may involve an initial down-turn in yields and high initial costs of new equipment, but input costs are far lower.
- CA can sequester carbon in the soil at rates of up to 0.5 ton/ha/year. One Lincolnshire farmer has increased SOC from 2 to 6 percent over a 10-year period.

If anyone would like copies of the presentations, please email eastanglia_convenor@taa.org.

Feedback from the participants was enthusiastic, and many requested copies of the presentations. Selected comments from the participants included:

- *It was incredibly insightful.*
- *The seminar was really interesting and inspiring.*
- *The seminar was very well organised.*
- *I thought everything was excellent!*
- *It was a really excellent seminar after which I felt quite inspired!*
- *It was very worthwhile.*
- *I certainly think that the exploration of rice intensification and sustainable agriculture should continue and look forward to future developments.*

Keith Virgo

Climate change impacts and mitigation: a review of predictions and reality

Brian Sims

Formerly leader of the International Development Group at Silsoe Research Institute, Brian Sims is now an FAO agricultural mechanisation consultant focusing on the needs of conservation agriculture.

Summary

Mark Lynas's 2011 book, *The God species: how the planet can survive the age of humans*, discusses the concept of planetary boundaries and one - the climate change boundary - is the subject of this review. Previous estimates of 'safe' levels of atmospheric CO_2 have been too high and we should now aim to limit it to 350 ppm. Sea-level rises could reach 1.6 m by 2100. Decarbonisation of Earth's economy is essential and this implies an increased use of nuclear and renewable energy sources. The IPCC's AR5 shows that GHG emissions will continue to rise and CO_2eq levels will be at 450 ppm by 2030. Efficiency enhancements and behavioural change are vital; decarbonising energy generation is a key component. The agriculture and forestry sector, which produces 25 percent of CO_2eq, must concentrate on increased forestation and improved soil management. We have lost the race to retreat to 350 ppm, and to contain the level at 450 ppm we need to drastically cut emissions to 2050 and thereafter have a C-negative global economy.

Introduction

In 2011 environmental campaigner Mark Lynas produced his book *The God species: how the planet can survive the age of humans* (Lynas, 2011). The basic idea encompassed was that, now we are in the throes of our sixth mass extinction, humans must consciously manage the planet and recognise the existence of 'planetary boundaries'. These boundaries are the elements of the Earth's systems most affected by humans and are the implied limits to human activities in these areas. Nine boundaries are discussed in the book and one - the climate change boundary - is the subject of this return visit. This year we have been presented with an update of the evidence for climate change, and an analysis of our efforts at mitigating its effects, in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014). This review looks at Mark Lynas's description of the status of climate change factors and the mitigation efforts needed to reduce the impacts, and compares them with the IPCC's assessment of the current situation and efforts to allay the direst of consequences.

The Climate Change Boundary

The Holocene epoch, which has lasted for 10,000 years since the last Ice Age, has now slipped into the Anthropocene and humans, if they are to survive on the planet, need very urgently to cease inflicting damage on its survival systems and husband it back to health. In terms of climate change, targets for mitigation have hitherto been too weak and we now have to aim for safe levels of CO_2 (and CO_2 equivalent - CO_2eq) in our atmosphere. Human civilisation remains 80 percent dependent on fossil fuels and as economies grow, so does the rate at which CO_2 from burning them enter the atmosphere. Levels are rising at 2 percent per year and reached 390 ppm in 2011; the result of this emission of billions of tonnes of greenhouse gases (GHGs) is global warming and climate change. The British government's Stern review of the economics of climate change (Stern, 2006) suggested a stabilisation target of 550 ppm CO_2. In 2004, the EU had endorsed a target temperature rise of 2ºC implying, then, a maximum of 450 ppm CO_2. Reviewing the evidence, Lynas agrees that these estimates were too optimistic and that we should now be aiming at stabilising CO_2 concentrations at 350 ppm. The climate boundary is humanity's greatest test for, if CO_2 levels continue to rise and global temperatures race out of control, then the boundaries for biodiversity, ozone, fresh water, land use and ocean acidification cannot be met either. Fortunately we have the tools necessary which, if applied diligently, can still rescue us from our stupidity.

Three broad lines of evidence give support to the 350 ppm concept:

- The rapidity of changes already under way warn of the looming danger.
- Climate models indicate that positive feedbacks (thresholds or tipping points) are getting perilously close.
- Evidence from the distant past irrefutably links high CO_2 concentrations to high global temperatures.

The energy imbalance (the difference between incoming and outgoing radiation) has resulted in a rapidly shifting climatic baseline. Every year of the 1990s was warmer than the average of the 1980s; and every year of the 2000s was warmer than the 1990s average. Air pressure distribution is changing around the world with rises in the sub-tropics and falls over the poles. One possible consequence of this is the shift southwards of the Jet Stream which brought such violent weather to northern Europe last winter. A more energetic (warmer) atmosphere will result in more extreme weather events, including precipitation and its consequent flooding. We have also precipitated the rapid thaw of Arctic ice which means that it is not 'if' but 'when' the ice sheet melts completely each summer (NSIDC, 2014). The ice has entered a death spiral as its extent is plummeting and what remains is thinner and more vulnerable. Estimates are that the Arctic will be ice-free in the summer of 2037 or earlier. Without a reflecting ice shield the ocean will absorb more solar energy in summer and release it in winter changing storm tracks and weather systems. The degradation of the Arctic ecosystem, a unique food chain, is not just bad news for polar bears, but also for many other ice-dependent species. It may be possible to avoid some of the damage by retreating, with all urgency, to within the 350 ppm boundary. More generally the 350 ppm pathway will allow fragile ecosystems, such as coral reefs, time to adapt to climate change.

Computer models will always give an imperfect representation of the planet, but they are the only way to run experiments into the future. They have been used to identify tipping points and the temperature rises that would trigger them. The first is the Arctic ice cap, already discussed; the second is the Greenland ice sheet which is thick enough to raise global oceans by 7 m if it all melts and this only needs a 1-2ºC rise in temperature. Estimates are that the process could be completed in 300 years, *unless* we retreat behind the 350 ppm boundary. Third is the West Antarctic ice sheet which has now entered a positive feedback phase (Rignot, 2014) and is set to raise sea levels by 3-5 m worldwide. As Rignot points out, there is no red button to stop the process. The current rate of sea level rise is 3 mm a year (double the rate for the 20th century) and a rise of up to 1.6 m before 2100 is now on the cards.

A 3ºC rise in temperature would collapse the Amazon rainforest ecosystem and replace it with savannah - releasing its sequestered C. An even greater threat will be permafrost melt which will release billions of tonnes of CO_2 and methane (around 25 times more potent than CO_2 as a GHG). A 10 percent thaw will add 80 ppm to the atmosphere resulting in a 0.7ºC temperature rise and so reinforcing the positive feedback.

To avoid pushing the earth to an ice-free state the policy of decarbonisation of the global economy must be accelerated. Technologies for achieving the 350 ppm boundary need to result in a C-neutral economy by 2050 and to be C-negative thereafter. This means energy production from nuclear and renewable sources (solar, wind, water and biofuels). This change-over requires a degree of central planning whereby governments can ensure financing and direct the process - leaving these crucial roles to the vagaries of the private sector will ensure failure. The use of biofuels is controversial as they displace food crops, and burning them will release stored C. The answer is to accelerate the use of carbon capture and storage (CCS) systems whereby emitted CO_2 is pumped and stored underground making CCS biomass power plants C-negative. Technology will never be enough on its own; sound policies are needed to drive the changes and to attract the investment required to solve our climate problems. The longer we prevaricate, the more expensive the solutions will become.

IPCC's Fifth Assessment Report (AR5)

Anthropogenic GHG emissions continued to increase over the period 1970 to 2010 with larger decadal increases towards the end of this period. Emissions were the highest in human history from 2000 to 2010 and reached 49 ($\pm$4.5) GtCO_2eq in 2010. That is 49 thousand million tonnes. CO_2 emissions from fossil fuel combustion and industrial processes contributed 78 percent of the total emission increase from 1970 to 2010.

Globally economic and population growth continue to be the most important drivers of increases in CO_2 emissions and between 2000 and 2010 both drivers outpaced emission reductions. Increased use of coal relative to other energy sources has reversed the trend of gradual decarbonisation of the world's energy supply. Without additional efforts to reduce GHG emissions they will continue to grow; baseline scenarios exceed

450 ppm CO_2eq by 2030 and reach between 750 and over 1300 ppm by 2100. This will result in a rise in global mean temperatures of between 3.7 and 4.8°C.

Mitigation scenarios which are likely to keep temperature change below 2°C equate to concentrations in 2100 of 450 ppm CO_2eq. To achieve this will require large-scale changes in energy systems to produce substantial cuts in anthropogenic GHG emissions by mid-century (40-70 percent globally) and emissions near-zero $GtCO_2$eq in 2100. This needs a near quadrupling of the share of zero and low-carbon energy supply from renewables, nuclear energy and fossil energy with CCS or bioenergy with CCS (BECCS). Land-use changes will also be needed and include afforestation, reduced deforestation and other carbon dioxide removal (CDR) technologies.

GHG emissions are projected to grow in all sectors, except for net CO_2 emissions in the agriculture, forestry and other land uses (AFOLU) sector. This is specifically due to C sequestration in forestry and C sinks in agricultural soils. Clearly agricultural soils can only be C sinks if they are not eroding or having their C oxidised by tillage - so that conservation agriculture has a clear part to play in this process.

Achieving the 450 ppm target will require efficiency enhancements and behavioural changes; near-term reductions in energy demand are required as are changes in consumption patterns. AR5 recognises and analyses the importance of reducing emissions in the transport, buildings, industrial and urbanisation sectors, but here the discussion is restricted to energy supply and the AFOLU sector.

Energy supply emissions are projected to double or triple by 2050 compared to the level of 14.4 $GtCO_2$ per year in 2010. Decarbonising electricity generation is a key component of cost-effective mitigation strategies. Fossil fuel power generation without CCS must be phased out by 2100 and renewable energy (RE) technologies must be matured and deployed at scale. RE accounted for over half of new electricity generating capacity added globally in 2012, led by growth in wind, hydro and solar power. Nuclear energy is a mature low-GHG emission source of baseload power but its share of global electricity generation has been declining since 1993 and suffered a further decline after the 2011 Fukushima disaster. GHG emissions will be reduced by switching from coal-fired power plants to efficient natural gas combined heat and power plants. The addition of CCS technologies to the mix has not yet been applied sufficiently at commercial scale; and the employment of BECCS offers the prospect of negative emissions.

The AFOLU sector accounts for about a quarter (10-12 $GtCO_2$eq/year) of net anthropogenic GHG emissions mainly from deforestation, soil (mis)management and livestock. With decreasing deforestation and increased afforestation coupled with better soil management, net emissions could be potentially halved by 2050 with the possibility of becoming a net CO_2 sink by 2100.

Policies governing agricultural practices and forest conservation and management are more effective when they involve both mitigation and adaptation. An example is the UN-REDD+ programme (Reducing Emissions from Deforestation and Forest Degradation) which is designed to mitigate climate change through C sequestration and at the same time add the adaptation elements of sustainable production and conservation of biodiversity.

Bioenergy options with low lifecycle emissions (eg sugar cane, *Miscanthus* and fast-growing tree species) can reduce total GHG emissions but they rely on efficient systems to convert them to bioenergy. In some regions specific bioenergy options, such as improved cooking stoves and small-scale biogas and biopower production can reduce emissions and improve health and livelihoods.

Conclusions

There is broad agreement between Mark Lynas's analysis and the findings of IPCC's AR5. However the possibility of retreating behind the 350 ppm of CO_2eq in the atmosphere has been lost and we are now trying to steer for a 450 ppm level by 2100. This will be very difficult to achieve and involves drastically cutting emissions up to 2050 and thereafter having a C-negative global economy. An important point of agreement is that both reports envisage continuing economic development. International agreement, cooperation and concerted action are requisites and any delay in implementation of the necessary mitigation strategies will vastly increase the cost and difficulty of containing global temperature rises to below 2°C by the end of the century.

