Proposal for

CGIAR Research Program 7:

Climate Change, Agriculture and Food Security (CCAFS)

Lead Center: International Center for Tropical Agriculture – CIAT)

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CLIMATE CHANGE AGRICULTURE AND FOOD SECURITY

CGIAR

Earth System Science Partnership

CIAT
Centro Internacional de Agricultura Tropical
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Preface

This proposal was prepared by the team leading the CGIAR Challenge Program on Climate Change, Agriculture and Food Security, in partnership with Contact Points from all CGIAR Centers and numerous research and development partners.

The CRP7 concept was discussed at GCARD (c. 100 participants, March, 2010) and received further input at three major meetings:

a) Meeting of CGIAR climate change Contact Points (Copenhagen, April, 2010);
b) Large stakeholder meeting (Nairobi, May, 2010), with participants from agricultural and climate regional agencies, civil society, national agencies, international agencies and advanced research institutes. This involved an open day with 140 persons[1] and a closed three-day planning meeting[2] with 80 invited participants, with good representation from persons familiar with West Africa, Eastern Africa and the Indo-Gangetic Plains, the proposal initial target regions.
c) Executive meeting (Venice, June, 2010) with 25 executives from private and public institutions, facilitated by Harvard University.[3]

Further consultations have been held with numerous stakeholders in Eastern Africa, West Africa and the Indo-Gangetic Plains, and follow-up planning has been done in several small meetings across the regions and with global stakeholders.

In CRP7, Challenge Program activities have been completely integrated, and with the initiation of CRP7 the entire research for development initiative will be managed as an integrated whole.

[1] http://www.ccafs.cgiar.org/sites/default/files/pdf/CCAFS_Conference_Report__May_2010_.pdf
[2] http://www.ccafs.cgiar.org/sites/default/files/pdf/CCAFS_MP7_Planning_Workshop_Report__May_2010__0.pdf
[3] http://www.hks.harvard.edu/centers/cid/publications/faculty-working-papers/cid-working-paper-no.-198

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Abstract

Achieving sustainable food security in a world of growing population and changing diets is a major challenge under climate change. Successful mitigation and adaptation will entail changes in behavior, technology, institutions and food production systems. These changes cannot be achieved without improving interactions among scientists, policy makers and civil society. This CGIAR Research Program (CRP7) will build on the new strategic collaboration between the Consultative Group on International Agricultural Research (CGIAR) and the Earth System Science Partnership (ESSP).

By 2020, CRP7 will contribute to increasing the incomes and well-being of millions of poor people dependent on rural livelihoods, contribute to a reduction in hunger, and contribute to climate change mitigation by enhancing carbon storage and/or reducing greenhouse gas emissions. The vision of success for CRP7 includes being recognized, together with the partners, as the foremost global source of relevant research that leads to strategies for tackling food insecurity in the face of climate change.

CRP7 will become a hub that facilitates collective action across multiple Centers/CRPs. The outcomes planned include (among others): technical and policy support for agricultural management strategies that buffer against climate shocks and enhance livelihood resilience in at least 20 countries; key agencies dealing with mitigation in at least 20 countries promoting new institutional arrangements and incentives that favor resource-poor farmers, particularly vulnerable groups and women; and tools for evaluating *ex-ante* returns to investments that enhance food security in the face of climate change.

The over-arching objectives of CRP7 are: (1) To identify and test pro-poor adaptation and mitigation practices, technologies and policies for food systems, adaptive capacity and rural livelihoods; and (2) To provide diagnosis and analysis that will ensure cost-effective investments, the inclusion of agriculture in climate change policies, and the inclusion of climate issues in agricultural policies, from the sub-national to the global level in a way that brings benefits to the rural poor.

There are four Themes. Three "place-based" Themes will identify and test (through adaptive research) technologies, practices and policies, and will enhance capacity, to decrease the vulnerability of rural communities to a variable and changing climate: Theme 1 – Adaptation to Progressive Climate Change; Theme 2 – Adaptation through Managing Climate Risk; and Theme 3 – Pro-poor Climate Change Mitigation. The fourth Theme – Integration for Decision Making – provides a framework for the whole of CRP7, ensures effective engagement with rural communities and institutional and policy stakeholders, grounds CRP7 in the policy context, and provides, through a demand-driven process, downscaled analyses and tools for future climates. Much of the place-based work will be integrated within target regions, with activities starting in three target regions in 2011 and extending to eight regions by 2013.

CRP7 will make a lasting difference through a strategic focus on capacity enhancement. CRP7 research will improve understanding of the underlying drivers of social differentiation and gender disparities as influenced by climate change, formulate strategies to tackle these, and provide inclusive access to emerging investments (e.g. carbon payments), information and policies that deal with climate change. In recognition that impacts on poor communities and the environment will be achieved with and through partners on the ground, this program will have partnership strategies at its core. Specific activities and procedures are planned to ensure coherence among Themes, and to build links across all CRPs. Innovative knowledge sharing platforms and communication approaches will be explored. Regional work, such as scenario development, will link directly to global policy processes. Early "wins" include a planned major role for agriculture in the post-2012 international climate change regime, and a global network of sites collecting comparative data to identify plausible options for adapting to climate change.

The management system for CRP7 will consist of a Lead Center (and its Board), an Independent Scientific Panel (constituted from nominations by the CGIAR and ESSP, and comprising scientific and development expertise), Program Leader and Program Management Committee. Theme Leaders and Regional Facilitators will help to initiate and coordinate activities.

The program will be reviewed in Year 5 and 10. The budget and logframe are presented for Phase 1 (Year 1-5). A total budget of US$63.2 million in 2011 is proposed, of which US$41.4 million is requested from the CGIAR Fund. The budget is allocated to 15 Centers, and 30% to partners. Partner contributions through leveraged resources are expected to be considerable, with a target of $30 million per annum by Year 5.

Introduction

Background, rationale and challenges

Background

Climate change will have far-reaching consequences for agriculture[4] that will disproportionately affect poor and marginalized groups who depend on agriculture for their livelihoods and have a lower capacity to adapt (World Bank, 2007). Climate-related crop failures, fishery collapses and livestock deaths already cause economic losses and undermine food security, and these are likely to become more severe as global warming continues. A recent study estimates the annual costs of adapting to climate change in the agricultural sector to be over US$ 7 billion (Nelson et al., 2009).

Agriculture and related activities also contribute to global warming, by generating greenhouse gas (GHG) emissions and altering the land surface. Agriculture is estimated to account for about 15% of global GHG emissions and for around 26% if the emissions from deforestation in developing countries – where agriculture is the leading cause of forest conversion – are included (World Bank, 2007). Around 80% of agricultural emissions, including deforestation, occur in developing countries (World Bank, 2007). There remains much untapped technical potential to reduce agricultural emissions and increase agricultural mitigation of emissions from other sectors, notably through reduced deforestation via changes in land use and agricultural practices.

Sustainable food security in a world of growing population and changing diets is a major challenge under climate change. Although estimates of food insecurity vary (Barrett, 2010), the number of undernourished people already exceeds 1 billion and feeding this many people will require more than incremental changes (Federoff et al., 2010). Food production may need to increase by as much as 70% by 2050 when the global population will likely number 9 billion (World Bank, 2007; Royal Society of London, 2009). Food security depends not only on gross production of staples, but also on agriculture's ability to provide income for its practitioners in developing countries, a diverse and balanced food basket, and on the socio-economic factors that determine whether poor people, particularly women, are able to purchase, store, prepare and consume sufficient food.

Rationale

The relationships among climate change, agriculture and food security are complex and dynamic. Agriculture and food systems are heavily influenced by socio-economic conditions such as changing patterns of consumption, macro-economic policies, political conflict and the spread of disease. A report by the World Economic Forum (WEF) warns that: "food security will become an increasingly complex political and economic problem over the next few years" (WEF, 2008). It is therefore vital that initiatives for better climate adaptation and food security are closely aligned.

Responses need to come quickly. Feeding the projected 9 billion people in 2050 requires radical transformation of agriculture over the next four decades, growing more food without exacerbating environmental problems and simultaneously coping with climate change (Godfray et al., 2010). The actions taken over the next 10 years will be especially critical. A new research initiative is needed – one that integrates and applies the best and most promising approaches, tools and technologies. The involvement of farmers, policy-makers, researchers, the private sector and civil society in the research process is vital. Successful mitigation and adaptation will entail changes in individual behavior, technology, institutions, agricultural systems and socio-economic systems. These changes cannot be achieved without improving interactions among scientists and decision makers at all levels of society.

[4] The term agriculture is used inclusively to capture the wide range of productive uses of extensive and intensive farmland, rangelands, fisheries and aquaculture and their wider landscapes.

CGIAR Research Program (CRP) 7 will address the increasing challenge of global warming and declining food security on agricultural practices, policies and measures. It will do so by building on the new strategic collaboration between the Consultative Group on International Agricultural Research (CGIAR) and the Earth System Science Partnership (ESSP) established under the CGIAR Challenge Program on climate change in 2009. This alliance and its partners bring together the world's best scientists in agricultural, climate, environmental and social sciences to identify and address the most important interactions, synergies and trade-offs between climate change and agriculture. CRP7 will thus define and implement a uniquely innovative and transformative research program that addresses agriculture in the context of climate variability, climate change and uncertainty about future climate conditions.

The challenge for climate change modeling

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) provides an in-depth analysis of recent scientific understanding on climate change (IPCC, 2007). It brings together evidence that confirm that human-induced temperature increases are taking place, with measurable and increasing effects on other parts of the Earth system. Many scenarios are available of how the global climate might change over the next century (IPCC, 2007). Although there are many uncertainties, it is becoming increasingly evident that regardless of mitigation efforts (undertaken today and in the future), temperatures will continue to rise over at least the next five decades because of earlier emissions of greenhouse gases. The magnitude and frequency of extreme events are also likely to increase. Adaptation is therefore a necessary response to climate change. At the same time, mitigation of further climate change is an urgent challenge if future changes are to be limited.

Climate, however, is only one element of the dynamic Earth system. Changes in the physical and biogeochemical environment, either caused naturally or influenced by human activities, contribute to global environmental change. Earth system sciences take a holistic approach to understanding the processes and outcomes of global environmental change by investigating the interactions among land, atmosphere, water, ice, biosphere, society, technologies and economies. The alliance between ESSP and the CGIAR will provide more context-specific (e.g. ecosystems, farming systems) data and information to enhance the predictive accuracy of downscaled climate change scenarios and identify cost-effective interventions.

The challenge for agriculture

Agricultural systems are complex and dynamic. Some systems are less vulnerable to short-term climate effects (e.g., some irrigated farming systems). Others (e.g., those relying on rain-fed agriculture) have always been exposed to uncertain and extreme climate but may now face variability beyond the current 'coping range'. In vulnerable systems, climate change threatens food security, livelihoods and economic prosperity (UNDP, 2007).

The AR4 has gathered scientific evidence and expert opinion on the expected impacts of climate change on agricultural systems (IPCC, 2007). The report notes that climate change is already having an impact, for instance, through changes in patterns of variability and associated changes in rainfall distribution. It anticipates with high confidence that projected changes in the frequency and severity of extreme climate events, together with increases in outbreaks of pests and diseases, will have significant consequences for food security. It identifies smallholder and subsistence farmers, pastoralists and fishers as those most vulnerable to these impacts.

The AR4 finds that Africa is highly vulnerable to climate change, because of multiple stresses and low adaptive capacity. Projections indicate an increase in arid and semi-arid land in some countries while others will get wetter but with changes in seasonal patterns. In Asia, potential changes in the monsoon and in glacier and snowmelt are perhaps the greatest threats. Sea-level rise is also of great concern as coastal and deltaic areas are often heavily populated and intensively cultivated. The natural and managed habitats of fish will be greatly influenced, with declining productivity in fisheries very likely. The report recognizes that,

with only a decade of research on climate change adaptation, considerable knowledge gaps remain concerning the adaptive capacity of agriculture.

Climate variability and risk has always been a part of agriculture, and farmers have developed many ways of dealing with risk. Enhancing risk management strategies is an important part of the work of the CGIAR, e.g. developing drought-resistant and other abiotic stress-tolerant crop varieties, and soil and water management practices for marginal areas. Climate change introduces a new dimension to the problem. The unprecedented rate and magnitude of climate change presents great challenges to farmers, researchers and policy makers alike.

Current efforts to increase adaptation and mitigation options provide a sound basis for the next phase of research on climate change and agriculture. However, this phase must go far beyond current activities. New responses are needed, as well as new ways of working with partners and also in conjunction with the other CRPs. These must be instilled with a degree of urgency, reflected in the research agenda and its implementation, and in the delivery and outreach of outputs.

Vision of success and intended impacts

CRP7 is designed to contribute to improved agricultural, natural resource management and food systems (Figure 1). It takes its mandate from the from the CGIAR vision[5], namely "*To reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience through high-quality international agricultural research, partnership, and leadership."* Impacts are sought in three dimensions: (a) environmental, in particular related to reducing emissions and improving carbon storage; (b) enhancing rural livelihoods, by reducing vulnerabilities, increasing adaptive capacity, securing assets and raising incomes; and (c) improving food security[6]. While much of the focus will be on agricultural production, the entire food system will be targeted, as solutions to the challenges posed by climate change have to go beyond agricultural production[7]. The three dimensions in which CRP7 seeks impact correspond to different groups of ultimate beneficiaries. For impact on livelihoods, the ultimate beneficiaries are resource-poor farmers and other members of the rural and peri-urban poor associated with the agricultural sector. These groups will benefit through reduced vulnerability, raised adaptive capacity and higher incomes. For impact on food security, CRP7 seeks to help not only the rural poor but also the urban poor that number among the world's one billion undernourished. For impact on environmental health and carbon storage, there will be both local beneficiaries and a global public goods benefit. Although the notion of securing win–win–win outcomes for these three dimensions is appealing (Global Donor Platform, 2009; FAO 2009a), we have to recognize the possibility of trade-offs among these dimensions (Campbell, 2009; FAO, 2009b).

By achieving impacts on livelihoods, hunger and environmental health, CRP7 will contribute directly, along with the other CRPs, to the Strategy and Results Framework (SRF) for the CGIAR, which establishes measurable targets.[8] CRP7 has the following impact targets, derived through our own analyses (e.g. see below and Annex 2) and from the analyses undertaken for the SRF:

- By 2020, contribute to cross-sectoral efforts to reduce poverty by 10%, increasing the incomes of hundreds of millions of people

[5] CGIAR Working Group on Visioning, Visioning the Future of the CGIAR, Report to the Executive Council (Washington, DC, CGIAR, 2008)

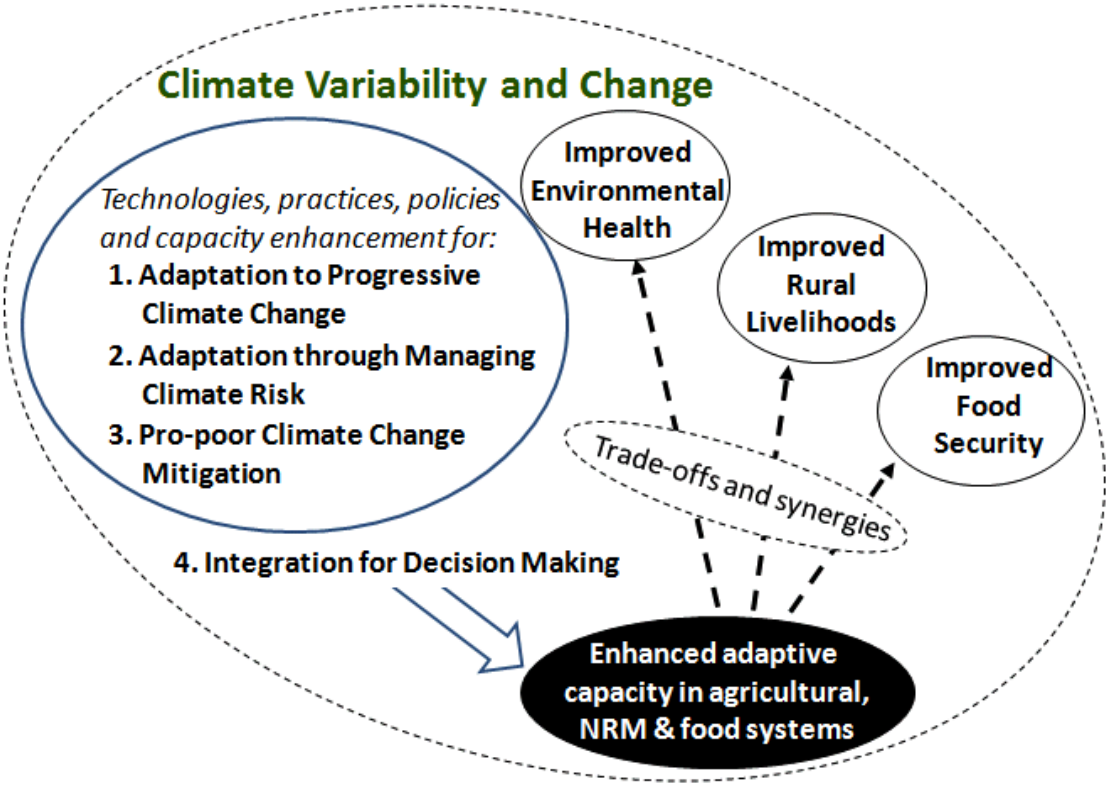
[6] ***Food security*** is the state achieved when food systems operate such that "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996).

[7] ***Food systems*** encompass (i) activities related to the production, processing, distribution, preparation and consumption of food; and (ii) the outcomes of these activities contributing to food security (Ericksen, 2008).

[8] CGIAR (unpublished). A Strategy and Results Framework for the CGIAR. For submission to the CGIAR Fund Council and Funders Forum. Document submitted for discussion in June, 2010.

- By 2020, contribute to a reduction in hunger, whereby the number of rural poor who are undernourished declines by 25%
- By 2020, help agriculture contribute to climate change mitigation by enhancing storage or reducing emissions, by 1000 Mt CO_2-eq (considering all gases) below the "business-as-usual" scenario.

Figure 1. Scope of CRP7: Climate Change, Agriculture and Food Security. Four research Themes are designed to develop adaptive capacity that is expected to have impacts on livelihoods, hunger and environmental health



These targets will be updated when the ex ante tools produced by Theme 4, Objective 2 become available.

The vision of success for CRP7 includes surpassing these impact targets, achieving the multiple outcomes of CRP7 over the next 5-10 years (Table 1), and being recognized, together with partners, as the foremost global source of relevant research results that lead to options and strategies for tackling food insecurity in the face of climate change. In terms of the new CGIAR, CRP7 seeks to become a hub that facilitates collective action across all Centers and all CRPs.

Evidence that intended impacts can be achieved

Linear pre-determined pathways to impact are the exception rather than the rule (Biggs, 1990), and thus CRP7 will put in place procedures and systems for exploiting the opportunities that emerge for outcomes, as well as having a clear strategy for impact. The strategy for impact recognises that good research may only be one of the multiple cornerstones of research for development (Figure 2) that includes attention to partnership development, scaling up, cross-disciplinarity, capacity enhancement and enabling governance and policy.

Figure 2. Cornerstones of successful research for development that achieves widespread impact (from Campbell et al., 2006).

To achieve the impacts listed in the previous section, CRP7 has planned for 12 key outcomes, to be achieved by Year 10 (Table 1).

