Climate, Agriculture and Knowledge in Africa: Agricultural Research and Advisory Services in the Face of Climate Change

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EXECUTIVE SUMMARY

The vulnerability of African agriculture to climate change creates key tasks of promoting agricultural adaptations and adaptive capacity in agriculture, and embracing opportunities for low-carbon development in agriculture. Agricultural research services, and agricultural advisory services, will be key actors in this work. This report synthesises findings from the project *Climate Learning for African Agriculture*, assessing how African agricultural research and advisory services are taking account of climate issues in their policies and practices, and how they can better do so in future. The project worked both at a regional level and through case studies in Sierra Leone, Benin, Uganda and Mozambique, with a strong emphasis on shared learning through national- and local-level workshops.

The incorporation of climate change in agricultural research and advisory services will take place against the current background of renewed interest in agriculture by donors and regional organisations, but also multiple and competing demands on the sector for livelihoods, food security and economic growth, as well as complex processes of globalisation. Agricultural research and advisory services in Africa are undergoing various changes, many of which can be summarised as a move away from linear models of technology transfer towards a greater emphasis on innovation systems, partnerships and networks. Advisory services are also experiencing a shift towards facilitation of farmer learning, and an increasing complexity of public, private and NGO roles in funding and service provision.

Literature on climate change, including the Fifth Assessment Report of the IPCC, underlines both the seriousness of climate threats to African agriculture and their complexity, which together point to the need for support to agricultural innovation that harnesses both scientific research and local knowledge, while fostering shared learning between smallholders and other stakeholders.

An e-discussion initiated by the project showed the importance to African stakeholders of broader framings of questions of climate and agriculture, in terms of climate justice, the broader determinants of adaptive capacity, underfunding of services, governance, and overlap with other controversies in agricultural development, such as that over GMOs. We concluded that knowledge management in the context of climate change cannot be divorced from these broader framings. New literature on participatory learning and social learning in a climate context can also inform consideration of our research questions.

The four case-studies reviewed the status of agriculture in national climate policies. The importance of agriculture to national economies and its vulnerability to climate change are arguments for a privileged role for agriculture in policy documents and in the processes by which climate policy is made. Substantive agricultural issues feature in climate policies, but there are weak linkages for the continuing involvement of agriculture ministries in climate policy processes dominated by environmental ministries, with potential negative impacts on the quality and implementation of climate policies in the agriculture sector.

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. Important topics of natural resource management and of agricultural risk management that are relevant to climate change are addressed, but without putting climate change centre-stage. The climate threat is generally 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.

The project case-studies examined a range of

local-level, mainly donor-funded projects in the four countries. These projects incorporate climate change in their design and rationale in different ways, but generally base themselves on broad-brush climate trends or climate uncertainty rather than on specific downscaled projections. They also demonstrate a continuum ranging from pure knowledge provision, through breeding, seed supply, input provision and marketing, to provision of hardware and infrastructure, especially in irrigation. Despite the opportunities for smallholders to benefit from climate mitigation programmes, this aspect was not significant for the projects we studied, and we suggest there are not yet significant numbers of donor-funded agricultural projects in Africa combining adaptation and mitigation objectives.

Three linked issues emerging from the research on projects are: the need for value chain approaches to support adaptation, so far little in evidence; the need to ensure that adaptation is supported by sustainable systems of input, including seed, supply; and the need for co-ordination between multiple stakeholders.

Issues of *learning* emerged in various ways within the project: the tendency for projects with participatory approaches to learning to demonstrate slippage towards more instrumental approaches; the potential for learning in multi-stakeholder workshop settings at both local and national scale; the potential for innovative use of information and communication technologies; and the arguments for, but also the difficulties of, institutionalising social learning on climate change.

In conclusion, there are now important factors favouring increased attention to climate change within African agricultural research and advisory services:

- Increased priority given to climate change in national policies, both cross-sectoral and specifically agricultural, largely driven by climate variability and extreme events;
- Involvement of African governments in internationally mandated policy processes such as NAPAs and National Communications to the UNFCCC etc., providing structures for inter-sectoral collaboration, identification and prioritisation of adaptation opportunities, and policy formulation;
- Improved understanding of climate variability, future climate change and their impacts, and improved availability of climate knowledge;
- More participatory, demand-led and innovation-focused conceptions of the roles of research and extension.

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

- Generic resource constraints; underfunding and/or dependence on donor funding, and 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; prioritization of outputs or technologies over processes of learning and capacity-building;
- Disconnects between projects and policies; positive experience in projects (NGO or donor-funded) failing 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 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.

Work to overcome these barriers can take place at three *scales*:

- Project-level, learning about what works in terms of climate adaptation, communication and learning;
- Africa-wide, exchanging good practice, but most importantly;
- At national level, engaging with national policies on both climate and agriculture, and national-level institutions.

Key principles and approaches include:

- Dealing with present climate variability and risk to engage farmers in adaptation;
- Using climate information, and integrating it with knowledge on adaptation alternatives;
- Taking up opportunities to involve farmers, properly incentivized, in climate mitigation;
- Increasing attention to value chains, input supply and marketing;
- Developing innovative ways of using Information and Communication Technologies;
- Adopting participatory research approaches at local level, but also facilitating learning at district, national and regional level, across those levels and between different stakeholders.

The two main entry points for new initiatives are therefore:

- At the local level to build networks or learning platforms of farmers and other stakeholders, to foster innovation for agriculture in the face of climate change;
- At national level to mainstream agriculture into climate policy and vice versa, to assert the importance of knowledge and innovation within those policies, to build up exchange of information across ministries, research institutions, and development partners, and to ensure that national-level stakeholders learn from farmers' experiences about what works, what does not work and what is needed.

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Introduction

In many 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 CC either directly through farming-related greenhouse gas emissions or indirectly through forest clearance (Smith *et al*. 2014). Key tasks for the agricultural sector will therefore include: a) promoting specific agricultural adaptations to climate change, b) addressing the challenges of the impact of climate change through strengthening adaptive capacity and enhancing resilience and c) embracing opportunities offered by climate mitigation and low-carbon development in agriculture. Agricultural research services, and agricultural advisory services[1], will be key actors in this work.