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International Agricultural Research News

Climate change

It is perhaps not surprising that most, if not all, international agricultural research centres focus a significant part of their efforts on finding ways to reduce agriculture's carbon footprint or conduct research to help rural communities adapt to the consequences of climate change. The CGIAR has made this the focus of one of its 15 major research programmes (see article by Bruce Campbell in this issue, pages 14-17). The following are examples of how three of the centres of the Association of International Research and Development Centres for Agriculture (AIRDC), are tackling the subject.

CAB International (CABI)

Headquartered in UK, CABI addresses climate change not only through its research and development but also through its knowledge management and publishing services. For example, CABI publishes a series of scientific books on climate change targeting researchers, upper level students and policy makers[1]. The series provides broad international coverage, including both a synthesis of the current state of knowledge as well as a discussion of future research needs and possible solutions. Titles published so far in this series include:

- *Climate Change and Crop Production*, Reynolds M, ed (2010);
- *Crop Stress Management and Global Climate Change*, Araus JL & Slafer GA, eds (2011);
- *Temperature Adaptation in a Changing Climate*, Storey KB & Tanino KK, eds (2011);
- *Plant Genetic Resources and Climate Change*, Jackson ML, Ford-Lloyd BV, Parry ML, eds (2013);
- *Climate Change Impact and Adaptation in Agricultural Systems*, Fuhrer J & Gregory P, eds (in press).

The *Initiative for Coffee and Climate* provides a good example of CABI's research and development work on climate change. The historically unprecedented *La Niña* conditions in Colombia from 2008 to 2011, the largest Coffee Leaf Rust outbreak ever recorded in Latin America in 2012, and the great Minas Gerais (Brazil) drought of 2014, together with less dramatic though still serious weather-related events in East Africa, India, Indonesia and Vietnam, have resulted in billions of dollars of lost production over recent years. While it is not possible to definitively prove that all these events are due to climate change, the initiative has adopted the reasonable hypothesis that climate change is already affecting coffee production in many areas and that the first duty of a practical field based approach is to help farmers cope with existing pressing difficulties.

The initiative, funded by a group of donors and coffee roasters and executed by Hanns R Neumann Stiftung (HRNS), CABI and GIZ provides tools to enable coffee-farming families to effectively respond to climate change. Recognising that climate change affects different coffee production zones and value chains differently, the initiative has established pilot projects in diverse producing areas in Brazil, Tanzania, El Salvador, Guatemala, Honduras, and Vietnam. These represent Arabica and Robusta production, a range of growing systems, as well as wet and dry processing methods. Tools have been developed by the initiative that can be used to address a wide array of problems and situations by providing recommendations that are tailored to the local situation. For example, in some situations a suggestion might be made to move production to a higher altitude or to switch from Arabica to Robusta varieties. Advice is also given on a wide range of production and post-production practices, including which shade species to grow and the optimal percentage of cover, soil and water management techniques, pests and disease management practices, and crop drying methods[2].

The International Fertilizer Development Centre (IFDC)

Based in Alabama, USA, the IFDC is conducting research on mitigating the greenhouse gas (GHG) emissions from lowland rice farms in Bangladesh. A project carried out in collaboration with the Bangladesh Rice Research Institute, Bangladesh Agriculture University and other national and private institutions, aims to quantify the environmental benefits of fertiliser deep placement (FDP) technology and build Bangladesh's national capacity to incorporate climate change activities into research and development programmes.

Rice farms account for 85 percent of Bangladesh's agricultural land and emit significant quantities of GHGs in the form of carbon dioxide, methane and nitrous oxide. In addition, runoff of excess nitrogen and phosphorus can severely impact wetland and coastal habitats, and the sub-optimal management of crops, soils, water and nutrients not only leads to lower yields and inefficient resource use but also results in higher GHG emissions.

Most rice farmers broadcast urea directly into the floodwater of lowland rice. This results in inefficient nitrogen uptake with only one-third of the applied nitrogen being used by the crop. FDP is a simple yet innovative technology that improves the efficiency in uptake of nitrogen. When used on lowland rice, FDP involves placing 1-3 grams of fertiliser super-granules (also known as briquettes) at a depth of 7-10 cm shortly after the rice is transplanted. FDP increases nitrogen use efficiency

[1] For more information on this series see: www.cabi.org/uploads/CABI/bookshop/Books-Catalogue-2014.pdf

[2] For more information on the coffee and climate initiative see www.coffeeandclimate.org/

because most of the nitrogen stays in the soil close to the plant roots where it is absorbed more effectively. The benefits of the technology are significant with crop yield increases averaging 20 percent and nitrogen losses decreasing by approximately 40 percent. The project is expanding FDP technology to over a million hectares, involving 2.5 million farmers.

A new component of the project has recently begun that aims to determine nitrous oxide and nitric oxide emission rates and the effect of resource-efficient technologies such as FDP on mitigating these emissions. IFDC has designed and constructed greenhouse gas chambers that take continuous long-term measurements of the amount of nitrous oxide and nitric oxide released from the soil during rice production and also during the non-rice fallow period[3].

The International Network for the Improvement of Bamboo and Rattan (INBAR)

Based in Beijing, China, INBAR has recently published a working paper entitled *Forests Beyond Trees: NTFPs as tools for Climate Change Mitigation and Adaptation*, by Nadkani M and Kuehl Y[4].

When it comes to forestry, climate change efforts traditionally focus on trees as a means of sequestering carbon. Forests, however, are made up of more than trees. Based on research at INBAR and elsewhere, the working paper points out that Non-timber Forest Products (NTFPs) can play an important, and so far largely unrecognised, role in climate change mitigation and adaptation. It argues that policy and research should look beyond trees to NTFPs when developing climate change strategies, especially in global schemes such as REDD+.[5]

NTFPs include fruits and nuts, vegetables, medicinal plants, resins, essences, dyes, fish and game, and a range of barks and fibers. In Cameroon, for example, CIFOR research has identified at least 570 plants and 110 animal species harvested from the wild, valued at over US$1 billion annually.

NTFPs are well placed to address the challenge of climate change through simultaneously contributing to forest conservation, carbon sequestration, resilience and livelihoods. Bamboo, for example can lock up carbon for many years through its use as a construction material, at the same time taking the pressure off forests as a source of timber for construction. NTFPs also give a value to forests for local people and thus an incentive for them to conserve local forest ecosystems. Through activities to enhance the value of NTFPs, eg increasing production through improved forest management or adding value through post-harvest processing, greater incentives can be provided for forest conservation.

Geoff Hawtin

[3] For more information on FDP, see: www.ifdc.org/Expertise/Fertilizer-Deep-Placement-(FDP)/

[4] The full paper can be downloaded at: www.inbar.int/wpcontent/uploads/downloads/2013/11/Working-paper-74.pdf

[5] For more information on REDD+ see: http://reddpluspartnership.org/en/

Climate change and livestock in developing countries: possibilities for adaptation

Philip Thornton

Philip Thornton is a Theme and Flagship research leader in the CGIAR Challenge Programme on Climate Change, Agriculture and Food Security (CCAFS), and Principal Scientist at the International Livestock Research Institute (ILRI) in Nairobi, Kenya, working on targeting and impact assessment. He is based in Edinburgh and is an Honorary Fellow in the College of Science and Engineering, University of Edinburgh. He is a Contributing Author on the chapter 'Food Security and Food Production Systems' of Working Group II on Impacts, Adaptation, and Vulnerability of the IPCC's Fifth Assessment Report, published in 2014.

Summary

As recent IPCC assessments make clear, the impacts of climate change on livestock systems in developing countries remain relatively understudied. At the same time, rangeland-based and mixed crop-livestock systems will continue to have a critical role in helping to meet the growing demand for food in the coming decades, particularly in sub-Saharan Africa and South Asia, where rural poverty and hunger are already concentrated. There are many ways in which livestock keepers may be able to adapt to the changing climate, and some of these revolve around increasing efficiencies of production that can provide mitigation co-benefits as well. The costs and benefits of many livestock adaptation options in developing countries are often unknown. In any case, effective adaptation needs an enabling policy, technical, infrastructural and informational environment. For the hundreds of millions of poor and vulnerable livestock keepers who live in the tropics and subtropics, the development challenge is daunting.

Introduction

The importance of livestock systems in developing countries has been well documented in many places; they cover 2.5 billion hectares of land globally. Mixed crop-livestock systems produce over 90 percent of the world's milk supply and 80 per cent of the meat from ruminants (Herrero *et al*, 2013). Both mixed crop-livestock and rangeland-based livestock systems are enormously important for livelihoods and food security, as they provide most of the staples consumed by poor people. The next decades are likely to see rapidly expanding populations in many parts of the tropics and subtropics, particularly Africa, along with expanding urban and income growth. Global food demand is projected to increase by between 60 and 110 percent by 2050, depending on the assumptions used. Livestock systems in developing countries will continue to be of critical importance in helping to meet this demand. To add to the challenges, production growth to meet rising food demand has to occur in the face of changes in climate and climate variability. In this article, some of the ways in which livestock keepers might adapt to changing climate patterns are discussed, along with the enabling factors that may be required, if the livelihoods and food security of hundreds of millions of poor people in developing countries are to be sustained and enhanced.

Does the Fifth Assessment Report contain new information concerning climate change impacts on livestock systems?

The possible impacts of climate change on crops and livestock have been reviewed in many places - the work of the CGIAR in this arena is summarised in Thornton & Cramer (2012), for example. Recently, the IPCC's Fifth Assessment Report (AR5) has been published (available online at www.ipcc.ch), which presents the current state of scientific knowledge concerning climate change. In terms of impacts, adaptation and vulnerability, does the AR5 add to what is known about possible and potential impacts on livestock systems? A few key messages can be distilled:

- First, new research since 2007, the year of publication of the previous Assessment Report, confirms prior conclusions, although now there is more evidence and higher confidence in the messages than previously. For example, several studies project widespread negative impacts on forage quality, from which we can confidently infer concomitant impacts on livestock productivity and production (and thus incomes and food security for resource-poor livestock keepers) in both high and low latitudes. Similarly, firm conclusions can be drawn across the range of livestock species concerning the negative effects of increased temperature on feed intake, reproduction and performance.
- Second, unlike the situation for crops, so far there is only limited evidence of impacts on livestock systems in terms of what is already happening, and almost all of that evidence comes from the realm of livestock disease and disease vectors.
- Third, aggregated summaries of impacts on livestock systems with or without adaptation are still not available, nor do we yet have summaries of impacts with or without adaptation in mixed crop-livestock systems that specifically address the interactions between crop and livestock enterprises. Furthermore, despite the importance of livestock as a risk management asset for hundreds of millions of people, the impacts of increasing climate variability on downside risk and on the stability of livestock production from year to year, and hence on human well-being, have not yet been robustly elucidated.

- Fourth, as for cropping and fisheries systems, there are many adaptations possible in livestock systems tailored to local conditions, but there is inadequate information to aggregate the possible costs and benefits (both social and private) of these adaptations, although there is high confidence that they will bring substantial benefit, particularly if implemented in combination.

Adapting to climate change in livestock systems

While AR5 contains only limited new information on climate change impacts on livestock systems, there are many ways in which livestock keepers may respond. Below, three (overlapping) types of response are outlined (Thornton & Herrero, 2014).

Increasing the resilience of livestock systems

There is often considerable genetic variability in domestic crops and livestock, and characteristics such as ability to withstand temperature extremes, drought, flooding and pests and diseases are often at least partially genetically controlled. The utilisation of different livestock breeds and undomesticated relatives is fundamental in developing resilience to climate shocks and longer-term climate change. In addition to their positive impacts on the rate of carbon sequestration in tropical systems, the leaves of some tree and legume species can significantly improve the diets of ruminant livestock because of their relatively high nutritive value and digestibility. A ruminant diet that is higher in quality will reduce the methane output per unit of product, so target quantities of animal product can be obtained for lower overall methane emissions and with fewer animals.

Figure 1. Increasing the quality of cattle diets can raise productivity as well as reduce the amount of greenhouse emissions per kg of milk and meat. Cattle near Zorro village, Bukina Faso (Photo: Ollivier Girard (CIFOR)).

