Chapter 5 Climate Change and African Agriculture: Unlocking the Potential of Research and Advisory Services

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Introduction

Throughout sub-Saharan African countries, people's livelihoods, poverty and food insecurity are linked to a risky and uncertain agricultural setting which accelerating climate change and other interconnected stressors threaten to make even worse (Niang *et al*., 2014). Agriculture is also a significant contributor to climate change either directly through farming-related greenhouse gas emissions or indirectly through forest clearance (Smith *et al*., 2014). Under these conditions, there is a potential for African agricultural research and advisory[1] services to become key actors in strengthening adaptive capacity and enhancing resilience– and more speculatively in embracing opportunities offered by climate mitigation and low-carbon development in agriculture – through the promotion of agricultural innovation and learning.

This chapter relays findings from the Climate Learning for African Agriculture (CLAA) project to show the current obstacles to African research and advisory services in realising this potential. These obstacles include: the disjuncture throughout Africa between climate policies on the one hand and agricultural policies on the other; the limited learning resulting from localized projects; and the generic resource constraints experienced by government services. Key issues for unlocking the potential will include: embracing and taking further the turn from dissemination of technology to facilitating innovation systems; dealing with climate variability and risk, including through seasonal forecasting, as a basis for longer-term adaptation; assuming the role of brokering or facilitating contacts between farmers and climate finance; uptake of new opportunities from information and communication technologies; and continuous learning within and between policy, service delivery and farmer levels.

Changing contexts for agricultural research and advisory services

A renewed focus on agriculture, by African governments and development donors, can be seen as acknowledging the multiple roles of agriculture, but also as putting multiple, and by some interpretations competing, demands upon it. These demands include (see Lamboll and Nelson, 2012a, Lamboll *et al*., 2011): ensuring the livelihoods of millions of existing farmers and their families; contributing to national food security (or in some readings "food sovereignty"); ensuring wider employment; contributing to national economic performance and growth, including through exports of crops and livestock; and supporting the provision of other ecosystem services such as water management and biodiversity, recognizing that natural resources are finite.

There are several other important features of the context in which African agriculture is developing (Lamboll *et al.*, 2011, citing Larsen *et al.*, 2009 and World Bank, 2007). These include most obviously globalization and the increasing connection of local production and livelihoods through international value chains to global preferences, trade standards, national

policies and phenomena such as animal disease outbreaks. They also include issues of knowledge, innovation and technology. Technological change is accelerating and becoming increasingly non-linear in a global economic network composed of diverse stakeholders, with the more rapid transmission of ideas and new interactions that the internet now facilitates among technologies, markets and policies. Knowledge is now networked: information and technology are no longer located in a single source such as a university or research centre, so innovation requires interactive collaboration often across widely dispersed sites. Rapidly advancing technology raises new questions of governance, for instance in relation to intellectual property rights and to genetically modified crops.

Additionally, it is important to note the increasing regional element in African agricultural policy, especially the establishment and development of the Comprehensive Africa Agriculture Development Programme (CAADP) of the New Partnership for African Development (NEPAD) and the African Union, to increase co-ordination of agricultural policies and share knowledge. CAADP has established its four "Pillars" or key focus areas: Land and Water Management, Market Access, Food Supply and Hunger, and Agricultural Research. Lamboll *et al*. (2011) note that there is little mention of climate change under the CAADP themes, a situation that does not seem to have markedly changed since.[2]

Added now to all these factors is climate change itself, which presents the imperatives for the agriculture sector in Africa countries to become resilient to climate change – fulfilling the multiple expectations on it within a warmer, more extreme and more uncertain climate – and also to reduce its significant greenhouse gas emissions, and/or provide opportunities for enhancing carbon sinks. In this sense the approach of Climate Compatible Development (CCD), the topic of this book, needs to be extended to agriculture. However, there are other labels for such an approach, most notably "climate-smart agriculture" (CSA), as reviewed critically by Arakelyan *et al*. (this volume), and it also connects to broader ideas of agroecology, sustainable agricultural intensification, green growth and the green economy (for a fuller discussion see Lamboll and Nelson, 2012a and 2012b). In the CLAA project we found very few concrete examples of mitigation activities in our four country case-studies, and also found that stakeholders in agricultural research and advisory services were relatively unlikely to use either the CCD or CSA labels. We accordingly did not foreground either the CCD or CSA terminology in the course of the research or the resulting reports, but the conclusion of the current chapter takes up the theme of how and through what approaches CCD can be made to happen in the agricultural sector.

Changing approaches to agricultural research and extension

There have been important changes in the way agricultural research and advisory services, in developing countries generally and in Africa, are understood, planned, funded, managed and implemented. The evolution of agricultural research shows strong medium-term trends towards: considering the perspectives of farmers, including the specific perspectives of women and youth; partnerships, between different sorts of research institutions, public and private, in different countries; not simply producing knowledge, but re-engaging with the dissemination of knowledge, including the dissemination, sharing and use of existing

knowledge; and capacity-building, linked to all the new roles and modes of working expected of research organisations. These trends have been strongly endorsed by development donors (Global Donor Platform on Rural Development, 2012a, 2012b, 2013). Another trend is an increased emphasis on information management, in both a technical sense of making use of new information technologies but also a broader sense of responding to stakeholder needs and building human resources for information management (Nathaniels *et al*., 2008).

Common to both research and advisory services is a shift away from a dominant model of linear technology transfer – transfer from research, through public extension, to the farmer – towards a greater emphasis on Agricultural Innovation Systems, defined by Pound and Essegbey (2008: 48) as "a dynamic, multi-stakeholder partnership working together to develop and use technologies and processes to improve livelihoods".

Much of what is happening in the conception and implementation of advisory services[3] can be considered part of this shift to an Innovation Systems paradigm. Swanson (2008) and Christoplos (2010) note the broader range of actors becoming involved, and the more multi-directional flow of information from stakeholders including advisory services that could and should influence research programmes and agendas. There is a view that the role of advisory services has rightly shifted from a service that 'extends' research-based knowledge to a role of facilitation, learning and support to farmer groups, and that it must include marketing and linking to a broader range of service providers and agencies (Davis, 2009). Leeuwis and Hall (2010) also use the vocabularies of "intermediation" (specifically a broader intermediation between more than just technology suppliers and farmers), "network brokerage", and "facilitation" for these trends, which they see as further necessitated by the requirements of climate change adaptation. Thus, agricultural extension can be defined as "the entire set of organisations that support people engaged in agricultural production and facilitate their efforts to solve problems; link to markets and other players in the agricultural value chain, and obtain information, skills and technologies to improve their livelihoods" (Davis, 2009: 1).

As well as changes in the conceptualisation of advisory services, there have been institutional changes, most notably a move away from straightforward public funding and public provision of advisory services towards a more pluralistic combination of public, private and NGO roles in funding and provision of services, new conceptions of accountability to clients, and a heightened concern with monitoring and measuring outputs and outcomes. There have also been changes in extension practice, including an increased emphasis on participatory and group-based advisory methods, and learning by doing, as in Farmer Field Schools, and exploration of the potential of information and communication methodologies (Lamboll *et al*., 2011, see also Leeuwis and Hall, 2010). The way these changes have played out is of course by no means uniform or equal across African countries.