This report represents the results of a two year project. [2] While detailed objectives evolved during the project[3] , our central aim was to assess how African agricultural research and advisory services, in the region as a whole and in selected case-study countries, are taking account of climate issues - issues both of adaptation and of mitigation - in their policies, management and practices, and how they can better do so in future. Our approach was qualitative and incorporated a strong emphasis on learning – research at the local level was largely based on workshops and focus groups for agricultural stakeholders, and in three of the four case-study countries we organised national-level stakeholder workshops.[4]

1. Background and Context

This study needs to be placed in the context both of the changing policy environment for the agriculture sector and research and advisory services within it, and of climate change, the challenges it poses for African agriculture, and the opportunities for responding to those challenges. Early e-discussions organised by our project also showed the need to place the study in the context of several broader policy debates.

The changing policy environment for agriculture

After a period of neglect of the agriculture sector by development donors, there is now renewed attention to it, in Africa as in other developing regions, attention reviewed and given further stimulus by the World Bank's *World Development Report 2008* (World Bank 2007). The new focus can be seen as acknowledging the multiple roles of agriculture, but also as putting multiple, and by some interpretations competing, demands upon it.

[1] Often referred to, though with somewhat different connotations, as agricultural extension services. We will generally use the terminology of agricultural advisory services in this report.

[2] The project was led by the Natural Resources Institute (NRI) of the University of Greenwich, in partnership with the Forum for Agricultural Research in Africa (FARA) and the African Forum for Agricultural Advisory Services (AFAAS).

[3] Our original objectives are set out in Annex A

[4] The emphasis on district-level workshops was particularly important in the Uganda case-study. The workshopping element in the Benin case-study involved meetings between staff of three projects rather than a national stakeholder workshop *per se*.

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
- Supporting the provision of other ecosystem services such as water management and biodiversity, recognizing that natural resources are finite.

To these must be added as demands on the agricultural sector, in the context of climate change:

- Climate resilience – fulfilling the above demands in a warmer, more extreme and more uncertain climate
- Reducing the significant greenhouse gas emissions associated with agriculture, and/or providing opportunities for enhancing carbon sinks.

These demands are reflected in the plethora of terminology for new paradigms in agriculture and the repackaging of some existing concepts: the concepts of sustainable agriculture and agroecology have been joined by sustainable intensification, climate smart agriculture, and the use in an agricultural context of the broader concepts of the green economy and climate-compatible development. These terms are further reviewed and discussed in Lamboll and Nelson 2012a and 2012b.

Besides the multiple demands on agriculture, including new demands related to climate change, there are several other important features of the contemporary agricultural scene: (Lamboll *et al.* 2011, citing Larsen *et al.* 2009 and World Bank 2007):

- Rapidly advancing technological frontiers: the results of public and private Research & Development present opportunities, but also raise new questions about the governance of science, for instance in relation to intellectual property rights and the ethics of genetically modified crops.
- Global links: local production and livelihoods are increasingly connected through international value chains to global preferences, trade standards, national policies and phenomena such as animal disease outbreaks.
- Capacities for innovation based on accessing, adapting, and applying worldwide knowledge are becoming a main source of competitive advantage for national economies.
- Increasing pace and nonlinearity of change 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.
- Networked knowledge: an appreciation that information and technology are no longer located in a single source such as a university or research centre; thus innovation requires interactive collaboration often across widely dispersed sites.

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.[5]

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

Changing roles of research and advisory services

There have been important changes relating to agricultural research and advisory services, in developing countries generally and in Africa: changes in the conceptions of their functions and the way those functions are planned, funded, managed and implemented. Various documents of international and African organizations both report on the new context for agricultural research and present visons for its future. The putting of these visions into practice is of course not equally apparent or important across African countries.

For the Global Donor Platform on Rural Development (2012b), research services are seen as serving four goals: productivity, income and food security; nutrition and health; poverty reduction; and natural resource sustainability. To meet these multiple objectives, and in particular the objective of food security, the Platform (2012a, 2013) emphasises the importance of:

- Considering the perspectives of farmers, including the specific perspectives of women, youth and indigenous peoples, as starting points
- Re-engaging with the dissemination of knowledge, including the dissemination, sharing and use of existing knowledge and technologies
- Partnerships, between different sorts of research institutions in different countries, but especially between public- and private-sector research
- Capacity-building, which is a recurrent theme in many recent discussions of research, linked to the all the new roles and modes of working expected of research organisations.

Other important issues emerging or being restated for research organisations are discussed in the volume of briefing papers produced by the SCARDA project of FARA, The Forum for Agricultural Research in Africa (FARA 2008):

- 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)
- Concerns about genetically-modified crops, biotechnology more generally, and biosafety (Seal et al. 2008)
- Gender and diversity (Nelson et al. 2008), and
- The shift towards the paradigm of Agricultural Innovation Systems (Pound and Essegbey 2008).

This last point is common to research and advisory services, with 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 the innovation system, defined by Pound and Essegbey as "a dynamic, multi-stakeholder partnership working together to develop and use technologies and processes to improve livelihoods" – other current definitions expand on this with use of the term *"network".*

A very relevant formulation is that of Integrated Agricultural Research for Development (IAR4D) promoted by FARA, as the apex organization for African stakeholders in agricultural research, and its research partners as an evolving "vision" for agricultural innovation, on the basis of discussions ongoing since 2003. Hawkins et al. (2009) set out as defining principles for IAR4D:

- IAR4D integrates the perspectives, knowledge and actions of different stakeholders around a common theme
- IAR4D integrates the learning that stakeholders achieve through working together

- IAR4D integrates analysis, action and change across the different (environmental, social, economic) "dimensions" of development
- IAR4D integrates analysis, action and change at different levels of spatial, economic and social organization.

Much of what is happening in the conception and implementation of advisory services[6] 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). 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).

Other trends are also important. Lamboll et al. (2011), drawing on Anderson (2007) and Birner et al. (2009), also highlight:

- 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.
- Decentralisation
- Increased emphasis on participatory and group-based advisory methods, and learning by doing, as in Farmer Field Schools
- A heightened concern with monitoring and measuring outputs and outcomes, as well as activities and inputs
- New conceptions of accountability to clients
- Exploration of the potential of information and communication methodologies
- More explicit rhetoric (though variable action) on gender-sensitive approaches.