Trees and legumes on mixed crop-livestock farms can increase the resilience of farming systems by increasing species richness and abundance, as well as providing substantial mitigation benefits. The longer-term effects of shocks, such as drought, on farming systems and livelihoods can be considerable; and such shocks can move households into poverty traps from which it is difficult to escape. In rural Ethiopia after the 1984-85 famine, caused by drought, it took on average 10 years for livestock holdings to recover to pre-drought levels (Dercon, 2004). In these households, livestock holdings are very important as a form of savings and as a way to accumulate assets. National safety net programmes can play a critical role in helping households to adapt and become more resilient and food secure, as can national strategies aimed at stimulating off-farm economic and employment opportunities.

Figure 2. Hybrid goats that produce more milk and meat: one of several 'climate-smart' practices being tested by farmers in Western Kenya (Photo: Cecilia Schubert (CCAFS)).

Diversification

Agricultural diversification occurs when more species, plant varieties or animal breeds are added to a given farm or farming community. This may include landscape diversification, in which different crops and cropping systems are interspersed in space and time. Livelihood diversification may occur when farming households are involved in more and different (non-agricultural) activities, for instance by taking up a job in the urban sector, setting up a shop, or by starting to process farm products. Both agricultural and non-agricultural forms of diversification may be highly relevant for helping to adapt to climate change, by helping to smooth out short-term household income fluctuations and providing households with a broader range of options to address future change.

Currently, there is little information that can help farmers and farming communities to effectively manage diversification possibilities: what works where is highly dependent on the geographical and socio-economic context. For example, crop diversification may be most beneficial in situations where growing conditions are neither so marginal that they limit diversification options nor so good as to allow the growing of a single high-return crop (Kandulu *et al*, 2012). Diet diversification may have an important role to play in adapting to climate change. Some communities in East Africa have been diversifying their diets considerably over the past 40 years, including some pastoral households that have taken up cropping even in marginal places where the practice is very risky (Rufino *et al*, 2013). Some householders are increasing their crop and diet diversity with more drought-tolerant crops such as millet, sorghum and cassava. In such communities, knowledge transfer concerning the growing and utilisation of unfamiliar and untraditional crops will be needed.

Risk management

Climate change is expected to result in increased climate variability in the future (IPCC, 2012). Increased frequency of droughts may result in decreased livestock herd sizes because

of increased mortality and poorer reproductive performance, severely compromising food security. Increasing climate variability may also have substantial impacts on environmental security, as the potential exists for conflicts over livestock assets and natural resources to escalate in the future. Households may engage in mixed crop-livestock farming when weather risks increase: livestock can be used as an asset to smooth income fluctuations, and opportunistic cropping can provide dietary calories for households at critical times of shortage.

The use of weather forecasts can lead to decisions that may affect large numbers of people in the landscape, such as the seasonal forecasts for West Africa in 2008 that warned of high probabilities of above-normal rainfall for the July-September rainy season. This information was used by emergency aid providers to increase preparedness and ultimately lives were saved as a result (Tall *et al*, 2012). Effective mechanisms for the delivery and utilisation of climate forecasts for crop and livestock management still need considerable work, but progress is being made in several countries in sub-Saharan Africa.

Another option is insurance, including weather-indexed insurance - policy holders are paid in response to 'trigger events' such as abnormal rainfall, for example. Weather insurance has been widely trialled and evaluated in parts of India. Recent developments in East Africa in weather-indexed livestock insurance highlight the potential for public-private partnerships in situations where the incentives and risks involved do not make it feasible for the private sector alone (Chantarat *et al*, 2012). The debate continues as to whether index insurance at scale can lead to tangible and sustainable impacts on poverty and food security.

Adaptation in livestock systems: are there 'best bets'?

Some of the adaptation options outlined above are listed in Table 1 in relation to their potential impacts on household food security, their potential contribution to household resilience, diversification and risk management, and some of the

Table 1. Some adaptation options available to livestock keepers in developing countries, and constraints to their adoption. From Thornton & Herrero (2014), based on FAO (2013).

Option (with some examples)	Impact on food security	Potential impact on resilience	Potential to promote diversification	Potential for managing risk	Constraints to adoption
Crop residue management (minimum tillage, cover cropping, mulch)	+	+	+	++	Competing demands for crop residue biomass, labour demands
Nutrient management (composting, appropriate fertiliser/manure use)	++	++	+	+	Cost, limited access to technology and information
Soil management (crop rotations, fallowing, intercropping with leguminous crops/shrubs)	++	+	+	+	Limited gains over the short term, labour demands
Change livestock breed (use of improved and/or stress-tolerant breeds)	+++	++	++	++	Cost, lack of experience and knowledge
Manure management (composting, improved manure handling / storage application methods)	+	+	+	+	Labour demands, lack of knowledge
Change livestock species (stress-tolerant species)	+++	++	++	++	Cost, accessibility, lack of knowledge
Improved feeding (diet supplementation, improved grass and fodder species)	++	+	+	++	High cost, labour demands, lack of knowledge
Grazing management (adjust stocking densities to feed availability, rotational grazing)	++	+	+	++	Labour demands, lack of knowledge
Alter integration within the system (addition /deletion of enterprises within the farming system, changing the ratio of crops to livestock and or the ratio of crops to pasture, addition of tree/shrubs)	++	++	++	+	Lack of information, lack of fit with household objectives
Use of weather information (to modify crop, livestock management)	+	+	+	++	Reliability, accessibility, timeliness, lack of knowledge
Weather-index insurance (for crops, livestock)	++	++	+	+++	Cost, covariate risk, lack of information, sustainability

+ less impact/potential, +++ most impact/potential

constraints to their adoption. Table 1 shows that there are no silver bullets: no options stand out that have high potential for enhancing food security and addressing resilience, diversification or risk management that do not also have constraints to their adoption in certain (perhaps many) situations. This suggests that all these options will be needed in different circumstances, and that their feasibility will depend on local conditions. Table 1 also indicates that there are limits to what can be achieved in increasing resilience through agricultural management. The importance of the policy and enabling environment with respect to adaptation is obvious, but identifying the boundaries of what endogenous adaptation can achieve in relation to incomes and food security in livestock systems is critical for informing national policy debates.

Conclusions: enabling adaptation in livestock systems

The increasing demand for food in the coming decades will continue to provide a massive opportunity for poverty reduction and economic growth in many developing countries, although the future role of smallholders in this is unclear. The development of sustainable and profitable smallholder agricultural production is likely to need considerable investment, particularly in Africa. In addition to investment, there are several ways in which an enabling environment can be fostered to help smallholders adapt to climate change.

First, a key factor in sustained adaptation of agricultural systems is social, institutional and technological innovation, the process by which social actors create value from knowledge (Douthwaite, 2002). Innovation can be fostered by increasing the pool of new ideas and technology that feed into learning cycles, changing how people interact while innovating and making sense of the results, and changing the ways they measure and select what works and what does not (Axelrod & Cohen, 2000). Participatory plant breeding and varietal selection via crowdsourcing are great examples of the possibilities (van Etten, 2011).

Second, there is the need to strengthen local institutions, both formal and informal, that can play a key role in facilitating and encouraging agricultural producers to make changes to their production systems and manage natural resources in a way that helps them achieve household food security. Local institutions also have important roles to play in the flow of information (such as weather forecasts and extension materials concerning new technologies) and in the management of communal resources such as grazing and water resources (McCarthy *et al*, 2011). Investing in institutions for the sharing of seasonal forecasts in local communities, and utilising new information technology, can significantly increase the ability of farmers to reduce their exposure to weather risk by altering the way in which they manage their crops and livestock.

Third, sustained adaptation will require coordinated and informed policies. In turn, this will require an integrated approach to addressing food security, agriculture and climate change, and addressing the often fragmented policy and institutional architecture that exists at national and international levels - particularly integrating climate change issues into the decision-making processes in ministries of agriculture (Thornton & Lipper, 2014). There are huge challenges in dealing with the uncertainties and addressing the trade-offs and synergies that may arise from different policy actions. This calls for considerable enhancement of the links between science and policy making, and making robust, timely information available in appropriate formats.

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Mailbox

Harvesting tea with plucking shears

Dear Editors

I refer to Keith Virgo's observations on the use of 'plucking shears' for harvesting tea in Kerala (South India) in the Spring 2014 issue of *Ag4Dev*.

As with many things this is not a new idea. Indeed, reference is made to the use of shears in Assam (India) and Japan in the late 19th century.

More recently, there was renewed interest in the use of modified garden shears (and indeed in other forms of machine-aided harvesting of tea) beginning in the 1970s. This was due to shortages of labour, for different reasons (civil strife, sickness, alternative employment opportunities), and in some places (South Africa) its cost, together with higher tea yields. South India led the way in evaluating and adopting the use of shears, closely followed by eastern (Tanzania, Kenya, Uganda) and southern (Malawi and Zimbabwe) Africa.

In South India an integrated approach is recommended with shears used during peak cropping periods and hand harvesting during the intervening low yielding periods. Shears are mainly used in the later years of a pruning cycle, when it is more difficult to pluck by hand and the shoots are smaller.

Providing the shears are suitably modified (Figure 1) and correctly used, there are no adverse effects on the quality of the processed tea, nor on the long-term productivity of the tea bush. Labour productivity is increased.

The results of a series of experiments over an eight-year period in Tanzania in which the use of shears was evaluated against hand harvesting on a selection of clones, with contrasting shoot sizes and leaf angle, have been published (Burgess *et al*, 2006).

Smallholders also have problems with shortages of labour available to harvest tea when, for example, a yield peak, following the start of the rains clashes with planting or weeding the food crops. Shears are then as useful to farmers as they are to managers of large estates.

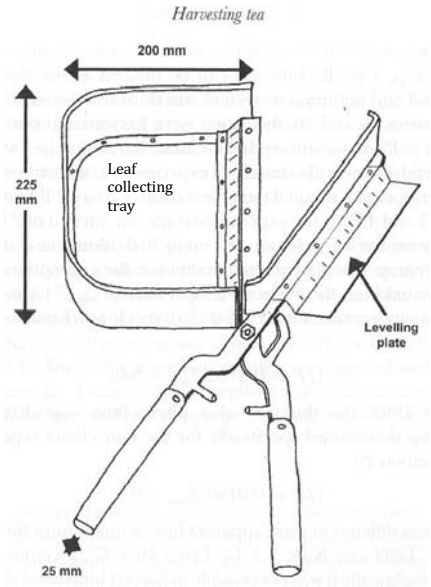

Figure 1. Modified garden shears as used for harvesting tea. The tray is attached to the lower blade, which rests on the bush and collects cut shoots, which are pushed into the tray by a plate on the upper blade. The height above the surface of the bush at which the shoots are cut is determined by a step between the tray and the top of the lower blade (from Burgess *et al*, 2006)

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Mike Carr
Ilmington, Warwickshire , UK
mikecarr@cwms.org.uk

Working in East Africa

Dear Sir

It is a pleasure to write to update members on what has happened to me since I received a TAAF award in 2011. It is even more of a pleasure given that the Association recently circulated an email on my behalf asking if any other members based in East Africa would get in touch. As a result I have received a really quite astounding amount of goodwill and good advice.

I was studying at the Royal Agricultural College (RAC) when I applied for a TAAF grant and used the money to fund a research trip to complete my MSc thesis on *Small-holder fruit tree cultivation and the factors affecting their species selection in Western Kenya* in collaboration with ICRAF (the World Agro-forestry Center). After completing my research it took me a short while to find a job – there still doesn't seem to be that great a job website for people wanting to continue working in tropical agriculture – but through contacts at the RAC and the TAA I eventually met with a very high level coffee trader to whom I had unsuccessfully applied for a job in the Congo. He in turn put me in touch with a long list of contacts in the trade and I more or less fell into a job working in coffee in East Africa with the ECOM Agroindustrial Corporation. Key to it was undoubtedly the fact that through the TAAF grant I had been on the ground in East Africa before applying.

I joined as a 'Management Trainee' and after four months sat in a back office in Kenya I was sent into the bush in Tanzania to manage the company's sustainability activities in Mbinga Ruvuma. As I think would probably be familiar to many people who have worked in East Africa, the training element of my management status seemed to be defined purely by the fact that they threw me into it with minimal experience and watched to see if I would sink or swim. I managed, in the first year, a team of about 12, and we certified the first small-holder Rainforest Alliance coffee supply chain in Tanzania, covering 7,339 farmers.