Climate challenges and opportunities in Africa

For the period between now and 2035, besides average temperature rises of around 1°C

across sub-Saharan Africa, models project increases in overall rainfall and changes in seasonal distribution of rainfall for West and East Africa, and drying trends in Southern Africa, especially for April to September rainfall, and particularly for Zambia and Zimbabwe.[4] It is important to note that these projections do not take into account rainfall variability and the prospects of heavy rainfall events, droughts, late onset of rains, in-season dry-spells etc. In general it is accepted that climate change will increase such variability and the likelihood of extreme events, and that impacts of extreme events will be among the most important impacts of climate change in rural areas of the developing world, including Africa (Dasgupta *et al*., 2014), especially in the near- and medium-terms.

Volume II of the Fifth Assessment Report presents assessments of likely impacts on Africa (Niang *et al*., 2014). An important conclusion, presented with high confidence, is that "climate change will interact with non-climate drivers and stressors to exacerbate vulnerability of agricultural systems, particularly in semi-arid areas" (Niang *et al*., 2014: 1202). With varying degrees of confidence, Niang *et al*. note projections of reductions in cereal crop yields, adverse impacts on perennial crops such as coffee, and increased problems of pests, diseases and weeds for crops and livestock, all in an increasingly complex context of demographic pressure, urbanisation and globalising food chains.

The chapter of the report on food security and food systems (Porter *et al.*, 2014) assesses large numbers of projections pointing to the decline in yields of major food crops under climate change, globally but particularly in the tropics. The chapter also demonstrates the potential benefits of agronomic adaptations in (at least partially) overcoming projected yield decreases associated with climate change. This evidence particularly relates to the benefits of choice of more appropriate cultivars, even more powerfully if this is combined with adjustment of planting dates.

Niang *et al*., 2014 emphasise livelihood-based approaches - for example participatory research, improved communication about climate risks and fostering livelihood diversification – more than they emphasise technological adaptation They also note the progress made in Africa in managing risks to agriculture from climate variability and other stressors, but also that current efforts will be inadequate to adapt to longer-term climate change.

Two contrasting but not contradictory lines of argument are relevant to the way African farmers can be helped to adapt. Thornton emphasises the need for external and science-based assistance in the face of rapid and profound climate change:

> *The issue of climate change and African agriculture cannot be left entirely to African farmers' undoubted skills in risk management. Climate changes in the next few decades will make agriculture in many places in Africa completely unlike anything Africa's farmers, even their great-grandparents, have experienced. The knowledge and skills built up in communities in Africa over the millennia are simply not going to be enough to deal with the scale of the changes that we know are going to come about.*[5]

On the other hand a strand of literature emphasises the local specificity of climate impacts on "complex, diverse and risk-prone" (Chambers *et al*., 1989: xviii) farming systems, making impacts hard to model (Morton, 2007). The chapter on worldwide rural areas of the IPCC Fifth Assessment Report (Dasgupta *et al*., 2014), which assesses much material on Africa, notes the multiple, interacting impacts of climate change on smallholder farmers and other groups of the rural poor, and emphasises the multiple factors that increase their vulnerability. The same chapter states that "public decision-making for adaptation can be strengthened by understanding the decision-making of rural people in context, and in particular considering examples of autonomous adaptation and the interplay between informal and formal institutions" (Dasgupta *et al*., 2014: 638).

The two arguments, taken together, point to the need for support to agricultural innovation that is place-based, harnesses both scientific research and local knowledge, and fosters shared learning and engagement between smallholders and broader stakeholders. This is the challenge for research and advisory services in Africa.

Our research

Our research centred around four country case-studies, designed to assess the extent to which agricultural research and advisory services (public, NGO and commercial private sectors) have incorporated climate considerations in their policies and operations. The case studies were also intended to identify practical strategies for making agricultural knowledge management, and thus smallholder agricultural development, more climate-compatible, through a strong emphasis on *collective learning processes*[6]. For case-study countries we chose Sierra Leone, Benin, Uganda and Mozambique, which represented a geographic spread across natural environments, climate types and language boundaries.[7] The case studies, which took different approaches to both the assessment and the learning objectives, were set in motion from May 2012 and reports were finalised, and placed on the project website, in mid-2013.

The following sections of this chapter use findings from the case-studies: on how agriculture is represented in national climate policies; how climate change is incorporated in national agricultural policies, and in the policies and practice of national agricultural research and advisory services; and what was learnt at the local level of districts and projects. The concluding sections cover issues of learning that arose at various stages of the research, and some conclusions and ways forward.

Agriculture in national climate policies

The majority of countries in sub-Saharan Africa have national climate policies. These may be enshrined in documents associated with international policy processes such as the National Adaptation Programmes of Action (NAPAs), National Communications to the UNFCCC, Intended Nationally Determined Contributions, or in independently initiated policies of national governments. Governments have also generally established bodies such as inter-ministerial committees to elaborate and co-ordinate climate change policy. The case-studies examined policies and policy mechanisms to see the extent to which agricultural issues and

agricultural stakeholders were represented in either.[8] Our overall conclusions centre round the inclusion of substantive agricultural issues in national climate policies, but with weak linkages for the involvement of agriculture ministries in the policy process.

Sierra Leone (Suale, unpublished report) submitted a NAPA in 2007. The NAPA lists priority areas, which are in effect outline project descriptions, in some cases linked to specific districts. Within the field of crop agriculture, these include development of inland valley swamps for rice production,[9] and development of irrigation and drainage, with various other more cross-cutting priorities regarding natural resources, environmental management, alongside priorities for forestry, fisheries, water, energy and several other sectors. Sustainable agriculture and food security is also a key element in the framework for drafting the National Climate Change Policy. In addition, a number of initiatives in agriculture are included as priority actions for mitigation in Sierra Leone's Second National Communication to the UNFCCC: better practices in rice cultivation, fodder modification to reduce livestock methane emissions, control of savannah burning, and improved use of crop residues. However, it appears that agriculture is somewhat marginalised in the climate policy *process*. The Environmental Protection Agency, which falls under the President's Office, houses the National Secretariat for Climate Change and is regarded, with the Meteorological Department of the Ministry of Transport and Aviation, as one of the two institutions responsible for the implementation of climate policy. There is an inter-ministerial National Committee on Climate Change, but the Ministry of Agriculture, Forestry and Food Security is represented on the committee by the Forestry Director, rather than anyone with a mandate on crops or food security.

Benin has also submitted a NAPA and two National Communications to the UNFCCC (Moumouni and Idrissou, 2013a). These documents include analyses of the forestry and agriculture sectors from the points of view of emissions, vulnerability and adaptation. There is a full analysis of multiple categories of direct and indirect impacts on agriculture[10]: projected declines in yields, increased unpredictability of rainfall, as well as impacts on or through agricultural labour supply, prices, throughput of processing industries, animal health and fisheries. Autonomous adaptation strategies are identified and planned adaptation strategies are proposed in detail, including water resource management and promotion of new practices to farmers. Organisationally, the key coordinating body is the National Committee on Climate Change, under the authority of the Ministry of the Environment and Nature Conservation. The Ministry of Agriculture is represented on this committee through the Directorates of Agriculture, of Forestry and Natural Resources, and of Fisheries, and also through the Benin National Institute of Agricultural Research (INRAB), and the National Centre for Agro-Pedology.