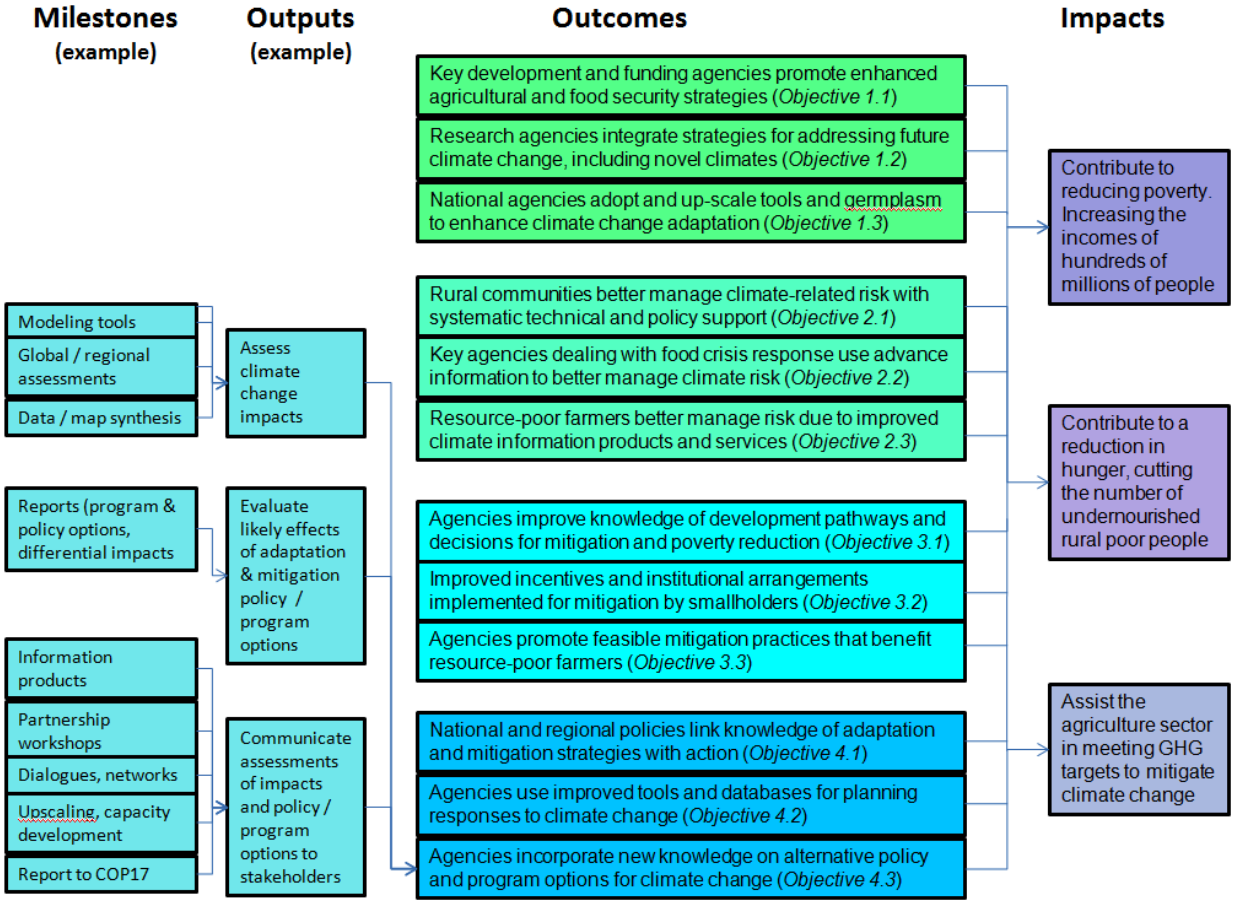
The planned outcomes cover an inter-woven package of technologies, approaches and policies for both adaptation and mitigation, and are targeted at various levels, from the farm to the global policy arena. To ensure that these outcomes are achieved CRP7 has defined impact pathways tailored to specific opportunities, working back from the outcomes desired to the outputs needed to achieve those outcomes, the partners needed to deliver on the outputs, and critical actors that need to be engaged who can help foster the outcomes. A generic impact pathway is given in Figure 3 for the entire program, with examples of more specific impact pathways given elsewhere (Figure 4: an integrated impact pathway for India in the Indo-Gangetic Plains; Figure 9-14: impact pathways for different Themes, for achieving outcomes from local to global scales).

Table 1. Outcomes planned in each of the four Themes, to be delivered by Year 10

CGIAR Vision	***To reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience through high-quality international agricultural research, partnership, and leadership***
CRP7 Goal	***To promote a food-secure world through the provision of science-based efforts that support sustainable agriculture and enhance livelihoods while adapting to climate change and conserving natural resources and environmental services***
CRP7 Sub-goals	***1. To identify and test pro-poor adaptation and mitigation practices, technologies and policies for food systems, adaptive capacity and rural livelihoods***
	2. To provide diagnosis and analysis that will ensure the inclusion of agriculture in climate change policies, and the inclusion of climate issues in agricultural policies, from the sub-national to the global level in a way that brings benefits to the rural poor
Theme 1: Adaptation to Progressive Climate Change	
Outcome 1.1: Agricultural and food security strategies that are adapted towards conditions of predicted climate change promoted by the key development and funding agencies (national and international), civil society organizations and private sector in at least 20 countries	
Outcome 1.2: Strategies for addressing abiotic and biotic stresses induced by future climate change, variability and extremes, including novel climates mainstreamed among more than 75% of the international research agencies, and by national agencies in at least 12 countries	
Outcome 1.3: Portfolio of information sources, guidelines and germplasm available for using genetic and species diversity to enhance adaptation and resilience to changing climate are adopted and up-scaled by national agencies in at least 20 countries and by international organizations for the benefits of resource-poor farmers	
Theme 2: Adaptation through Managing Climate Risk	
Outcome 2.1: Systematic technical and policy support by development agencies for farm- to community-level agricultural risk management strategies and actions that buffer against climate shocks and enhance livelihood resilience in at least 20 countries	
Outcome 2.2: Better climate-informed management by key international, regional and national agencies of food crisis response, post-crisis recovery, and food trade and delivery in at least 12 countries	
Outcome 2.3 Enhanced uptake and use of improved climate information products and services, and of information about agricultural production and biological threats, by resource-poor farmers, particularly vulnerable groups and women, in at least 12 countries	
Theme 3: Pro-Poor Climate Change Mitigation	
Outcome 3.1: Enhanced knowledge about agricultural development pathways that lead to better decisions for climate mitigation, poverty alleviation, food security and environmental heath, used by national agencies in at least 20 countries	
Outcome 3.2: Improved knowledge about incentives and institutional arrangements for mitigation practices by resource-poor smallholders used by farmers, (including farmers' organizations), project developers and policy makers in at least 12 countries	
Outcome 3.3: Key agencies dealing with climate mitigation in at least 12 countries promoting technically and economically feasible agricultural mitigation practices that have co-benefits for resource-poor farmers, particularly vulnerable groups and women	
Theme 4: Integration for Decision Making	
Outcome 4.1: Appropriate adaptation and mitigation strategies mainstreamed into national policies in at least 20 countries, in the development plans of at least five economic areas (e.g. ECOWAS, EAC, South Asia) covering each of the target regions, and in the key global processes related to food security and climate change	
Outcome 4.2 Improved frameworks, databases and methods for planning responses to climate change used by national agencies in at least 20 countries and by at least 10 key international and regional agencies	
Outcome 4.3 New knowledge on how alternative policy and program options impact agriculture and food security under climate change incorporated into strategy development by national agencies in at least 20 countries and by at least 10 key international and regional agencies	

Achievement of some of these outcomes will require close collaboration with other CRPs, especially in relation to Outcomes 1.1, 2.1 and 3.3, where there will be considerable interaction with other CRPs.[9] However, given that CRP7 will be collaborating with numerous Centers/CRPs in different regions, we believe that the outcomes can be achieved even if a few of the other CRPs fail to deliver on their outputs in specific locations. In addition, each of these outcomes has a considerable amount of research inputs from CRP7 alone, so even in the face of failure of other CRPs we will be able to deliver on the bulk of the target. As illustrated in Figure 3 achieving the impacts is not dependent on a specific outcome, but rather on a portfolio of outcomes. Having one outcome that is somewhat weaker than others will not jeopardise the entire effort.

Figure 3. Generic impact pathway for CRP7 showing how annual Milestones build up to five-year Outputs and in turn lead to long-term Outcomes and Impacts (showing Milestones and Outputs for one of the twelve Outcomes). The overview of the Goals and Outcomes is shown in Table 1; the intermediate performance indicators in Table 4; the structure of Objectives/Outcomes/Outputs for each Theme in Tables 11, 13, 15 and 17; and the full details of the annual Milestones in Annex 1. For specific impact pathways, see Figures 4 and 9-14.



CRP7 will work on outputs that are directly relevant to the outcomes listed in Table 1 and in the defined impact pathways. The outputs will, *inter alia*: improve the effectiveness of research undertaken in other CRPs so that they incorporate the effects of climate change; identify climate risk adjustment strategies to reduce variability in production; undertake analysis of the enabling and disabling policy and institutional environment which influences how productivity gains result in enhanced food and livelihood security, and critically, for whom; and develop mechanisms by which small farmers can participate in carbon markets.

[9] See section on "Roles of CGIAR centers and integration with other CRPs" for a description on collaboration and cofinancing. Also see Table 8 to show budget allocations for cofinancing.

In order to reach the desired impacts, at a scale well beyond the sites where field trials and surveys will be undertaken, CRP7 will partner with some of the major international multi-lateral and non-governmental agencies, while at the same time being grounded in work with national agricultural, natural resource, environmental and meteorological agencies, the private sector and local non-governmental organizations (NGOs). By influencing global and regional policy processes, CRP7 and its partners will also be able to scale up impact. Considerable attention will be given to ensuring coherence across the scales of operation (Cash et al., 2006). Strengthening partnership platforms and developing reflexive approaches, where researchers keep returning to stakeholders to jointly develop means of adapting, learning and responding to feedback, will be built into the program's structures and functions. Exploration of innovative use of ICTs (e.g. climate information and community feedback via mobile phones and crowdsourcing methodologies) will address this challenge.

The technologies, practices and policies that are developed to counter climate change and climate risk will have direct effects (e.g., through agricultural productivity increases and indirect effects (e.g., increased gross domestic product (GDP) growth rates brought about by agricultural development). We estimate for sub-Saharan Africa (SSA) that there are about 260 million poor in the rural sector who are likely beneficiaries for direct effects, and about 150 million urban poor and 150 million rural poor (poorest of the poor) who are likely beneficiaries for indirect effects (Annex 2). Similar kinds of data and analyses are not available for other parts of the globe, but it can be seen that the number of potential beneficiaries runs into hundreds of millions (within the first five years of CRP7, one of the research outputs is a set of sophisticated *ex ante* assessment tools to evaluate the likely impacts of different research and development approaches, building on previous integrated assessment work at many different institutions and integrating different components in novel ways).

Modest successes in reducing GHG emissions growth, e.g. 10% reductions below "business-as-usual" scenarios, in concert with similar levels of improvement in the substitution of fossil fuels by biomass energy, can enhance global climate mitigation by agriculture for the period 2015–2020 by about 1000 Mt CO_2-eq. (considering all gases) below the "business-as-usual" scenario[10]. Intensifying agriculture in existing cultivated and grazed areas while limiting the expansion of extensive production practices into carbon-rich landscapes (e.g. forests in West Africa and grasslands with high soil carbon in the Andes) will be a major route to reducing emissions. If deforestation through agricultural expansion can be reduced by 10% for the period 2015–2020 through agricultural development pathways that involve intensification, a further 500 Mt CO_2-eq. (approx) can be stored. It is also assumed that mitigation initiatives by smallholder farmers will be rewarded, with incomes being supplemented by up to US$50 per household per annum in some cases.

Assuring poverty reduction under climate change is a high-level goal of the CGIAR and CRP7. It will mean decreasing the vulnerability and improving the adaptation and adaptability of different groups of the poor to improve their well-being. Given anticipated food supply shortfalls, poverty reduction also includes special attention to food security and food delivery systems. Therefore, in addition to standard livelihood indicators, poverty reduction under climate change will require new concepts and indicators. Poverty needs to be measured across multiple dimensions, including social, political, economic, and natural resource assets, and at multiple levels, including intra-household, household, community and region. Poverty is relative in different contexts and times. Reducing poverty requires the involvement (agency) of poor and marginalized people in decision-making and governance. Poverty is dynamic and influenced by power relations and socioeconomic conditions that can interact with climate-related shocks, such as political instability and the occurrence of natural disasters. There is therefore a need to understand and monitor poverty and poverty reduction over time, with the involvement of government and other development intermediary stakeholders.

[10] For original figures, see: Smith et al. (2008).

Strategic Goals

The overall Goal of CRP7 is *to promote a food-secure world through the provision of science-based efforts that support sustainable agriculture and enhance livelihoods while adapting to climate change and conserving natural resources and environmental services.* Working with national and regional partners, promising adaptation options will be identified and evaluated, and through modeling approaches their efficacy in adapting agricultural systems will be quantified and used to provide detailed adaptation pathways at the national, regional and global levels.

CRP7 will address this goal by generating the knowledge base and toolsets needed to empower farmers, policy makers, researchers and civil society to manage agricultural and food systems successfully so as to strengthen food security, enhance rural livelihoods and improve environmental health in the context of the challenges arising from current climate variability and progressive climate change.

The Sub-goals of CRP7 are:

1. To identify and test pro-poor adaptation and mitigation practices, technologies and policies for food systems, adaptive capacity and rural livelihoods.
2. To provide diagnosis and analysis that will ensure the inclusion of agriculture in climate change policies, and the inclusion of climate issues in agricultural policies, from the sub-national to the global level in a way that brings benefits to the rural poor.

Specific 3-year performance indicators have been defined for these Sub-goals, so that they can form the basis of an evaluation in Year 5; part of the process towards moving between the 5-year Phase 1 and Phase 2 (see Annex 1 for the logframe).

The proposed program

Program design

CRP7 is designed to help deliver impacts at global, regional and national levels cost-effectively, with a strong emphasis on capacity enhancement, inclusiveness – particularly of women and other marginalized groups – and on pragmatic recognition and evaluation of trade-offs among food security, poverty alleviation and environmental health objectives.

The global Themes

CRP7 is structured around four closely inter-linked global Themes (Figure 1). Three of these involve field-level work in benchmark sites in the target regions. These so-called "place-based" Themes will work together to identify and test (through adaptive research) technologies, practices and policies, and will enhance capacity to reduce the vulnerability of rural communities to a variable and changing climate:

- Theme 1: Adaptation to Progressive Climate Change
- Theme 2: Adaptation through Managing Climate Risk
- Theme 3: Pro-poor Climate Change Mitigation

Themes 1 and 2 identify and assess adaptation pathways at different time-scales. Theme 1 tackles decadal time periods (mostly 2020 to 2050), while Theme 2 addresses current risks associated with climate variability. In the shorter term, since rain-fed farmers, pastoralists and coastal fishers are already vulnerable to current climate shocks, it is essential to help them build resilience through better information and strategies to deal with current climate-induced risk. Not only will greater resilience allow farmers and fishers a wider range of adaptation options in the future, but perhaps more important is the assumption that variation will be even more extreme under climate change. Collectively, these three Themes will demonstrate and assess the feasibility, effectiveness and acceptability of integrated strategies for advancing food security, rural livelihoods and environmental goals in the face of a changing climate; will identify and prioritize institutional and policy options for overcoming obstacles to implementing these strategies at the scale of the development challenge; and will ensure that appropriate practices and technologies get into the hands of farmers. Silos among the three Themes will be avoided through joint benchmark sites, joint field personnel, the coordinating functions of the Regional Facilitators and regular inter-Theme meetings.

Theme 4 – Integration for Decision Making – provides an analytical and diagnostic framework for the whole of CRP7. It also ensures effective engagement of rural communities and institutional and policy stakeholders, and grounds CRP7 in the policy context. CRP7 recognizes that many of the challenges poor communities are dealing with involve institutional, policy and infrastructural constraints and not just technical issues. Theme 4 will ensure that principles for linking knowledge with action for sustainable poverty reduction (Kristjanson et al., 2009) are applied and local innovation capacity is strengthened. In doing vulnerability assessments and building integrative *ex ante* assessment tools, this Theme helps set the agenda for the place-based Themes, and as such will also provide support to other CRPs. The analytical and diagnostic framework of Theme 4 will allow information at multiple scales to be brought to bear on the key research questions addressed in CRP7, such as the downscaling of climate and global socio-economic processes to the local level and the upscaling of case-study results to broader, regional and cross-regional domains. Theme 4 also provides the framework and tools for baseline diagnoses and ongoing monitoring and evaluation. The policy environment increasingly influences the opportunities and constraints affecting local and national-scale actions that can be taken in response to a changing climate, thus boundary spanning strategies for linking the science to policy at various levels will be critical. Understanding vulnerability, jointly identifying appropriate interventions and assessing their effectiveness with partners,

and leaving a sustained legacy of improved decision-making and improved information flows, all depend critically on effective modes of engagement with a range of stakeholders. Theme 4 will interact with the three "place-based" Themes through regular inter-Theme meetings, cross-fertilization of data and modeling outputs, generation of hypotheses for fieldwork and macro analyses, and through participation in activities in the place-based themes that have a strong stakeholder engagement element. Theme 4 activities and products will be both demand and supply-driven; demand-driven through the needs identified by the place-based Themes and other CRPs, and supply driven by the early recognition of challenges that comes with sophisticated forward-looking analyses that are supported by novel data collection and fusion.

Beneficiaries

The three dimensions in which CRP7 seeks impact correspond to different groups of ultimate beneficiaries. For impact on rural livelihoods, the ultimate beneficiaries are resource-poor farmers and other members of the rural and peri-urban poor associated with the agricultural sector, including pastoralists, fishers, sawyers, users of wild resources, landless agricultural labourers, local traders, input suppliers and processors (i.e. people found throughout the value chain, from input supply, to production, to processing, to trading, to selling to the ultimate consumers). These groups will benefit through reduced vulnerabilities, raised adaptive capacity and sustained incomes. For impact on food security, CRP7 seeks to help not only the rural poor but also the urban poor that number among the world's one billion undernourished. For impact on environmental health and carbon storage, there will be both local beneficiaries and a global public goods benefit.

CRP7 will reach its ultimate beneficiaries through different sets of carefully selected proximate beneficiaries for each Theme and Objective.[11] To demonstrate the diversity with a few examples, proximate beneficiaries will include public, private and civil society sectors, and will range from global bodies and processes such as the United Nations Framework Convention on Climate Change (UNFCCC), the World Food Program and the Voluntary Carbon Standard through to organizations and change makers at national and local levels, such as farmers' groups, research stations, insurance companies and government departments. One of the lessons from past CG research has been that stronger links to the private sector are key to impact, yet fraught with challenges – thus a key strategy here will be to work closely with industry platforms, where many private sector companies have already come together to address global food security concerns. Examples from different industries and different levels of platforms with which CRP7 will work include: the Sustainable Agriculture Initiative (SAI); Federation of Indian Chamber of Commerce and Industry (FICCI); ISEAL Alliance (alliance of all major agri-certification schemes/labels).

The regional approach

Much of the place-based research will be undertaken at several spatial levels within so-called "target regions", and will share common research sites and infrastructure where appropriate. CRP7 activities will be fully integrated with activities of CRP1 (Integrated agricultural systems for the poor and vulnerable) in shared target regions. While there are many regions in the developing world that warrant research investment, CRP7 will not overstretch itself. It will initiate work in three target regions in 2011, add two regions in 2012, and a further three regions in 2013. The three initial focus regions are eastern Africa, West Africa and the Indo-Gangetic Plains (IGP). Criteria for selecting the initial focus regions were:

- Poverty and vulnerability: high degree of vulnerability to climate, large poor and vulnerable populations, drivers of vulnerability that extend beyond the focus region;
- Complementary set of social, cultural and institutional contexts;

[11] For each of the four Themes there are three Objectives. These are detailed in the description of the CRP7 portfolio.

- Complementary climatic contexts, with different temporal and spatial scales of climate variability and degrees of predictability;
- Significant but contrasting climate-related problems and opportunities for intervention;
- Security, governance and institutional capacity that favor the likelihood of scaling-out results.

A range of regional partners have been involved in the selection of field sites and countries within target regions.[12]

By early 2011 the initial vulnerability studies undertaken by Theme 4 (Objective 1) [13] will be complete, and will be used to help identify the regions to be initiated in 2012 and 2013[14]. The stakeholder meeting in May (2010) identified the key criteria to be used in making the selection of future regions.[15] Work will not be conducted exclusively in target regions, as a series of global comparative analyses are planned within Themes, where site selection has been guided by thematic and impact considerations. In the regions, while most field work will be conducted at the same site, some specific activities, such as mitigation studies, may use other sites that are better suited for the objectives.

Data availability and quality will not be equal in all regions and this will limit, for example, the capacity of CRP7 to design and run models at the regional or site level where data are poor. The overlap of themes and regions will help to provide tools with wide geographic applicability. Two mechanisms in particular will be used in CRP7 to effect transitions of scale. First, the regional scenarios activities will provide an integrating framework. Second, careful characterisation work will also provide the basis for judicious extrapolation of site- and model-based research outputs to broader domains, where this is possible.