Climate challenges and opportunities in Africa

Projections for the future African climate are presented in the "Atlas" appended to the Volume I of the IPCC Fifth Assessment Report (van Oldenburgh et al. 2013) – our summary here will focus on the nearer term projections between 2016 and 2035.[7] In this period nearly all climate models project an average temperature rise of 1^{o}C across sub-Saharan Africa, with some models projecting 1.5^{o}C in West Africa, Sudan, Ethiopia, much of Central Africa and much of Southern Africa. For precipitation trends, the median projection for West and East Africa October to March rainfall is for a rise in precipitation of up to 10% across both regions, and up to 20% in some parts of East Africa in some models. For April to September, projections favour drying of up to 10% in East Africa, and rainfall increase of up to 10% in West Africa. For Southern Africa October to March rainfall, projections range from a 10% decrease to a 10% increase, but for April to September some models show a rainfall decrease of up to 30% in some areas, and the majority of models show some drying in Zambia and Zimbabwe.

[6] This section draws heavily on Lamboll et al. 2011.

[7] The projections synthesised here use RCP 4.5, a scenario of moderate mitigation of greenhouse gas emissions, but for the timescale considered the choice of emissions scenario makes little difference.

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". 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, and 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.*[8]

On the other hand a strand of literature emphasises the local specificity of climate impacts on "complex, diverse and risk-prone" 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".

[8] 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/

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

Broader framings of climate change

Early in our project, as one of our core research activities, we initiated an e-discussion open to stakeholders throughout Africa (Nelson et al. 2013).[9] Initially designed to gather information on practical experience on the way climate issues have been incorporated into research and advisory services, e-discussion participants explored a much wider range of concepts and issues, which relate to the context of our work and can be reported here. Participants specifically highlighted the following:

- There were widespread concerns about *climate justice*, both between industrialised countries and developing countries (with the former responsible for both historic and continuing greenhouse gas emissions), and between rich and poor within developing countries (where the poor may *appear* to be responsible for environmental degradation, for example by charcoal production, but in fact driven to it by lack of alternatives). Climate justice was raised in various contexts, including but not limited to the questions of who should pay the costs of mitigation (including afforestation and development of alternative energy) and the costs of adaptation (including the additional costs of research and advisory services as they respond to climate change).
- Contributors were concerned to go beyond the project's focus on knowledge and information in climate adaptation towards *the broader determinants of adaptive capacity in agriculture*, or as some contributors framed it, food security. These determinants may be economic, institutional, cultural, due to insecure or uncertain land tenure, or related to education, health, governance and the responsiveness of services to farmer voice.
- Climate change brings to the fore issues of the *underfunding of agricultural services*, and of their *governance* – who decides on research priorities and modalities of extension: donors, bureaucrats or farmers, and if the latter through what mechanisms?
- There is a need to *integrate the provision of agricultural knowledge with input supply* and other services, especially provision where appropriate of improved seed (this is an issue that also emerged in the case studies, especially that from Benin – see Box 6).
- One contributor offered an example of the *innovative use of communication technologies* in advisory services, with the suggestion that it not only helped overcome underfunding, but that it could become more relevant under climate change.[10]
- Current *controversies in agricultural development*, particularly the use of GMOs, were brought into the discussion, in ways that did not necessarily relate to climate change, except in fairly tenuous ways, but reminded us that the broader field of agricultural technology is highly contested and controversies can seep into each other and amplify a sense of overall concern and dissatisfaction.

In the light of the contributions made to the e-discussion, we feel it should be emphasised here that knowledge management in the context of climate change cannot be divorced from these broader

[9] The e-discussion was held between early March and early May 2012, making use of FARA's D-Group facility. It attracted 118 participants from over 33 countries. Senior managers of research and extension services were under-represented, but participants included NGO staff, project personnel and active researchers.

[10] The innovation was the participation of farmers at every stage of the development and implementation of radio campaigns. It is explained in more detail in Farm Radio International (2011).

framings of debates around agricultural knowledge.

Parallel studies and initiatives

Our research reported here has areas of overlap with a range of current and recent research and development initiatives to strengthen both research and advisory services in the face of climate change. The Rockefeller Foundation is funding eight Climate Change Units located within agricultural research institutions and universities in East and Central Africa to develop and promote climate change adaptation strategies and technologies for rainfed farming systems, and to mainstream climate change agendas within their host institutions.[11] These Units are supported by, among other sources of expertise, The University of Reading, which provides backstopping on climate risk assessment, crop modelling, learning and curriculum development, and institutional sustainability.[12]

Some of the current authors were involved in a desk-based review commissioned by AFAAS (Lamboll et al. 2011) on the potential role of agricultural advisory services in addressing climate change in Africa, and some of the characteristics that would be required of them to do this, using the headings of governance and vision, management, capacity, and advisory methods. Focusing on the practical needs of frontline workers and farmers themselves, particularly in understanding and using climate information, Agritex (the agricultural advisory service in Zimbabwe), the NGO Practical Action and the University of Reading been involved in action research, leading to the production of "Mainstreaming Climate Change Adaptation in Agricultural Extension" (Agritex et al. 2013), subtitled "a training manual on the use of climate information and vulnerability and capacity assessment for agricultural extension staff in Zimbabwe" and related work by the University of Reading is now underway in Tanzania.

Our research also concerns the issues of learning and here it has significant points of contact with Harvey et al.'s 2013 review for the CCAFS Programme of the concepts around "social learning", their importance for response to climate change and examples of their practical use. Social learning is defined as "iterative and learning-based processes of collective decision-making and problem solving in the face of change", particularly as it links different categories of stakeholder and their viewpoints. Some of the current authors (Lamboll et al. 2013) have also been involved in developing CCAFS' "Farms of the Future" approach facilitating learning through farmer visits to sites chosen as "climate analogues" of potential future climates in their home area. This work has produced important reflections on the connections between learning, participation, and climate adaptation, and on particular tools such as participatory video. These issues of learning are covered in more detail in Section 6.

[11] See for example the brochure of the Climate Change Unit within the Kenyan Agricultural Research Institute http://cenafrica.net/kari/files/2011/11/KARI-CCU-Brochure-Nov-2011.pdf

[12] See the project brochure at http://www.walker-institute.ac.uk/publications/factsheets/walker_factsheet_Rockefeller.pdf and, for more details on the approach, Cooper et al. (2012).