In **Uganda**, the National Development Plan of 2010 "emphasises the need for a statutory order to fast-track integration of climate change into local legislation and relevant sector policies" (Mangheni *et al*., 2013) and policy is led by the Climate Change Unit within the Ministry of Lands, Water and Environment (MLWE). The NAPA of 2007 prioritises nine projects of which six (Community Tree Growing, Land Degradation Management, Water for Production, Drought Adaptation, Vectors, Pests and Disease Control, and Indigenous

Knowledge and Natural Resources Management) are directly related to the agriculture/natural resources sector. Agricultural stakeholders at the national level are generally content with the NAPA process and the level of inclusion of agriculture. However, there are concerns about: the speed of implementation; the low level of budgetary resources available for agricultural activity within the NAPA, for example for breeding drought-resistant varieties and for promotion of irrigation; and the absence of detailed strategies necessary for implementation, such as the need for markets for tree products to accompany tree-planting projects. There are also concerns that the location of climate policy in MLWE has delayed the elaboration of climate policy specifically for the agricultural sector.

Mozambique has important differences from the other countries, in that it has a recent history of catastrophic riverine flooding, and a much longer coastline. These facts dictate that (relative to the other case-study countries) disaster management is emphasised more in the NAPA, although strengthening the capacities of family farmers to cope with climate change is one of four NAPA objectives (Parkinson, 2013). The Ministry for the Coordination of Environmental Affairs takes the overall lead in climate policy and planning, although the National Institute for Disaster Management is also influential. The Ministry of Agriculture has been identified in an IFPRI report (IFPRI, 2011) as one of eight main institutional players in climate policy, but in practice has only been weakly engaged.

Overall, our four case studies show the inclusion of substantive agricultural issues in national climate policies, but in general terms there are weak linkages for the continuing involvement of agriculture ministries, which cannot bode well for the quality and implementation of policies in the agriculture sector. If agriculture was "just another sector" in African countries this would not be seen as a problem, but much stronger integration of agriculture is needed at the heart of national climate policy processes, for three reasons. Firstly, agriculture is by far the largest sector in the economic activity, the employment profile and the export earnings of mist African countries, including all four case-study countries (Morton *et al.*, 2014). Secondly, natural resource use, including agriculture, relative to other sectors is particularly and directly sensitive to climate variability and climate change (Dasgupta *et al*., 2014, Niang *et al*., 2014). Thirdly, notwithstanding arguments on Africa's share of greenhouse gas emissions and lack of historic responsibility for mitigation, the agricultural and forestry sectors represent a major share of emissions, worldwide and in Africa, and therefore present important opportunities for mitigation (Smith *et al*., 2014). For all these reasons, there is a need for a privileged role for agriculture not only in the content of national climate policy but also in the process by which policy is made - a need that is not currently being met.

Climate in agriculture policy

As the last section has examined the extent to which agriculture is incorporated in national climate policy, this section examines the ways in which climate change issues were reflected in national agricultural policy: national policies for agriculture and agricultural development in general, policies for agricultural research and advisory services in particular.

In **Sierra Leone**, there is no overall policy for agricultural research, although the relevant agency, the Sierra Leone Agricultural Research Institute (SLARI), has developed its own

strategic and operational plans (Suale, unpublished ~~material~~report). The latter contains a section on "Sustainable Environmental Management and Climate Change". This starts from the assumptions that there is a need for data and information on climate and that farmers and other agricultural stakeholders need assistance in dealing with the effects of climate change and climate variability. Intervention strategies include: agricultural value chain analysis with identification of constraints and opportunities presented by climate change; and development and scaling up of adaptation and mitigation technologies. In practice, there is a focus on the development of drought-tolerant and early maturing varieties of cassava, cowpea, sorghum and pearl millet. An innovation platform approach, as promoted by the DONATA project of FARA[11], including an effort to understand farmers' own approaches to climate change and risk management, will be a key entry point for climate change activities.

Agricultural advisory services are poorly developed, delivered by multiple and not necessarily well-coordinated actors including government, universities and the private sector, and still dominated by the use of calendars and pre-selected messages – though there are increasing moves to a Farmer Field School approach. The extension service within the Ministry of Agriculture, Forestry and Food Security (MAFFS) is developing its own strategy and operational plan, which do recognise climate change and climate variability as urgent issues. MAFFS is also developing mechanisms for collecting and disseminating weather information for farmers.

Agricultural and rural development policy in **Benin** is governed by a number of policy documents (Moumouni and Idrissou, 2013a). None focus specifically on the challenges of climate change for agriculture, but several take them into account. In particular, policy statements from 2010 onwards explicitly recognise that:

> *"the productive agricultural sector in Benin is characterised by the predominance of small farms and the sector's vulnerability to climate variability and extreme weather events. Current climate challenges…could further exacerbate the difficulties, delay the relaunch of the agricultural sector, and hamper efforts to reduce poverty"* (Moumouni and Idrissou, 2013a: 12).

Threats of climate change to agriculture include: decline in average rainfall, decline in soil fertility, decreased production and yields, reduction of water resources, changes to the agricultural calendar and risk of food insecurity, as well as reduction of fisheries resources and deforestation. Adaptation strategies proposed include development of land and water management strategies at local level, early warning, farming practices for water conservation, and development of short-cycle crop varieties.

Benin has a well-developed network of agricultural research centres under INRAB: one INRAB-implemented project is discussed in Section 5 below. Agricultural advisory services are decentralised to the levels of Départements and Communes. Benin has made important policy declarations on moving from previous extension approaches based on dissemination of knowledge from research to farmers ~~extension~~ (*vulgarisation*) ~~approaches~~ towards the use of agricultural advisory services (*conseil agricole*). The latter are being developed under project funding, particularly the French-funded PADYP project. Such projects do not directly set out

to address climate change, but there is a feeling that PADYP's farm advisers will be able to put farmers in touch with appropriate expertise on climate-related topics.

In **Uganda**, the Ministry of Agriculture, Animal Industries and Food does not have a climate change policy of its own (Mangheni *et al.*, 2013). There are criticisms that the location of climate policy in the Climate Change Unit of MLWE has delayed this process, and made it less transparent to agricultural stakeholders. Climate change concerns are incorporated into the overarching Development Strategy and Investment Plan for the agricultural sector, which specifically mentions: water for production, pest, vector and disease control; and improved communication on key agriculture-climate issues. The Agricultural Technology and Agribusiness Advisory Services (ATAAS) programme, which serves as a key part of the strategy by building research-extension linkages, explicitly writes in climate change, especially through mention of climate risk in its sub-component on sustainable land management. Implementation of the programme is still in early stages, and there are criticisms that it does not recognise some areas seen as important in the NAPA, including indigenous knowledge, farm forestry and climate information. The Uganda National Farmers Federation, in an audit of the NAADS[12] programme (UNFFE, 2011), was critical of NAADS's lack of leadership on climate change and failure to institutionalise climate issues; more climate adaptation technologies needed to be included in NAADS packages. Uganda's National Agricultural Research Policy dates from 2003, and does not explicitly mention climate change, even when there are clear opportunities for climate-related research in agriculture. [13]

In **Mozambique**, the Strategic Plan for Development of the Agriculture Sector (which also functions as Mozambique's CAADP Compact agreement) is intended to address mitigation and adaptation measures, mitigation relating mainly to an envisaged REDD+ programme, but also carbon sequestration through agro-forestry (Parkinson, 2013). The adaptation measures include reduction of vulnerability to disasters, improved community-based natural resource management, and improved soil and water management, but MINAG itself has no programmes to implement these measures, apart from their limited incorporation in to agricultural extension. The Mozambique Institute for Agricultural Research (IIAM) carries out some research highly relevant to climate change, for example on soil fertility, soil conservation, erosion control and development of drought-tolerant varieties. Previously such research has not been explicitly designed for climate adaptation, but IIAM is beginning to be involved in donor-funded projects that have a more explicit climate focus. Agricultural advisory services are provided by a wide range of public, private and civil society organisations, with rather weak co-ordination and weak linkages to research. The main governmental extension service, DNEA, has low levels of funding and operational capacity, does not have climate-specific programmes, but has identified some interventions relevant to climate change, including promotion of soil and water management, improved seed, fire management and diversification through bee-keeping.