The regional approach will be used to ensure complementarity of thematic research, will be the basis of a strong network of partners implementing the work, and the regional teams will spearhead achievement of outcomes and impacts at national and regional levels. In this regard, integrated impact pathways have been developed for national and regional levels, as illustrated in Figure 4[16].

Achieving coherence among Themes

The agricultural sector is where the adaptation and mitigation agendas are most closely interconnected (Global Donor Platform, 2009). In consequence, the place-based work has to be planned and implemented in a coordinated manner, especially as farmers have to grapple with both adaptation and mitigation issues simultaneously (Figure 5). Theme 3 will have a specific focus on the synergies and trade-offs between adaptation and mitigation strategies (Objective 3.1). Themes 1 and 2 also have to be implemented in a coordinated manner, as current farmer strategies, coping mechanisms and indigenous knowledge give important insights on how to tackle future climate change. Finally, all the place-based Themes will be tied closely to Theme 4, to ensure the tools developed and policy analyses conducted are demand-driven and guide the place-based Themes. To achieve this coherence, mechanisms include: a team approach to planning and implementation, a common conceptual framework, joint fieldwork at shared benchmark sites, sharing of data and results, cross-generation of hypotheses, integrated impact pathways at national and regional levels, and specific roles for Regional Facilitators (see “management systems”) in bridging Themes at the site, national and regional levels.

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[12] Through scoping studies and regional consultations 4-7 sites have been selected in each region in the following countries: Eastern Africa – Ethiopia, Kenya, Uganda, Tanzania; West Africa: Burkina Faso, Ghana, Mali, Niger, Senegal; IGP: Bangladesh, India, Nepal.

[13] See “Description of Program Portfolio"

[14] Several candidate regions have been put forward by stakeholders: Amazonia, Central America, Southern Africa, South-East Asia, Pacific, arid zones

[15] The workshop report is available at ccafs.cgiar.org/content/planning-workshop-report

[16] The impact pathways shown in Figures 4, and 9-13, have been developed with stakeholder inputs from the Nairobi (2010) meeting and from follow-up regional consultations. The displayed impact pathways are illustrative, with others developed for particular sub-themes and national contexts.

Figure 4. Empowering national and regional stakeholders for meeting the adaptation and mitigation challenges to agriculture under climate change. This example is for India (Indo-Gangetic Plains target region). While the impact pathways are similar from region to region and country to country, there are some specific differences and, of course, the actors differ[17]

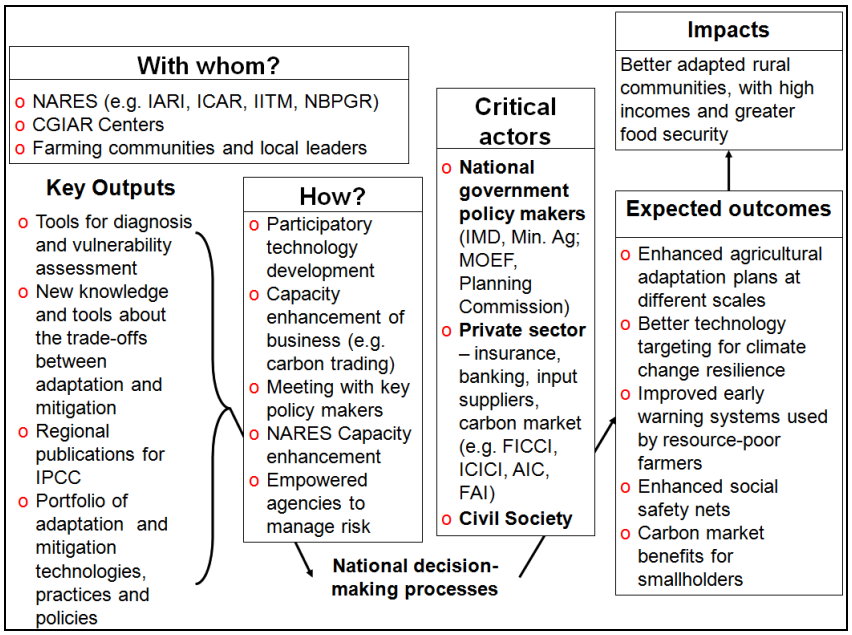
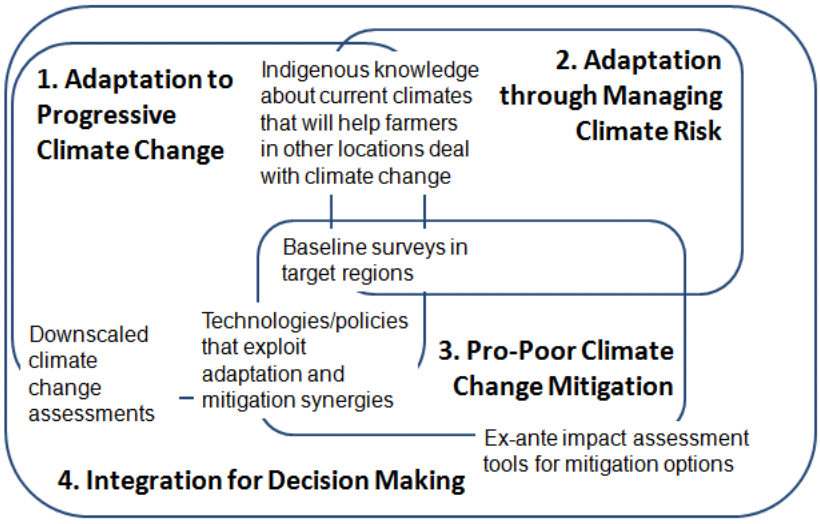


Figure 5. Coherence among CRP7 Themes needs to be fostered through team work, strong conceptual underpinning and joint activities. Some examples of joint activities/products are illustrated



One of the specific activities that will be conducted to build coherence across Themes will be scenario development (Objective 4.1). Identifying viable technological and policy options to improve food security in the face of climate and other environmental changes requires improved dialogue among researchers, policy makers and resource managers. Scenario analyses conducted at the regional level and linked to the global level will help to systematically explore such options. These scenarios will form an important aspect of

[17] See list of acronyms for expansions of all acronyms in figures.

communications and capacity enhancement and will help build regional science and policy teams who can take the CRP7 outputs forward. Scenario building carried out under CRP7 will also inform decision-making in other CRPs.

Research outputs will be *integrated across Themes within regions* to provide regional public goods linked to specific impact strategies (e.g. work from Theme 1 Objective 3 on diversification strategies to reduce risk and from Theme 2 Objective 2 on improved weather forecasting for managing extreme weather events, will be linked to the key players managing regional crisis preparedness). Research outputs will also be *integrated across regions within Themes* to provide generic understanding and other international public goods (IPGs), feeding into global impact strategies.

Communications and early wins

Part of the vision of success for CRP7 is that it becomes the "go-to place" for key stakeholders to seek relevant evidence, knowledge and tools to formulate options and strategies for tackling food insecurity in the face of climate change. CRP7 will have an ambitious, well-resourced, proactive communications strategy. A focus of the research strategy will be on developing and implementing innovative approaches to strengthen the link between research, policy and practice. Partnerships will be essential, especially with organizations that communicate directly with farmers, and with global and local media to capture the attention of policy makers and general interest groups in public, private and civil society sectors.

CRP7 will use outreach tools geared to specific audiences to communicate knowledge, evidence, tools and other outputs, and to maintain a two-way conversation with stakeholders. Outreach tools have been chosen to reach a good balance between indirect communication from a "basic" platform (website), direct communication (newsletters, briefings, AgClim Letters[18] and journal articles), and dialogue among stakeholders (events, webinars, blog). Particular effort will be put into a dynamic Agriculture and Rural Development Day (ARDD)[19] at the annual UNFCCC Conference of Parties (COP), aimed at raising the visibility of agriculture and food security in the global climate dialogue and advancing the position of agriculture in the negotiations[20]. Materials for communication will go beyond CRP7 products, drawing in all noteworthy advances in science that link climate change, agriculture and food security. Building relationships with the media will be a strong focus, with a systematic approach to preparation, timing and networking carried out in close cooperation with the Consortium Office communications team, the ESSP Communications Office, and the communications teams of the Participating Centers/Partners. A number of strategic partnerships will be developed for global and regional outreach (e.g. CTA, Farming First).

Communication beyond research circles requires highly relevant research in accessible and tailored formats. An early task for CRP7 will be to communicate the major near-term outputs, which will include:

- Identification of current farmer practices that have relevance to future climate change (Theme 1);
- Analysis of how institutions concerned with management of food crises and price volatility respond to current climate information systems and how this response could be more accurate and timely (Theme 2);
- Assessment of potential emissions reductions from technical options compatible with maintaining food supply under alternative intensification scenarios (Theme 3);
- New vulnerability characterization of agricultural systems for the global tropics to enhance targeting (Theme 4).

[18] 9-10 per year, a one page carefully crafted policy message drawing on peer-reviewed literature will be sent to the 5000 individuals in the global and regional communities that are setting the agenda for climate change, agriculture and food security.

[19] This is organised with a large number of partners, e.g. Global Donor Platform for Rural Development, FAO, IFAD, CTA

[20] ARDD 2009 was regarded as highly successful: www.cgiar.org/pdf/Collective%20Action%20News_December2009.pdf

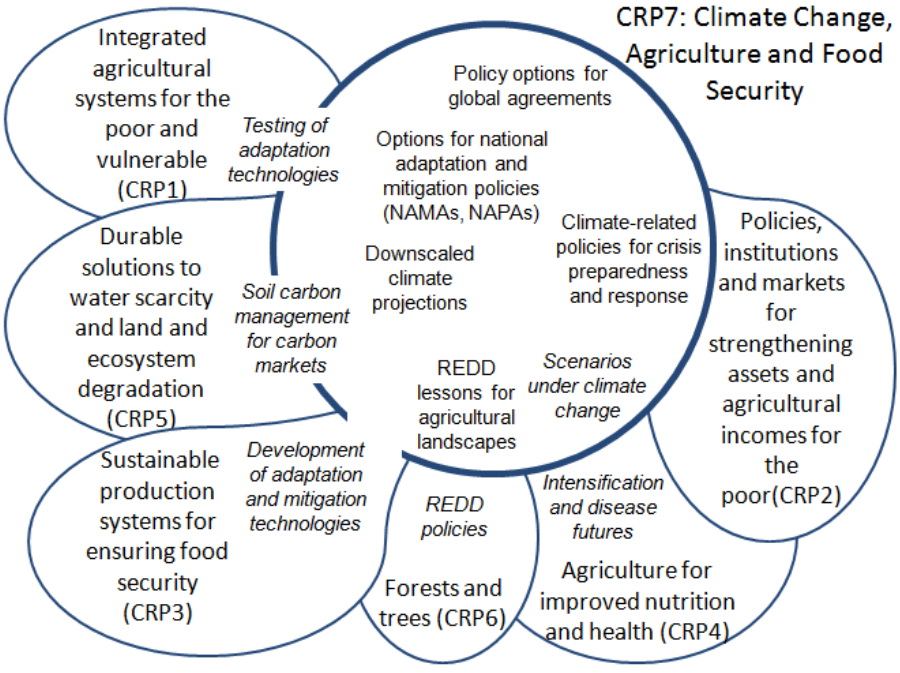
Roles of CGIAR Centers and Integration with other CGIAR Research Programs

The cross-Center and cross-CRP collaboration and alignment of research on agriculture and climate change will be a fundamental aspect of CRP7. All Centers will participate in CRP7; and CRP7 will work closely with all other CRPs. This cross-Center and cross-CRP initiative makes for outstanding opportunities, and heralds a new way of working in the CGIAR.

Examples of cross-Center collaboration will include (a) hotspot and vulnerability assessments (AfricaRice, CIFOR[21], CIMMYT, CIP, ICARDA, IITA, ILRI, IRRI, WorldFish); (b) climate change modeling impacts on agriculture and livelihoods (AfricaRice, Bioversity, CIAT, CIP, ICARDA, ICRISAT, IFPRI, IITA, ILRI, IRRI, IWMI, World Agroforestry Center); (c) informatics tools for selecting germplasm with desired traits for future climates (Bioversity, CIP, ICARDA); (d) mitigation options (AfricaRice, CIAT, CIFOR, CIP, ICRISAT, IFPRI, ILRI, IRRI, IWMI, World Agroforestry Center); (e) responses of pests and diseases to climate change (AfricaRice, Bioversity, CIAT, CIP, ICRISAT, IITA, ILRI); and (f) policy research on adaptation and mitigation options that enhance food security (Bioversity, CIAT, CIFOR, ICARDA, ICRISAT, IFPRI, IITA, World Agroforestry Center).

The relationships between CRP7 and other CRPs are summarised in Table 2 and Figure 6, and further details are provided for each CRP7 Theme in Tables 12, 14, 16 and 18. CRP7 research products will make a significant input to other CRPs, most importantly in providing the climate change context for activities, outputs and impacts in other CRPs. CRP7 has a major role to play in mainstreaming climate-related research into all the CRPs.

Figure 6. Mainstreaming climate-related research into all CGIAR CRPs – some illustrative activities/products in CRP7 – some part of other CRPs and cofinanced by CRP7 (in italics)[22], while others being part of CRP7.



[21] See list of acronyms for expansions of all acronyms in bracketed lists.
[22] Titles of CRPs are likely to undergo further change.

Table 2. Interaction of CRP7 with other CGIAR Research Programs and Services

Thematic Area/ CRPs/Services (with which CRP7 will interact)	Work to be undertaken in other CRPs that is relevant to CRP7	Work to be undertaken in CRP7 that is relevant to other CRPs
1. Integrated agricultural systems for the poor and vulnerable. Initially work will be conducted with CRP1.1 (Drylands) in East and West Africa, and with CRP1.3 (Coastal and Aquatic Ecosystems) in the Indo-Gangetic Plains. Future work with these CRPs will be expanded to other regions (see section "the regional approach")	CRP1 will provide opportunities for developing climate-resilient integrated technologies and practices (e.g. water-efficient management systems, conservation farming), Modeling and decision-support tools developed within CRP7 will be tested and validated within CRP1 (Box 1 suggests how CRP1 and CRP7 can interact in terms of field testing).	For specific regions, CRP7 will provide downscaled assessments of the agricultural and livelihood impacts of climate change. CRP7 will provide modeling and decision-support tools. CRP7 will support CRP1 in working with partners to define possible agricultural development scenarios under climate change. CRP7 will provide research methods to ensure that cross-regional comparisons with respect to climate change are possible (e.g. technologies currently being tested in one region may be useful for future climates in other regions). CRP7 will provide opportunities for achieving outcomes and impacts related to climate change policy through linking CRP1 outputs to climate change policy processes. CRP7 will test technologies and practices in the context of integrated adaptation-mitigation strategies derived from CRP1, through cofinancing.
2. Policies, institutions and markets for strengthening assets and agricultural incomes for the poor	CRP2 will promote work on assessments of the technology (e.g. biotechnology, conservation agriculture, etc), strategies (e.g. sustainable land and water management) and policies in an economy-wide setting and focus on the relationship between macroeconomic policies, non-agricultural policies, and institutional factors that affect the willingness of the private sector (domestic and international) to invest in agriculture and maximize the benefits for the rural poor. CRP2 will undertake research on strengthening the capacity and incentives of implementing organizations	CRP7 will undertake work on collective action in relation to climate change strategies (e.g. on institutions for building alliances of smallholders to engage in carbon markets). CRP7 will use results generated in CRP2 to enhance the effectiveness of organizations implementing climate change actions, particularly those related to technology assessments, strategies and marketing ensuring the benefits of the rural poor.
3. Sustainable production systems for ensuring food security (3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7)	CRP3 will provide technologies (e.g. drought, water-logging or heat stress tolerant varieties and germplasm), and information that can be tested in CRP7 target regions.	CRP7 contributes large-scale research on climate change vulnerability assessment, modeling, adaptation and mitigation strategies. The climate change context will allow for better diagnosis and understanding of risks and vulnerabilities, and allow for ex-ante analysis of climate impacts and climate-friendly future investment. CRP7 will work with CRP3 partners to define phenotyping and breeding targets for future climates. CRP7 will offer opportunities for testing CRP3-derived technologies in some target regions where CRP3 is less active, through cofinancing.
4. Agriculture for improved nutrition and health	CRP4 will produce scenarios of intensification and disease futures that will inform CRP7's work on development scenarios that balance the trade-offs among adaptation and mitigation strategies.	CRP7 will produce downscaled climate and development scenarios for targeted regions. CRP7 will bring CRP4 outputs into the broader climate community.
5. Durable solutions to water scarcity and land and ecosystem degradation	CRP5 will develop and test appropriate adaptive water and land management strategies under progressive climate change. CRP5 will provide a link to the broader water and land communities.	CRP7 will collaborate on protocols for carbon, methane and other GHG measurements in agricultural landscapes and provide downscaled climate change scenarios. CRP7 will offer opportunities for testing CRP5-derived technologies and practices in the context of integrated adaptation-mitigation strategies through cofinancing. CRP7 will provide CRP5 the link to the broader climate communities.
6. Forests and trees	CRP6 will develop and test agroforestry	CRP7 will offer opportunities for testing CRP6-derived

Thematic Area/ CRPs/Services (with which CRP7 will interact)	**Work to be undertaken in other CRPs that is relevant to CRP7**	**Work to be undertaken in CRP7 that is relevant to other CRPs**
	and forestry technologies and policies to enhance climate change mitigation and to enhance local and societal resilience to climate change. CRP7 will derive lessons from the forestry community (where progress has been rapid in relation to forests and climate change) for integration in the agricultural community.	technologies and practices in the context of broader adaptation-mitigation strategies through cofinancing. CRP7 will provide access for CRP6 to the key stakeholders in the agricultural community to advance forest protection through strategies that promote agricultural intensification rather than forest clearance.
7. Genomics and Integrated Breeding Service (GIB Service)	GIB Service plans to establish one-stop-shop providing access to genetic stocks, prebreeding materials, high throughput services for marker and trait evaluation, informatics tools, support services, capacity development and community support for conducting genomics research and integrated breeding projects.	CRP7 will help design the GIB database so as to ensure that the data can be used as a source of cross-site comparative data for future climates. CRP7 will work with GIB Service partners to define breeding strategies for future climates.

Other CRPs will provide significant inputs to CRP7. In particular, CRPs 1, 3, 5 and 6 will develop a portfolio of technologies and integrated systems that will be assessed for their relevance in target regions and then tested in the context of integrated climate change strategies, and CRP2 will have strong synergies with the climate-change-specific policy analyses of CRP7.

Interactions with other CRPs follow two major models (many examples are given in Tables 12, 14, 16 and 18):

- *Collaboration,* in which CRP7 interacts with other CRPs on specific topics that need to be jointly addressed. This can involve targeting, priority setting, crop modeling, research on technical and institutional options, capacity enhancement and communication/outreach activities.
- *Cofinancing*, where CRP7 finances activities in other CRPs. This approach is particularly important in the case of technology testing, where technologies developed in other CRPs are tested in the field in CRP7 targeted regions. CRP7 would sub-contract a partner in one of the other relevant CRPs to do adaptive research on its technologies in the CRP7 targeted regions. In principle, cofinancing can be allocated to CRP1, CRP3, CRP5, CRP6 and CRP7 (see Table 8 and budget discussion). CRP7 will hold other CRPs accountable for any funds they receive from CRP7 through strong contractual arrangements. If the other CRP fails to deliver, which in turn results in failure of CRP7 to deliver on its performance contract, then CRP7 takes the final responsibility for non-performance. CRP7 will appraise and manage risks associated with all funds passed to CRPs and partners.

CRP7's contribution to other CRPs involves four areas of activity: (a) providing tools, methods and data that can be used in climate-related work in all the CRPs (e.g., methods for vulnerability assessment, downscaled climate scenarios for specific regions, modeling tools for linking climate and agricultural impact models); (b) providing communication and partnership platforms for multi-site comparative work that will be implemented within diverse CRPs (e.g., establishing the research protocols for the testing of specific management systems across regions that address adaptation and mitigation challenges); (c) producing syntheses across CGIAR CRPs that relate to climate change (e.g. synthesizing the state of knowledge on mitigation options that are developed as part of other CRPs); and (d) providing the partnerships and opportunities for CRPs to deliver results that are relevant to the climate change agenda (e.g. hosting UNFCCC side-events to which other CRPs contribute).