2. Our Research

Following a planning workshop between the partners, NRI, FARA and AFAAS in October 2011, the first stage of our research was to clarify, for ourselves and for other stakeholders, the multitude of concepts and terminologies that can be used to study the intersection of agriculture and climate change. Two project outputs (Lamboll and Nelson 2012a, intended as a briefing paper and Lamboll and Nelson 2012b as a more detailed resource document) set out and explored some of the important concepts of agricultural development – sustainable agriculture, sustainable intensification, agro-ecology – and of climate change – adaptation, mitigation and climate resilience. They then explore various terms proposed for processes that deliver both development and climate goals – climate-compatible development, the green economy, and climate-smart agriculture.

Lamboll and Nelson stress the advantages of these more holistic concepts that can integrate responses to climate change and development objectives, including the fact that they highlight potential trade-offs and synergies. However they note a) how ambitious it may be in practice to put such concepts into implementation, and b) that the breadth of such concepts can both encourage more productive debate but also be used to mask fundamental differences in vision and questions about participation, technology, markets and power.

During the case studies we found that these integrative concepts had gained little traction in the day-to-day practice of research and extension, or even at policy levels. Of climate-compatible development, the green economy, and climate-smart agriculture, it is the third that has most currency. In this report we have preferred to use more neutral (and therefore inclusive) terminology as we discuss a range of policies and practices that address various combinations of climate adaptation, climate mitigation and development.

After this conceptual review and the e-discussion mentioned above, the main phase of the project consisted of 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, and identify practical strategies for making agricultural knowledge management, and thus smallholder agricultural development, more climate-compatible'.*

The case studies were intended to include a strong emphasis on *collective learning processes* with the objective of stimulating awareness and reflection within agricultural research and advisory services on how to manage agricultural knowledge in the face of climate change and increasing uncertainty. They were also designed to capture information, and stimulate learning, at both national and local levels.

The countries were chosen by the research partners in consultation with CDKN, in accordance with the following criteria:

- Geographic spread across West, East and Southern Africa, and across anglophone, francophone and lusophone countries.
- A range of natural environments and climate types, and of climate hazards
- Inclusion of at least one country that could be regarded as in a "post-conflict" situation or suffering from state fragility.

- Existing activity by AFAAS and availability of national researchers/facilitators who were already involved in AFAAS's work.[13]

As a result of these criteria we chose Sierra Leone, Benin, Uganda and Mozambique. The researchers/facilitators all had previously participated in AFAAS work: two (in Benin and Uganda) were from national universities, while those from Sierra Leone and Mozambique had more of a consultancy background. The case studies were set in motion from May 2012 and reports were finalised, and placed on the project website, in mid-2013.

In practice, each case study approached both the assessment and the learning objectives in different ways and at different scales. All four surveyed national policies, but at the local level the Benin study focussed its local efforts on *projects*, and the Uganda study on *districts*, with the others taking a combination of these approaches: the Benin study laid comparatively less emphasis on learning in workshops, while the Uganda case study involved workshops at the level of two districts and that of national stakeholders. An additional variation was that following initial findings, all four case studies focussed mainly on climate adaptation in agriculture, but that in Sierra Leone included comparatively more material on climate mitigation in Africa.

A final research activity was a questionnaire circulated by email to the national directors of extension in a large number of African countries. Response rates were disappointingly low, and generally from countries less representative of the African mainstream. Information from the questionnaires that were received, from Sudan, Somalia and DRC, is reported in Morton (forthcoming).

The remainder of this report is structured as follows: Section 3 deals with the way agriculture is represented in national climate policies; Section 4 discusses how climate change is incorporated in national agricultural policies, and in the policies and practice of national agricultural research and advisory services; Section 5 discusses findings from the local-level of districts and projects; Section 6 picks up issues of learning that arise from various parts of the work; and Section 7 contains some conclusions and ways forward.

3. 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)[14], or National Communications to the UNFCCC,[15] 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

[13] 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).

[14] NAPAs (https://unfccc.int/national_reports/napa/items/2719.php) were defined and promoted by the 7th Conference of Parties of the UNFCC (Marrakesh, 2001), particularly Decisions 5, 6 and 28, which states that "National adaptation programmes of action (NAPAs) will communicate priority activities addressing the urgent and immediate needs and concerns of the least developed countries (LDCs), relating to adaptation to the adverse effects of climate change". To date 35 countries of Sub-Saharan Africa have submitted NAPAs to the UNFCCC Secretariat.

[15] 44 countries in sub-Saharan Africa have submitted a National Communication to the UNFCCC, of which 33 have also submitted a Second Communication.

represented in either.[16] 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[17] 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,[18] 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. 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[19] : 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

[16] 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.

[17] Findings presented in sections 3-6 of the report are drawn, unless specified otherwise. from the case studies: Suale (forthcoming) for Sierra Leone, Moumouni and Idrissou (2013a) for national-level issues in Benin, Moumouni and Idrissou (2013b) for project-level issues in Benin, Mangheni et al. (2013) for Uganda and Parkinson (2013) for Mozambique. Unless required otherwise by the argument, findings are presented in the same order of countries.

[18] Now an IFAD-funded project.

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

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. 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 economies (including employment and export earnings) of all four case-study countries, as Table 1, derived from World Bank and WTO indicators, shows.

Table 1: Agriculture* in the Economies of the Four Case-Study Countries

Country	Year	Agriculture as % of GDP	Year	Agriculture as % of employment	Year	Agriculture as % of exports
Sierra Leone	2011	57	2004	69	-	n/a
Benin	2010	32	2003	43	2012	29
Uganda	2012	26	2009	66	2012	52
Mozambique	2012	30	2003	81	2012	18
Africa Regional	2012	32	various	65	2009	60

* includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production.
Sources: http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS for country-level GDP statistics, http://data.worldbank.org/indicator/SL.AGR.EMPL.ZS for country-level employment statistics, http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,,contentMDK:21935583~pagePK:146736~piPK:146830~theSitePK:258644,00.html for Africa regional statistics on GDP and employment, http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm for country-level export statistics, http://www.ifpri.org/publication/agriculture-s-critical-role-africa-s-development for regional export statistics.

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 responsibility (or otherwise) 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, we conclude 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.

4. 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. 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[20], 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. 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).