In general, across the four countries, there is little explicit recognition of climate change within high-level agricultural policy, and limited attention to climate change in research and extension policies. The perception that climate change is a topic for environmental policy-

making may be a factor in this. Policies and practice in the agriculture sector address important topics of natural resource management and of agricultural risk management that are relevant to climate change, but do so without putting climate change centre-stage. With the partial exception of Benin, the climate threat is seen as an intensification of current patterns of extreme events. Questions of resource scarcity and low coverage remain inescapable for both advisory services and research.

Experience at project level

Three of the four case-studies used local-level projects, two or three per country, as their primary lens for investigating experience at local level[14] (the Uganda case-study, while gathering information from a large number of relevant projects used more of a district lens to present perceptions, experiences and issues). The projects were supported by different donors and were being variously implemented by national NGOs, government bodies and international agencies. Some of the projects were specifically designed to work in a single area, some worked in several areas across a country or even across several countries, some were national programmes with pilot implementation areas, but all involved work at a local level with farmers (other national-level projects, including capacity-building projects, were contacted in the case studies and are mentioned by them in various connections).

Most of the projects explicitly mentioned climate change in their project titles and key documents, but in one, the Drought Tolerant Maize for Africa project, the linkage to climate change was rather more implicit. However, this project demonstrates, and we feel it is more widely true, that many projects concerned with managing the risks of climate variability, but without an explicit focus on climate change, allow valuable learning opportunities regarding climate change. Some of the projects, such as BRACE in Sierra Leone, started from a low knowledge base on climate change and start with exploring farmer perceptions of climate threats, and fostering discussion on climate change among stakeholders. Others identified specific threats or challenges, including increased unpredictability of rainfall amounts, changing or less predictable rates for rainfall onset, risks of serious drought and risk of flooding. These projects based themselves on broad-brush climate trends or climate *uncertainty* rather than specific downscaled projections.

The projects could be seen as on a continuum ranging from pure knowledge provision, through breeding and seed supply, and involvement in other input supply and marketing, to provision of hardware and infrastructure, especially in irrigation. In two cases, the Bas-Fonds project in Benin and the GEF project in Sierra Leone, the same highly specific adaptation strategy - intensification of rice production in lowland valleys - was central to project design. In the Benin case this represented a transformational shift to this form of cultivation, from rain-fed maize cropping on higher ground (see Box 5.1).

The particular set of projects covered in our case-studies did not include any with a central focus on climate services in the sense of provision of near-term or seasonal forecasts or drought early warning, although there were important early warning activities in projects in Mozambique and Benin. However, interest in climate services and seasonal forecasting

among donors and researchers in Africa has strongly increased in recent years (see Tall *et al*., 2013, Dasgupta *et al*., 2014, and many other sources).

<BOX 5.1 HERE>

Box 5.1 The Project for Sustainable Management of Agricultural Land in the Bas-Fonds in the Context of Climate Change in Southern Benin

This project, launched in 2014, was funded by the START Programme, CDKN and the CGIAR, and implemented jointly by the University of Parakou and Aldipe, a national NGO already active in the area. The project was premised on the increasing variability and unpredictability of rainfed maize harvests in Southern Benin, which was felt to amount to an "existential" threat to their livelihoods, and the previous research that rainfed farmers were unaware of the agricultural potential of the bas-fonds (seasonally flooded valley bottoms) and ways to exploit them, even when bas-fonds were available within comparatively short distances.

Project activities included both technical and socio-economic studies to define the concrete steps necessary for maize farmers to use the bas-fonds in rice cultivation; creation and strengthening of farmer groups to participate, in the planning of bas-fonds cultivation, the construction of irrigation and drainage infrastructure, and joint learning on cultivation (though production remains based on family plots); and facilitation by Aldipe of linkages to input suppliers and markets for rice.

The project has been ambitious in aiming for a geographical displacement of farm production, a transformation in farming systems, and by implication a change in dietary habits. It appears highly successful and farmers reported positively on the end to cycles of forced sale of maize before buying it back, a reduction in labour migration to Nigeria, and an end to the "wretchedness" (misère) of their previous existence. In terms of project implementation, four points stand out.

1) The project has had a relatively major infrastructural component (relative to many NGO and action-research projects) in supporting drainage of the bas-fonds and demarcation of irrigable plots.

2) The project has had to grapple with questions of land tenure; there were traditional claims of ownership to bas-fonds land even where it was not being exploited, that had to be carefully and patiently negotiated.

3) The commitment to farmer learning, and support to it through multiple learning and awareness strategies, has not only given farmers technical knowledge but has also led to "a change in relations between the people…and their physical and institutional environment" (Moumouni and Idrissou, 2013b: 10).

4) Aldipe has had to pay close attention to the development of a new value chain for rice, and to input supply. It has itself sourced rice seed from farmer seed-banks elsewhere in the country, collaborated with the Benin National Agricultural Research Institute on varietal development, facilitated farmer seed-selection and seed-exchange, collaborated with the local governmental research/extension centre in fertiliser supply, and provided credit to farmers for fertiliser. Aldipe has purchased a de-husking machine for the producers, and advised on rice marketing to local merchants, having experimented unsuccessfully with collective marketing through the National Office for Food Security.

Our Benin case-study expressed certain reservations about the level of farmer participation in

strategic decision-making, and whether farmers were being empowered to negotiate more long-term and sustainable access to inputs and marketing opportunities, but did emphasise the importance in particular of the value-chain approach in removing key constraints to the adapted livelihood the project promoted.

Source: Moumouni and Idrissou (2013b)

Only one of our case-study projects, the United Nations Joint Programme in Chicualacuala District Mozambique, had any strong focus on mitigation activities – in this case agroforestry and conservation agriculture (which can be viewed as having both adaptation and mitigation benefits) and alternative energy supply. These aspects are discussed in Box 5.2.

<BOX 5.2 HERE>

Box 5.2 Mitigation-Oriented Activities in the United Nations Joint Programme on Environmental Mainstreaming and Adaptation to Climate Change, Chicualacuala District, Mozambique

The programme, which ran from 2008 to 2012, operated both at the level of national policy and at grassroots level, with around 1000 direct beneficiaries, in Chicualacuala District, an area of the Limpopo basin prone to both droughts and floods. MICOA, the Ministry for the Co-ordination of Environmental Affairs, is the lead implementing partner, assisted by other government ministries, research institutes, provincial and district governments, the National Union of Peasant Farmers (UNAC), the International Union for the Conservation of Nature, and Save the Children Fund.

Beside adaptation activities, building on but also going beyond existing community coping mechanisms, the programme has promoted several activities aimed mainly at emissions reduction, or having significant mitigation co-benefits:

- Establishment of agro-forestry demonstration sites for fruit or fodder trees; the demonstrations were popular but actual reforestation achievements limited;
- Provision of solar energy systems, including establishment of solar-powered boreholes for irrigated vegetable production;
- Promotion of conservation agriculture (minimum tillage, maintenance of soil cover and intercropping); intercropping cereals and legumes was widely adopted but minimum tillage and maintenance of soil cover were difficult to introduce in the presence of established patterns of draught animal use and livestock grazing;
- Biogas generation and promotion of composting.