The other CRPs provide technologies and information highly relevant to CRP7. The technologies that will be developed in other CRPs that have relevance to climate change include germplasm with improved

tolerance to drought, heat, salinity and submergence, conservation agriculture practices and resource-efficient crop management practices that increase farming system resilience, water and land management strategies and help meet emission reduction targets, and the development of disease and insect resistant crop germplasm, with emphasis on pests that are likely to become more destructive as a result of climate change. CRP7, in association with other CRPs (e.g. CRP1, CRP3), and through cofinancing, will provide opportunities for testing some of these technologies in the context of integrated adaptation-mitigation strategies. Specific joint activities are planned in the targeted regions sites with CRP1 and CRP3 (e.g., work in the Brahmaputra–Ganges–Megna focus region of CRP1 and CRP3 will be integrated with CRP7 work in IGP). Box 1 suggests how CRP1 and CRP7 can interact in terms of field testing options. Similarly, technological options and practices developed in CRP3, CRP5 and CRP6 will be selected for testing in the context of integrated adaptation-mitigation strategies, through cofinancing (see Box 2 for an example of how this is proposed).

Box 1: Proposed Working Relationships Between CRP7 and CRP1

Step 1. ***Get agreement on goals that serve both CRP1 and CRP7***, with CGIAR Centers and partners. This includes conducting scenario analyses of visions for the future.

Step 2: ***Data collection*** in CRP1 on agro-ecosystems characteristics, including land use (e.g. cropping, rangeland), geographical specifics (e.g. land slopes), poverty dimension, cropping patterns, crops grown, livestock specifics, rotation practices, soil specifics (e.g. organic matter, fertility), water availability (e.g. precipitation, wells, access to rivers), market connectivity, value chain specifics, existing analysis on how future production systems may change under climate change. Data collection will be in collaboration with other CRPs at regional level, and will include participatory approaches so that farmer and community perspectives are understood.

Step 3: ***Sharing data with modeling community***. Carrying out of modeling in CRP7 using various climate change and development scenarios to identify possible mitigation and adaptation interventions.

Step 4: ***Joint analysis***, between CRP1 and CRP7 and partners. Selecting sub-set of scenarios that seem congruent in their predictions. Identifying the possible sets of mitigation and adaptation interventions in terms of food security, poverty alleviation and environmental sustainability (these options may come from any points in the overall food system).

Step 5: ***Developing and testing options***. CRP1 will test possible options, with cofinancing from CRP7. CRP7 will provide the expertise for climate-specific components where needed (e.g. climate risk insurance methods, improved delivery of climate and weather related information for smallholders, mechanisms to enhance access to carbon markets).

Step 6: ***Multi-location and multi-year trials will be conducted in benchmark sites***, both existing (with historical data already available) and new sites based on site-similarity and analogue mapping of the future production conditions for the target sites (from modeling). This will allow real-term experimentation on future predictions.

Step 7: ***Joint analysis*** between CRP1 and CRP7 and partners.

Step 8: ***Monitoring and evaluation*** for learning and improvement to maximize added value.

Box 2: Proposed Working Relationships Between CRP7 and CRP3

Step 1. ***CRP7 will undertake priority setting exercises*** in targeted regions, with appropriate partners, that include ex ante modeling, participatory research at community level and expert feedback, and will thereby identify target technologies that are appropriate for adaptive research (e.g. perhaps drought-resistant maize developed in CRP3 could be identified for testing within a specific target region; e.g. in GRiSP new rice varieties and practices will be developed that would be relevant for climate-smart agriculture).

Step 2: ***Scope and nature of proposed adaptive research*** to be clarified and budgeted for, by the appropriate partners in CRP3 and CRP7. Linkages between these proposed activities and other activities in the target regions will be clarified, and proposals made for ensuring integrated approaches. Budgets and workplans for such work to be submitted to ISP for consideration.

Step 3: For workplans with approved budgets, ***adaptive research*** will be initiated by the appropriate set of partners, through cofinancing from CRP7. CRP3 will test and optimize new crop technologies (germplasm and resource management) as a basis for climate adaptation and mitigation in selected target regions.

Step 4: ***Joint analysis,*** between CRP3 and CRP7 and partners.

Step 5: ***Monitoring and evaluation*** for learning and improvement to maximize added value.

Partnership strategy

CRP7 will be integrated within a network of partners in order to improve the quality of the research and to respond effectively to demand from, and dialogue with, decision-makers at all levels. Research within the Themes will be co-designed by research and policy communities and local partners so as to: (i) maximize benefits to regional/national policy formulation by addressing issues co-defined by regional and national stakeholders; (ii) help transform the research agenda to more effectively deliver the information needs for improved food security policy formulation; and (iii) raise awareness of climate change issues among agricultural and food policy makers and resource managers.

CRP7 recognizes policy as dynamic and polycentric. The domains that CRP7 seeks to influence are not only state legislation and policy instruments, but also the processes of policy deliberation, formation and implementation, and the narratives and paradigms that determine how problems are understood and what solutions are considered tenable. In seeking to inform change in knowledge, attitudes and practices over the long term, CRP7 will focus effort both on formal government policies such as macro and trade policy, agricultural productivity investments, physical infrastructure and market-supporting institutions and on the much wider set of informal norms and procedures, including the strategies of producer organizations, local governance structures, and businesses. The most effective managers of agricultural systems under climate change, particularly women, may be excluded from formal public-sector policy and program processes. Working only with formal agencies runs the risk of entrenching inefficient and inequitable arrangements at a time when transformational institutional change may be needed to deal with climatic uncertainty. Therefore CRP7 envisages multiple strategic partnerships at different levels, from community to national to regional to international, seeking to involve these different users of knowledge right from the problem definition stage. These partnerships will need to be accountable, fostering a co-learning approach between CRP7 and decision-makers. CRP7 envisages strategic delineation of roles among partners to make the most of partners' competencies and networks (Table 3).

Table 3. Priority roles for partners in CRP7

	CRP7 Program strategy	Research implementation	Communications & outreach	Uptake of data & tools	Impact on policy & practice
CRP7 & CGIAR Centers	✓	✓	✓	✓	
Other CRPs	✓	✓		✓	
ESSP	✓	✓		✓	
ARI, NARES & NMS	✓	✓	✓	✓	✓
National & local govts, agencies dealing with NAMAs & NAPAs	✓		✓	✓	✓
IPCC & global assessments			✓	✓	✓
Farmers' organizations and rural communities of practice		✓	✓	✓	✓
Development & food security/delivery agencies	✓		✓	✓	✓
Industry and private sector platforms & players in carbon market	✓		✓	✓	✓
Mitigation & adaptation funds				✓	✓
CSOs, CBOs & media	✓	✓	✓	✓	✓

Given the regional focus of much of the place-based work, CRP7 will engage key regional research, development and policy organizations in agriculture and climate change (e.g. ACMAD, AGHRYMET, ASARECA, FARA, ICPAC, CORAF/WECARD, SAARC, and SDMC). Producing outputs and outcomes at national level requires a diversity of strategic national partners, and in the target regions partners will comprise government departments, farmers' organizations, agricultural research and extension services, business associations, meteorological services and civil society organizations (see Annex 1 for many of the partners; a full list of partners is available from CCAFS).

On the global level, CRP7 will implement a global engagement strategy through which key organizations will be invited to develop ongoing partnerships. These partners will come from a set of targeted groups, spread across government, private and civil society sectors, that were identified through a multi-stakeholder planning process[23]: scientific assessment secretariats and their technical support units, sponsors and managers of adaptation and mitigation funds, global development and food security agencies, farmers' organizations and platforms, industry platforms, carbon market players and regulators, and environment and development NGOs. A major multi-agency partnership has already been developed through ARDD 2009 and 2010 (including FAO, GFAR, Global Donor Platform for Rural Development, IFAD, IFAP, CTA), which will deepened in future ARDDs. The role of these global partners will be to provide accountability to the ultimate beneficiaries of CRP7, create widespread positive change in policies and strategies, ensure reflexive science-policy dialogue, help set research agendas, share communication channels, interrogate scientific methods and results, and combine knowledge to generate best-bet policy options.

[23] At the Nairobi planning workshop, May 2010

CRP7 has an innovative feature in its formal alliance with the ESSP community[24]. The marriage of CGIAR (whose comparative advantage lies in developing new technologies and management systems of relevance to developing countries) with the ESSP community (which brings advanced theory, tools and global understanding to biophysical and socioeconomic sciences), will enhance the quality and pertinence of joint research outcomes (e.g., higher-resolution, spatially-explicit models and improved quantification of uncertainty through ensembles). CRP7 plans to establish and contribute to exciting platforms and opportunities for allowing exchange and engagement between the CGIAR and ESSP communities. The CGIAR-ESSP partnership includes a role for the ESSP in the management system (see next section). Linking local, regional and global agricultural development and food security futures scenarios/assessments is a unique and exciting challenge that CRP7 will address. Empowering regional bodies with their own such assessments to feed into the global climate processes will be important progress and a need that has been pointed out in all the global assessments (e.g. MA, IAASTD). Bringing together the "climate world" and the "agriculture for development world" will happen at all levels (e.g., also involving the national and regional climate/meteorological agencies and their agricultural counterparts). Additional research partnerships are being developed with Advanced Research Institutes (ARIs) such as CIRAD, CSIRO, the Resilience Alliance, and numerous universities, as well as major international research networks (e.g. Global Research Alliance on Agricultural Greenhouse Gases).[25] As a result of an international competitive process key ESSP players based at ARIs have been included in the management of some of the Themes (see next section). Several partnerships will include global activities as well as on-the-ground case study activities (e.g. with FAO, CARE).

Management mechanisms[26]

The governance and management system is based on lessons learned by the CGIAR in other initiatives involving multiple Centers and partners, including Challenge Programs (CPs)[27]. A key lesson is that "*a governance body that is composed of independent individuals with no institutional connection to consortium members or CP partners appears to have more advantages and higher potential for effective and efficient performance. However, it should also take into account the need for support provided by a host institution as a legally constituted entity. Programmatic decisions should be left entirely to the CP's steering committee."*[28] CRP7 is characterized by all Centers having a stake, with numerous Centers having considerable climate change expertise and activities. In addition, there is an on-going commitment to a major international partner (ESSP). It is proposed that CRP7 have an Independent Scientific Panel (ISP) (with both scientific and development expertise), a Lead Center (and its associated Board) (namely CIAT), a Program Leader and a Program Management Committee (see Figure 7). There will be a small CRP7 coordinating unit. Theme Leaders and Regional Facilitators will be responsible for aspects of CRP7 implementation. CGIAR Climate Change Contact Points will help ensure CRP7 is appropriately linked to all Centers and CRPs.

The ***Independent Scientific Panel (ISP)*** will have a major role on priority setting, partnerships and on the strategic allocation of resources, to ensure that the needed set of partners and Centers participate in CRP7 in order to achieve the goals and over-arching objectives of CRP7. CRP7 has the opportunity to drive budget allocations by foresight analysis and *ex ante* impact assessments, since a major component of the research (Theme 4, Objectives 1, 2 and 3)[29] is to set up *ex ante* systems that can be used in the context of climate change. The ISP will consider the major strategic proposals being made by the Program Leader and

[24] Including the four pillar programs of the ESSP: the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP) and DIVERSITAS: An International Programme on Biodiversity Science

[25] www.globalresearchalliance.org

[26] We thank governance expert Markus Palenberg for his advice.

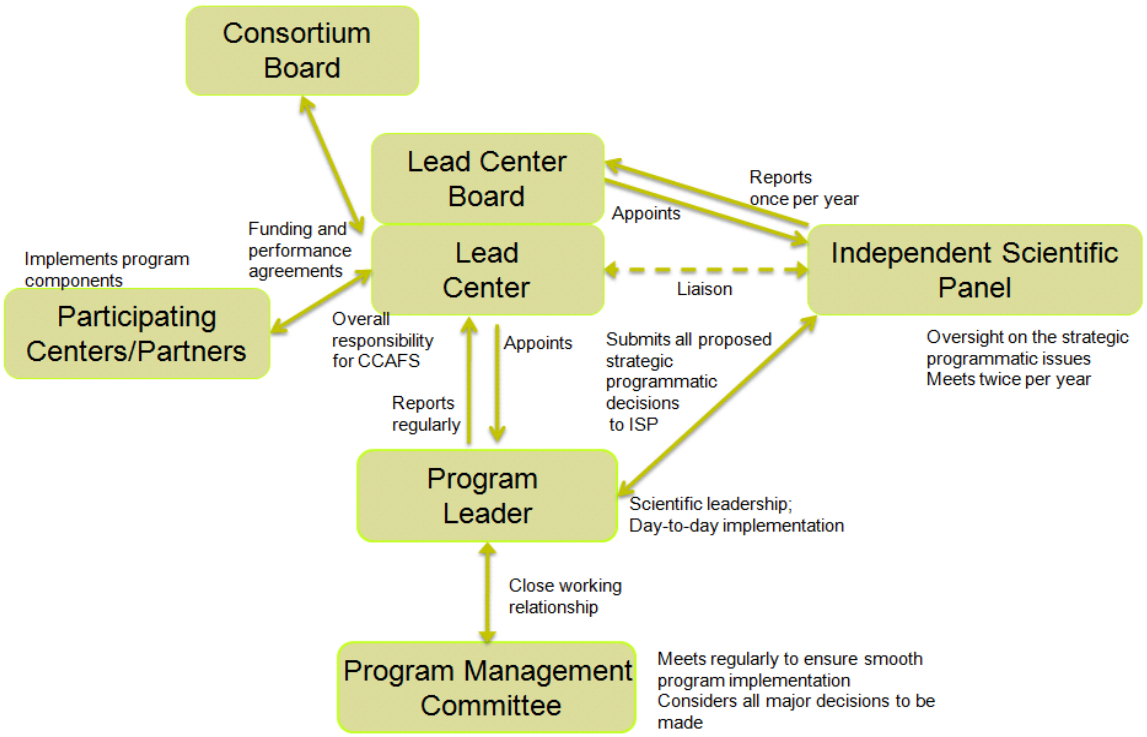
[27] E.g. Woolley et al. 2009; CGIAR Science Council, 2008.

[28] CGIAR Science Council and CGIAR Secretariat, 2007.

[29] "Objectives" are fully described in "Description of program Portfolio"

Program Management Committee in terms of partnerships and budget allocation to different Themes and Objectives, and provide the needed advice to the Center Board. The ISP will provide the key mechanism to ensure that the emerging results from *ex ante* analyses are leading to strategic allocation of resources. The ISP will also deliberate on how effective CRP7 is in meeting its outcome and impact goals. Having an ISP ensures independence of the CRPs programmatic directions, shields the Lead Center from real or perceived conflict of interest, while still being accountable to the Lead Center. The cost of the ISP is estimated to be $170.000 per year, a small percentage of the total budget.

Figure 7. Key governance and management structures and their major roles



The ISP will be appointed by the Lead Center's Board, through a nomination process that seeks input from the ISP Chair, a CGIAR Center/Consortium representative and an ESSP representative. The CGIAR representative will be selected by the Centers, and will consult all Centers in making nominations. The ISP will have a Chair, nine members, and three observers (one from the ESSP, one from the Lead Center Board, and the representative from the Centers). The membership will consist of internationally recognised scientists in the field of climate change and food security, as well as persons drawn from development agencies with a strong record of ensuring outcomes and impacts. Membership will be balanced in terms of disciplinary mix, gender and diversity. Members will be appointed for 3 years, but terms of 2-4 years in the initial year may be used to ensure a staggered turnover of members or continuity of the Chair's position. The Lead Center Board may renew the appointment of an ISP member, in consultation with the CGIAR and ESSP representative, once, at the end of his or her term. The ISP will generally meet twice per year, one of its meetings arranged back-to-back with the Lead Center Board.

The ISP will have similar functions to the Program Committee of the Center Boards, but, unlike any of the current Center Boards, will have a membership that covers the breadth of the CGIAR in relation to climate change and food security. The Chair of the ISP will be required to make an annual report to the Center Board, and will communicate regularly with the Chair of the Center Board. Observers on the ISP are required to regularly update their constituencies on relevant CRP7 progress and alert them to any emerging opportunities or threats that are of significance. They will not have voting rights. The ISP Chair will liaise

with the Director-General of the Lead Center, when a particular issue requires such liaison. Once per year, the Program Leader on behalf of the Program Management Committee will prepare an annual report that is considered by the ISP. The workings of the ISP and its relationship to the Lead Center will be reviewed after 18 months, as part of a management and governance review (Annex 3).

The ***Lead Center*** will be the main contracting body for CRP7. Centers wishing to lead CRP7 were asked to prepare an Expression of Interest (EOI). Five such EOIs were received and were evaluated by the Challenge Program Steering Committee. On this basis CIAT was selected as the Lead Center. The Lead Center will sign the performance contract for CRP7 with the Consortium Board, and sign the sub-contracts with Participating Centers/Partners. The Lead Center Board Chair and Director-General will report to the Consortium Board on CRP7 as a whole, including annual financial and progress report in relation to the performance contract signed between the Consortium Board and the Lead Center.

Ultimately, the Lead Center Board will have authority over all CRP7 management policies. CRP7 activities will be reported by the respective Centers in their audited financial statements. The CRP7 coordinating unit will prepare consolidated financial statements for review by the Program Management Committee and ISP. The Lead Center will coordinate the audit assurance work required by the performance agreement with the Consortium.

The Lead Center Board will appoint the ISP through the nomination process described above, the Lead Center will be represented on the ISP through an observer from its Center Board, its Director-General will appoint and supervise the Program Leader, and it will have one representative on the Program Management Committee. The Lead Center will have the right to review all decisions made in CRP7 in respect to potential legal, financial or reputational risks that such decisions may pose, and communicate its concerns through the appropriate channels. In the first instance, the Lead Center will communicate its concerns with the Program Leader. In cases where resolution is not found the Chair of the ISP will be engaged. Failing resolution the Lead Center Board will be approached for its decision.

The ***Program Leader*** will be responsible for intellectual leadership and representation, sign off on deliverables, and have decision-making authority with respect to day-to-day operations of CRP7. The Program Leader will be appointed by, and will report to, the Director-General of the Lead Center. The Program Leader will give regular updates to the Lead Center management team, and to the Chair of the ISP. On behalf of the Program Management Committee, the Program Leader will prepare the annual report that will go to the ISP and Lead Center (for onward submission to the Consortium Board).

The Program Leader will be assisted by five CRP7 staff members, who shall comprise the CRP7 coordinating unit. This unit will oversee the implementation of CRP7, in particular the coordination of activities across Centers, CRPs and other partners; coordinating strategic foresight, planning, and reporting at the CRP7 level; preparing the annual work plans and budgets; interfacing between CRP7 and the Consortium Office and CGIAR Fund on budgets, contracts and financial reporting; preparing funding proposals; compiling annual reports and monitoring indicators; producing synthesis products; overseeing CRP7 capacity enhancement; and ensuring global outreach and visibility. Staffing levels in the coordinating unit will be small given that the bulk of activities will be implemented through the Centers and partners involved in CRP7 using existing research management and administrative support systems.

In the short-term the University of Copenhagen will host the coordinating unit, but with CIAT-Colombia undertaking some administrative functions. As per the proposed transitional arrangements (Annex 3) there will be a review of this arrangement after 18 months. If the coordinating unit is to move a leading candidate location is Nairobi.

The ***Program Management Committee*** will assist the Program Leader in implementing CRP7. A key role will be to assist in ensuring coherence across Centers, CRPs, Themes, Regions and partners, through strategic planning, and reporting at the CRP7 level. The Program Management Committee will comprise eight individuals in the CRP, drawn from the Theme Leaders and Regional Facilitators. Provisions for changing the composition of the Program Management Committee will be made so that the composition reflects how

research priorities shift over time. The Program Management Committee will interact with the ISP at its regular meetings.

Participating Centers/Partners: All Centers receiving a budget from CRP7 will be Participating Centers. A number of significant partners that play a leadership role in the Themes will also be recognized in this category. Some of the Participating Centers/Partners will have scientists on the Program Management Committee.