Unfortunately in July of last year, as happens in the bush sometimes, I came off a motorbike, smashing my right tibia and fibula, and ended up working remotely for eight months. I am however now back in Mbinga with an expanded team, since I have taken on more of the buying and operations responsibilities, while maintaining my role covering training and certification work. I am not sure if I should recommend East Africa on the basis that it is much like a drug - if it gets under your skin, it is in turns both infuriating and unbearably astounding. No day is the same if you make it out here.

This season I am, among other things, organising and supervising the building of a new 1,800 m^2 warehouse, supervising the construction of a new coffee wet mill, managing extension to 12,000 farmers, and trying to implement a new phone based wet mill accounting system. I am also trying to grow lettuces - a new and novel activity in Mbinga.

I would just like to re-iterate my thanks to the TAA for all its support, and to float the suggestion of a members' dinner sometime this year in either Dar or Nairobi.

Warm regards

Richard Bliault

Editor's note: since sending us this letter, Richard has informed us that he has left Tanzania and is currently seeking other opportunities in the coffee industry

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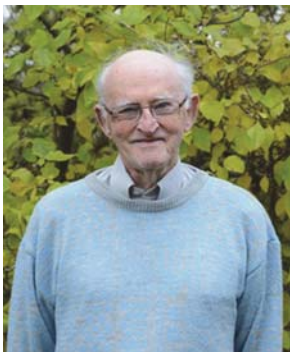
Newsflash

Hugh Brammer honoured



On World Environment Day, 5 June 2014, the University Press Ltd, Dhaka, Bangladesh, honoured TAA member Hugh Brammer by issuing a special feature showcasing his upcoming book on *Climate change, sea-level rise and development in Bangladesh*, and his many previous books on soils, agriculture and land use in Bangladesh published by UPL, stating that *'His relentless contribution to the scholarly discourse on these important areas is an invaluable asset for agricultural and environmental policy making in Bangladesh'*.

This is a well-deserved honour and we extend our congratulations to Hugh.

TAA Forum

LendwithCARE, CARE International-UK (CIUK), and TAA

Following considerable research by our Treasurer, the Executive Committee meeting on 9 June 2014 agreed that the TAA should invest a small proportion (initially up to £2,000) of its reserves in LendwithCare. This is in accordance with the Association's commitment to supporting poor rural people in developing countries, and in line with our charitable status. Further investments may be considered later based on our experience with the scheme.

LendwithCARE is an innovative micro-finance funding programme operated by CARE-UK. It is a revolving fund for interest-free loans to assist entrepreneurs in developing countries to lift themselves out of poverty. It involves a lending relationship between people in the UK and people in developing countries. Lenders are bound by an agreement whereby loans will only be repaid up to a maximum of the amount originally loaned, subject to exchange rate fluctuations, with lenders never receiving a return by way of interest or a share of any profits made. Lenders also acknowledge and accept that loans may occasionally not be repaid.

Small loans are made to businesses involved in agriculture and natural resource management. Detailed information of TAA's involvement can be viewed at: http://www.lendwithcare.org/groups/profile/tropical_agriculture_association. The data available includes the name of the borrowers and type (individual or group), the loan type, country, gender, amounts by categories, and dates loans are made. Loan repayments are made monthly and credited to TAA's account. They are then available for relending to other businesses. TAA's funds continue to revolve in support of many small businesses, until the TAA decides to withdraw or donate all or part of its funds.

The scheme presently operates in nine countries, namely Benin, Cambodia, Ecuador, Malawi, Pakistan, Philippines, Togo, Vietnam and Zambia. It involves carefully chosen micro-finance institutions, regulated within in each country and selected against a number of success criteria and closely monitored by CARE-UK. The micro-finance institutions have other sources of loan financing and typically obtain between 5-10 percent of their funds through LendwithCARE. A further country may shortly be added, Rwanda. In some countries, such as India and South Africa, exchange control regulations prevent peer-to-peer lending. In other countries CIUK has made a decision not to operate LendwithCARE so as not to jeopardise their humanitarian response reputation.

Contributions by TAA regional and specialist groups and individuals can also be made, linked to the existing TAA LendwithCARE account, but managed by the group or individual. Further information is available from the Treasurer (treasurer@taa.org.uk).

Jim Ellis-Jones
TAA Honorary Treasurer

Land Husbandry Group update

A joint TAA-IIED Seminar by Bill Crabtree (no-till farmer from Western Australia) on *No-till farming and the search for sustainability in dryland agriculture*, was given on 28 March at the International Institute for Environment and Development (IIED), London. Bill Crabtree was video interviewed by the IIED communication unit. The blog and the ten minute video interview can be accessed at: http://www.iied.org/spreading-word-about-no-till-agricultural-revolution

Tony Reynolds kindly hosted a visit by TAA members to his farm on Saturday 29 March 2014. Bill Crabtree was a guest speaker. The farm is located at Thurby, Bourne, Lincolnshire. A note on the visit, prepared by Brian Sims, is uploaded to the *Land Husbandry Group Reports* on the TAA website.

Amir Kassam and Andrew Bennett served on the Organising Committee of the European Conference on Green Carbon which was arranged by the European Conservation Agriculture Federation (ECAF), in Brussels from 1-3 April 2014 (www.greencarbon-ca.eu). The Conference aimed at raising awareness regarding the role of Conservation Agriculture in 'making sustainable agriculture real' in Europe. Amir Kassam and Tony Reynolds both attended the Conference as keynote speakers. The book of abstracts of the Conference is available at: http://www.greencarbon-ca.eu/abstracts-papers.

CABI published a book early this year entitled *Conservation Agriculture: prospects and challenges across the world*. The book is edited by Ram Jat, ICAR, India, Kanwar Sahrawat, ICRISAT, India, and Amir Kassam. The book provides an up-to-date 'state of the art' assessment of the status of Conservation Agriculture in the different regions of the world.

The International Journal of Soil and Water Conservation Research has just published a special issue on *Soil and water conservation in different countries*. The journal includes a lead article from Amir Kassam, Rolf Derpsch (from Paraguay) and Theodor Friedrich (FAO Resident Representative, Cuba) on the *Global achievements in soil and water conservation*, focusing on the adoption of no-till systems. The whole issue is available at: http://www.waswac.org/newsShow.asp?fileSort=19&id=278

Amir Kassam attended, as a keynote speaker, the 1st Africa Congress on Conservation Agriculture held in Lusaka from 18-21 March in Lusaka, Zambia. The Lusaka Declaration is available at: www.act-africa.org/

Brian Sims and Amir Kassam attended the 6th World Congress on Conservation Agriculture held in Winnipeg, Canada, from 22-25 June. They both made presentations. More information is available at www.wcca6.org

Amir Kassam
Coordinator LHG

Publications and Communications (P&C) Committee update

***Ag4Dev22* – a Special Issue on Climate Change and Agriculture**

This issue of *Ag4Dev*, the Summer 2014 issue, is a Special Issue on Climate Change and Agriculture. We very much appreciate the contributions from the invited authors, and from three of our Corporate Members.

***Ag4Dev23* – an Open issue**

The Winter 2014 issue of *Ag4Dev* will be an open issue, providing members an opportunity to submit papers for consideration. Many papers are already in the pipeline, but there is still room for a few others to be considered.

***Ag4Dev24* – a Special Issue on Soils**

The year 2015 has been declared the International Year of Soils, so in recognition of this, the Spring 2015 issue of *Ag4Dev* will be a special issue on Soils. David Dent has kindly offered to be the Guest Editor of this Special Issue. The contents are yet to be finalised, so any members with ideas or items for this issue should contact either Paul Harding or David Dent (dentsinengland@hotmail.com).

Succession planning for the P&C Committee

The Chairman of the P&C Committee (Paul Harding) would welcome any expressions of interest from potential new members of the Committee. Possible roles include Coordinating Editor of *Ag4Dev*, Technical Editors of *Ag4Dev*, coordinating reviews for Bookstack, coordinating obituaries, providing international agricultural research news, coordinating the new feature Reminiscences and Reflections, coordinating the Corporate Members' Page, and providing Upcoming Events. Volunteers would work alongside the current incumbent for a number of months, until the time comes to take over the role.

Occasional Technical Editors

The Coordinating Editor would be pleased to hear from members who would be willing to act as Occasional Technical Editors, editing items for publication in *Ag4Dev* from within their field of expertise. We hope to establish a network of Occasional Technical Editors, to work with and to complement the efforts of the two regular Technical Editors.

Paul Harding,
Coordinating Editor, *Agriculture for Development*

News from the Regions

New Coordinator appointed for Branches and Regional Groups

Fiona Johnson

We welcome Fiona Johnson to the Executive Committee (ExCo). Fiona lives in Wiltshire, UK, and has been involved with the TAA South-West Group. At the June meeting of ExCo she kindly volunteered to take on responsibility for the new post of 'Coordinator for Overseas Branches and UK Regional Groups'.

This post had been envisaged some years ago. The idea was recently resurrected by Sanjeev Vasudev, of our India Branch. We are now developing terms of reference for the new post, but the basic aim is that she should communicate with, and facilitate the activities of, our existing Overseas Branch Organisers (Bruce Lauckner, Caribbean; Sanjeev Vasudev, India; Wyn Ellis, SE Asia) and UK Regional Convenors (Tim Roberts, SW Group; John Gowing, Scottish Borders & NE England Group; Terry Wiles, London & SE Group; Keith Virgo, East Anglia Group). We would also hope that she can encourage new branches and groups.

Fiona has been co-opted onto ExCo, but her appointment will need to be endorsed by members at the AGM. Members can contact her on branch_coordinator@taa.org.uk.

Fiona is Managing Director of Vellag Ltd (http://www.vellag.com), an agricultural procurement company, focused on West Africa, supplying new and used agricultural machinery, equipment and spare parts for export to Nigeria and worldwide. Her responsibilities include meeting customers in Nigeria to take orders and to increase business contacts, visiting factories in Europe, Turkey, USA and Pakistan to check quality and compliance, and liaising with banks, customers, suppliers and shipping lines over letters of credit.

She has a diverse educational background, including Music Technology, Social Sciences and Accountancy.

Keith Virgo
TAA Chairman

News from the Regions

TAA South-West Branch, Cannington Seminar, 20 March 2014

Family farms at the heart of tropical agro-ecology for ecosystem security

Professor John Wibberley, Royal Agricultural University, Cirencester.
ejwibberley@btinternet.com

Introduction

Family has always been the key unit of kinship since human society has existed. More specifically, this is the nuclear family of two parents and their children, but it extends to grandparents and siblings and their offspring, including cousins several times removed from direct relationship, culminating in clans of common ancestry. Thus farmland may be worked physically and managerially by members of the same family and cover quite extensive areas. 'Family-worked' may mean providing physical work for two parents, their children after school hours and any surviving grandparents whose input may often be crucial to farm business survival (Wibberley, 1992). Among larger farming businesses, the majority may still be family-owned but with many family members being 'sleeping partners' as far as employment in farming is concerned (Gasson *et al*, 1988). Even in the USA, 98 percent of farms are in this last sense 'family farms' - though the other 2 percent of large agribusinesses produce 14 percent of total farm output. In the context of family farming, philosophical attention needs to be given to questions about the moral limits of markets (Sandel, 2012). Biosystems attention needs to be given to questions of natural capital and revenues of nature itself which tend to be taken for granted as having been delivered historically alongside responsible family farming (Juniper, 2013). Wider values derived from farming are usefully collated by Carruthers *et al* (2014) for the UK and are somewhat applicable elsewhere.

Farm-household systems for ecosystem security

In sub-Saharan Africa (SSA) some 80 percent of all food is still derived from small farms and is strategically and resiliently located where the people are. Farmers themselves perceive the biggest factor in sustainability as their own control over crop seed supplies, rotations and mixtures. However, in SSA, the yield gap between farmers' yields and potential yields is estimated at 76 percent, meaning farmers produce less than one quarter of what they could with better management. In Central America and the Caribbean, the yield gap is 65 percent (Arias *et al*, 2013). This indicates the huge potential for improved management, food preservation and local marketing, which is dependent upon many farmers - ideally working collaboratively.