Source: Parkinson (2013)

There are a range of opportunities for smallholders to get involved in mitigation activities, and benefit directly from them in the form of payments for environmental services and climate finance, but there are also serious challenges, especially in achieving equity (Lamboll *et al*., 2011). Advisory services also have an important role to play in advising farmers and other actors on negotiating involvement in biofuel schemes. In spite of these opportunities, our case-studies and wider evidence-gathering suggest that there are not yet significant numbers of donor-funded agricultural projects in Africa combining adaptation and mitigation objectives.

Themes from the projects

There are important general issues about project experience in the field of agriculture and climate change, including the all too common tendencies for projects to work in isolation from developments in "mainstream" national services and national policy, for the benefits of projects to be limited to direct beneficiaries and target communities rather than achieving more geographically widespread impacts, and for even those benefits to dissipate after project completion, typically a three- or five-year cycle. Such concerns were raised in all our case-studies.

Four issues more specific to climate-compatible agricultural research and extension emerged from the projects studies. These are the importance of taking a value chain approach to adaptation, the importance of integrating input supply with information provision, and the question of multi-stakeholder co-ordination. Perhaps even more important than these is a cluster of issues around the importance of *learning*.

Value chains

The importance of value chain approaches for agricultural research and advisory services is underlined in emerging redefinitions of extension such as that of Davis (2009) quoted above, and in the published policies of government research and advisory services (such as that in Sierra Leone, see Section 4 above). In climate change research we have seen the importance given to globalising food chains as a contextual factor for climate impacts in the Africa chapter of the IPCC Fifth Assessment Report (Niang *et al*., 2014). Where a new variety or crop is introduced, in the name of climate adaptation or for other reasons, consideration should be given to the value chain along which it will be processed and marketed, and farmers should be supported to contribute to and benefit from existing value chains or construct new ones. However, we saw little evidence that climate change projects or services were using value chain approaches in researching, planning and promoting adaptation.[15]

A successful exception, which is presented at more length in Box 5.1, was the Bas-Fonds Project in Benin. This was also one of the projects that involved the most radical or transformational adaptation in farming systems, by promoting irrigated rice cultivation to farmers traditionally growing rainfed maize. To do this the project had to become involved in processing, by supplying a rice de-husker to the farmer group, and also facilitate farmers marketing their new crops. There is a need for further identification and study of projects using a value chain approach with new crops and varieties in the cause of either adaptation or mitigation. A value chain approach will also allow due consideration of the risks - of encouraging dependency on particular crops or particular markets – of such strategies.

Input supply

Projects and services working on climate and agriculture have to be prepared to involve themselves also in issues of agricultural input supply. Where the objective is to change agricultural practices, the supply of information is unlikely to be sufficient, and external actors may need to ensure that other necessary inputs, such as fertilisers, pesticides, tools and

credit, are also available. Again the Bas-Fonds project in Benin (see Box 5.1) is a useful example: the NGO involved, Aldipe, facilitated supply of rice-seed, fertiliser and agricultural credit. Another project in Benin, the Drought Tolerant Maize for Africa project, was actually designed around the promotion of a specific input, improved seed: yet at the time of our study the linkages that would have created a sustainable seed supply chain from breeders through supervised multiplication to farmers were not yet in place. The question of linkages to input supply needs to be addressed not only during the project lifetime and on a local scale, but if the benefits of the project are to be sustainable, also at a policy and institutional level and at a sub-national or national scale.

Multi-stakeholder co-ordination

Rather than suggesting that the organisations involved in dissemination of knowledge should themselves take responsibility for purchasing or selling produce or inputs, the case studies underline the importance of proper *co-ordination* among all the relevant stakeholders in agricultural adaptation.[16] The project in Chicualacuala, Mozambique (Box 5.2), which involves a very wide range of implementing agencies, is a good example of co-ordination among ministries, research institutes, local governments and NGOs. However, there are strong arguments to include in these networks a broader set of stakeholders than this - private sector traders and processors, whether from the formal or informal sectors, or in the form of SMEs or large companies.

Learning

Our research raised the issue of learning in the following ways: learning within projects; learning between projects; the organisation within our study of stakeholder workshops and their results; and the possibilities for learning presented by new information technologies. Our findings resonate with recent work on social learning in climate change response.

Learning by farmers is a key theme of most of the projects studied, but has been most explicitly explored for Benin (Moumouni and Idrissou, 2013b). That case-study, following Daane (2010), sees *what* is learnt and *how* it has been learnt as key criteria in judging the performance of an innovation system. It also adopts the "double loop" terminology of Argyris and Schön (1978): the first loop consists of solving problems and reflecting on how they were solved, the second loop consists of relating this learning to the original assumptions. "When it is collective, learning should enable the stakeholders involved in the innovation process to learn from each other, to learn from the process, and to produce new knowledge" (Moumouni and Idrissou, 2013b: 2).

As much learning in projects relating to climate change and agriculture can also be categorised as "participatory research", the well-known continuum developed by Biggs (1987), of contractual, consultative, collaborative and collegial participation can also be a useful tool in categorising exactly what is happening in such projects. These tools and other approaches are of relevance particularly to the analysis of the limits of learning in the PRECAB project (Box 5.3).

<BOX 5.3 HERE>

Box 5.3 The Project to Strengthen Economic Knowledge and Adaptive Capacity in the face of Climate Change in Benin (PRECAB)

PRECAB is a project that aims to improve the adaptive capacity and resilience to climate change of local communities in Benin. The project began in 2011, as a successor to the previous PARBCC programme (2007-2011). Our case-study focussed on PRECAB activities in the village of Koïwali, Bassila Commune in northern Benin, where the project is leading participatory trials on identifying optimal sowing dates for maize and the use of *Mucuna* as a green manure. However, farmers really only contributed land and labour to these trials, making the research process "contractual" in Biggs' (1987) terminology. At the end of the process, farmers adopted new sowing dates, but did not seem to have reflected, or been encouraged to reflect, on the learning process that generated them. They were not asked why they had not themselves been able to identify more suitable sowing dates, or whether they would be able to refine the choice in future. When asked about the future during our study, farmers replied they would have to ask the project adviser. The situation with *Mucuna* was more complex, as farmers adopted a practice of growing *Mucuna* in pure stands, at variance with the trial treatment, demonstrating a learning experience that was an unintended side-effect of the project.

In general, our case-studies show a pattern of *slippage* of projects, away from participatory approaches. This may be generic to projects using participatory approaches, but it is certainly a risk to guard against in climate and agriculture projects. Projects that are designed to use participatory research approaches, and feature participation in their rhetoric, risk coming to prioritise specific outputs and technologies over the learning and capacity-building processes that would contribute better to building farmer resilience.

Our research also directly facilitated learning by stakeholders, in Benin through meetings between different projects, in the other three countries through national stakeholder meetings. The significant learning generated is suggested by a summary of the main topics in Box 5.4.