Theme Leaders: Theme Leaders will be responsible for scientific leadership for Themes. They will ensure that the Themes are appropriately planned, implemented and monitored, and will manage the thematic impact pathways. They will assist the Program Leader in synthesis work and ensuring integration among Themes. Theme Leaders will collaborate closely with Regional Facilitators to ensure that the thematic work is appropriately linked to regional priorities. They will ensure appropriate linkages to other CRPs and to all Centers and partners. Theme Leaders will be selected from Participating Centers/Partners in a competitive process overseen by the ISP, and in consultation with the Lead Center Director-General[30]. Through a competitive process during the Challenge Program the following ARIs were selected to lead Themes, or parts of Themes: University of Leeds (co-theme leader Theme 1), International Research Institute for Climate and Society (IRI, Columbia University) (Theme 2), University of Vermont (Theme 3). In this process, certain Centers were also selected: CIAT (co-theme leader Theme 1), ICRAF (Theme 4, Objective 1), ILRI (Theme 4, Objective 2) and IFPRI (Theme 4, Objective 3). They will continue in this role at least to the end of their current three year term.

Regional Facilitators: In each of the target regions, Regional Facilitators will coordinate activities of CRP7. A key part of this role is partnership development and management. They will be responsible for ensuring coherence among Themes from field to regional level, and will play a key role in achieving outcomes and impacts at local, national and regional levels. Regional Facilitators will also be responsible for facilitating the appropriate linkages to other CRP activities in the regions. Regional Facilitators will be selected from Centers that have a comparative advantage in the target regions in a process overseen by the ISP, and in consultation with the Lead Center Director-General. For the initial targeted regions the Challenge Program Centers will remain as hosting Regional Facilitators: IWMI – Indo-Gangetic Plains; ILRI – Eastern Africa; ICRISAT – West Africa.

CGIAR Climate Change Contact Points: Climate Change Contact Points from each Center and each CRP will be established.[31] Their responsibility, working with CRP7 Theme Leaders and Regional Facilitators, will be to ensure that climate change activities in Centers are appropriately integrated into CRP7 and to ensure that the relationships between CRP7 and other CRPs are effective. They will be selected by the Director-Generals responsible for the specific Centers and CRPs.

Transitioning from the CP to the new Program: The CP on Climate Change was initiated in late 2009 with ten three-year contracts issued in the last 6-9 months for key members of the CP team. That team is crucial in terms of the funded agenda, and that agenda needs to be implemented immediately. And, most importantly, that agenda is core to CRP7. A Steering Committee for the CP, selected by the Alliance and ESSP for their expertise on climate change, agriculture and food security, have completed one full year of service. It is proposed that there be a transitional period for management arrangements, where the old structures, with modifications, remain as components of the transitional management system (see Annex 3). In this transitional period CIAT will maintain the coordinating unit at the University of Copenhagen. Two transitional periods are recognized, period 1 for six months, where the current system remains in place, but where preparations are made for period 2, and period 2 of an additional 24 months, where new elements are implemented and, where needed, recruitments are conducted. After 18 months a governance and

[30] In selecting Theme Leaders and Regional Facilitators care will be taken to ensure balanced representation across disciplines, gender and diversity.

[31] The Challenge Program established Contact Points in all Centers. This will be expanded to ensure its membership covers representation of all CRPs.

management review will be conducted, drawing on the experiences from this Program and other fast-tracked Programs.

Conflict resolution mechanisms: Conflicts among Centers/partners will in the first instance be referred to the Program Management Committee. When the conflicts cannot be resolved at that level the issue will be referred to the Chair of the ISP if they concern programmatic issues and to the Lead Center Director-General if they concern fiduciary, legal or reputational issues. If necessary, the Lead Center Board will be consulted, and the issue may, where appropriate, be referred to them for a decision. Only when the conflict cannot be resolved at these levels will it be referred to the Consortium Board.

Capacity enhancement

CRP7 will make a lasting difference through a strategic, fully embedded focus on capacity enhancement. To achieve its overall goals, the two related areas in which CRP7 needs to raise capacity are: (1) researchers' capacity to generate knowledge on managing agriculture and food security under climate change; and (2) multiple stakeholders' capacity to demand, shape and use this knowledge effectively to develop, implement and review policy and technical options in a dynamic environment. These stakeholders include members of farmers' organizations and other community-based organizations; frontline extension agents and development workers; policy makers in civil service departments, parliaments and funding agencies; opinion-formers in civil society, research organizations, national meteorological services (NMS), university networks and the media; and managers and strategists in businesses and NGOs. The vision for capacity development is to enable a co-learning approach between researchers and other stakeholders, building on and enhancing the knowledge and skills of both through structured cross-disciplinary interactions.

Three principles will guide capacity enhancement within CRP7. The first is to add value through partnership, by complementing existing capacity enhancement programs rather than establishing new programs, undertaking joint activities that build on comparative advantages and provide mutual benefits, and working with networks rather than single stakeholder groups. The second is to take a systems approach, acknowledging that capacity enhancement requires institutional investment, not just training packages for individuals, and that agriculture and food security need innovation in governance and institutional change as well as technical agricultural advances to cope with the challenges of climate change. The third is to promote integration rather than add-on of capacity enhancement activities, ensuring that development of new tools, knowledge and evidence within the research Themes includes strategies and resources for enhancing the capacity of researchers and stakeholders to use, adapt and critique these outputs.

Each of the four research Themes includes attention to capacity enhancement outcomes, achieved by working closely with partners. The global change System for Analysis, Research and Training (START, a non-governmental research organization within the ESSP that has a strong track-record in assisting developing countries to build the expertise needed to understand and respond to global and regional environmental change) will be a key partner. Others include the community-based adaptation network AfricaAdapt, women's organizations such as Women's Environment and Development Organization (WEDO) and university networks such as Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) and African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE). FAO will also be engaged in capacity enhancement activities.

In enhancing researchers' capacity, CRP7 will focus on mid-career scientists and post-graduate students, working with partners to provide opportunities for researcher capacity development in ways that also contribute to the research goals of CRP7. Illustrative activities and outcomes will include:

- Establish a network of 20–30 PhD students working on GHG emissions from agriculture in the target regions (Theme 3);
- Pilot emerging options for agricultural mitigation and managing near-term climate risk, enhancing local capacity in action research and communication (Themes 2 and 3);
- Provide for greater integration across disciplines, particularly between the global environmental change

community and its large-scale modeling approaches and the localized agricultural and livelihoods research communities, for example through cross-disciplinary group projects or workshops (all Themes);

- Create opportunities in the form of research projects, internships and exchanges for students, early- and mid-career research scientists, and research-oriented policy makers (e.g. START associates) within CRP7's research Themes, with positive discrimination towards women and nationals of the regions (all Themes).

CRP7 also aims to build capacity among farmers, policy makers, the private sector and civil society to develop knowledge-based policy options and to apply, monitor and adapt these options. CRP7 will work strategically with partners to reach this wide spectrum of stakeholders, working with associations and organizations rather than attempting to reach many thousands of individual farmers. Activities and outcomes will include:

- Provide farmers' organizations, community-based natural resource management (CBNRM) institutions and development NGOs with a knowledge platform of promising adaptation practices, technologies and policies (Theme 1);
- Familiarize farmers' organizations, CBNRM institutions and agricultural development agencies with tools and data sets for climate-informed monitoring and prediction of crop, fishery and pasture production, and biological threats (Theme 2);
- Expose policy makers to opportunities, trade-offs and synergies for agricultural mitigation, enabling them to choose among complex options (Theme 3);
- Facilitate development and analysis of a structured range of plausible future scenarios for climate change, agriculture and food security with strategic stakeholder groups at regional level (Theme 4);
- Enable partners to develop better means of communicating information and tools to target under-served groups, which may include specialist technical groups (e.g. meteorological offices), socially or gender differentiated groups (e.g. pastoralists, herbalists or fishers), or private sector groups (e.g. insurance or mobile phone companies) (all Themes);
- Support linkages and knowledge sharing within and across different stakeholder groups (e.g. farmers' organizations, civil society groups working in food security, small-scale enterprise associations, and community-based adaptation networks) (all Themes, overseen by Regional Facilitators).

Gender

Gender matters in how we transform our farming and food systems in response to climate change. Any effort to increase productivity, adapt to climate change, manage climate risks better, or mitigate agricultural emissions, must address the differences and relationships in how women and men manage their assets and activities. In particular, we need to redress historical tendencies to underplay the roles of women. Women are especially vulnerable to climate change and its impacts on food security. At the same time women have special capacity as agents of change in the face of climate change: they manage many of the world's agricultural resources and are also likely to have primary responsibility for raising children. Activities that increase the productivity and well-being of women will benefit children, families, households and communities – in this generation and future generations.

CRP7 has an explicit goal of gender impact. CRP7 will be guided by the CG-wide gender strategy that is currently under development. The four research themes of CRP7 will put effort into analyzing the underlying drivers of gender differences, then formulating strategies to tackle these disparities and provide inclusive access to emerging investments, tools and policies that deal with climate change. CRP7 is committed to spending a third of its research budget on understanding and responding to social stratification, including gender, wealth and age. These commitments apply particularly to the three "place-

based" research themes (1-3) that use participatory field research to address on-the-ground technical and institutional challenges.

The CRP7 goals for gender and social stratification have strong implications for *how* research and policy engagement are carried out, and with whom. Special effort must be taken to include those who may be politically marginalized (e.g. women in UNFCCC processes), and those least likely to have access to functioning markets and services (e.g. smallholders' access to carbon markets). It is important that both women and men are actively engaged in climate change related processes from local to global levels, so as to allow each gender to voice needs and priorities and be heard by policy makers. Partnering with civil society women's organizations is key to our strategy. They include the Gender and Climate Change Network (GenderCC) together with the Women for Climate Justice Network, and the Women's Environment and Development Organization. Identifying women entrepreneurs in private food processing, trading and retailing will be important, as they are today owning or running huge enterprises in both the informal (e.g. West Africa) and formal sectors (e.g. India).

Men dominate professional agricultural research and policy positions despite the fact that most agricultural work is done by women. We will set appropriate gender participation targets with our partners and invest in enhanced female leadership and scientific capacity within local partner implementing agencies. Based upon the approach and lessons learned in the Fellowship Program African Women in Agricultural Research and Development (AWARD) of CGIAR's Gender and Diversity Program, we propose to set up a program targeting female scientists to work across the target regions of CRP7.

Other approaches and strategies for achieving gender impact include the following:

- Gender-disaggregated analyses of livelihoods and access to key resources, including information and finance, among resource-poor farmers;
- Gender-related research questions, such as the role of gender roles and relations in constraining or enabling adaptation;
- Gender-related targets related to partnerships for impact, as many local partner organizations tend to exclude women (e.g. farmer's organizations), developed with Regional Facilitators;
- Gender-specific monitoring and evaluation (M&E) indicators developed (e.g. women's control of agricultural decision-making, women's participation in leadership positions in farmer organizations and regional climate and food security networks, etc);
- Assessing the impacts of agricultural development strategies, technologies and benefit flows on women, e.g., adaptation scenarios, mitigation practices and associated benefits
- A competitive small grants program to facilitate innovative ideas for gender-responsive climate change, agriculture and food security research;
- Synthesis 'white paper' on gender, climate change, agriculture and food security, based on site-specific analysis.

Each of the four research Themes has identified key gender-related research questions and outcomes, and gender-disaggregated strategies for achieving outcomes will be developed with partners. Specific Outputs and Milestones in the logframe cover gender issues (Annex 1). No less than 35% of each research Theme and Regional Facilitator budgets will be targeted towards efforts that take account of differentiation in society, including gender differentiation. Theme Leaders and Regional Facilitators will be held accountable for developing and reporting on the gender indicators and targets identified with partners.

Foresight, priority setting and impact assessment

Targeting food security, poverty reduction and sustainable natural resource management interventions that are robust in the face of a changing and uncertain climate requires a strong *ex-ante* analytical capacity

to diagnose points of vulnerability and assess the impacts and trade-offs between socioeconomic and environmental goals associated with alternative strategies. Major components of this CRP will involve foresight studies, vulnerability assessment and *ex ante* impact assessment. These components will have a strong capacity enhancement component, ensuring persisting use of the methods beyond CRP7, and a strong methodological component, developing new approaches to undertake such activities. In addition, baseline indicators in all target regions will be identified and collected in the first year of regional activities in preparation for impact analysis.

Foresight studies and action involve critical thinking concerning long-term developments, debate to create wider understanding of potential future trajectories, and action to help shape the future. These are all crucial activities in relation to climate change impacts and solutions, given that climates will progressively change over long periods, and given that a multitude of other drivers will influence how such change plays out for agriculture and food security. Thus, Objective 1 in Theme 4 is scenario development.[32] In this Objective we will explore, with a range of stakeholders, possible scenarios of the future, potential options for influencing trajectories of change, and opportunities for achieving outcomes and impact. The stakeholder engagement process for the scenario development will draw on emerging results from all CRP7 Themes. A major focus will be at the regional scale, but global and local work will also be conducted. Some participants will work at a number of scales (e.g. representatives from national farmer's organizations working with CRP7 in national level activities will also participate at regional level). Kok et al. (2007) recognise that a major methodological challenge is to achieve coherence and synergies when conducting scenario development across scales. CRP7 will do novel work to tackle that challenge and will develop both qualitative scenarios and quantitative analyses, at all scales, as well as using modeling tools developed in Theme 4 Objective 2 and Objective 3. Debate during the engagement process will inform priority setting. Theme 4 Objective 1 will focus on vulnerability assessment, using novel techniques to capture elements of adaptive capacity in communities, and thus earmark areas where specific adaptation and mitigation options may be feasible.

Considerable effort in CRP7 will be given to the bringing together of existing, and development of new, *ex ante* tools for assessing the costs and benefits of different adaptation and mitigation options (Theme 4, Objective 2 and Objective 3). These will be designed so as to examine the synergies and trade-offs among the different goals for agricultural development (poverty alleviation, food security and environmental health). The tools will also be designed to assess the synergies and trade-offs between adaptation and mitigation options, a topic running throughout Theme 3. These tools need a comprehensive and quantitative framework that both interrogates and pulls together what is known about the climate system and other drivers of change, how they may change in the future, the associated impacts on agro-ecosystems and the livelihoods of those who depend on them, food security, and feedbacks to the earth system. While much is known about many components, no integrated framework yet exists and there are key gaps and uncertainties in knowledge. The work proposed under Theme 4, Objective 2 and Objective 3 is designed to address these gaps, many of which CRP7 is uniquely placed to fill. This is a key innovation of CRP7. By Year 3 these tools, supplemented where appropriate by such tools as the Delphi technique, will be used with regional and local partners to drive priority setting in CRP7 and help determine the future allocation of funds to Themes and Objectives. The tools will also be international public goods (e.g. for use by development agencies in making strategic choices among different options).

While foresight debates, vulnerability assessments and *ex ante* tools can give insight into priorities, priority setting can be undermined by the self-interest of CRP7 participants and institutional politics. This culminates in priorities and budget allocations that are more a result of self-centeredness and compromise than by strategic allocation of resources to those endeavors that will lead to the highest impact. CRP7 is fortunate in that it cuts across the entire CGIAR, and if, for example, aquaculture is the key option within a specific context, then it should be possible to allocate funds in that direction. For this to happen the Independent Scientific Panel needs to play a key role in terms of considering strategic programmatic directions and partners selected, and being able to advise on how funds should be allocated, without

[32] See "Description of Program Portfolio"

pressure from the Lead Center or Participating Centers/Partners. This independence then has to be a cornerstone of the governance and management system (see previous section).

Monitoring, evaluation, reporting and smart learning loops

The CGIAR envisages that monitoring and evaluation will be centrally coordinated across all CRPs. CRP7 will follow this CG-wide process. In addition, CRP7 will undertake its own efforts to ensure rigorous appraisal and internal learning. The CRP7 Program Director and Program Management Committee will establish an annual monitoring system on approval of the ISP, with a set of performance indicators against stated Milestones, Outputs, and higher-level Objectives, compiled into an annual report. This system will be as simple as possible so as to not over-burden partners. The indicator data and reports will be compiled by the Centers and partners and synthesized by the CRP7 coordinating unit for deliberation by the ISP for transmission to the Lead Center Board.

Across all regions in which CRP7 works, Regional Facilitators and Theme Leaders will work with partners to select and measure key indicators that can be used to monitor and evaluate CRP7 progress towards outcomes and impacts. A globally common set of appropriate baseline indicators, on agricultural productivity, rural livelihoods, and biogeophysical attributes, will be collected at selected study sites, so that monitoring and *ex post* impact assessment can be carried out. These global indicators will be supplemented by regional and sub-regional indicators where deemed appropriate by partners and Regional Facilitators. Care will be given to ensuring that indicators capture cross-scale impacts. The integrated assessment framework described above in the section on impact assessment will also be used for *ex-post* assessment of the research work, its outputs, and its outcomes, in relation to the baseline indicators.

Existing baseline surveys will be used where possible. For example, ICRISAT's Village Level Surveys or IFPRI's panel household surveys in Ethiopia might be targeted for additional visits that collect climate-specific information. These indicators will relate, for example, to human well-being, the status of natural resources, and the institutional, infrastructural, and socio-cultural context of households in the study sites. Some of the indicators collected will pertain to social differentiation, including wealth classes and gender, such as statistics related to women's roles in agricultural decision-making and local and regional networks.

Inter-institutional programs that tackle such complex issues[33] as those at the nexus of climate change, agriculture and food security, conducted at multiple scales, are difficult to implement in a coherent and impact-orientated manner. CRP7 will be implemented using principles of adaptive management, with attention to the multiple cornerstones needed for effective research for development (see Figure 2). CRP7 learning will center on teamwork, partnerships (including inter-Center effectiveness; effectiveness of the ESSP-CGIAR partnership), building consensus around objectives, approaches, problems and solutions, and internal and external communications.

Smart learning loops among CRP7 staff, partners and stakeholders will be the framework for iterative improvement of the program. CRP7 will regularly undertake reflection and review through the following mechanisms:

- Twice yearly meetings of the Independent Scientific Panel (ISP) to provide critical guidance on the direction of the program. The ISP will provide the key mechanism to ensure that the emerging results from *ex ante* analyses are leading to strategic allocation of resources, and that CRP7 is being effective in meeting its intended Outcomes and Impacts.
- Use of the logframe (Appendix 1) as a living document to guide and measure the performance of CRP7, with full participatory review on an annual cycle.
- Annual progress reporting, including on indicators for capacity enhancement, gender and social differentiation, and at least twice yearly meetings of the Program Management Committee (PMC)

[33] Sayer and Campbell (2004).

to reflect on learning and progress, respond to the guidance of the ISP and collectively build on these inputs for coherent future planning.

- Monthly teleconferences amongst the full team of CRP7 implementers (Theme Leaders, Regional Facilitators)
- At least one meeting per year among the PMC and the Contact Points from the CGIAR Centers to undertake shared critical review of scientific progress and identify emerging opportunities for policy impact and research coordination.
- Annual meetings with key stakeholder groups in all regions to gather critical appraisal of CRP7 progress and contributions to policy processes in the region, with equivalent processes at the global level with key policy partners.
- Annual reflection exercise among Theme Leaders, Regional Facilitators, Science Officers and the Program Director, facilitated by a professional facilitator, experienced in change management and the implementation of complex programs, to expose weaknesses, seize opportunities and, most importantly, build the cohesion of the team[34].
- Continual monitoring as part of the communications strategy to provide rapid feedback on the utility of science and policy outputs from CRP7.
- Active links with Chief Scientific Officer and staff at the CGIAR Consortium Office to be fully integrated into CGIAR processes for monitoring and evaluation and to benefit from cutting-edge approaches to internal learning.

Two formal reviews of CRP7 are planned in Phase 1. After 18 months a governance and management review will be conducted by independent evaluators, and in Year 5 a comprehensive external evaluation of CRP7 will be conducted. Intermediate performance indicators have been defined for Year 3, on which to base the Year 5 external evaluation (Table 4).

Key dates in the implementation of CRP7 are given in Annex 4.

Table 4. Intermediate performance indicators for outcomes to be achieved by Year 3

CRP7 sub-goals	Intermediate performance indicators (Year 3)
1. To identify and test pro-poor adaptation and mitigation practices, technologies and policies for food systems, adaptive capacity and rural livelihoods	12 pro-poor adaptation and mitigation practices, technologies and policies, which have been developed and tested by CCAFS partners for food systems, adaptive capacity and rural livelihoods, adopted in 6 countries
2. To provide diagnosis and analysis that will ensure the inclusion of agriculture in climate change policies, and the inclusion of climate issues in agricultural policies, from the sub-national to the global level in a way that brings benefits to the rural poor	CCAFS partners' findings consistently used in IPCC, in global policy processes on food security, and in climate change and agriculture policies in 6 countries, as evidenced in policy documents, documentation of processes and inclusion of stakeholders from both agriculture and climate change circles

[34] In the CRP7 proposal development process, three such facilitated meetings were conducted.