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.

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

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 (*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. 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[21] 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. 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.[22]

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. The adaptation measures include reduction of vulnerability to disasters, improved community 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

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

[22] The project is outlined at http://cenafrica.net/abstracts/strengthening-naro%E2%80%99s-capacity-to-develop-climate-change-adaptation-interventions-and-policy-recommendations-that-ensure-their-adoption/ but unfortunately further information on its implementation was not readily available to our study.

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.

5. Experience at Project Level

Three of the four case-studies used local-level projects as their primary lens for investigating experience at local level. The Uganda case-study, while gathering information from a large number of relevant projects[23] used more of a district lens to present perceptions, experiences and issues (see Box 1). The most important of the projects studied in the other countries, with donors and implementing agencies, are presented in Box 2.

The projects[24] can be classified along various axes. Some are specifically designed to work in a single area, some work in several areas across a country or even across several countries, some are national programmes with pilot implementation areas, but all involve 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 mention 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, start 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 identify 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 base 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

[23] Box 13 of Mangheni et al. (2013) lists nine in Masindi District alone.

[24] 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 her and in the case-studies should not be taken as stemming from any formal evaluation or review.

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 3).

Box 1: Climate Planning at District Level in Uganda

While the case-studies on Sierra Leone and Mozambique looked at the level of local government districts in order to capture information on projects implemented within them, the Uganda case-study, in the light of Uganda's thoroughgoing decentralisation policy, looked at district-level climate planning policies in their own right, based on research in Masindi and Nakasongola Districts of Central Uganda. Decentralisation means that many policy decisions, which are decided in other countries by the national headquarters of sectoral ministries, are devolved to district level, and district-level technical specialists in different sectors are expected to co-ordinate among themselves and with the elected local authorities. Districts in Uganda therefore have their own District Environment Policies, in both of our cases in place since 2009, with technical assistance from the National Environmental Management Agency, UNEP and UNDP. Each Policy contains statements on agriculture and on climate with in these two cases at least broadly similar objectives and strategies. The agriculture statements in each case are broad in nature, covering both sustainability and commercialisation objectives, and not explicitly mentioning climate. The climate statements are heavily focussed on agriculture, their objectives reading in each case:

- To reduce the vulnerability of the rural poor farmers and herdsmen to the severe weather regularly experience in the District;
- To increase the adaptation within the District to the severe climate conditions among the pastoral and farming communities;

And additionally for Masindi:

- To promote the integrity of the changing environment and the survival of biodiversity in the face of extreme shocks.

The climate strategies cover environmental protection, diversification within and beyond agriculture, and managing information on various aspects of climate and its impacts, for farmers and others. Each makes mention of operationalising the UNCCD and the UNFCCC (a mention that could be seen in various lights).

Despite the existence of these policies, of which they are not all aware, "technical staff at district level are not able to work on climate change in a joined up way, or link their practice to relevant policy" (Mangheni et al. 2013). NGOs within the districts still adopt a short-term project focus. The lack of technical capacity and leadership was more evident in Masindi than in Nakosongola, where the District production department was able to, on its own initiative: hold a planning workshop; set in motion the establishment of a District Climate Change Forum; agree on highly specific priority areas within crops, livestock, forestry, apiculture and the environment; and develop a policy statement on "environmental information, education, human resource development, research, and public participation in environment management".

Box 2: Projects Studied in the Course of the Research

Benin:

- Sustainable Management of Agricultural Land in the Bas-Fonds (CDKN via START; Université de Parakou and Aldipe*)
- Drought-Tolerant Maize for Africa (Bill and Melinda Gates Foundation; Benin National Institute for Agricultural Research)
- Project to Strengthening Economic Knowledge and Adaptive Capacity in the Face of Climate Change (IDRC, IDID*)

Mozambique:

- UN Joint Programme on Environmental Mainstreaming and Adaptation to Climate Change (UNDP/Spain; Ministry for the Co-ordination of Environmental Affairs, other government bodies, and NGOs)
- Coping with Drought and Climate Change (UNDP/GEF; Ministry for the Co-ordination of Environmental Affairs)
- Climate Change Project (CARE; AENA*)

Sierra Leone:

- BRACE-Building Resilience and Community Engagement (European Commission; Concern/NRI)
- Integrating Adaptation to CC into Agricultural Production and Food Security (GEF; UNDP/UNEP)

* Denotes national or local NGOs

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 are important early warning activities in the GEF-funded project on Coping with Drought and Climate Change in Guija District, Mozambique, where agricultural early warning systems are reaching almost 4,000 farmers, and the PRECAB project in Benin. Interest in climate services and seasonal forecasting among donors and researchers in Africa has strongly increased in recent years (see Tall et al., 2013). Box 4 summarises some of the issues.

Box 3: 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 and ways to exploit them, even when bas-fonds were available within comparatively short distances.

Project activities included the following:

- Technical research on the hydrology and production potential of the bas-fonds
- Socio-economic studies, of a qualitative and participatory nature, i) of general perceptions of climate change and opportunities for adaptation, and ii) access to the bas-fonds and concrete steps necessary for maize farmers to use them in rice cultivation.
- Information and awareness creation on the potential of the bas-fonds for cultivation
- A facilitated learning process for farmers on climate change and adaptation in general, and sustainable management of the bas-fonds in particular
- Further awareness raising through radio, posters and village events
- Exchange visits to farmers using bas-fonds elsewhere in the country
- Training of young university researchers who carried research on and of use to the project
- Creation and strengthening of farmer groups to participate, with technical assistance from Aldipe, 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)
- 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 also to "a change in relations between the people…and their physical and institutional environment" (Moumouni and Idrissou 2013b).

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.

The Benin case-study for our project 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.