<BOX 5.4 HERE>

Box 5.4 Main Categories of Findings from National-Level Stakeholder Workshops

Sierra Leone:
- Major institutions holding knowledge of climate change
- Potential users of climate change information and knowledge
- Constraints in organising, accessing and using climate change knowledge, as identified by researchers, farmers, advisory service providers and local leaders/policy-makers

Uganda:
- Critical missing aspects of climate change responses, for research and advisory services
- Recommended media for communication of information on climate change, for farmers, advisory service providers, and policy-makers
- Constraints in organising, accessing and using climate change knowledge, as identified by researchers, farmers, advisory service providers and local leaders/policy-makers

- Suggested practical strategies and appropriate actors to implement them, as suggested by researchers, farmers, advisory service providers and local leaders/policy-makers
- Factors driving and limiting climate change response, in research and advisory services
- Recommended actions

Mozambique:
- Agriculture's contribution to the causes of climate change, and effects of climate change on agricultural production
- Recommended actions, at community level and at national level
- Major constraints to adaptation in agriculture

In Uganda, the workshop was able to identify factors driving and limiting climate change response, in research and advisory services, as identified across stakeholder groups. The limiting factors could be summarised as issues of low capacity and poor co-ordination, including (for research) the perception of climate change as an environmental not an agricultural issue, and for advisory services, failure to implement policies and low capacity of the Agricultural Advisory Service Providers (frontline advisory workers from various organisations). The Uganda workshop was also able to set out in detail the constraints in organising, accessing and using climate change knowledge, as differentially identified by specific stakeholder groups (in this case researchers, farmers, advisory service providers and government actors). A key common theme in the recommendations produced by national workshops was that of information management, between stakeholders within and between national and local levels. There were also more nationally-specific workshop recommendations, such as calls for the establishment of a National Climate Change Secretariat in Sierra Leone.

The additional district-level workshops in Uganda recommended district-wide networks linking a wide range of local stakeholders including farmers, local and national government, NGOs and the private sector, to be co-ordinated by a District Secretariat. The workshops seem not only to have identified this need but to have produced concrete actions to satisfy it: in Nakosongola District it was agreed that an interim committee draft terms of reference for a district climate change forum.

Workshops in all three countries, and the discussion provided in the Uganda case-study, emphasised media for communication, including the possibilities presented by new information and communication technologies. At farmer level, a broad spectrum of means of communicating with farmers, and encouraging farmers to communicate between themselves and with local stakeholders will be needed: traditional communication media such as flyers and posters but also mobiles, radio, video, and participatory use of GIS. For the national and regional levels, the Uganda case-study discusses the opportunities of online platforms, but also the need to avoid duplication of internet platforms, and ensure they do not overshadow face-to-face communication. The Uganda study, drawing on the work of Flor (2011) in the field of climate change and biodiversity management, makes the case for web-based content management systems integrating multimedia content, geographic/geospatial information, a metadata search engine, messaging and collaboration and networking. Such a system would

need an agreed and specific role within broader patterns of open communication and innovation on climate and agriculture issues between all stakeholders.

Our case-studies demonstrate the importance of critically examining how initiatives on climate and agriculture, such as the projects we looked at, perform from the point of view of learning. The workshops organised within the studies, with their wealth of insights and recommendations, show the potential for collective and cross-stakeholder learning on climate and agriculture. Here there is a strong connection with the findings of Harvey *et al*.'s (2013) review of social learning, and its conclusion that "one of the greatest challenges remains institutionalising social learning to ensure its sustainability. This warrants considerable investment and engagement, and documenting these would contribute important lesson-learning to this field" (Harvey *et al*., 2013: 5).

Conclusions: making African agricultural research and advisory services more climate compatible

The multiple threats that climate change poses to agriculture in Africa act in synergy with other forces that hold back development for Africa as a whole and for the rural poor of Africa in particular. The impacts of climate change and climate variability are exacerbated by existing socio-economic stressors, including under-investment in agriculture, problems with land and natural resource policy, and processes of environmental degradation (Dasgupta *et al*., 2014), but also household and community-level inequalities (Olsson *et al*., 2014), and poor access to services. Conversely, climate change erodes the assets of the poor and thus further heightens their vulnerability (Olsson *et al*., 2014). At the same time, international expectations grow on African countries to reduce agriculture- and landuse-related greenhouse gas emissions, accompanied (hopefully) by new opportunities from climate finance. These threats and opportunities present a need for climate-compatible development in the agriculture sector (or climate-smart agriculture, though this term can be critiqued for an excessive focus on agronomic processes over policies). African agricultural research and advisory services must assume a key role here, and the dissemination of new thinking on agricultural innovation presents a favourable environment for this.

There are however multiple barriers to increasing the climate-compatibility of agricultural research and advisory services in Africa:

- Generic resource constraints: governmental services remain under-funded, and in many cases dependent on donor funding which is often delivered through projects that are time-limited, focused on particular areas, or governed by donors' own priorities. The mainstream government services continue to have limited capacity to reach farmers. Recent developments in out-sourcing advisory services to NGOs or the private sector have not fundamentally changed this picture of limited outreach.
- Multiple expectations: agriculture and the services which support it are expected to simultaneously serve growth, equity, food security and sustainability goals.
- Slippage of projects away from participatory approaches: projects designed to use participatory research approaches may come to prioritise outputs or technologies over

processes of learning and capacity-building.

- Disconnects between projects and policies: positive experience in projects (NGO or donor-funded) frequently fails to be sustained after project completion, scaled-out geographically or scaled-up into policy.
- Disconnects between climate policy and agricultural policy: agricultural stakeholders have limited participation in national climate policy processes dominated by environment ministries, and agricultural policies (for the sector as a whole or for specific aspects such as research and advisory services) may not give adequate priority to, or adequate detail about, climate change.
- Limited attention to agricultural mitigation (e.g. through agro-forestry): there appear to be poor linkages between agricultural agencies and climate finance. As interest in mitigation through e.g. agro-forestry and on-farm tree planting grows, agricultural agencies may be missing opportunities to facilitate farmer linkages to voluntary carbon markets and climate finance schemes such as REDD+ and the CDM.

There is then both an important need, and a significant opportunity, for work that will enhance the role of African agricultural research and advisory services in assisting farmers to adapt to climate change, and in building long-term farmer resilience. Knowledge, innovation and learning, including the generation of new knowledge through research, the harnessing of farmers' own capacity to innovate, and the mobilisation of effective advisory services, will be key issues. We suggest more tentatively, because of a scarcity of evidence, that there is also scope for those services to enhance climate mitigation and low-carbon growth through agriculture. There are opportunities to move forward at various scales; the establishment of good practice at local or project level should not be neglected, and regional or pan-African initiatives will also be important. However, in our view the level or scale where new work on this theme is most needed is a *national* one. It is at the national level that climate and agriculture policies are made, implemented and integrated with each other (or not), and at which key institutions and organisations, such as NAROs, are established and structured. National policy-makers, and those who advise them, must make greater efforts: to mainstream agriculture into climate policy; to mainstream climate into agriculture policy; and to assert the importance of knowledge, innovation and learning in policies and practice. For all these levels, we can identify a number of key issues and approaches in strengthening of research and advisory services for climate-compatible agricultural development.

Dealing with present climate variability and risk is an essential strategy for engaging farmers in adaptation. Smallholder farmers almost universally see present climate uncertainty as a greater threat than long-term climate trends – and their adaptations to uncertainty are in any case likely to be a basis on which adaptation to longer term trends can be built. It is significant that one of the most transformational of the adaptations we saw, of rain-fed maize farmers to irrigated rice farmers in Benin, was still presented to farmers and to the outside world as an adaptation to unpredictable maize harvests. Drought is a climate threat that has obvious scope for integration into agricultural projects and policies. In Mozambique, we saw examples of projects that are able to address both agricultural threats and threats of floods and storms. Where the circumstances are appropriate, agricultural adaptation can be

promoted, to farmers and other stakeholders, in the context of preparedness for a wide range of climate hazards. There is increasing evidence that *climate information,* in the form of short-term or seasonal forecasts, can be delivered at scale to farmers in ways they understand, trust, and can act upon. There is a need to integrate climate information services with the creation and dissemination of knowledge on adaptation alternatives.