CRP outcomes	Intermediate performance indicators
Outcome 1.1: Agricultural and food security strategies that are adapted towards predicted conditions of climate change promoted and communicated by the key development and funding agencies (national and international), civil society organizations and private sector in at least 20 countries	One to five flagship technical and/or institutional approaches identified and developed with farmers, key development and funding agencies (national and international), civil society organizations and private sector in three regions, which would directly enhance the adaptive capacity of the farming systems to the climate change conditions
Outcome 1.2: Strategies for addressing abiotic and biotic stresses induced by future climate change, variability and extremes, including novel climates mainstreamed among the majority of the international research agencies who engage with CCAFS, and by national agencies in at least 12 countries	Breeding strategies of regional and national crop breeding institutions in three target regions are coordinated, informed by CCAFS-led crop modeling approaches that are developed and evaluated for biotic and abiotic constraints for the period 2020 to 2050
Outcome 1.3: Portfolio of information sources, guidelines and germplasm available for using genetic and species diversity to enhance adaptation and resilience to changing climate are adopted and up-scaled by national agencies in at least 20 countries and by international organization for the benefits of resource poor farmers	Breeders and NARES use global information systems to select and make available to farmers varieties of crops pre-adapted to projected future climatic conditions in five countries
Outcome 2.1: Systematic technical and policy support by development agencies for farm- to community-level agricultural risk management strategies and actions that buffer against climate shocks and enhance livelihood resilience in at least 20 countries	One to five flagship risk management interventions evaluated and demonstrated by farmers and agencies at benchmark locations in three regions
Outcome 2.2: Better climate-informed management by key international, regional and national agencies of food crisis response, post-crisis recovery, and food trade and delivery in at least 12 countries	Three food crisis response, post-crisis recovery, and food trade and delivery strategies tested and evaluated with partner crisis response organizations at benchmark locations in three regions
Outcome 2.3: Enhanced uptake and use of improved climate information products and services, and of information about agricultural production and biological threats, by resource-poor farmers, particularly vulnerable groups and women, in at least 12 countries	National meteorological services and regional climate centers trained and equipped to produce downscaled seasonal forecast products for rural communities in two countries in each of three regions
Outcome 3.1: Enhanced knowledge about agricultural development pathways that lead to better decisions for climate mitigation, poverty alleviation, food security and environmental health, used by national agencies in at least 20 countries	Findings and evaluation tools on mitigation and livelihoods benefits of alternative agricultural development pathways used by global agencies and decision-makers in two countries in each of the three regions
Outcome 3.2: Improved knowledge about incentives and institutional arrangements for mitigation practices by resource-poor smallholders (including farmers' organizations), project developers and policy makers in at least 10 countries	Decision-makers in three regions better informed re options and policy choices for incentivizing and rewarding smallholders for GHG emission reductions
Outcome 3.3: Key agencies dealing with climate mitigation in at least 10 countries promoting technically and economically feasible agricultural mitigation practices that have co-benefits for resource-poor farmers, particularly vulnerable groups and women	Project design and monitoring guidelines for smallholder agriculture in developing countries produced and contributing to global standards
Outcome 4.1: Appropriate adaptation and mitigation strategies mainstreamed into national policies in at least 20 countries, in the development plans of at least five economic areas (e.g. ECOWAS, EAC, South Asia) covering each of the target regions, and in the key global processes related to food security and climate change	Agriculture mainstreamed into the global climate change policies, and major international food security initiatives fully incorporate climate change concerns
Outcome 4.2: Improved frameworks, databases and methods for planning responses to climate change used by national agencies in at least 20 countries and by at least 10 key international and regional agencies	Global database and set of tools for climate-smart agriculture established and used by key international and regional agencies
Outcome 4.3: New knowledge on how alternative policy and program options impact agriculture and food security under climate change incorporated into strategy development by national agencies in at least 20 countries and by at least 10 key international and regional agencies	New knowledge on how alternative policy and program options impact agriculture and food security under climate change incorporated into strategy development by at least 3 national agencies, and 3 key international and regional agencies

Budget (Phase 1: Year 1-5)

Budget summary

The projected CRP7 budget (including all funds from the CGIAR Fund as well as other sources) is US$63.2 million in 2011, rising to US$90.3 million in 2015 (Table 5a). CRP7 assumes a general 5% increase per year on ongoing activities. The remaining, and larger, portion of the projected annual budget increases represents investments in new regions where targeted work will be undertaken, as described in "The Regional Approach" (above)[35]. In constructing the initial budget Centers provided 2009 audited figures plus 10% (for 2011 budget). The request to the CGIAR Fund for 2011 is US$41.4 million (Table 5b). While the 2011 budget is final, the 2012-2015 is indicative. As soon as the ISP is operative, they will start to consider future budget reallocations, in relation to strategic goals.

Table 5. Budget for CRP7 showing (a) projected CRP7 expenditures by year by cost categories (2011-2015), and (b) projected sources of funds (US$ million). The percentage distribution amongst cost categories and amongst sources is shown.

a) Projected Expenditure

Cost category	Description	2011	2012	2013	2014	2015	Total CRP7 Costs	Percent (2011)
1	Personnel costs	18.7	20.0	21.7	22.8	24.0	**107.2**	30%
2	Travel	2.6	2.8	3.0	3.2	3.4	**15.0**	4%
3	Operating expenses	8.7	9.3	10.1	10.6	11.2	**50.0**	14%
4	Training / Workshop	1.8	1.9	2.1	2.2	2.3	**10.3**	3%
5	Partners / Collaborator / Consultancy Contracts	18.9	23.2	29.6	31.1	32.7	**135.5**	30%
6	Capital and other equipment for project	1.1	1.2	1.2	1.3	1.3	**6.1**	2%
7	Contingency	0.6	0.6	0.7	0.7	0.7	**3.3**	1%
	Total	**52.4**	**59.1**	**68.5**	**71.9**	**75.5**	**327.3**	**83%**
8	Institutional Overhead	10.0	10.9	12.0	12.6	13.3	**58.8**	16%
9	CGIAR System Costs	0.8	1.1	1.4	1.5	1.6	**6.4**	1%
	Total Program expenditures	**63.2**	**71.1**	**81.9**	**86.0**	**90.3**	**392.5**	**100%**

b) Projected source of program funding

Description	2011	2012	2013	2014	2015	Total CRP7 Costs	Percent (2011)
CGIAR Fund (1)	41.4	56.1	70.0	75.2	81.2	323.9	65%
Current/Projected Restricted Donor Projects (2)	17.3	11.4	8.9	8.2	6.6	52.4	27%
Other Income	4.5	3.6	3.0	2.6	2.6	16.2	7%
Total Funding	**63.2**	**71.1**	**81.9**	**86.0**	**90.3**	**392.5**	**100%**

Notes:

1. This assumes that current funding to the Challenge Program will instead be channeled through the CGIAR Fund in 2011.
2. The Current and projected project fund is assumed to go down over time, as the CGIAR reform proceeds.

[35] In 2011 work will be initiated in three regions, two further regions will be added in 2012, and three further in 2013

Budget categories

Given the key roles that partners play in CRP7, some 30% of the 2011 budget is allocated to partners and collaborators (Table 5a). Partners are expected to play significant roles in CRP7, including representation as Theme Leaders and on the Program Management Committee. Partnership budgets will be managed by each Participating Center, for the specific partners that will be engaged. Table 6 shows how the partnership funds of Table 5a are allocated amongst key categories of partners (ESSP, other ARIs, and NARES).

Projected expenditure on personnel is 30% (in 2011). The institutional overhead stands at 16%, this being a combination of Center overhead rates for the Center-managed funds and 5% for pass-through funds. The budget for training and workshops is 3%, but it is important to note that CRP7 will mainstream capacity enhancement into all research activities, so the bulk of capacity enhancement funds fall under the 'partners and collaborators' budget line.

Sources of funding

$41.4 million is requested from the CGIAR Fund for 2011 (Table 5b).[36] This amount rises through to 2015, with an assumed decrease from restricted sources, as the CGIAR reform process progresses. The request from the CGIAR Fund is based on the assumption that most of the current funding that the Challenge Program receives will instead be channeled through the CGIAR Fund in 2011.

Table 6. Budget allocation to major categories of CRP7 partners (US$ million).

Partner category	2011	2012	2013	2014	2015	Total CRP7 Costs
ESSP	5.9	9.5	15.3	16.0	16.8	**63.5**
ARIs	4.7	4.9	5.2	5.5	5.7	**26.0**
NARES	8.4	8.8	9.1	9.6	10.1	**46.0**

Leveraging new resources

In addition to the budget shown here, considerable potential exists for leveraging partner contributions, especially through meaningful partnerships with regional organisations and the ESSP. For example, the budget flowing to the global environmental change research community (of which the ESSP is part) is estimated to be 2 billion dollars per annum in the US alone – many times greater than that going to the whole of the CGIAR. Through an active strategy to align agendas and develop joint activities, CRP7 expects to leverage human capital and resources that will greatly magnify the funds coming direct to CRP7. Leveraged funds will be tracked and are expected to exceed $30 million per annum by Year 5. CRP7 staff, partners and ISP members will become active partners in the following global initiatives: Global Research Alliance for Agricultural Greenhouse Gasses; Joint Programming Initiative of the EU on Agriculture, Food Security and Climate Change; Resilience Alliance; ICSU Program on Ecosystem Change and Society (PECS), among others. Similarly, at regional level CRP7 will actively engage in the major regional initiatives.

Allocation to Centers

Six Centers have total budgets over $5million per annum in CRP7 for 2011 (Table 7), namely ILRI, ICRAF, CIAT, CIMMYT, Bioversity and IWMI. IRRI, AfricaRice, CIFOR and IITA have budgets less than $1.5 million,

[36] The budget submitted with this proposal differs slightly from that submitted for the November Fund Council meeting. The request from the Fund Council has increased by 0.9 million. This includes additional requests from ICRAF and CIFOR in relation to the need to enhance the forestry component of CRP7, as well as the 2% system costs.

with the other Centers intermediate. In relative terms the following Centers are heavily dependent on the CGIAR Fund for their climate change work, with 70% or more of their total climate change funding requested from the CGIAR Fund: AfricaRice, CIMMYT, ICARDA, ICRAF, ICRISAT, IITA. Some Centers will largely undertake their climate-related work with restricted funds in 2011, namely WorldFish and IFPRI, with less than 50% of their CRP7 funds requested from the CGIAR Fund. All partner funds are managed within Center budgets.

Table 7. Projected CRP7 Theme expenditures for 2011 by Center (US$ million), and projected source of Center funding (US$ million). The percentage of Center funds that are expected to come from the CGIAR Fund is shown, as is the central funds for "coordination, synthesis, capacity enhancement and communications". The budget for each Center includes an allocation to partnerships.

	2011 Theme Budgets						Source of funds (2011)		
Center	**Theme 1: Progressive Climate Change**	**Theme 2: Climate Risk**	**Theme 3: Mitiga-tion**	**Theme 4: Integra-tion for Decision Making**	**CRP7, Theme and Regional Coordina-tion**	**Total Budget**	**CGIAR Fund**	**Current and Projected Restricted Donor Projects and Other Sources of Funds**	**% of Center Budget from Fund**
AfricaRice	0.2	0.2	0.4	0.0	-	**0.8**	0.6	0.2	75%
Bioversity	5.6	-	-	-	-	**5.6**	3.7	1.9	66%
CIAT	2.3	0.8	1.2	0.7	0.9	**6.0**	4.1	1.9	68%
CIFOR	-	-	1.0	-	-	**1.0**	0.5	0.5	50%
CIMMYT	2.0	2.1	0.9	0.5	-	**5.5**	4.2	1.3	76%
CIP	0.9	0.7	0.3	1.0	-	**3.0**	1.8	1.2	61%
ICARDA	1.7	0.2	0.1	-	-	**2.0**	1.5	0.5	74%
ICRAF	0.9	0.5	3.7	2.6	0.3	**7.9**	5.5	2.4	70%
ICRISAT	1.2	1.3	0.6	1.3	0.1	**4.5**	3.5	1.1	77%
IFPRI	-	-	0.3	3.8	0.2	**4.2**	2.0	2.2	47%
IITA	0.2	0.2	0.2	0.3	-	**1.0**	0.8	0.1	85%
ILRI	1.7	1.0	1.0	4.1	0.2	**8.0**	5.1	2.9	64%
IRRI	0.4	0.0	0.6	0.0	-	**1.1**	0.7	0.4	68%
IWMI	3.6	0.5	0.4	0.6	0.2	**5.2**	3.1	2.1	59%
WorldFish	0.4	0.6	0.2	0.8	-	**2.0**	0.4	1.6	20%
Total	**21.2**	**8.3**	**10.9**	**15.6**	**1.8**	**57.8**	**37.4**	**20.3**	65%
Coordination, Synthesis, Capacity Enhancement, Communications (1)						**4.6**	3.1	1.5	68%
CGIAR System Costs						**0.8**	0.8		100%
Total Program costs						**63.2**	**41.4**	**21.8**	**65%**

Notes: 1. Budget allocated to CIAT, part of which is sub-contracted to University of Copenhagen

Allocation of funding among Themes and Objectives[37]

The largest portion of the budget (Figure 8, Table 7) goes to Theme 1 (Adaptation to Progressive Climate Change). This is the Theme that links to the heartland of CGIAR research. Nevertheless, the distribution in budget between other Themes is relatively even. Regional Facilitator budgets have been broken down into "Themes" to ensure that regional activities are implemented in line with the agreed agenda for CRP7, and thus are not shown separately but are budgeted under each Theme.

[37] See "Description of Program Portfolio" for detailed descriptions of each Objective.

Within Theme 1 the largest budget goes to Objective 1.1 (Adapted farming systems to changing climate conditions) (Table 8). This is where the bulk of CGIAR activity has been in the past. Nearly $1 million in 2011 is allocated to cofinancing other CRPs, where technologies developed by those CRPs will be tested and further developed in the context of holistic adaptation-mitigation strategies in the CRP7 targeted regions.[38]

Figure 8. Distribution of funds among Themes. Also shown is the allocation to "Coordination, Synthesis, Capacity enhancement and Communications" (includes central funds for these purposes as well as coordination funds held by partners for theme and regional coordination)

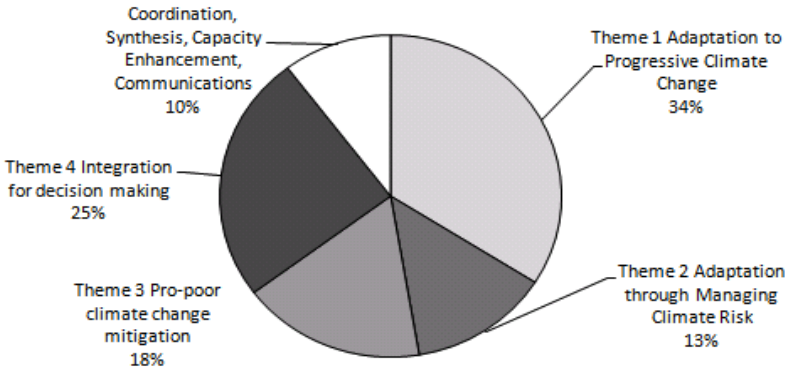


Table 8. Projected CRP7 Theme expenditures (US$ million) in 2011 for the different Objectives in each Theme. Shown is the projected expenditure for core CRP7 activities (i.e. those that don't involve cofinancing) as well as projected expenditure on cofinancing activities with other CRPs.

Themes	Objectives	Total
Theme 1	1.1 Adapted farming systems to changing climate conditions	11.03
	1.2 : Breeding strategies for future climatic conditions	1.90
	1.3 Species and genetic diversity for climate change	7.57
	1.4 Co-financing of other CRPs (1)	0.73
Theme 2	2.1 Managing climate risk and building resilient livelihoods	6.34
	2.2 Managing climate risk through food delivery, trade and crisis response	0.67
	2.3 Prediction of climate impacts, and enhanced climate services	1.29
Theme 3	3.1 Low-carbon agricultural development pathways	3.21
	3.2 Institutional arrangements and incentives for mitigation	1.90
	3.3 On-farm mitigation practices and landscape implications	5.01
	3.4 Co-financing of other CRPs (1)	0.75
Theme 4	4.1 Linking knowledge with action	3.45
	4.2 Data and tools for analysis and planning	6.15
	4.3 Refining frameworks for policy analysis	5.99
	Subtotal	**55.98**
	Theme and Region Coordination costs	1.79
	Total	**57.77**

Notes: 1. Further descriptive notes on cofinancing can be found in Tables 12, 14, 16 and 18.

[38] For further details on cofinancing see section "Roles of CGIAR Centers and Integration with Other CRPs" and Tables 12, 14, 16 and 18. Small amounts are allocated in 2011, given that other CRPs are largely yet to be initiated.

Within Theme 2 the largest Objective is 2.1 (Managing climate risk and building resilient livelihoods). This is also the Objective in this Theme that best links to the heartland CGIAR work of technology development. For Theme 3, the largest Objective is 3.3 (On-farm mitigation practices and landscape implications). In Theme 4, the largest Objective is 4.2 (Data and tools for analysis and planning) which covers much of the model development, the compilation of databases on which the modelling and analysis relies, and baseline and monitoring activities in target regions.

Allocation to Regions

The distribution of funds to regions for 2011 is shown in Table 9. Each of the targeted regions are allocated 15-18% of the overall CCAFS budget. In addition the "global funds" (27%) are for products and activities that will be tested and used throughout all CCAFS sites and countries. Some work will be conducted outside the targeted regions (11%). This is either strategic work that is needed to tackle thematic priorities (e.g. mitigation activities will be conducted in Brazil because it is key to the global mitigation agenda) or work that CCAFS is inheriting from on-going Centre work (these kind of activities will be brought into line with the strategic directions for CCAFS as soon as current commitments to projects and partners are complete).

Table 9. Regional allocation of funds in 2011 by Theme (US$ millions)

Theme	West Africa (WA)	East Africa (EA)	Indo-Gangetic Plains (IGP)	Global	Other Regions	Sub-total	CRP7, Theme and Regional Coordination	CGIAR System Costs (2%)	Total
Theme 1 Adaptation to Progressive Climate Change	3.1	4.5	4.4	3.8	5.4	21.2			**21.2**
Theme 2 Adaptation through Managing Climate Risk	1.5	2.2	1.9	1.3	1.4	8.3			**8.3**
Theme 3 Pro-poor climate change mitigation	1.7	1.8	2.5	2.4	2.4	10.9			**10.9**
Theme 4 Integration for decision making	2.3	1.9	1.8	8.1	1.5	15.6			**15.6**
CRP7, Theme and Regional Coordination	-	-	-	-	-	-	1.8		**1.8**
Subtotal	**8.6**	**10.4**	**10.5**	**15.7**	**10.8**	**56.0**	**1.8**	**-**	**57.8**
CGIAR System Costs (2%)								0.8	**0.8**
TOTAL	**8.6**	**10.4**	**10.5**	**15.7**	**10.8**	**56.0**	**1.8**	**0.8**	**58.6**
Percentage	**15%**	**18%**	**18%**	**27%**	**18%**	**96%**	**3%**	**1%**	**100%**

Program coordination, Synthesis, Capacity enhancement and Communications

Ten percent of the overall budget for 2011 is allocated to this function (US$4.62 million) (Table 10)**.** This covers the work of the coordinating unit that includes management and governance meetings, cross-Theme and cross-regional integration workshops, administrative support, the CRP7 external communications work (especially that linking into global processes such as UNFCCC), overseeing capacity enhancement activities throughout CRP7[39] and synthesis activities. Given that 15 Centers will contribute to CRP7 a strong unit for integration and synthesis, and for facilitating the connections among Centers and CRPs, is crucial. The budget is allocated to CIAT as the Lead Center, with CIAT making a sub-contract to the University of Copenhagen for a major portion of this coordinating and synthesis function. US$1.5 million in 2011 has been secured from restricted funding for this budget line.

[39] Most capacity enhancement activities are conducted within Themes, not at the coordinating unit level.