Of huge significance is the heritage of place and inter-generational succession to it (Wibberley, 2005). The rural Prophet Micah articulated a valid vision of rural development (*'everyone under their vine and their fig tree and no-one making them afraid'* Micah 4:4) (Gwaivangmin & Wibberley, 2004). Sadly, conflict in many places around the world results in massive displacement. For instance, in Uganda there were some 1.8 million Internally Displaced People (IDP) at the peak of conflict in the north, with some 30,000 still remaining in camps either too old or weak or having no land to which to return. Inter-relationships in each place are significant. While these obviously vary with different agro-ecological zones, there are certain elements which make for ecosystem security and must be satisfied simultaneously at each place in sustainable agricultural management for future generations of people and other creatures (Figure 1). Ecosystem security is a comprehensive concept meaning the capacity of land to produce and go on producing all the requirements for livelihood security, including food, non-food items, water, energy, carbon sequestration, cultural and heritage needs.

An agrarian structure of small family-worked farms is a strength not a weakness, leading to resilience and potential sustainability. Conversely, their general demise and amalgamation into large agribusiness units is seen as threatening reduced resilience of ecosystem security with increased geopolitical instability. Furthermore, increasing dependency through ceding of farmer sovereignty over strategic managerial decisions is seen as counter to the genuine progress of human dignity and capacity-building.

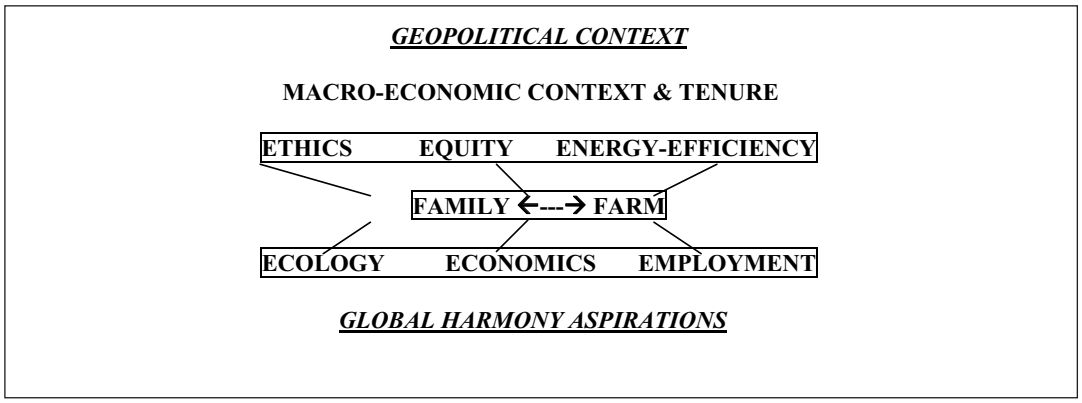


Figure 1. The dynamics between family and farm at the heart of global ecosystem security

Agro-ecology with family farms at its heart

Agro-ecological farming systems integrating trees are required in future (Maathai, 2009 and www.greenbeltmovement.org). The 'Great Green Wall' of trees proposed in 2012 by Dennis Garrity of the World Agroforestry Centre (ICRAF) will extend from the Senegalese coast to the Djibouti coast upon completion. It can be achieved when practices such as Evergreen Agriculture are used against desertification because its affordable, sustainable and accessible farming methods benefit not only rural smallholder farmers but also the environment, encouraging agro-ecological farming systems among the world's 500 million farm families (Wibberley & Turner, 2012; Wibberley, 2014).

Kassam & Uphoff (2012) enthuse about Laulanié's practical work on the 'system of rice intensification' with Madagascar's small farmers, using 2/3-leaf seedlings quickly transplanted at 25x25cm at 1 per hill, restricting watering and applying compost. This approach strengthens farmers' own control over their farming, with substantial improvement to outputs and resilience.

One of the greatest farming system hopes already adopted widely is 'conservation farming' (Wibberley & Turner, 2012). Based on moisture conservation from much reduced cultivation and mulching plus disciplined agronomy, conservation farming is already adopted on over half Brazil's arable land and by almost one-third of Zambian farmers, whose maize and other crop yields have increased typically by 60 to 200 percent or even more. Conservation farming merits promoting widely (Kassam, 2011; www.fao.org/ag/ca).

AGRA (Alliance for a Green Revolution in Africa) was set up in 2006 - with support from the Bill & Melinda Gates Foundation - as a not-for-profit organisation with its HQ in Nairobi, to emulate India's double yields of cereals. However, it is necessary to heed the now well-known agrarian structural downsides of India's green revolution, as well as the huge corporatisation agenda; farmers need to beware globalisation issues (Wibberley, 2004). Such corporatisation is resisted by the Alliance for Food Sovereignty in Africa (AFSA) set up in 2009 and consisting of a network of African Farmers' and Civil Society organisations, supported by Dr Vandana Shiva (Shiva, 2000). Farmers need to study and work together to increase not only their knowledge and pool of practical experience but also to boost their collective impact, both farm managerially and politically (Kyamuwendo & Wibberley, 2011).

The alternatives to family farmers internationally, 'there to care' for land and all its resources, freely associating in relational communities, do not bear contemplation. We further lose farmers at our common geopolitical peril. There are unwelcome indicators already, such as the spectacle of 40 percent youth unemployment in Kenya and elsewhere (such as Spain), depopulation in Bulgaria (predicted to be 35 percent down from 2005 to 2050), speculative land grabbing in Africa (Wibberley, 2011) plus the growing suicide rate among Indian farmers and their displacement by inequitable farm returns while hunger increases (Nagaraj, 2010).

Conclusions and Recommendations

The time is right to put the 'spotlight' on family-worked farms in this UN *'Year of the Family Farm 2014'*. This 'spotlight' involves first listening to farming families, researching their realities and realising the rate at which they are currently being lost, and the factors leading to this in the tropics and beyond. It is frequently over-borrowing that kills small farm businesses, plus unwillingness to diversify income sources in order to boost an inadequate aggregate return from farming - though small-scale tropical farm-households are less prone to this than their European and North American counterparts! (Wibberley, 1990). Secondly, research needs to be intensified towards collating practically proven means of improving the management of family-worked farms as viable entities. Thirdly, evidence needs to be collated on factors militating against family-worked farm survival, and to expose the longer term consequences of large-scale corporate farming with its consequent loss of farmer sovereignty. Ecosystem security requires improved management of natural resources by widely dispersed, independent but voluntarily collaborative, family-worked farms delivering resilience for a geopolitically sustainable future globally. There is huge hope and scope from such improved management among tropical farmers.

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South-West Branch Events

Date	Location	Event	Organiser/Convenor
16 October 2014	Royal Agricultural University, Cirencester	Seminar on *Agriculture and Conflict – Food and Peace*	Roger Cozens (with RAU)
8 January 2015		SW Branch Annual General Meeting, with lunch, Keynote Speaker, and short presentations	George Taylor-Hunt
19 March 2015	Cannington College, Bridgwater	Seminar on *Livestock Production*	To be confirmed
7 May 2015	Bicton College/BOAT	Country topic seminar to be confirmed	David Wendover (tbc)
July 2015		Visit to food processing plant	

Obituaries

We regret to announce the death in July of Geoff Wilkinson. A Memorial Service will be held at Leominster Priory at 14.00 on 29 August 2014. An obituary for Geoff will be included in *Ag4Dev23*.

TAAF News

Antony Ellman and Alastair Stewart

Eight MSc students from six UK universities received TAAF awards in April 2014. These enabled them to undertake overseas research for their dissertations, on topics ranging from forest resource management in Cameroon and Congo, to soil and water management in Burkina Faso and cocoa agroforestry in Peru. The full list of awardees and their research topics is shown below.

Many TAAF awardees from earlier years have graduated to important jobs in development. Richard Bliault (MSc awardee 2011) was until recently managing a smallholder coffee extension programme in Tanzania (his letter to the Editor describing how his award helped him to get this job appears on page 39 of this issue); Ben Frampton (long term awardee 2011) runs Conservation Agriculture training programmes for the Zimbabwean NGO Foundations for Farming in Zambia; Gediminas Lesutis (MSc 2013) is employed on an FAO food security project in Lesotho; Jessica Chu (PhD 2012) has almost completed her thesis on the impact of land grabs in Zambia; and Alastair Stewart (MSc 2011) works on an Aga Khan Foundation food security project in Mozambique (details in the box below).

Alastair Stewart writes:

In 2011, I graduated from the University of Reading's School of Agriculture, Policy and Development having completed my research on the *Impact of conservation agriculture on the livelihoods of smallholder farmers in Northern Tanzania*. The research was funded through the Tropical Agriculture Association's Award Fund and involved two months of field work in Arusha Region. The experience of conducting field research in Tanzania gave me the opportunity to oversee all stages of a research project and I gained an understanding of the challenges of fieldwork. I also was fortunate enough to co-author a case study for the FAO based on my research (http://www.fao.org/fileadmin/user_upload/agp/icm15.pdf).

After completing my Masters programme I began a one year internship with 'theIDLgroup', a UK based international development consultancy, with representative offices in South East Asia and West Africa (http://www.theidlgroup.com/index.html). They provide advisory, analytical and process support services to governments, non-government agencies, policy think-tanks and research groups. During my year with 'theIDLgroup', I was involved in a variety of activities including desk research to investigate conditions that affect agricultural technology and knowledge transfer through a project called *SIMLESA (Sustainable Intensification of Maize and Legumes in East and Southern Africa)*; a mid-term review of Practical Action's DFID PPA funding involving field research in Nepal; and proposal writing for large consortiums and a smaller consultancy project. The internship involved six months placement in the Bristol office and six months in the Ghana office in Accra, helping me to gain further overseas experience.

After completing the internship with 'theIDLgroup', I was offered a job with the Aga Khan Foundation (AKF) as the M&E Coordinator for a food security and incomes project being implemented in Northern Mozambique. The Aga Khan Foundation (AKF) is a non-denominational, international development agency established in 1967 by His Highness the Aga Khan. Its mission is to develop and promote creative solutions to problems that impede social development, primarily in Asia and East Africa (http://www.akdn.org/akf.asp). The *Enhancing food security and increasing incomes (FSI)* project in Northern Mozambique is a six-year project aimed at improving the overall quality of life of women and men living in Cabo Delgado province. FSI has two main components - food security (through adoption of improved agricultural practices and increased understanding of nutrition) and economic empowerment (through improvement in access to basic financial services and market development).

I have been in this role for 18 months and tasks have ranged from the review and roll-out of routine monitoring tools; development of management information systems (MIS); design and implementation of quantitative and qualitative studies; data analysis; report writing and presentations to the donor, as well as managing a small team of M&E Assistants. The study implementation and data analysis has been an interesting part of the role as they enable us to learn more

about the impact of the project. We are currently conducting yield measurement studies through crop cut and recall methods as well as exploring adoption rates of Conservation Agriculture (CA) practices, and in August we will be rolling out a panel survey to measure change in asset ownership and savings rates for members of community based savings groups (CBSGs). In early 2013 we completed a Food Security study using the Household Food Insecurity Access Scale (HFIAS) and Household Dietary Diversity Score (HDDS) to assess the situation of food availability and access amongst target communities during the lean season; and more recently a qualitative study investigated the distribution of workload amongst male and female producers and the extent to which women are involved in decision making at the household and community level.

Nearly three years on from my TAAF funded research in Tanzania, and I struggle to comprehend where the time has gone, but also how much has happened since then. There is no doubt that the Masters course at the University of Reading and research in Tanzania opened up the opportunities for me with 'theIDLgroup' and the AKF(M). As well as the TAAF fund, TAA has also been a great way of keeping up to date on the latest agricultural development issues and connecting with experienced professionals. Amir Kassam, who I first met when attending his class on Rethinking Agricultural Development, has also been instrumental in connecting me to various opportunities and I continue to work with him through AKF(M). I have also been working with the Publications and Communications Committee for *Agriculture for Development* to provide short summaries of the research conducted by other TAAF awardees, a task which makes me want to go back and do my studies all over again.

Case studies of other TAAF awardees can be read on the TAA website (www.taa.org.uk: click on TAAF and Case Studies). These show how effective the awards have proved in enabling many new graduates in natural resource subjects to get a foot on the ladder towards a career in development.

TAAF had a budget of £10,000 in the financial year 2013/14 and a similar amount is predicted for 2014/15. A large proportion of our money comes from generous donations made by individual TAA members: £9,300 was contributed in 2013/14, nearly half of it from a private family foundation established by a TAA member. With no other source of funding other than TAA itself, these donations are enormously appreciated. Without them TAAF would have great difficulty keeping its head above water.