Box 4: Climate Services, Seasonal Forecasts and Early Warning in Africa

There is rapidly increasing experience in the provision of climate information to farmers in developing countries, generally concerning timescales between those of a few days and of the whole of an agricultural season. Research and action-research on these topics is being carried out under the CCAFS programme, which produced an important stocktaking by Tall et al. (2013), and has in particular built a climate information service for farmers in Senegal linked to community radio, which now serves over 2 million farmers.[25] There is also a rapidly expanding research literature, reviewed in the case of Africa by Dasgupta et al. (2014), Box 9-4 in the IPCC Fifth Assessment Report.[26] Hansen et al. 2011 highlighted the key issues of legitimacy (farmer ownership and contribution to design of services), salience (relevance to farming systems), access (in terms of media and infrastructure), understanding and capacity to respond. Tall et al. (2013) added to that list equity (especially with regard to women, the poor and socially marginalised groups) and integration (with other forms of agricultural support and development assistance). Dasgupta et al. (2014) specify the importance of user wealth and risk aversion, and the forecast parameters and ways of presenting probability within the forecasts. They mention the promise of integrating scientific forecasts with indigenous knowledge, the importance of securing collaboration of multiple stakeholders, and the additional opportunities for coordinating seasonal forecast with input and credit supply, crisis management, trade and insurance.

We were also aware that 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.

Box 5: 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.

[25] http://ccafs.cgiar.org/publications/scaling-seasonal-forecasts-over-2-million-users-senegal#.U4yrkVOLU40
[26] A box drafted by Katharine Vincent

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). 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+. They conclude 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. 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.

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.

We would like to highlight here three further important issues that have emerged from projects researched by the case-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.

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). It can be seen as entirely logical that where a new variety or crop is introduced, in the name of climate adaptation or for other reasons, that consideration should be given to the value chain along which it will be processed and marketed, and that farmers should be supported to contribute to and benefit 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.[27]

A successful exception, which is presented at more length in Box 3, 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.

[27] 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.

Besides the practicalities of ensuring that the infrastructure and linkages to process and market crops exist, projects should also be asking some more fundamental questions about *risks*:

- Will there be risks of specialising in particular crops in a context of uncertainty?
- What are the risks and benefits of engaging in different types of value chains and at different levels?
- How do production risks and market risks intersect?
- Will specialisation in non-food cash crops (if that is what is proposed) have implications for risks to food security?

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. External actors should ensure that other necessary inputs, such as fertilisers, pesticides, tools and credit, are also available. Again the Bas-Fonds project in Benin (see Box A) 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 (Box 6).

As the example shows, 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.

Box 6: The Drought Tolerant Maize for Africa Project

The multi-country Drought Tolerant Maize for Africa project, on-going since 2006, is not explicitly designed around climate change, but, as its name suggests around drought as a present and possibly increasing threat. Its central objective is to increase food security for poor smallholders through the development and dissemination of varieties of maize tolerant to drought (while also fulfilling other criteria of disease-resistance and processing quality important to smallholders). Among the key partners are CRAN, the regional centre of the Benin National Institute for Agricultural Research, and 12 individual smallholder seed multipliers that CRAN has trained. The project combines a synthesis of previously existing studies of adoption in Northern Benin, greenhouse and on-station trials by CRAN of new varieties, and a process of multiplication and further screening of varieties, by the 12 smallholder multipliers, up to the stage of seed that can be accepted by the responsible government body the DPQC, and produced as pre-basic seed by CRAN. After this stage, the original plan was to use Department of Agriculture farms for further multiplication to basic and certified seed (which given the close supervision required would have been a reasonable option), but linkages between the project and Department of Agriculture have not been strong enough to allow this, and instead existing seed-producers' organisations, which have limited organisational and managerial capacity, have been used instead. Linkages to other organisations, such as the DPQC and the Regional Centre for Agricultural Promotion, which should have been key stakeholders in the project, have also been weak. Farmers taking ownership of the seed value chain, a long-term vision of the organisations supporting DTMA, is still a long way off.

Multi-stakeholder co-ordination

Neither in the case of value chains for processing and marketing, nor for input supply chains, are we necessarily suggesting that the organisations involved in dissemination of knowledge should themselves take responsibility for purchasing or selling produce or inputs. Rather we are underlining the importance

of proper *co-ordination* among all the relevant stakeholders in agricultural adaptation.[28] The project in Chicualacuala, Mozambique (Box 6), 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. The doctrine associated with the Training and Visit extension system, that extension agents should not get involved in marketing or input supply, has been dead for several years, but the requirements of climate adaptation put another nail in its coffin.

6. Learning

This section considers the theme of learning from various angles. We look at 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. We also relate our findings to recent work on social learning in climate change response.

Learning within and between projects

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). The 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).

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 7).

Box 7: 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.

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

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 (or participatory projects, 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.

The Benin case-study also organised a meeting between staff of the three projects studied, which identified learning points for each project from the others, around: participatory trials; institutional experiments for new forms of partnerships; value chain approaches; the possibilities of working with different levels of resources, on different timescales, and on different points on the continuum between coping with climate variability and transformative adaptation.

Learning from national and district workshops

Three of the four case-studies contain detailed accounts of the main findings of national stakeholder workshops. It would be impossible to produce this wealth of information here, and in any case the objective of the workshops was for the exchange of information between national stakeholders, not simply the generation of findings for a report like this. But to show the range of topics covered, Box 8 sets out the main topics covered in the three countries.

Box 8: 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

Some of these sets of findings are particularly interesting to set out in more detail. Box 9, from Uganda, sets out factors driving and limiting climate change response, in research and advisory services, as identified across stakeholder groups. The limiting factors are could be summarised as issues of low capacity and poor co-ordination are emphasised, 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).

Box 9: Factors Driving and Limiting Climate Change Response, in Research and Advisory Services, as identified across Stakeholder Groups in the Ugandan National Workshop

	Research	Advisory services
Driving factors	• Food security • Improved livelihoods (increased incomes) • Conservation of nature • Availability of funds/Donor funding/interests • Government policies e.g. Agriculture Sector Development Strategy and Investment Plan • Climate change effects e.g. increased pests and diseases/ emerging hazards and risks	• Food security • Improved livelihoods (increased incomes) • Conservation of nature • Farmers' demands/needs • Government funding • Government policies • Donor funding/interests
Limiting factors	• Inadequate funding • Lack of government commitment • Inadequate capacity • Limited implementation of policies • Perceiving climate change as largely an environmental issue and not an agricultural one • Lack of relevant information (statistics) • Limited funding at lower levels to facilitate community initiatives	• Lack of capacity in environment and natural resource issues • Lack of coordination between relevant sectors • Inadequate funding • Inadequate capacity of Agricultural Advisory Service Providers • Failure to implement policies • Short term conditional grants which do not ensure sustained service delivery.