Table 10. Projected expenditure in 2011 (US$ millions) for Coordination, Synthesis, Capacity Enhancement and Communications broken down by cost category

Cost category	Description	2011 Amount (US$ million)
1	Personnel costs	**0.48**
2	Travel	**0.02**
3	Operating expenses	**0.05**
4	Training / Workshop	**0.05**
5	Partners / Collaborator / Consultancy Contracts (pass through)	**2.05**
6	Capital and other equipment for project	**0.01**
7	Contingency	**0.05**
	Subtotal	**2.71**
	Institutional Overhead (5% on total pass through funds received from CGIAR Fund passed through to other Centers/Partners + 20% on CIAT-administered portion of funds)	**1.9**
8	**Total cost**	**4.62**

Notes on cost categories:

1. Personnel: CIAT will employ the Program Leader (to be based at the coordination unit in Copenhagen initially) and two support staff (administrator and events/outreach manager).

4. Training/Workshops: This budget item includes specific capacity enhancement initiatives that cut across all Themes/Regions. Most of the capacity enhancement budget is held within Theme budgets.

5. Partners/Collaborator/Consultancy contracts. This is the major contract to University of Copenhagen (KU) to run the coordinating unit, and a smaller contract ($200,000) to Oxford Univ. to synthesize scenario development (see Theme 4, Objective 1). KU will take no overhead. This portion of the budget will cover the costs of three staff members ($450,000) for contracts management, synthesis, capacity enhancement, communications). KU will have funds to develop partnerships for synthesis ($230,000); host major events (e.g. side events at SBSTA, Agriculture and Rural Development Day) (US$ 170,000); engage and work with capacity development partners (e.g. START) (US$150,000); facilitate the Independent Scientific Panel and Management Team meetings (US$210,000); Travel (US$110,000); Communications, websites and data management (US$320,000); support services and operating costs (US210,000). Operating costs includes hiring the services of consultants for specific administrative tasks, phones, special audits.

8. Of this amount, US$1.5 million has been secured from restricted sources.

Description of Program Portfolio for Phase 1 (Year 1-5)

Theme 1: Adaptation to Progressive Climate Change

Rationale

Climate change means that future farming and food systems will face substantially modified environments as they struggle to meet the demands of a changing global population. Efforts to cope with the stresses on the resource base caused by growth in demand for food and water will be confounded by a range of additional abiotic and biotic stresses consequent upon a progressively changing climate manifested by higher temperatures, altered precipitation patterns and rising sea levels. Adaptation will need to be supported by an integrated program of research that includes analysis of current farming systems and how they are likely to change, identification of technologies and practices, and understanding processes of institutional learning and adaptation. Some lines of research have shown promise. For example, germplasm improvement; improved crop, livestock, aquaculture, agroforestry and natural resource management; and enhanced agro-biodiversity have a proven track record of decreasing susceptibility to individual stresses, and will offer increasingly important solutions for adapting to progressive climate change (Jackson et al., 2007). Strengthening the adaptive capacities of farmers and other land and aquatic resource users requires a variety of strategies ranging from diversification of production systems to improved institutional settings and enabling policies (Tubiello et al. 2008; Beddington, 2010). The major challenge is to enable accelerated adaptation at a rate faster than the demands that will otherwise overtake them, and without threatening sensitive livelihood systems as they strive to cope with stress. Significant knowledge gaps exist as to what adaptations options are available, what their likely benefits or costs, where and when they should be deployed, and what the learning processes are that can support widespread change under uncertainty.

For example, least-developed countries are required to submit National Adaptation Plans of Action (NAPAs) to the UNFCCC, whose objectives are to identify priority activities that respond to their urgent and immediate needs to adapt to climate change. Many NAPAs do not present concrete proposals for agriculture and food security. Even basic aspects of food and water systems are dealt with separately, although both are likely to be affected by climate change. This is just one example of the low level of preparedness of national institutions and rural communities. Yet preparation in these and other organizations will be core to accelerated adaptation. Research for development must play a crucial role in providing cost-effective solutions that not only address current challenges facing rural development and poverty, but also ensure that – despite the uncertainties presented by climate change – society continues to develop and ensure food security at multiple scales from villages to the globe.

The challenges lie in the development of holistic approaches to support accelerated adaptation to progressive climate change (Challinor et al. 2009), which consider the interactions of different technical and policy sectors (including management innovation that increases diversification). Research must also work with the processes that support institutional learning, recognizing the potential threats that change (or lack of it) presents to people's livelihoods, particularly in already precarious situations. This would allow for the development of adaptation options that go beyond sector-specific management and lead to more systemic changes in resource management and allocation. This Theme sees adaptation as an opportunity to improve agricultural and food systems through facilitated and targeted change, tracking climate over the coming decades. Impacts are not always negative; hence adaptation is a question of both mitigating or eliminating the negative impacts and taking advantage of the opportunities. In some cases transformational change may be required in the food systems, and very little is understood about the means by which this can be sustained through institutional development.

Objectives

The overall aim of this Theme is to build adaptive capacity and food systems that are more resilient to progressive climate change through the provision of technologies, practices and policies. Promising adaptation options will be identified and evaluated, and through modeling approaches their efficacy will be quantified in relation to expected future conditions. Research will examine the processes required for promising adaptation options to function (i.e. understanding and harnessing of social, economic, cultural and institutional processes of adaptation), and together will be used to provide plans and strategies to establish detailed adaptation pathways of food systems at the national, regional and global level. The Theme will also provide a portfolio of adaptation options (including agricultural technologies, agronomic practices and community- to global- level policies) that typify how food systems will adapt to a 2030 world and beyond. Specifically, the Objectives (Table 11) are to:

- Analyze and design processes to support adaptation of farming systems in the face of future uncertainties of climate in space and time. A key new component will be the development of improved choices, and integration of crop, livestock, fish, agroforestry and natural resources management approaches;
- Develop breeding strategies for addressing abiotic and biotic stresses under future climate change, including changes in the mean and variability of climate. The intention here is to try and stay ahead of future change;
- Identify and enhance deployment and conservation of species and genetic diversity for increased resilience and productivity under conditions resulting from climate change. This has the additional benefit of protecting long-term biological and cultural diversity.

Research approach to International Public Goods

An essential aspect is to combine socio-economic with biophysical aspect of change processes in a multi-disciplinary approach. Through field-based evaluations of promising adaptation practices and technologies, and modeling and analysis of likely benefits of different adaptation options at the food-system level, detailed plans and strategies for adapting the food system over the coming decades can be developed to reduce the uncertainties of change. The principal research questions for this Theme include:

- How can global climate model (GCM)-based and regional climate model (RCM)-based, near-term (i.e., 1–2 decades) information be incorporated into support for adaptation processes that are both location specific yet robust enough to apply across the range of possible climate realizations?
- How can climate-driven shifts in the geographical domains of crop cultivars, crop wild relatives, pests and diseases, and beneficial soil biota be anticipated and best managed to protect food security, rural livelihoods and ecosystem services?
- Given a rapidly changing environment of non-climatic drivers, what is the best approach for integrating individual technological, biodiversity management, livelihood, market adaptation and policy options into comprehensive local-level adaptation packages?
- How do social, cultural, economic and institutional factors mediate adaptation processes at the local level and how can these be mobilized to improve resilience?

The kinds of research products envisaged include new modeling methodologies, new scientific insights into decision-making processes in the face of multiple uncertainties, tested adaptation practices, policies and technologies, and a more profound understanding of the role of socio-cultural factors in the process of enacting system level change.

Table 11. Objectives, Outcomes and Outputs for Theme 1 for Phase 1 (Year 1-5) (the full list of milestones is given in Annex 1). Outputs to be achieved by Year 5, Outcomes by Year 10.

Theme 1. Adaptation to Progressive Climate Change		
OBJECTIVES	**OUTCOMES**	**OUTPUTS**
Objective 1.1 Analyze and design processes to support adaptation of farming systems in the face of future uncertainties of climate in space and time	Outcome 1.1: Agricultural and food security strategies that are adapted towards predicted conditions of climate change promoted and communicated by the key development and funding agencies (national and international), civil society organizations and private sector in at least 20 countries	Output 1.1.1 Development of farming systems and production technologies adapted to climate change conditions in time and space through design of tools for improving crops, livestock, and agronomic and natural resource management practices
		Output 1.1.2 Building of regional and national capacities to produce and communicate appropriate adaptation and mitigation strategies for progressive climate change at the national level (e.g. through NAPAs)
		Output 1.1.3 New knowledge-synthesizing institutional arrangements, policies and mechanisms for improving the adaptive capacity of agricultural sector actors and those involved in managing the food system
		Output 1.1.4 Testing of participatory methods that are sensitive to gender, livelihoods categories and other social differentiators, to apply globally
Objective 1.2 Develop breeding strategies for addressing abiotic and biotic stresses induced by future climatic conditions, variability and extremes, including novel climates	Outcome 1.2: Strategies for addressing abiotic and biotic stresses induced by future climate change, variability and extremes, including novel climates mainstreamed among the majority of the international research agencies who engage with CCAFS, and by national agencies in at least 12 countries	Output 1.2.1 Understanding and evaluating the response of different varieties/crops to climate change in time and space, and generating comprehensive strategies for crop improvement through a combination of modelling, expert consultation and stakeholder dialogue
		Output 1.2.2 Breeding strategies disseminated to key national agencies and research partners
		Output 1.2.3 Differential impact on different social groups of strategies for addressing abiotic and biotic stresses induced by future climate change, variability and extremes are identified, evaluated and disseminated
Objective 1.3 Identify and enhance deployment and conservation of species and genetic diversity for increased resilience and productivity under conditions resulting from climate change	Outcome 1.3: Portfolio of information sources, guidelines and germplasm available for using genetic and species diversity to enhance adaptation and resilience to changing climate are adopted and up-scaled by national agencies in at least 20 countries and by international organization for the benefits of resource poor farmers	Output 1.3.1 New knowledge, guidelines and access to germplasm are provided for using genetic and species diversity to enhance adaptation, productivity and resilience to changing climate
		Output 1.3.2: New information, knowledge, guidelines and germplasm are made available to farmers, breeders, local communities and scientists and promoted through knowledge sharing, peer reviewed articles, information systems and media
		Output 1.3.4: Identification and evaluation of the differential roles of women and men, and other social groups, in strategies for conservation and use of species and genetic diversity; and the impact of those strategies on those different groups, are integrated into knowledge sharing and other activities to achieve outcomes

New content and innovation

This Theme brings together state-of-the-art global-scale modeling with knowledge and research capacity in the many components of farming systems through collaboration between multiple CGIAR centers, ARIs, NARES, civil society and private sector. This multi-disciplinary, multi-sectoral and multi-institutional approach to develop resilient farming systems that maintain or enhance food security and sustain the food delivery system despite a fundamentally changing climate is novel, needed and achievable. The use of solid climate science to provide projections of climate change with all uncertainties quantified, coupled with agricultural science modeling tools, and explicit expert knowledge of crops, agricultural production systems, food systems and food security has not yet been harnessed and used to truly understand how we can adapt to a 2030 climate and beyond.

Risks

The risks involved are due chiefly to the need for strong integration and significant collaboration with others. For example, as noted in the logframe, Milestone 1.1.1.1 cannot be achieved without the willingness of partners to carry out the trials and share the trial data; and Milestone 1.1.1.6 cannot be achieved without uptake of tools and guidelines. Collaboration across themes in CRP7 and to the other CRPs is also important, as it will ensure that synergies are exploited. This risk will be managed through proactive efforts to avoid Theme silos, including joint benchmark sites among Themes 1-3, joint field personnel, the coordinating functions of the Regional Facilitators in each target region, and regular inter-Theme and Management Team meetings. These mechanisms will be further supplemented by both appropriate governance structures and sustained communication efforts that go beyond CRP7.

There is also some risk associated with the underpinning science and the availability of data. For example, crop adaptation traits will need to be identifiable using available data (see Milestone 1.3.1.1). Sound climate projections to 2030 and beyond, together with an understanding of the inherent uncertainties, will be needed. The embedded involvement of the global change community, and the work of Theme 4, ensures access to cutting-edge science in this field. Whilst this does not mitigate entirely the danger of insufficiently precise predictions, it does maximize the chances of success.

Regional balance

This Theme is global in scope, with regional focus to address particular threats to livelihoods. Theme 4 will provide support to the process of defining regional specificities, but it is already fairly clear that the most vulnerable communities requiring support in adapting food systems are in many parts of Africa; and stresses systems in South and East Asia (Thornton et al. 2008). However, threats to biological and cultural diversity also exist in Mesoamerica, the Andes, the Middle East and North Africa, the Pacific Islands, and parts of Southeast Asia. Centers of origin for important wild and cultivated genetic resources do not necessarily occur in high-poverty regions, and hence some priorities for Objective 3 may lie in different areas to those of, say, Objective 1.

Linkages to other CRPs

This Theme is not designed to individually develop new adaptation technologies. Rather, it is designed to add value to technology development from other CRPs (CRP1, CRP3, CRP5, CRP6) by providing the climate change context for those CRPs and taking a holistic view to agricultural development plans and strategies under a changing climate. This will require close collaboration with all CRPs (Table 12), including:

- CRP 1: Major collaboration is envisaged (see Box 1 for operational details). System-specific technologies and management regimes will be tested for their efficacy in a 2030 world and beyond;

- CRP 2: Evaluation of adaptation options and strategies within value chains to enable coordinated adaptation from farm-gate to market, and evaluation of global policy contexts which may influence local-national level policy development addressing adaptation;
- CRP 3: Major collaboration envisaged, whereby Objective 2 supports the development of breeding strategies for major commodities in the face of climate change and subsequently evaluates, in Objective 3, specific technologies coming out of CRP3 for their efficacy in adapting to a 2030 world;
- CRP 4: Analysis of adaptation options that may feed back to nutrition and human health through shifts in the food system, and beneficial nutritional factors arising from diversification;
- CRP 5: Testing and evaluation of water and land management options for potential in enabling adaptation;
- CRP 6: Building on the lessons of forest-based mitigation and coupling mitigation plans with adaptation processes in forest margins and agroforestry systems.

Table 12 Interaction of CRP7 Theme 1 with other CRPs (Priority activities are indicated in bold).

CRP7 Objective # and Title	CRP1 – Integrated Systems	CRP2 - Policies, Institutions and Markets	CRP3 – Sustainable Production	CRP4 – Nutrition and Health	CRP5 – Water, Land and Ecosystems	CRP6 – Forests and Trees
1.1 Adapted farming systems to changing climate conditions through the integration of tested technologies, practices and policies	*In CRP7:* Evaluation of the resilience of technologies, practices and policies under climate change. *In CRP1:* Development of new production systems, technologies and policies appropriate for specific systems. *Collaboration:* Priority setting for technology, practice and policy development. ***Cofinancing:*** **Coordinated set of trial sites in target regions for technology testing.**	*In CRP7:* Evaluation of sub-national level climate change and market policy options *In CRP2:* Developing and evaluating changes in contract farming arrangements to promote adaptation under the value chain component. *Collaboration:* Organization of value-chain partnerships for holistic adaptation; development of models for evaluating adaptation policy options.	*In CRP7:* Priority setting for new technologies for adaptation and mitigation, provision of tools to address climate context. *In CRP3:* Development of new crop, livestock and fish varieties and management technologies. ***Cofinancing:*** **Testing of new technologies out of CRP3 within a region-specific context and in combination with other agricultural practices, policies and technologies to develop holistic adaptation/ mitigation strategies.**	*In CRP7:* Evaluation of future human and animal health challenges in food systems *In CRP4:* Health-related development of analytical approaches for food systems *Collaboration:* Evaluation of health implications in adaptation options.	*In CRP7:* Priority setting for new soil/water mgmt options under climate change *In CRP5:* Development of new soil/water mgmt options ***Cofinancing:*** **Testing of developed strategies and technologies with other agricultural practices, policies and technologies to develop holistic adaptation options.**	*In CRP7:* Evaluation of resilience of agroforestry systems to future climate changes, provision of tools. *In CRP6:* Agroforestry technology development. ***Cofinancing:*** **Testing of developed technologies with other agricultural practices, policies and technologies to develop holistic adaptation options.**
1.2 Breeding strategies for addressing abiotic and biotic stresses induced by future		*In CRP7:* Evaluation of new breeding technologies under climate change *In CRP2:*	*In CRP7:* Modelling of virtual crops[40] under a changing climate to identify future priority traits *In CRP3:* Development of new	*In CRP7:* Evaluation of new breeding technologies under future conditions *In CRP4:*		

[40] "Crops" created in software, using model parameters that represent desired crop traits that could be the objective of breeding programs.

CRP7 Objective # and Title	CRP1 – Integrated Systems	CRP2 - Policies, Institutions and Markets	CRP3 – Sustainable Production	CRP4 – Nutrition and Health	CRP5 – Water, Land and Ecosystems	CRP6 – Forests and Trees
climatic conditions, variability and extremes, including novel climates		Evaluation of new breeding technologies for impact under current climates and analysis of adoption constraints	crop technologies through climate-orientated breeding ***Collaboration:*** **Setting of breeding priorities** *Cofinancing:* Expert workshops, capacity enhancement NARS	Biofortification of major staples *Collaboration:* Inclusion of human health-related challenges in virtual crop modelling		
1.3 Targeted identification and enhanced deployment and conservation of species and genetic diversity for increased resilience and productivity under conditions resulting from climate change	*In CRP7:* Scoping of promising genetic resources for adaption options ***In CRP1:*** **Evaluation of genetic resources for improving farming systems.** Cofinancing: Trialing diversified systems in areas of high climate risk and evaluating benefits of diversity under future conditions.	*In CRP7:* Evaluation of changing policy needs for genetic resource access and benefit sharing under changed climate *In CRP2:* Evaluation of current status and needs for genetic resource access and benefit sharing policies.	*In CRP7:* Evaluation of potential neglected/under-utilized species for adapting to climate change. *In CRP3:* Development of agricultural technologies. *Cofinancing:* Co-development of adaptation options that increase on-farm diversity through inclusion of neglected and underutilized genetic resources.	*In CRP7:* Evaluation of potential of neglected/under-utilized species for adapting food systems to climate change. *In CRP4:* Evaluation of nutritional needs. *Collaboration:* Evaluation of nutritional benefits of identified adaptation options.		*In CRP7:* Evaluation of benefits of diversity in adaptation. *In CRP6:* Evaluation of tree use in increasing income and resilience. *Collaboration:* Identification of diversified agroforestry systems for climate change adaptation.

Theme 1 Objective 1: Adapted farming systems to changing climate conditions through the integration of tested technologies, practices and policies

Rationale and research questions

Today's farming systems are adapted, to the extent possible given resource endowments, to the current climate conditions they experience (Below et al. 2010), yet we know little about how well they will stand up to progressive climate change particularly as they come under increasing pressure from other global drivers Many broad-scale analyses identify potentially sensitive regions or crops under progressive climate change (Jones and Thornton, 2003; Parry, 2007; Jarvis et al,. 2008; Lobell et al., 2008; Waddington et al., 2010), but there is sparse knowledge at the field, community or sub-national scale as to how current farming systems can adapt, and what particular agricultural practices, technologies or policies are needed to enable adaptation, or how adaptation will occur.

This Objective is about identifying and testing candidate adaptation options in production systems, pulling these options together into holistic adaptation packages and supporting the cultural, social, economic and institutional factors that promote adaptation at the local to national level. Adaptation options to be studied include practices (e.g. agronomic innovations, planting strategies, improved livestock and fish management system, pest/disease management, agroforestry, diversification etc.), technologies (seed varieties, irrigation techniques such as supplemental irrigation and deficit irrigation, on-farm water harvesting etc.) and policies (local- to national-scale benefit-sharing, subsidies, trade agreements, investment packages, insurance schemes, private-sector business models, community-organization models etc.).

This Theme has neither the capacity nor the mandate to undertake large efforts for crop improvement or NRM; it is expected that new technologies and practices will largely be developed in CRPs 3 and 5, while CRP7, in conjunction with CRP1, will identify promising options for testing in target regions. One significant

novelty coming from this Objective will be the establishment of focus areas in target regions where policies, practices or technologies coming out of other Programs are evaluated, not in isolation but together. The strength of this Theme lies in the combination of individual adaptation options (social, policy-based, economic or technological innovations) into geographically explicit agricultural design processes and strategies to support adaptation of rural farming communities, development organizations and sub-national level bodies. CRP7 will work closely with CRP1 in the target regions, with CRP1 leading the implementation of integrated R&D, and with CRP7 adding the climate context and adding climate-related components into on-going testing of technologies, practices and institutional arrangements.