With the growth of opportunities for *climate finance* (voluntary carbon markets, Clean Development Mechanism) for activities such as on-farm tree planting, agro-forestry, and carbon sequestration through soil management, agricultural advisory services could have a critical role, both at the level of facilitating policy debate and identifying synergies, trade-offs and good practice, and also in improving farmers' access to information about climate market mechanisms, including REDD+. Lamboll *et al*. (2011) have concluded that a good aggregator or coordinator is essential, that combining that role with a capacity to advise on agricultural practices is advantageous, and that there should be simple, accessible and transparent monitoring. This role of agricultural advisory services in brokering or facilitating contacts between farmers and farmer organisations and such institutions should be explored, bearing in mind the need for learning about what approaches work, where and with what implications for equity.

Adaptation, particularly where it involves new crops or farming systems, rather than simply new varieties or farming practices, will require an increased focus on *value chains, input supply and marketing* alongside production: agencies involved in knowledge creation and dissemination will also need to pay attention to these aspects, whether by involving themselves in marketing and input supply, or, more likely, in facilitating farmers' contact with other stakeholders, almost certainly including those in the private sector. Innovation in climate and agriculture will also require *innovative ways of using Information and Communication Technologies* for managing and disseminating knowledge.

Work on climate adaptation in agriculture centrally concerns *learning*. At a local or project level, work will benefit enormously from the adoption of *participatory research* methodologies. Within these, there are strong arguments for "collegial" research, where decisions are taken collectively by stakeholders including farmers. Participation should be seen not just as a short-cut to new agronomic adaptation strategies, but as a means of learning from farmers' needs and empowering them. Agencies which follow a participatory approach should establish clarity about why they are promoting participation, and the degree of participation envisaged, and monitor the levels and types of participation and learning that result.

But learning must also be central to initiatives beyond the farm and community levels - at district, national and regional level. Learning needs to take place between different stakeholders – agricultural researchers, advisory service managers, climate scientists, the private sector, local governments, representatives of line ministries and policy-makers. Development actors must also ensure that there is linkage between learning at the different levels; that national-level stakeholders learn from farmers' experiences about what works, what does not work and what is needed.

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References

Acacha Akoha, J. J. (2003) *Stratégie Nationale de Mise en Œuvre au Bénin de la Convention Cadre des Nations Unies sur les Changements Climatiques*, Cotonou: MEHU.

Argyris, C. and Schön, D. (1978) *Organizational Learning: A Theory of Action Perspective*, Reading MA: Addison-Wesley.

Biggs, S. (1987) 'Proposed Methodology for Analysing Farmer Participation in the ISNAR OFCOR Study', *ODI Agricultural Administration (Research and Extension) Network Paper 17*, London: Overseas Development Institute.

Chambers, R., Pacey, A. and Thrupp, L.A. (1989) Introduction,, in Chambers, R., Pacey, A. and Thrupp, L.A. (eds.) *Farmer First: Farmer innovation and agricultural research*, London: Intermediate Technology Publications.

Christoplos, I. (2010) *Mobilizing the Potential of Rural and Agricultural Extension*, Rome and Gland: FAO and GFRAR.

Daane, J. (2010) 'Enhancing performance of agricultural innovation systems', *Rural Development News*, 1: 76-82.

Dasgupta, P., Morton, J., Dodman, D., Karapinar, D., Meza, F., Rivera-Ferre, M.G., Toure Sarr, A. and Vincent, K.E. (2014) 'Rural Areas', in Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, Y.O. and White, L.L. (eds.) *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge and New York: Cambridge University Press.

Davis, K. (2009) Agriculture and Climate Change: an agenda for negotiation in Copenhagen; the important role of extension systems, *IFPRI 2020 Vision Focus 16, Brief 11*, Washington, D.C.: IFPRI.

Flor, A.G. (2011) *DENR-GIZ Adaptation to Climate Change and Biodiversity Conservation Project – Knowledge management for Climate Change: Strategic and M&E Plans 2012-2016*, Quezon City: Department of Environment and Natural Resources.

Global Donor Platform on Rural Development (2012a) 'Promoting Scientific Partnerships for Food Security: The G20 Conference on Agricultural Research for Development', *Platform Policy Brief No.7*, Bonn: Global Donor Platform on Rural Development.

Global Donor Platform on Rural Development (2012b) 'Donor Methods to Prioritise Investments in Agricultural Research and Development', *Platform Policy Brief No.8*, Bonn: Global Donor Platform on Rural Development.

Global Donor Platform on Rural Development (2013) *On Common Ground – Donor perspectives on agriculture and rural development and food security and nutrition*, Revised

version following member consultation in 2012-2013, Bonn: Global Donor Platform on Rural Development.

Harvey, B., Ensor, J., Garside, B., Woodend, J., Naess, L.O. and Carlile, L. (2013) 'Social Learning in Practice: A review of lessons, impacts and tools for climate change adaptation', *CCAFS Working Paper no. 38*, Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

IFPRI (2011) *Climate Change: Assessment of institutional systems and government organizations in Mozambique*, Washington, D.C.: IFAD-IFPRI Strategic Partnership Programme.

IPCC (2013) 'Annex I: Atlas of Global and Regional Climate Projections' [van Oldenborgh, G.J., Collins, M., Arblaster, J., Christensen, J.H., Marotzke, J., Power, S.B., Rummukainen, M. and Zhou, T. (eds.)], in Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P.M. (eds.), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge and New York: Cambridge University Press.

Lamboll, R., Nelson, V. and Nathaniels, N. (2011) *Emerging Approaches for Responding to Climate Change in African Agricultural Advisory Services: Challenges, opportunities and recommendations for an AFAAS climate response strategy*, Kampala: African Forum for Agricultural Advisory Services.

Lamboll, R. and Nelson, V. (2012a) 'Exploring the Links between Climate Change, Agriculture & Development', Climate Learning for African Agriculture, *CLAA Working Paper No.1*, Chatham Maritime: Natural Resources Institute, University of Greenwich.

Lamboll, R. and Nelson, V. (2012b*)* 'Exploring the Linkages and Guiding Concepts Relevant to Climate Change, Agriculture and Development', Climate Learning for African Agriculture, *CLAA Working Paper No. 2*, Chatham Maritime: Natural Resources Institute, University of Greenwich.

Larsen, K., Kim, R., and Theus, F. (2009) *Agribusiness and Innovation Systems in Africa*, Washington, D.C.: The World Bank.

Leeuwis, C. and Hall, A. (2010) *Facing the Challenges of Climate Change and Food Security: The role of research, extension and communication institutions*, Occasional Papers on Innovation in Family Farming, Rome: FAO.

Mangheni, M.N., Kisauzi, T. and Miiro, R. (2013) 'Climate Learning and Knowledge Management within Uganda's Agricultural Research and Advisory Services', Climate Learning for African Agriculture *CLAA Working Paper No. 7*, Chatham Maritime: Natural Resources Institute, University of Greenwich.

Morton, J. (2007) 'The impact of climate change on smallholder and subsistence agriculture', *Proceedings of the National Academy of Sciences*, 104: 19680-19685.