Box 10, also from Uganda, sets out constraints in organising, accessing and using climate change knowledge, as identified by four different stakeholder groups. The box is hard to summarise, rather it demonstrates the highly detailed and relevant account of constraints that the workshop could generate.

Box 10: Constraints in Organising, Accessing and Using Climate Change Knowledge, as identified by different Stakeholder Groups at the Ugandan National Workshop

Researchers	Farmers	Advisory service providers	Local leaders/policy makers
• Costs involved in accessing e.g. subscribing to journals and other information sources • Authenticity of work not guaranteed • Lack of coordination among researchers • Donor restrictions to share information generated from some research • Lack of information processing equipment • Limited or lack of internet connectivity • Limited resources e.g. funds and time	• Language barrier since most information is in English which many do not understand • Limited access to information communication technology • Gender insensitivity of some information providers which disadvantages women • Conflicting information from different information sources • Untimely delivery of information • High illiteracy rates • Poor reading culture	• Lack of up-to-date information and technologies • Low capacity to utilise the information • Lack of initiative to search for new information • Limited resources (human and financial) for accessing and disseminating information • Lack of network/platform to share • Political interference and preferences • Weak research-	• Poor culture of seeking information • Unfavorable political environment for sharing information (it is not valued and/or rewarded) • Limited access to credible sources of information • Lack of information on climate change • Low capacity of some leaders to correctly interpret and disseminate information • Poor networking and collaboration leading

• Lack of interest to share/negative attitude towards sharing information • Lack of expertise in packaging information targeted at various audiences	• Inappropriate information packaging • Poor data capture by service providers • Negative attitude towards /fear of new things • Low exposure • Dependency on men for information (specific to women) • Confinement to domestic work (specific to women) • Limited access to relevant information • Limited access to radio by some family members • Unreliability of information • Low turn up of farmers to meetings/trainings • Lack of awareness about what information exists and where to get it • Poor attitude towards educative programmes • Lack of money to regularly buy batteries for radio	extension interface • Unhealthy competition among service providers which hinders sharing • Lack of knowledge sharing strategy by districts • Limited sources of credible information • Limited facilitation to collect information e.g. from newspapers, magazines and internet • Irregular workshops/training • Lack of plan for capacity building • Work overload resulting from low ratio of service providers to farmers and engagement by multiple programmes/projects	to poor coordination and mobilisation

The Mozambique workshop, in two parallel workgroups, collectively provided recommended actions, at community and national level (Box 11).

Box 11: Recommended Actions from the Mozambique National Workshop

At community level

- Identify how communities cope with drought, including traditional knowledge and systems that aim to mitigate drought effects.
- Develop and implement plans on climate change and development that engage rural communities directly.
- Greater integration and implementation of effective adaptation and mitigation into local and community based development plans.
- Strengthened collaboration with the private sector, civil society and development partners, to integrate climate change issues into strategies and development programmes.
- Develop and promote strategies and technologies to manage the impacts of climate change on agriculture and food security, water resources, health, energy and environment.
- Develop and promote information services to public, private and civil society for enhanced awareness and practical management of climate risks.
- Improve data collection, analysis and production of recommendations for activities underway on climate risk management.
- Oversee climate variability and change by strengthening networks and weather stations at national and community level.

At national level

- Identify the needs and constraints of farmers in the implementation of risk management techniques and in the utilisation of climatic information, including seasonal forecasts and products from the Drought Monitoring Center (INAM, INGC).
- Improve communication and outreach to rural communities. This requires identification of existing communication systems and their effectiveness in processing information flow from the producers to

the end users (rural communities and small scale farmers), communications constraints and how can they be overcome, and how local knowledge be combined with modern communication systems.
- Promote research and analysis of stakeholder perceptions and perspectives on climate change and climate change mitigation.
- Strengthen institutional capacity and coordination.
- Improve advice and technical assistance available.
- Develop knowledge, management and learning between organisations and institutions in the country.
- Create, empower, and indicate the mechanism or institution that will serve as a platform for climate knowledge dissemination and learning.
- Promote, if possible, regular meetings, debate, and sharing of information between institutions on climate change.
- Formulate public policies in such a way as to guide institutions to develop and disseminate appropriate technologies and practices.

Key themes in these recommendations are those of information management, coordination and networking, between stakeholders within and between national and local levels.

Recommendations from the workshops in Sierra Leone and Uganda included specific lists of recommended media for sharing information, particularly with farmers - recommendations were overwhelmingly for broad spectra of traditional and non-traditional media. Otherwise recommendations focussed on institutions: in Sierra Leone this meant calls for the establishment of a National Climate Change Secretariat, but also for a formalised network of knowledge providers and knowledge users co-ordinated by such a Secretariat. There should also be sharing of information at the level of commodity sub-sectors and/or agro-ecological zones.

In Uganda, the district-level workshops 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 it was agreed that an interim committee draft terms of reference for a district climate change forum. The national-level workshop agreed on the need for a national climate change stakeholders' forum, again with broad membership across relevant actors, which could form the apex of forums at agro-ecological zone, district and sub-county.

Information and communication technology

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 connection with the findings of the CCAFS review of social learning: "iterative and learning-based processes of collective decision-making and problem solving in the face of change" (Harvey et al. 2013). The review supports the use of social learning approaches, in the context of agreed theories of change (models of how they will achieve climate and development objectives), plans for monitoring the learning processes and achievements, and supported by dedicated facilitation, all of which points are borne out by our research. Harvey et al.'s stress on the need for attention to power relations, social differentiation and gender is not directly supported by our case study findings, but relates strongly to points raised in our e-discussion (see Section 1) that we summarise under the heading of climate justice. On the basis of the learning carried out during our research we also support, for our case-study countries and elsewhere, Harvey et al.'s view 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".