TAA members are urgently requested to keep the funds flowing so that TAAF can continue its good work. A painless way of contributing in future may be for members to include a legacy to TAAF in their wills. An explanation of how this can be done, including important tax advantages that have recently become available both to donors and recipient, will appear in the next issue of *Agriculture for Development*.

2014 MSc Awardees

Applicant/ University	Course	Project Title/Country	Dates in the field	Mentor
Imperial				
(1) Ben Evans	MSc Conservation Science	Resource user responses to environmental and management change, Republic of Congo.	10/4-10/7	Antony Ellman Jonathan Stern
(2) Andrew Kirkby	MSc Conservation Science	Understanding burning regimes in Lac Tele, Republic of Congo.	21/4-19/7	Antony Ellman Jonathan Stern
Newcastle				
(3) Islam Abdel-Aziz	MSc Agricultural & Env Science	Impact of soil and water conservation and rainfall on soil fertility and crop yields in Burkina Faso.	2/6-14/7	Jim Watson
Reading				
(4) Richard Carpenter	MSc Climate Change & Development	Testing climate smart technologies using biochar stoves in Malawi.	15/5-1/8	Jane Wilkinson
Sheffield				
(5) Alexander Chaudhary	MSc Env Change & International Development	Safeguarding forest peoples alongside forest resource management in Cameroon.	4/6-1/8	Margaret Pasquini
(6) Miriam Denis La Seve	MA, International Development & Env Change	Institutional bricolage for analysing the communal management of water in rural Uganda.	3/6-15/7	Naysan Adlparvar
Southampton				
(7) Samuel Holmes	MSc Env Science	Charcoal use in Zomba, Malawi: a necessity or choice?	20/6-15/8	Laurence Sewell
UCL				
(8) Alex O'Connor	MSc Anthropology, Env & Development	Cocoa agroforestry and reforestation in the Northern Peruvian Amazon.	8/4-6/6	James Brockington

Corporate Members' Page

Rothamsted Research and climate change

Rothamsted is the longest running agricultural research station in the world, providing cutting-edge science and innovation for nearly 170 years (Figure 1). Our mission is to deliver the knowledge and new practices to increase crop productivity and quality and to develop environmentally sustainable solutions for food and energy production. No single approach can deliver sustainable agriculture with high productivity and value. A broad perspective that encompasses the whole plant system is needed and a careful balance of approaches is required. Rothamsted integrates biotechnology with other areas of science such as agronomy and agro-ecology so both existing and new knowledge can be implemented through agricultural practice. Our strength therefore lies in our integrated, multidisciplinary approach to research in plant and soil science. Here we summarise some of the research that Rothamsted undertakes on climate change.

Figure 1. Broadbalk, Rothamsted - the longest continuously running agricultural trial in the world

Agriculture and land use change are responsible for one-third of global greenhouse gas (GHG) emissions. These emissions have risen steadily during the 20th Century and pressures to increase food production to support growing human populations threaten to increase emissions still further, as climate change induced by the accumulation of GHGs threatens the sustainability of agricultural production. Rothamsted scientists research opportunities to mitigate emissions through modifications to agricultural management that involve more efficient use of inputs and promotion of carbon sequestration in the UK and across the world.

The use of nitrogen (N) and other fertilisers has been one of the keys to achieving food security in China. Grain production almost doubled in China between 1980 and 2010, yet total fertiliser use increased more than four-fold in the same period. There is overwhelming evidence that rates of N applied to many crops in many regions of China are greatly in excess of the rates required to achieve maximum economic yield. These excessively high rates, combined with inappropriate fertiliser management practices, such as timing and method of application, have led to very inefficient use of N and considerable losses to water and air with numerous adverse environmental impacts. As part of an international consortium, funded by the UK FCO and DFID, we have found the reasons for this and suggested appropriate technological solutions through changes in both fertiliser manufacture and agricultural use.

At the farm level, a particularly welcome change would be measures to promote more farmer-oriented approaches to the delivery of technical advice, such as the farmer field-school approach, and development of a contractor sector for fertiliser application.

New crop cultivars will be required for a changing climate characterised by increased summer drought and heat stress in Europe. However, the uncertainty in climate predictions poses a challenge to crop scientists and breeders who have limited time and resources and must select the most appropriate traits for improvement. Modelling is a powerful tool to quantify future threats to crops and hence identify targets for improvement. Rothamsted researchers have used a wheat simulation model combined with local-scale climate scenarios to predict impacts of heat stress and drought on winter wheat in Europe. Despite the lower summer precipitation projected for the 2050s across Europe, the relative yield loss from drought is predicted to be smaller in the future because wheat will mature earlier avoiding severe drought. By contrast, the risk of heat stress around flowering will increase, potentially resulting in substantial yield losses for heat sensitive cultivars commonly grown in northern Europe.

Our scientists reviewed research from the UK to quantify the impact on climate change mitigation of soil organic carbon

(SOC) stocks as a result of a change from conventional to less intensive tillage and the addition of organic materials including farm manures (Figure 2), digested biosolids, cereal straw, green manure and paper crumble. The average annual increase in SOC deriving from reduced tillage was 310 kg C ha^{-1} yr^{-1}. But even this modest accumulation of C is unlikely to be achieved in the UK and northwest Europe because farmers practise rotational tillage. In addition, nitrous oxide (a potent greenhouse gas 300 times more effective at radiative forcing than carbon dioxide) may increase under reduced tillage, counteracting increases in SOC. The addition of biosolids increased SOC a little but biosolids are typically already applied to soil, so increases in SOC cannot be regarded as mitigation. Large increases in SOC were deduced for paper crumble (>6 t C ha^{-1} yr^{-1}) but outweighed by nitrous oxide emissions deriving from additional fertiliser needed to offset the lock-up of N when so much C is added. Compost offers genuine potential for mitigation because application replaces disposal to landfill; it also decreases nitrous oxide emissions.

Figure 2. Manure application

In parts of the world, zero-tillage and conservation agriculture (CA, comprising reduced tillage, retention of crop residues and diversification of cropping systems) are promoted as a means of either increasing crop yields, achieving greater stability of yields between years, saving labour, and improving soil quality and hence system sustainability. There is some controversy about whether CA or its variations are appropriate in all situations. Whilst the approach almost always has positive impacts on soil quality, these do not always translate into increased crop yields. It is often claimed that the increased concentration of SOC resulting from CA is a form of carbon sequestration that mitigates climate change. In collaboration with CIMMYT, Rothamsted scientists have been critically evaluating the experimental evidence on this in the context of small-holder farmers in sub-Saharan Africa and the Indo-Gangetic Plains. Emerging results suggest that, while there is some tendency for climate change mitigation, the quantitative contribution is considerably less than is often claimed. This is because of a combination of sampling issues leading to data that may be misleading, interpretation of the data, and to barriers to uptake of the approach due to social and economic factors.

The dynamics of roots and carbon (SOC) in deeper soil layers are amongst the least well understood components of the global C cycle, but a better understanding is essential if soil C is to be managed effectively. Our scientists at North Wyke worked with US researchers to compare a harvested tallgrass prairie (with the C4 photosynthesis pathway) and wheat (with the C3 pathway) that were under continuous management for 75 years, to investigate and compare the storage, turnover and allocation of SOC in the two systems down to 1 m. Soils growing wheat contained 25 percent less SOC than the grassland soils. There was also a significant turnover of grassland-derived SOC down to 80 cm depth under the wheat. Grassland soils had significantly more root biomass C than wheat soils and microbial biomass C (in the living soil microorganisms) down to 1 m. Our research shows that: (i) SOC pools that are perceived to be stable are not always so and, in particular, are affected by land-use change; (ii) managed perennial grasslands, not surprisingly, contain larger SOC stocks and exhibit much larger C allocations to roots and soil microorganisms than an annual crop such as wheat.

Due to the complexity of SOC, mathematical models have proved very useful in helping to improve our understanding of how SOC might change as the climate changes. We used the Rothamsted carbon model (RothC), which considers the effect of climate, soil texture and crop management on SOC decomposition to predict changes in SOC under different land uses and the different climates that may occur in the UK in the future. SOC turnover was evaluated in land uses under different levels of agricultural intensification currently existing in southern Europe. Climate change scenarios were generated using two Global Climate Models: GISS (Goddard Institute of Space Studies, USA), and HadCM3 (Met Office, Hadley Centre, UK), for two of the Intergovernmental Panel on Climate Change (IPCC) emission scenarios (SRES A2 and B2). Land uses at low cropping intensity were more efficient than intensive agricultural systems in terms of SOC storage. Land use change to vineyards caused a loss of SOC, but amounts recovered as the vineyards became established.

Keith Goulding, John Crawford and David Powlson
Sustainable Soils and Grassland Systems Department, Rothamsted Research, Harpenden, Herts. AL5 2JQ

Concern Worldwide and climate smart agriculture

Introduction

Concern Worldwide is an international humanitarian organisation dedicated to tackling poverty and suffering in the world's poorest areas, with operations in 27 countries across Africa, Asia and the Caribbean. Climate change poses a significant risk for the poor, who are predominantly smallholder farmers, or who rely on cheap food produced by smallholder farmers.

Concern Worldwide's focus is on **adapting** to climate change through **climate smart agriculture (CSA)** which:

- Sustainably increases agricultural productivity, especially returns to family labour, and income, contributing to poverty reduction.
- Adapts, and builds resilience, to changes in the climate.
- Reduces or removes greenhouse gases.

Though many of Concern's interventions reduce greenhouse gas emissions or sequester carbon, Concern does not have technical expertise in carbon trading so does not, at this stage, work on climate change **mitigation**.

Farmers are used to surviving in highly unpredictable conditions. Innovative farmers may have already found local solutions to the effects of climate change, or elders may remember similar conditions when they were young, but some changes are outside the experience of the community and/or changes in the social, economic, political environment, particularly population growth, may make it impossible to go back to traditional, resilient, systems.

Changes in climate may reduce overall crop and livestock production and, through a variety of pathways, increases in CO_2 levels may reduce the nutritional value of crops, limiting the impact of current initiatives to combat chronic malnutrition and micro-nutrient deficiencies through agriculture (Myers *et al*, 2014).

Women and CSA

As readers will be aware, as much of the farming workload in Africa and Asia is carried out by women, women are the key entry point for CSA interventions. Unless female farmers approve of the technologies CSA will not be adopted, yet women in Africa receive less information than men on agricultural practices and climate issues (CCAFS, 2014). On the positive side, when female farmers are informed they tend to be faster adopters of CSA, when not constrained by land tenure issues. This is confirmed by Concern's work in Malawi and Zambia that found that women tend to adopt Conservation Agriculture faster than men. Contrary to previous reports, Concern Worldwide found that CA reduced the workload of Malawian women by around 34 days compared to conventional farming (Maher, 2012), and non-beneficiary women in Zambia asked to attend Conservation Agriculture training at their own expense. There are also significant yield gains when female farmers are mentored by female extension workers, but readers will be familiar with the challenge of encouraging more women to opt for careers in agricultural extension.

Figure 1. Planting basins prepared in the dry season for concentrating rain-water and plant nutrients, Nyanga, Zimbabwe.

Climate change analogue sites

Long-term investments in agriculture, like trees, need to be designed with the future climate in mind. Concern is currently testing the **climate change analogue sites** (http://analogues.ciat.cgiar.org/climate/) approach. In theory someone, somewhere, is already experiencing the climate that the project area will experience in *x* years' time. If you can predict what the project site climate will be like in year X it should be possible to find 'analogue sites' that are already experiencing these conditions and where farmers and herders have already adapted. Concern is currently working with the World Agroforestry Centre (ICRAF) to determine climate analogue sites in Chad and to model changes in tree species distribution up to 2030.

Crop and variety diversity

By growing a range of crops farmers can hedge against climate risks. This not only provides insurance against climate risks but also increases dietary diversity, improves soil fertility

management and may reduce disease incidence. In South Sudan the traditional approach to coping with climatic variability has been to plant a range of sorghum (*Sorghum bicolor*) varieties to ensure a yield in all but the most extreme weather conditions. In Liberia, farmers plant 5-7 varieties of rice; while in Niger, farmers may mix sorghum and pearl millet (*Pennisetum glaucum*) seed.