Morton, J., Kisauzi, D., Ohiomoba, I., Demby, D., Mangheni, M., Moumouni, I., Parkinson, V., Suale, D., Lamboll, R., Nelson, V. and Quan, J., 2014. Climate, agriculture and knowledge in Africa: Agricultural research and advisory services in the face of climate change. Final synthesis report of the Climate Learning for African Agriculture project, Chatham Maritime: Natural Resources Institute, University of Greenwich.

Moumouni, I. and Idrissou, L. (2013a) 'Innovation Systems for Agriculture and Climate in Benin: an Inventory', Climate Learning for African Agriculture, *CLAA Working Paper No.3*, Chatham Maritime: Natural Resources Institute, University of Greenwich.

Moumouni, I. and Idrissou, L. (2013b) 'Innovation Systems for Agriculture and Climate: Analysis of Three Case-studies from Benin', Climate Learning for African Agriculture, *CLAA Working Paper No. 5*, Chatham Maritime: Natural Resources Institute, University of Greenwich.

Nathaniels, N., Lamboll, R., Conroy, M., and Youdowei, A. (2008) 'Agricultural Information Management', in FARA (Forum for Agricultural Research in Africa) *SCARDA (Strengthening Capacity for Agricultural Research and Development in Africa) Briefing Papers, Volume 3*, Accra: FARA.

Niang, I., Ruppel, O., Abdrabo, M., Essel, A., Lennard, C., Padgham, J. and Urquhart, P. (2014) 'Africa', in Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R. and White, L.L. (eds.) *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge and New York: Cambridge University Press.

Olsson, L., Opondo, M., Tschakert, P., Agrawal, A., Eriksen, S.H., Ma, S., Perch, L.N., and Zakieldeen, S.A. (2014) 'Livelihoods and poverty', in Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R. and White, L.L. (eds.) *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge and New York: Cambridge University Press.

Parkinson, V. (2013) 'Climate Learning for African Agriculture: The Case of Mozambique', Climate Learning for African Agriculture, *CLAA Working Paper No. 6*, Chatham Maritime: Natural Resources Institute, University of Greenwich.

Porter, J.R., Xie, L., Challinor, A., Cochrane, K., Howden, S.M., Iqbal, M.M., Lobell, D. and Travasso, M.I. (2014) 'Food Security and Food Production Systems', in Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R. and White, L.L. (eds.) *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge and New York: Cambridge University Press.

Pound, B. and Essegbey, G. (2008) 'Agricultural Innovation Systems', in FARA (Forum for Agricultural Research in Africa) *SCARDA (Strengthening Capacity for Agricultural Research and Development in Africa) Briefing Papers, Volume 3*, Accra: FARA.

Rhodes, E., Jalloh, A. and Diouf, A. (2014) 'Review of Research and Policies for Climate Change Adaptation in the Agriculture Sector in West Africa', *Working Paper 090*, AfricaInteract, IDS, Brighton: Future Agricultures Consortium.

Richards, M., Bruun, T.B. Campbell, B.M., Gregersen, L.E., Huyer, S., Kuntze, V., Madsen, S.T.N., Oldvig, M.B. and Vasileiou, I. (2015) 'How Countries Plan to Address Agricultural Adapatation and Mitigation: an analysis of Intended Nationally Determined Contributions', *Info Note*, December, Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security.

Smith, P., Bustamante, M., Ahammad, H., Clark, H., Dong, H., Elsiddig, E.A., Haberl, H., Harper, R., House, J., Jafari, M., Masera, O., Mbow, C., Ravindranath, N.H., Rice, C.W., Robledo Abad, C., Romanovskaya, A., Sperling, F. and Tubiello, F.N. (2014) 'Agriculture, Forestry and Other Land Use (AFOLU)', in Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I.,, Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T. and Minx, J.C. (eds.) *Climate Change 2014, Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge and New York: Cambridge University Press.

Suale, D.S. (~~forthcoming~~unpublished) 'Sierra Leone Country Report', prepared for Climate Learning for African Agriculture, ~~*CLAA Working Paper,*~~ Chatham Maritime: Natural Resources Institute, University of Greenwich.

Swanson, B.E. (2008) *Global Review of Good Agricultural Extension and Advisory Services Practices,* Rome: FAO.

Tall, A., Jay, A., and Hansen, J. (2013) 'Scaling Up Climate Services for Farmers in Africa and South Asia: Workshop Report', *CCAFS Working Paper No.40,* Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

UNFFE (2011) *Action Research to Audit Effectiveness of NAADS and Proposals for Reforms: The NAADS that farmers want*, Farmers' Fireplace Conversations, Kampala: Uganda National Farmers Federation.

World Bank (2007) *World Development Report 2008: Agriculture for Development*, Washington, D.C.: World Bank.

[1] Often referred to, though with somewhat different connotations, as agricultural extension services. This chapter will generally use the terminology of "agricultural advisory services".

[2] Rhodes *et al*. (2014) place a more favourable interpretation on the mentions of climate in CAADP and other NEPAD documents.

[3] This section draws heavily on Lamboll *et al*. 2011, which is in turn informed by Anderson (2007) and Birner *et al*. (2009).

[4] Projections synthesised from the regional Atlas appended to the Volume I of the IPCC Fifth Assessment Report (van Oldenburgh et al. 2013). For the timescale considered the choice of emissions scenario makes little difference.

[5] Philip Thornton, "IPCC, and its publics, are in trouble again", ILRI blogpost 2010 http://clippings.ilri.org/2010/10/28/ipcc-and-its-publics-are-in-trouble-again/

[6] This element was facilitated by the lead researchers for each country being active in the country platforms of the African Forum for Agricultural Advisory Services.

[7] We also decided not to include the most populous African countries, given limited resources, and especially as Nigeria, Ethiopia and South Africa also have federal structures, and would have required work at three levels (national, regional and local).

[8] Lamboll *et al*. (2011) give additional analysis of the NAPAs of Mozambique, Tanzania and Malawi, and equivalent high-level climate policy in Ghana, their incorporation of agriculture, and issues in their implementation, and Richards *et al*. (2015) review the inclusion of agriculture in the 102 Intended Nationally Determined Contributions submitted by developing and developed countries.

[9] Now an IFAD-funded project.

[10] Particularly in the National Strategy for Implementation of the UNFCCC (Acacha Akoha 2003).

[11] The Dissemination of New Agricultural Technology in Africa, funded by the African Development Bank

[12] NAADS is the National Agricultural Advisory Services, which is also one of the two parent bodies for ATAAS.

[13] A project under the Rockefeller-funded Climate Smart Initiative for Rural Development has worked to mainstream awareness of climate change throughout the National Agricultural Research Organisation, improve agro-meteorological services, assess farmer needs for climate change adaptation technologies, and develop climate and agriculture policies at all levels.The project is outlined at http://africanclimate.net/sites/default/files/content/National-Agricultural-Research-Institute-NARO.pdf but unfortunately further information on its implementation has not been readily available to our study.

[14] Projects were at various stages of implementation. Our approach in the case-studies was to identify lessons of broader interest from the projects, and comments here and in the case-studies should not be taken as stemming from any formal evaluation or review.

[15] Value chain development initiatives rarely make a connection to climate change. Where this is occurring it is most often in relation to global agrifood value chains (e.g. cocoa) and/or in higher GDP countries (Valerie Nelson, pers.comm.).

[16] The same points would apply to mitigation activities such as reforestation or promotion of biofuel cultivation.