7. Conclusions and Ways Forward

In the face of the multiple threats that climate change poses to agriculture in Africa, there is a need to understand complex and diverse farming and livelihood systems, to support smallholders' information needs and to foster shared learning and engagement between smallholders and broader stakeholders. This must be done in the context of multiple climate risks and multiple vulnerabilities, while also furthering development objectives, and if possible climate mitigation objectives also. African agricultural research and advisory services must assume a key role here. As discussed in Section 1, there are now important factors favouring their increased attention to climate change:

- Increased priority given to climate change in national policies, both cross-sectoral and specifically agricultural, largely driven by climate variability and extreme events
- Involvement of African governments in internationally mandated policy processes such as NAPAs and National Communications to the UNFCCC etc., providing structures for inter-sectoral collaboration, identification and prioritisation of adaptation opportunities, and policy formulation
- Improved understanding of climate variability, future climate change and their impacts, and improved availability of climate knowledge.[29]

New thinking on agricultural knowledge is increasingly, but very unevenly, permeating research and extension services, in ways that are generally positive for agricultural adaptation. Some aspects of this new thinking include:

- Participatory research approaches at field level
- Increased attention to research-extension linkages
- Increased importance of innovation system approaches
- Shifts from top-down extension to demand-led advisory services

[29] The influence of development donors has been important in establishing these drivers, but they are increasingly internalised by African governments.

- Increased recognition of complementarity of knowledge management and input supply, and of importance of working though value chains.

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 and innovation*, 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. We discuss these ways forward in terms of scale, principles and approaches, and entry points.[30]

[30] Several of the elements of this discussion – learning between stakeholders, innovative use of ICTs, work across dimensions of development and across scales - are extremely consonant with the IAR4D approach promoted by FARA and reviewed in Section 1 above.

Scale

We see future work as taking place at three scales:

The role of area-based *projects* in piloting new approaches to fostering farmer adaptation remains important. While this reports in places points out the well-known limits of a project approach, and the risks of project achievements remaining localised or disappearing after three years, we do not wish to discourage donors and NGOs from designing and funding field-level projects. As some of our examples show, the intensive engagement possible in a project setting can allow real progress in learning about what works in terms of climate adaptation, communication and learning itself.

Our research has benefitted greatly from the *Africa-wide* mandate, reach and networking of two of the partners, FARA and AFAAS. We consider that future initiatives to encourage development and exchange of good practice on strengthening of research and advisory services for climate-compatible agricultural development, at the level of Africa as a region, would be very beneficial, and FARA and AFAAS are ready to engage on this with organisations willing to support such work.

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.

Principles and approaches

We can identify a number of key issues and approaches in strengthening of research and advisory services for climate-compatible agricultural development. Some of these have emerged from our case-studies and from the findings of the stakeholder workshops, whereas others have already been current in literature and debates on adaptation. Not all of these will be relevant in all cases, but they are important principles to be considered in design of support.

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, the 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. Value chain approaches, however, must be informed by an awareness of the risks of engaging in different value chains, and of focusing adaptation efforts on single crops.

Innovation in climate and agriculture will 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 – and reinforced continuously by learning at farm level.

Entry points

We therefore see two main entry points for new initiatives, at local level and at national level – but we see it as crucial to foster learning processes that link these levels.

At local level there should be initiatives to building networks or learning platforms, of farmers, researchers, extensionists, NGOs, the private sector, and with linkages to national networks, to foster innovation for agriculture in the face of climate change.

At national level there must be much greater efforts: to mainstream agriculture into climate policy; to mainstream climate into agriculture policy; to assert the importance of knowledge and innovation within the resulting policies and to put that into practice by managing and exchanging information across ministries, research institutions, and development partners; and to ensure that national-level stakeholders learn from farmers' experiences about what works, what does not work and what is needed.

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Annex A: List of project outputs

Project outputs to date comprise the Working Papers, which are posted on the project's website at http://www.erails.net/FARA/climate-learning/climate-learning/library/ :

R. Lamboll and V. Nelson (2012) Exploring the Links between Climate Change, Agriculture & Development. Working Paper No.1[31]*

R. Lamboll and V. Nelson (2012) Exploring the Linkages and Guiding Concepts Relevant to Climate Change, Agriculture and Development. Working Paper No. 2*

I. Moumouni and L. Idrissou (2013) Innovation Systems for Agriculture and Climate in Benin: an Inventory. Working Paper No.3

V. Nelson, J. Morton, E. Apenteng and R. Lamboll (2013) African Agricultural Research and Advisory Services under Climate Change: Perspectives from an E-Discussion. Working Paper No. 4

I. Moumouni and L. Idrissou (2013) Innovation Systems for Agriculture and Climate: Analysis of Three Case-studies from Benin. Working Paper No. 5

V. Parkinson (2013) Climate Learning for African Agriculture: The Case of Mozambique. Working Paper No. 6

M.N. Mangheni, T. Kisauzi and R. Miiro (2013) Climate Learning and Knowledge Management within Uganda's Agricultural Research and Advisory Services. Working Paper No. 7.

The Sierra Leone country report is forthcoming as a Working Paper, as is a short report on perspectives from DRC, Somalia and Sudan.

Project findings have been presented at:

- The Planet under Pressure conference, London 2012
- The CCAFS Workshop on Climate Services for Farmers, Saly, Senegal 2012
- AFAAS Agricultural Extension Week, Gaborone, Botswana 2013
- The Annual Conference of the Development Studies Association, Birmingham 2013
- Adaptation Futures 2014, the Third International Climate Change Adaptation Conference, Fortaleza, Brazil, 2014.

[31] Working Paper Nos. 1 and 2 cover similar topics: WP1 is a more policy-focussed output.

Annex B: Project Objectives

The project objective, as expressed in the original project proposal, was as follows:

To assess through a shared learning process, for sub-Saharan Africa as a whole and for selected case-study countries, the extent to which agricultural research and advisory services (public, NGO and commercial private sectors) have incorporated climate considerations in their policies and operations, and identify practical strategies for making agricultural knowledge management, and thus smallholder agricultural development, in Africa more climate-compatible.

In particular, project partners through a shared learning process will:

a) Explore with diverse actors in Africa the meaning of climate compatible development (CCD) in relation to agriculture to develop a shared understanding.
b) Assess the extent to which ideas and practices connected with CCD are being used by African agricultural research and advisory services (across scales, sectors and actors), and what has influenced decisions regarding their use.
c) Facilitate stakeholders in the identification of the primary challenges and opportunities for enhancing CCD in agriculture and ways forward.
d) Identify and share possible future pathways for African research and advisory services under climate change *and* practical strategies for capacity strengthening (e.g. information dissemination, training and institutional change) to promote CCD in agricultural knowledge management

As discussed in the report, these objectives evolved during project implementation.

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