Concern Worldwide tries to ensure a supply of diverse local varieties, as well as helping marginalised farmers benefit from new varieties. Like most agencies Concern has moved away from direct provision of inputs to working with the private seed and input supply sector through seed fairs, seed vouchers, local production of Quality Declared Seed and, recently, E-vouchers: scratch cards for inputs where the dealer is reimbursed through mobile money.

Coping with drought

Concern supports a range of drought escaping, avoiding and tolerating varieties. Concern in Ethiopia has been working with the National Agriculture Research Institution to develop and promote drought tolerant taro (*Berekat*), a crop normally associated with wetlands.

Figure 2. Ethiopian drought tolerant Berekat taro (corm on the right) with corms from local plants.

Transplanting is one way to escape drought. Traditionally used for rice, transplanting also works for a range of crops. Seeds can be germinated using small amounts of water and then transplanted when the rains start. Concern piloted transplanting sorghum in Northern Uganda. The yields were good but transplanting was more labour intensive and there was little uptake by farmers. CA farmers in Western Zambia have, on their own initiative, started transplanting maize.

Some crops can withstand mild droughts, but currently few crops are fully adapted to drought. Wild species can be very drought tolerant and Concern has started working with ICRAF in Chad to identify drought tolerant wild fruit species, select the best individuals for collecting seeds, and train farmers in new nursery techniques that reduce the time to come into bearing.

After many years of stagnation, demand for sisal is rising as new uses are found. Sisal fibres are now used to make sound-proofing panels for cars, paper, geotextiles, carpets, and cortico-steroid drugs can be extracted from the pulp. Research by Dr David Machin in Eritrea, financed by Concern Worldwide, showed that sisal pulp (a by-product of sisal fibre extraction) can provide a good quality, easily stored, animal feed (Gebremariam & Machin, 2008). Concern Worldwide currently plants sisal in semi-arid areas to reclaim degraded land, so the next stage is to help farmers extract the fibres for sale and to utilise the pulp for their livestock. Farmers have earned up to $2,000 per year from Oxfam sisal projects in Tanzania, so Concern Worldwide is scaling-out the Oxfam model.

Figure 3. Lines of sisal planted to stabilise gullies in Ethiopia.

Pastoralism

Nomadic pastoralism is inherently climate smart, as it evolved to enable communities to exploit environments, often semi-arid, with heterogeneous and highly seasonal grazing resources that are unsuitable for more intensive livestock production or the production of grains. For the system to work, herders must be able to move their animals to where the grass is greener. National boundaries, game reserves, irrigated agriculture and conflict have reduced mobility. In Northern Kenya, Concern Worldwide has facilitated community dialogue to reduce tension and ensure reciprocal access to grazing resources.

Cattle raised by pastoralists may produce large amounts of methane per animal, but this has little overall effect on the net production of greenhouse gases per km^2. Grass not eaten by cattle would be eaten by other methane producing herbivores, including termites, or burnt in seasonal bush fires, releasing CO_2.

Livestock diversity

Climate change will affect livestock production directly through heat stress and water shortages, and indirectly through changes in grassland species to more drought tolerant, but less digestible, species and changes in the distribution of animal diseases. Over much of Africa, traditional cattle breeds have been crossed with Friesian Holsteins. This has resulted in a large increase in milk production but the cross-bred animals need large quantities of water and are vulnerable to heat stress. Protecting the genetic diversity of dryland breeds is an important CSA strategy. Concern Kenya has been working with the International Livestock Research Institute to protect

the Red Maasai sheep breed. To improve meat production and quality (such as 'marbled' meat for urban markets in Kenya, or large white sheep breeds for Eid celebrations), the traditional Red Maasai sheep have been crossed with other breeds. This has resulted in animals with a thick coat that is difficult to keep free from parasites, increases heat stress, and there has been a reduction in natural resistance to the parasitic nematode *Haemonchus contortus*.

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Paul Wagstaff

The UK Collaborative on Development Sciences (UKCDS)

The UK spends approximately £400 million a year on research directly relevant to international development. This includes exploring how to reduce the risks of natural disasters, tackle global health issues and increase food security. Money is also spent on improving the enabling environment for science, making sure this science has an impact on the lives of the poor and strengthening the capacity of low and middle income countries (LICs and MICs) to conduct their own high-quality research. The goal of UKCDS is to make the most of all these investments.

In 2004, a Parliamentary inquiry concluded that science and research was not being used effectively enough in the UK's approach to international development. A Development Sciences Working Group was formed to respond to the review's recommendations of a better coordinated approach to UK research for development. It decided to create the UK Collaborative on Development Sciences (UKCDS) - a group of (now) 14 UK government departments and major research funders, supported by a Secretariat - to provide a strategic overview of the development science research base and help to coordinate its work so as to maximise the impact of UK science.

It is this collaboration between development and science ministries, funding agencies and an independent research funder which makes UKCDS so unique. Since 2006, UKCDS has been facilitating research for international development by bringing people together, sharing knowledge and promoting opportunities. UKCDS works to stimulate collaboration and ensure the best science is funded and used to benefit international development, as well as the UK.

The Secretariat is based at the Wellcome Trust in London and has become well known for hosting in-depth workshops and fruitful, high-level discussions - in part thanks to its direct links to major UK research funders and policy-makers. As well as utilising its considerable convening power, UKCDS acts as an information-sharing network; disseminating important development news and providing a gateway to funding and job opportunities via its network of contacts and public facing channels.

Given the multi-disciplinary nature of science for development, the remit of UKCDS is broad and varied, covering all sciences and involving stakeholders in government, research organisations, higher education institutions and NGOs. The Secretariat tries to focus its work on key areas in which it feels it can add value, one of which is food security and agriculture.

From the very beginning, UKCDS has recognised the importance of agricultural research for development, and in 2008 worked with the International Agri-Technology Centre to produce *The UK Agri-Food Science Directory* - a comprehensive profiling of the UK's national and international agri-food science expertise. The directory was created as a resource for individuals and organisations outside of the UK, aiming to provide a who's who guide to enable new international partnerships.

Lately, the UKCDS Secretariat has been discussing agriculture on a panel focussing on the science and technology aspect of an Africa-EU partnership. UKCDS represents the UK Department of Business Innovation and Skills on the Bureau of the EU-Africa High Level Policy Dialogue on Science, Technology and Innovation. UKCDS was part of the discussion in 2013 when

the Bureau decided to focus on food and nutrition security and sustainable agriculture, and which led to the appointment of an expert working group to map out how the Africa-EU partnership will fund research to tackle these challenges.

Agriculture is, of course, intrinsically linked to the environment. This makes global climate change a major issue, and nowhere more so than in LICs and MICs where the effects of environmental change will be felt the most *and* where ensuring sustainable food security remains a crucial challenge. Climate change is therefore a significant area of interest for UKCDS members, reflected by the fact that 10 of our members are partners of *Living with Environmental Change*, a programme connecting world-leading environmental research.

Another example of UKCDS involvement in climate change research is the *Future Climate for Africa (FCFA) programme*. The FCFA programme was launched in April 2014 and aims to support research to better understand climate variability and change across sub-Saharan Africa that can lead to better adaptation measures. It is jointly funded by two UKCDS members - the Department for International Development (DFID) and the Natural Environment Research Council (NERC) - and the UKCDS Secretariat helped in the planning process. In 2013, UKCDS co-hosted a two-day workshop to bring together scientists, research users and intermediaries to help identify research priorities for the FCFA directly matched to the capabilities of the science needs of the users.

We live in a world where one billion people are hungry, and on a planet whose climate is undergoing drastic change. As a result, issues of food security and climate change are interconnected, at many different levels and over different time scales. Research can help us understand how to respond to these cross-cutting development challenges with multidisciplinary approaches and, especially in the context of agriculture, find in-country solutions by exploring the systems at work.

The UKCDS Secretariat is working with its members and other key organisations through a number of UK and international initiatives to coordinate agricultural research and address the challenges of climate change. We will continue to make science work for development by bringing people together, sharing knowledge and promoting opportunities.

For more information about us and our work please visit our web site www.ukcds.org.uk or get in contact at info@ukcds.org.uk.

Alex Gwyther
Communications Manager, UKCDS - Making science work for development

Newsflash

Dr Christie Peacock, Farm Africa's livestock specialist, receives CBE

Christie Peacock

TAA Corporate Member Farm Africa is hugely proud to announce that Dr Christie Peacock's work over three decades, to improve the lives of some of the poorest and most remote people in Africa, has been recognised at the highest level.

Christie's entire life has been dedicated to making the world a better place, right from her early years. Her decision to study agriculture at the University of Reading was driven by this passion, and her first visit to the remote parts of northern Kenya to study nomadic pastoralists inspired her PhD research on the Maasai, one of the first systematic studies of traditional sheep and goat management practices in Africa. Christie identified that, for women in particular, goats have many advantages over cows, and in 1988, aged 30, she started Farm Africa's first goat project in Ethiopia.

With only £120,000 funding from Band Aid – enough for just 12 months – and with no sign of continuing funding, Christie arrived in Ethiopia and spent weeks on the road, virtually living in a small 4 x 4 whilst she set up an office from scratch.

As the first example of her life-long mission to get the best science, technology and good practice to the poorest people, Christie set up a project providing goats on credit to women who had been widowed by war or drought. By cross-breeding the goats, she aimed to improve their milk yields to 1–2 litres a day to improve the nutrition of small children and give desperately poor families an asset to sell in times of trouble.

Two years later, after much persuasion, Christie received permission from the Director of Veterinary Services to train

women as 'barefoot vets' or Community Animal Health Workers to provide basic care to the goats. She then enhanced this model even further by adding a savings association to allow women to access credit to set up small businesses. As evidence of the success of this approach grew, it was replicated by Farm Africa across eastern Africa and is adopted to this day by many other development agencies.

Christie faced many challenges in her career in Africa, none more so than during the change of government in Ethiopia in 1991 when an outbreak of fighting saw Christie braving gunfire to rescue some of her precious cross-breed goats by distributing them into the hands of her farmers.

In 1999, Christie became CEO of Farm Africa and, over the next 11 years, she transformed the organisation from a small informal group raising £2m to a highly-regarded, professional organisation of £12m.

Christie's unstoppable drive, dedication and innovation have been a recurring theme of her career. Recently, Christie has established Sidai Africa Ltd, a social enterprise that provides livestock care services to farmers across Kenya as a commercial business (see *Ag4Dev17*,11-12). Despite huge initial scepticism, Sidai is now widely cited as a model of self-sustaining development.

As she looks back on her career to date, Christie reflected *'It is important to take the long view of Africa - to understand its past and have the courage to have a bold and positive vision for its future. If you are serious, never, never give up. Persistence pays off in Africa, and Africans appreciate people who make a long-term commitment. Looking back over thirty years in eastern Africa, the most important change is that the importance of the need to invest in African farmers in a sustainable way is much better recognised.'*

She continued, *'I am highly honoured by this award that also honours my former and current colleagues in Farm Africa and Sidai. I hope that in some way we have all made the world a better place and that I have made a contribution to developing my profession. I also hope that the award recognises the vital role that agricultural development plays in Africa.'*

From announcement by Farm Africa

Reminiscences and Reflections

A background to conservation agriculture: reflections on eight years in Brazil, 1980-1988

TF (Francis) Shaxson

Francis Shaxson worked in land husbandry and tea research in Malawi 1958-1976; in village agriculture in India 1976-1980; on land husbandry in Brazil 1980-1988 and in Lesotho 1988-90; as consultant to the Food and Agriculture Organization of the United Nations (FAO) and development agencies of several governments until 2002. Now retired, but still writing.

Summary

The author's career has concentrated on the improvements which can be wrought by the better husbandry of land, derived mainly from agro-ecological experiences in Malawi, India, Lesotho and Brazil. Formerly, much emphasis in controlling runoff and soil erosion was given to physical structures. More recently, better understanding of the ecology of plant/soil interactions has enabled development of strategies which improve and integrate biological, physical, chemical and hydrologic components of agro-ecosystems. Good land husbandry is exemplified by 'Conservation Agriculture'.

Introduction

On arrival in Brazil, neither my wife nor I could speak a word of Portuguese, and much hilarity ensued as we began to learn it the hard way - total immersion in the day-to-day life. We survived, and enjoyed living in Brasilia, high on the ancient soils of the Cerrado region, where I reported to the FAO Representative and to the Coordinator of Soil and Water Conservation in the Natural Resources Secretariat of the Federal Ministry of Agriculture.

The first task, within the one-year project FAO/TCP/BRA/8911, was to assess and report on the situation of soil erosion and its control in the country as a whole, and to suggest means of improvement and of any need for further support which might appear to be appropriate. This took the first year, travelling throughout Brazil, observing and discussing, to produce the first report, in collaboration with the Brazilian staff, for FAO HQ in Rome.

The report highlighted the severity and extent of erosion problems and the difficulties associated with remedying them; its recommendation for the provision of further technical support was subsequently approved, leading to my further seven years in the country, under Project FAO/UNDP/BRA/82/011.

Problems of land degradation

Brazil is huge: 8.5 million km^2, between longitudes 74°W-35°W and latitudes 6°N and 33°S - approximately 4,300 km between N-S and E-W extremities. Five main biomes are represented: tropical broadleaf rainforest (*Amazon*); seasonal swamp grassland (*Pantanal*); sub-tropical dry forest (*Caatinga*); wet/dry tropical savanna (*Cerrado*); broadleaf subtropical forest (*Atlantic*), each with a wide variety of soil types. (For a map, see IBGE (*Instituto Brasileiro de Geografía e Estatística*), in Landers, 2007).

Figure 1. Field with severe loss of topsoil and exposure of subsoil, due to high runoff from compacted layer due to heavy-disc tillage, São Paulo, Brazil (Photo: Francis Shaxson).

Serious problems of land degradation were widespread (Figure 1)and found within every major agro-ecological region - evidenced by significant runoff, soil loss, increasing seasonality of river-flows, flooding, sedimentation, damage to infrastructure, accompanied by decline in soil productivity and damage to roads and other infrastructures. The Brazilian Government was well aware of these problems, and had already widely promoted conventional 'soil and water conservation measures' in all the States, supported by significant erosion-research. Unfortunately, although there were already in Brazil thousands of kilometres of large conservation banks aligned strictly on the contour, they frequently broke and caused worse damage than before (Figure 2). Such measures did not on their own achieve what was expected. My earlier assessment had been that an overarching concept for 'achieving' - rather than 'doing' - soil and water conservation was needed, but how was this to be defined?

Figure 2. Conventional soil conservation 'works' didn't work. Compacted soil led to great volumes of runoff. Even these banks were sometimes over-topped and broke, causing much damage downslope, Paraná, Brazil (Photo: Francis Shaxson).

Towards solutions

In the southern state of Paraná, some innovative research, supported by GTZ *(Deutsche Gesellschaft für Technische Zusammenarbeit)*, was being undertaken in support of some farmers' early development of no-till farming, which had been sparked in response to severe economic and soil-erosion conditions which threatened the viability of their farms. This research focused on the effects of maintaining soil cover and on minimising the soil-damaging effects of tillage. It showed clearly the benefits of enabling rainwater easily to enter the soil and of keeping the soil covered with crop residues against the damaging effects of intense rainfall, thus significantly increasing the proportion of rainfall stored in the soil and minimising the risk of soil movement.

Collaboration between these few pioneering farmers and the researchers showed impressive results in minimising losses of water, soil, and applied inputs, and also in greatly-increased efficiency of water-use and of fertiliser-use in terms of yield/unit input, while at the same time lessening the energy required in field-preparation for planting.

Under the auspices of the FAO/UNDP Project, FAO mobilised a number of external consultants who had expertise relevant to the situation. While travelling in different parts of the country with them and with Brazilian colleagues, we gained insights particularly in agricultural hydrology (Pereira), agricultural economics (Timmons, Dumsday), soil conservation (Hudson), as well as (and most significantly) the ecological aspects - physical x chemical x biological x hydrological - of soil erosion and its avoidance (Downes).

The ecological principles articulated by Dr Downes, an eminent Australian, in his 1982 report for this FAO/UNDP project are in fact those enshrined in the World Soil Charter (FAO, 1982), (which I later realised he had recently finished writing for the United Nations, and to which readers of this article are referred in order to perceive the underpinnings of good land husbandry). The chief points made by Downes are given in Shaxson *et al* (1989). The key ingredient is the acknowledgement of the essential functions of the biological aspects of soils and plants, and their inter-relations, further detailed in Uphoff *et al* (2006).

All at once, all my past and present experiences fell into a pattern defined by the concepts and recommendations that Downes described. This was an astonishing moment. It suddenly provided not only a framework for my own future thinking and work, but also a validation of the ecological and practical emerging principles of No-till Farming being articulated in Brazil, which has now become known as 'Conservation Agriculture'.

Such principles underpin not only the current sustainable productivity of Brazil's soils under good no-till systems but also the marked improvements in river-flows, reduced production-costs in such agricultural systems, improvements in the lives of rural families and communities, and reduced cost of repairing flooding damage to private and public infrastructures.

Consolidation

The FAO/UNDP project also funded two study tours, on which I accompanied Brazilian Government staff members (a) to the USA and (b) to Australia and New Zealand, to see and discuss examples of conservation-effective agriculture in different agro-ecological situations, and thus show the validity of what had been suggested as a way forward for Brazil.

The principles of good land husbandry apply as much to small farms as to large ones. While larger farms aiming at

commercial crop production predominate in the undulating landscapes of São Paulo, Paraná, and Rio Grande do Sul, the more-hilly landscapes of the State of Santa Catarina, in the same southern region, have a predominance of much smaller farms, with a greater proportional dedication to production primarily for the household. Would the same principles apply to them also? The World Bank became interested in testing this possibility, and funded what proved to be a very satisfactory Land Management project in the State. The recommendations to move towards a mulch-based no-tillage approach to caring for land were conveyed by effective extension/advisory work, interacting with groups of farm families in topographic micro-catchments as the extension-planning units. The World Bank was well satisfied with the outcomes, which exceeded 100 percent of expectations of the number of farmers taking part and in the uptake of recommendations in many aspects (Figure 3). The experiences have been recorded by the programme's Brazilian leader (de Freitas, 2000). The sustainability of the system was judged to be good, validating the further promotion by FAO of such an approach in other small-farm situations beyond Brazil. On this basis, both FAO and the World Bank (among other agencies) serving farmers - both large and small - have subsequently promoted expansion of no-till farming systems into other countries across the world (eg Kassam *et al*, 2013).

Figure 3. Conservation-effective agriculture in action: maize direct-drilled through straw of previous wheat crop, Paraná, Brazil (Photo: Francis Shaxson).

Round-up

Those were enjoyable and informative years, which I much enjoyed and from which I benefitted greatly. The experiences enlarged the scope of my understanding of better land husbandry, whose ramifications are of the greatest relevance to optimising land uses and their management for achieving self-sustaining perpetuation of agriculture into the future.

The extent to which Brazil benefitted is not for me to say, but I was encouraged when, after a week's fieldwork training in land-resource assessment, one of the Brazilian trainees said: *'We knew all the individual facts, from our formal studies at school and university - but we never knew how they all fitted together'*. Perhaps my undefined role as a technical catalyst proved useful after all!

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Upcoming events

British Society of Soil Science Annual Meeting 2014

Date and time: 3-4 September 2014,09.00

Details: Delving into the dark - emerging techniques, approaches and tools for soils research. We will have presentations about the development and application of entirely new approaches as well as the novel application of existing techniques. You may be investigating soil biological, chemical or physical properties, soil processes or soil functioning in its broadest sense. We would like to hear how these techniques, approaches and tools could improve our understanding of soils and how we can use these to tackle the global challenges of more food, water and energy alongside habitat conservation and mounting soil degradation. Keynote speakers: Dr Jennifer Pett-Ridge - Mapping Soil Carbon from Cradle to Grave: C Transformations from Plant Roots to Microbes to Mineral Surfaces and Professor John Crawford - 'Towards a Theory of Soil'.

Venue: Manchester University, Manchester, United Kingdom, 3rd and 4th September 2014.

Contact: Registration details to follow shortly. For more details email the Event Coordinator events@soils.org.uk

International Symposium on Agroecology for Food Security and Nutrition

Date and time: 18-19 September 2014, 09.00

Details: The Symposium is being organized by CIRAD, INRA, the French Ministry of Agriculture and the FAO. Visit the dedicated web site for the Agroecology Symposium http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/international-symposium/en/, including the draft programme http://www.fao.org/fileadmin/templates/agphome/scpi/Agroecology/Linear_AG_Agenda_Website_16_June_V1.pdf

Venue: FAO, Viale delle Terme di Caracalla
00153 Rome, Italy

Contact: Please download the registration form http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/international-symposium/symposium-registration/en/ to participate in the meeting and email completed form to: Juliette.prazak@fao.org or john.choptiany@fao.org. Moderator, Amir Kassam.

Seminar on 'Agriculture & Conflict - Food & Peace'

Date and time: 16 October 2014, 10.00

Details: Joint seminar by TAA SW Group and RAU, with focus on agriculture in conflict zones. Details to be posted later.

Venue: Royal Agriculture University, Cirencester, UK. GL7 6JS.

Contact: RSVP Tim Roberts
(southwest_organiser@taa.org.uk),
or JohnWibberley (ejwibberley@btinternet.com)

AGM, Ralph Melville Memorial Lecture & Reunion

Dates: 10 December 2014,17.00

Details: The TAA will hold its Annual General Meeting at the Royal Over-seas League. This will be followed by the Ralph Melville Memorial Lecture to be given by Mike Bushell of Syngenta Research (title awaited) and the annual reunion, with buffet dinner. The cash bar will be open. This is the first announcement: please add to your diary. More details to follow.

Venue: Royal Over-seas League, Piccadilly, London SW1A 1LR

Contact: Details of ticket charges will be announced. Please contact Elizabeth Warham general_secretary@taa.org.uk for more details

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The latest journal will be sent to full members.

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TAA Executive Committee

Regional Group Convenors

Scotland/North of England

John Gowing, University of Newcastle upon Tyne, 1 Park Terrace, Newcastle upon Tyne NE1 7RU.
Tel: 0191 222 8488; email: scotlandne_convenor@taa.org.uk

South-West

Tim Roberts, Greenways, 15 Marksbury, Bath, Somerset BA2 9HS
Tel: 01761 470455;
email: southwest_organiser@taa.org.uk

Bill Reed, 7 Woodlands Mead, Marnhull, Sturminster Newton, Dorset DT10 1JW. Tel/Fax: 01258 820245;
email: southwest_organiser@taa.org.uk

London/South-East

Terry Wiles, 54 King George Gardens, Chichester, West Sussex PO19 6LE. Tel: 07971 626372;
email: southwest_convenor@taa.org.uk

East Anglia

Keith Virgo, Pettets Farm, Great Bradley, Newmarket, Suffolk CB8 9LU. Tel: 01440 783413;
email: eastanglia_convenor@taa.org.uk

Specialist Group Convenors

Agribusiness

Roger Cozens, Coombe Bank, Tipton St John, Sidmouth, Devon EX10 0AX. Tel: 01404 815829;
email: agribusiness@taa.org.uk

Land Husbandry

Amir Kassam, 88 Gunnersbury Avenue, Ealing, London W5 4HA.
Tel: 020 8993 3426; Fax: 020 8993 3632;
email: landhusbandry@taa.org.uk

Environmental Conservation

Keith Virgo, Pettets Farm, Great Bradley, Newmarket, Suffolk CB8 9LU. Tel: 01440 783413;
email: environment_conservation@taa.org.uk

Overseas Branch Coordinator/Organiser

TAA India: **Sanjeev Vasudev**, S-154, Greater Kailash II, New Delhi 110048, India. Tel: +91 98101 12773.
email: india_organiser@taa.org.uk

TAA Caribbean: **Bruce Lauckner**, c/o CARDI, PO Box 212, University Campus, St Augustine, Trinidad & Tobago
Tel: 1 868 645 1205/6/7; email: caribbean_organiser@taa.org.uk

TAA SE Asia: **Wyn Ellis**, 4/185 Bouban Maneenin, Ladplakhad 66, Bangkhen, Bangkok 10220, Thailand. Mobile: +66 818 357380;
email: seasia_organiser@taa.org.uk

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Robert Lewin Graphic Design
Tel: (01353) 722005
lewin994@btinternet.com

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