Research questions include:

- What are the likely future stresses and demands from climate change on geographically specific food systems? What are the implications of these, particularly for the poor and marginalized?
- Within the context of livelihood systems, what practices, technologies and institutions are likely to prove most effective in enabling adaptation for specific target regions, and what is needed to support their transfer?
- What new institutional arrangements are required to support transformational change in food systems?

Activities

Objective 1 will require the characterization of pressures and adaptation options in target regions. Analysis of pressures will draw from work in Theme 4 on scenario modeling to identify threats to land and water resources, livelihood systems analysis to identify the implications of stresses on particular groups; and analysis to describe performance factors of crop, livestock, and aquatic and agroforestry systems. Work on adaptation options will entail the compilation of existing databases from multiple sources. An example includes the collation of multi-site trial data of a range of crop varieties, which can then be used to examine varietal potential for different future climates across a range of target environments. Another activity will include analysis of institutional arrangements, policies and mechanisms that enhance the adaptive capacity of resource-poor households to adopt new (and existing) farming practices, strategies and behaviors. Objective 1 will require the testing of new technologies across a range of pilot sites, established in collaboration with other Themes in the CRP, and put into the context of farming systems with CRP1. Objective 1 will include modeling activities to out-scale potential adoption areas across a wide-range of geographies, and through the use of analogs, for example, support field validation of adaptation options for 2030 in today's climates. Community-based trialing of holistic adaptation options will be used to learn about the social, cultural, economic and institutional processes of adaptation, and to support the design of strategies for the implementation of adaptation in target regions.

Outputs/milestones

- Portfolio of adaptation options with likely changes in production systems identified, developed and/or tested;
- New and/or existing production system technologies tested which contribute directly to enhanced adaptive capacity in farming systems;
- Learning processes to support institutional development and behavioral change designed and evaluated
- Document synthesizing institutional arrangements, policies and mechanisms for improving the adaptive capacity of agricultural sector actors; what is working where, how and why, and what else is needed.

Partner roles

There is a strong emphasis of homeland CGIAR research in this Objective requiring the involvement of multiple centers, but strong collaboration with NARES is required, and with the ESSP in the generation of decadal climate forecasts among other things. The research within this Objective should be developed hand-in-hand with development practitioners interested in the dissemination and implementation of adaptation options at the community level, and so strong collaboration with development NGOs, civil society organizations and the private sector will be fostered.

Impact pathways for target environments

The aim is to support change processes therefore impact pathways will target (a) institutions already engaged in development who will use insight and learning processes to accelerate adaptation; (b) research organizations who need to identify promising enabling technologies and (c) NARES, Ministries and donor agencies who can use the insight to target or safeguard investment. Work will be conducted closely with development and funding agencies, so that development practitioners will be informed on the most promising adaptation options for specific geographies and socio-cultural and economic settings, and so that key decision makers will allocate resources for such options. Knowledge and insights into the most appropriate mechanisms of transference and successful adoption will support stakeholders such as development NGOs, civil society organizations and private sector companies. Impact strategies will be developed for specific countries in the target regions by working with a coalition of partners, especially the NARES (e.g. EIAR, NARO, ICAR, IARI, KARI, INRAN, ISRA, IER, INERA) and development NGOs (e.g. Oxfam, CARE). At global level, the work will feed into the global impact strategy to help shape how adaptation funds are allocated (Figure 9) and how the program influences the food security agenda (Figure 10).

Figure 9. Impact pathway for how CRP7 Theme 1, Objective 1 proposes to engage with the global adaptation funds, to ensure that fund guidelines are based on best practice information.

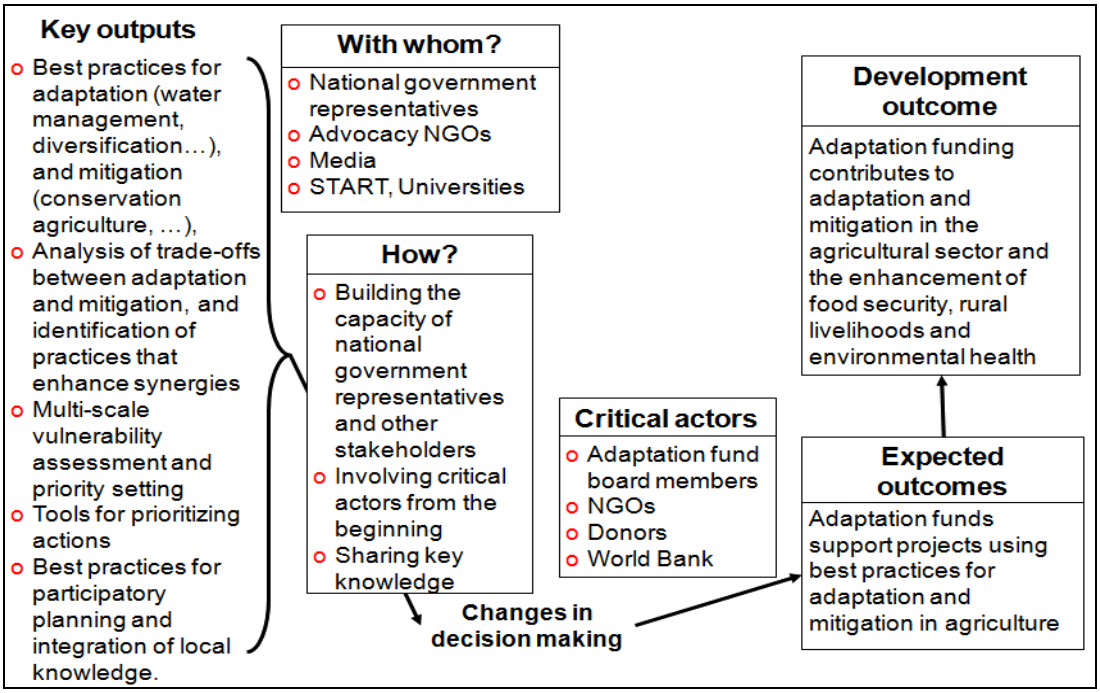
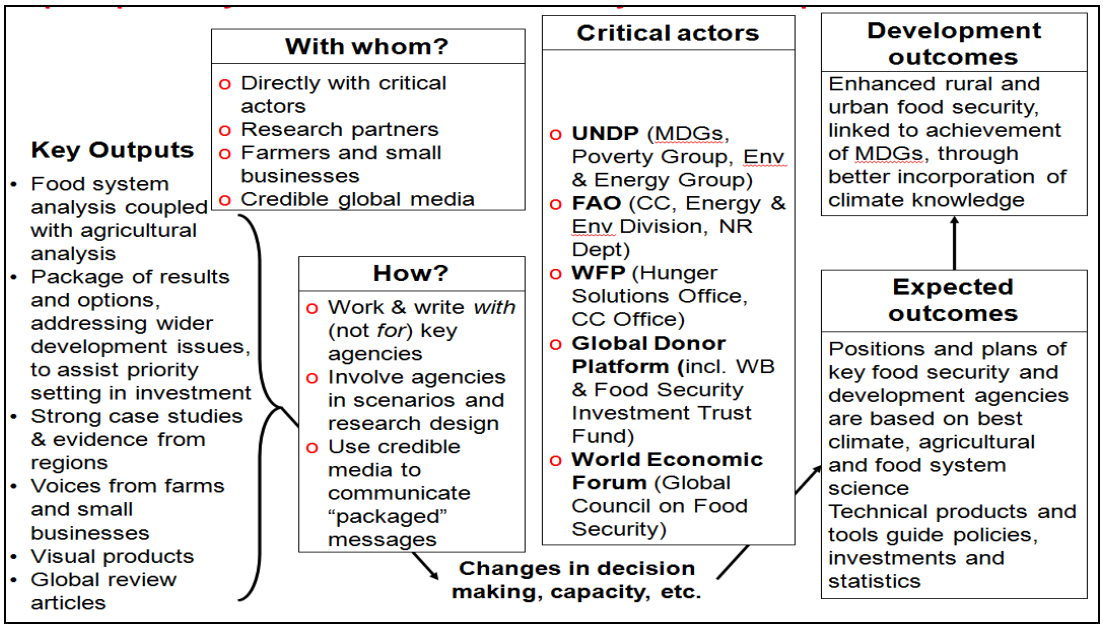


Figure 10. Impact pathway for how CRP7 Theme 1, Objective 1 proposes to engage with the global food security community, to ensure that strategies and plans are based on best climate change and other information. Similar engagement will be undertaken with regional, national and sub-national actors and processes.



Theme 1 Objective 2: Breeding strategies for addressing abiotic and biotic stresses induced by future climatic conditions, variability and extremes, including novel climates

Rationale and research questions

The expected increases in temperature and shifts in precipitation regimes are predicted to cause significant changes in crop productivity across the globe, through direct abiotic influence or through associated changes in pest and disease pressure. While significant adaptive capacity exists within agricultural and socio-economic systems, models suggest that the germplasm that currently underpins production is likely to be 'out-reached' in some places by change. Hence, crop improvement through conventional breeding or through biotechnological innovations is hailed as a crucial strategy to ensure long-term maintenance or gain in agricultural productivity (Tester and Langridge 2010). Given that projected demand for food is likely to increase by 60–70% from now to 2050 (Schmidhuber and Tubiello, 2007; World Bank, 2008), significant expectations are being placed on crop improvement to provide a large proportion of these gains, despite the complexities that climatic change bring to the problem. Given the long lead-time between commencement of a breeding program and the release and large-scale adoption of new cultivars in farmers' fields (minimum 8 years, although evidence suggests that true adoption can take as many as 20+ years to be successful), it is critical that breeding programs are initiated today to address future problems.

It is therefore key that priorities are developed for crop improvement programs based on sound *ex-ante* analysis of future benefits, and that coherent strategies across multiple countries and between institutions are adopted and implemented. International and national donor and government policies should be coordinated in enabling the conception and implementation of these strategies. This Objective is about generating comprehensive strategies for crop improvement through a combination of modeling, expert consultation and stakeholder dialogue, and translating these insights into coordinated global, regional and national research and technology investment policies.

Research question include:

- What are the most cost-effective crop improvement investments to enable tomorrow's crops to produce more food under a changed climate, with the additional consequences to resources that entails?
- What are the most appropriate modeling approaches to design "virtual crops" for the future that can then inform crop improvement programs on a crop-by-crop basis?
- Can currently farmed livestock and fish species cope with expected changes in temperature and salinity, and if not, how can new species or improved breeds be brought into production?

Activities

Activities for this Objective will use globally consistent models to identify future environments that will 'outreach' existing germplasm. Multi-site trial data will be collated as a critical input to calibrate and validate crop models. This will be done in collaboration with Objective 1 of this Theme. Objective 2 will then model biotic and abiotic constraints under decadal futures from 2020 to 2050 through the development of a range of crop modeling approaches. The modeling approaches will include the application of mechanistic crop models such as those within the Decision Support System for Agrotechnology Transfer (DSSAT) and the GLAM model (Challinor et al. 2004), niche-based approaches such as the modified EcoCrop model used by Lane and Jarvis (2007), as well as a number of models to quantify biotic elements. The models will provide the biophysical decision support for the scenario-based analysis of social, cultural and economic risks (in Theme 4, Objectives 1 and 3). Through the models, and in close consultation with crop-based experts, a set of "virtual crops" will be designed as targets for breeding programs. The efficacy of the virtual crops in addressing the likely conditions for 2020, 2030, 2040 and 2050 will be quantified in terms of the economic, social and cultural benefits expected. This will produce a set of concrete crop improvement strategies for further qualitative analysis. A series of activities will guarantee that research and policy organizations are actively engaged from the early stages of the research in both design and post-project implementation. They will also ensure that once a set of breeding strategies are identified, they will be socialized with funding bodies, national and international organizations, universities and other actors, and that concrete plans will be established. Additionally, strategies should be mainstreamed into workplans and existing breeding programs, e.g. for crop breeding. For the breeding elements, close collaboration with CRP3 is required so that outputs from this Objective inform breeding programs for each of the CRP3 components.

Outputs/milestones

- Detailed crop-by-crop strategies and plans of action for crop improvement that ensure future crops and agricultural systems are adapted to a progressively changing climate;
- Range of modeling approaches developed and validated for assessing future constraints to crop, livestock, fish and agroforestry production and the design of virtual crops;
- Global, regional and national policy briefs for investments in climate-proofed crop, livestock, fish and agroforestry breeding initiatives, feeding into impact strategies related to adaptation funds.

Partner roles

This Objective will build on close collaboration with crop and livestock-based components of CRP3, and integrate closely with the ongoing Generation Challenge Program (GCP) molecular and breeding platform and the future GIB Service that do not currently address demands only evident after taking climate change into account. For each crop all major crop improvement programs will be incorporated into the research, including crop improvement programs at CGIAR centers, NARES, ARIs or indeed in the private sector.

Strategies will also be developed jointly with donors and national and regional research funding agencies to drive donor policy towards coherent crop improvement plans without duplicity of efforts.

Impact pathways for target environments

Crop breeding initiatives at the national, regional and global scale will be fully engaged to ensure that the best-bet plans are put in place, and global and regional donors will be fully briefed on the priorities for investments not only at the crop level but also at the food system level. In the first six months of the CRP a multi-stakeholder and cross-CGIAR high-level meeting will be conducted to build consensus among partners about the R&D and engagement process.

Theme 1 Objective 3: Targeted identification and enhanced deployment and conservation of species and genetic diversity for increased resilience and productivity under conditions resulting from climate change

Rationale and research questions

This Objective targets the genetic and cultural diversity that is threatened by climate change, but also seeks to exploit potential opportunities it provides. The diversity of traits and characteristics among existing varieties of agricultural biodiversity (both inter- and intra-specific) provide enormous potential for adaptation to progressive climate change. Biodiversity, and the cultures that interact with it, are at risk of being lost before they are even fully valued. Its potential is poorly understood, and under-exploited. Under this Objective, research will develop innovative methods and tools for the rapid identification of suitable materials both *in situ* (in the wild and on farm) and *ex situ* (in gene banks) for integration into production systems to facilitate adaptation to progressive climate change, and their enhanced use in breeding priorities identified in Objective 2. This will include the exploration of underutilized crops and species and their potential role in providing adaptation options as more conventional crops undergo losses. In addition to testing materials of interest, through collaboration with CRP1, under conditions including analogs for projected future climates, research will evaluate how to facilitate their integration into local production systems and adoption by farmers by analyzing enabling policies and seed systems and defining key interventions to enhance them. In addition to looking at specific varieties/species, the benefits of crop, fish and livestock diversity in production systems as a strategy for maintaining productivity despite climate change and variability and associated impacts (notably pests and diseases) will be assessed.

Research questions include:

- What priority gene pools for climate change adaptation are threatened, and how can they be conserved to ensure their continuing availability?
- How do cultural practices exploit this diversity and how can farmers' knowledge be used to help identify landraces and crop varieties suited for specific climatic conditions?
- How can access to crop diversity by local farmers be facilitated through enhanced seed systems or other mechanisms?
- How does on farm crop diversity in production systems contribute to maintaining productivity in the face of progressive climate change and increased variability in climate?

Activities

Activities will consist of developing tools and methodologies to rapidly identify materials *in situ* and *ex situ* with traits useful for climate change adaptation and to assure their conservation. Once candidate materials are identified, on-farm evaluation on a range of sites, in collaboration with CRP1, will be used to test their response in different climate conditions in the target regions. This participatory approach will not only

allow testing the material in a cost-effective way in a significant number of different agro-ecological conditions, it will also allow farmers' perceptions to be integrated into the evaluation, a key to future adoption. Additional strategies needed to facilitate the uptake will be formulated, focusing on both access to the material and its management. Finally, the contribution of crop, fish and livestock diversity in production systems as a strategy to climate variability and change will be evaluated and promoted.

Outputs/milestones

- *In situ* populations of priority genepools important to climate change adaptation identified, threats understood and conservation solutions proposed identified;
- Methods and tools developed to facilitate targeted identification of *ex situ* conserved germplasm with traits useful for climate change adaptation, including resistance to biotic and abiotic stresses;
- Strategies to improve existing policies, local management and seed systems, to facilitate the deployment of adapted germplasm;
- Assessment of the contribution of crop, fish and livestock diversity for climate change adaptation.

Partner roles

Collaborators on the *in situ* research will include NARES for crops, fish and livestock, ministries of forestry, fisheries and the environment and international and national conservation organizations for wild relatives, aquatic biodiversity and trees *in situ* in the wild. The *ex situ* activities will be carried out in collaboration with CGIAR centers that manage mandate collections as well as with national genebanks. The local evaluation and adaptation activities and the research on resilience of diverse production systems to progressive climate change will be carried out in close collaboration with NARES, development agencies, local farmer organizations and the global change community (including the Resilience Alliance and DIVERSITAS).

Impact pathways for target environments

Research will produce knowledge, information sources and guidelines as well as make available germplasm that has been selected, collected, conserved and tested to address targeted needs for climate change adaptation in areas likely to suffer most. Intermediate users of the information will include government agencies in target countries, genebank managers and conservation organizations that will participate and then continue to carry out the priority conservation actions defined by the research. Researchers and breeders in NARES and other institutions will use both the information about the germplasm (and the germplasm itself) to produce varieties better adapted to the conditions resulting from changed climates, including the changed dynamics, distribution and virulence of pests and diseases. Farmers will use and evaluate the selected germplasm and mixtures as well as varieties bred from it by the breeders. New knowledge about the benefits of crop diversity and about seed systems and the policies that affect deployment of germplasm will be used by crisis management agencies as well as NARES and international agricultural/rural development agencies to ensure that suitable and adapted germplasm reaches farmers.

Theme 2: Adaptation through Managing Climate Risk

Rationale

Managing the risk associated with climate variability is integral to a comprehensive strategy for adapting agriculture and food systems to a changing climate. Climate variability today and long-term climate change are two ends of a continuum of time scales at which the climate varies and impacts agriculture. The damage of climate shocks, such as droughts or floods, to health, productive assets and infrastructure can impact livelihoods long after the shock has passed. Climate variability and the conservative strategies that risk-averse decision makers employ contribute to the existence and persistence of poverty – sacrificing income-generating investment, intensification and adoption of innovation to protect against the threat of shocks. Apart from effective intervention, projected increases in climate variability can be expected to intensify the cycle of poverty, vulnerability and dependence on external assistance. This Theme enables promising innovations for managing climate-related agricultural risk at local and regional levels, and addresses gaps and supports improvements to climate-related information products and services that enable a range of agricultural risk management interventions. It targets the many short-term, climate-sensitive decisions that farmers, humanitarian response organizations and other private- and public-sector actors in the food system make routinely, which influence vulnerability to a changing climate in the longer term.

Objectives

The overall aim of Theme 2 is to bring promising innovations in climate risk management to bear on the challenge of protecting and enhancing food security and rural livelihoods in the face of a variable and changing climate. Its Objectives (Table 13) are to:

- Identify and test innovations in partnership with rural communities that enable them to better manage climate-related risk and build more resilient livelihoods;
- Identify and test tools and strategies to use advance information to better manage climate risk through food delivery, trade and crisis response;
- Support risk management through enhanced prediction of climate impacts on agriculture, and enhanced climate information and services.

Research approach to international public goods

Theme research targets strategic gaps in knowledge, methodology, climate products and services, evidence and capacity that currently impede development of climate-resilient rural livelihoods across regions. A combination of analytical research and participatory co-learning with rural communities and other key actors in the food system, across a range of agroecological and socioeconomic contexts, will produce international public goods including:

- Synthesized knowledge on innovative risk management strategies and actions that support climate-resilient rural livelihoods; and evidence of their feasibility, acceptability and livelihood impacts;
- An analytical framework and decision tools for targeting and evaluating the livelihood benefits of promising risk management innovations;
- Synthesized knowledge and evidence about differential impacts of a range of climate risk management interventions on different social groups, particularly women and men, and strategies for overcoming inequities;
- Synthesized knowledge of effective methods for using advance information to manage climate-related risk through food delivery, trade, crisis response and post-crisis recovery; and evidence of the impacts of climate-informed food system interventions on food security and rural livelihoods;

Table 13. Objectives, Outcomes and Outputs for Theme 2 for Phase 1 (Year 1-5) (the full list of milestones is given in Annex 1). Outputs to be achieved by Year 5, Outcomes by Year 10.

Theme 2. Adaptation through Managing Climate Risk		
OBJECTIVES	**OUTCOMES**	**OUTPUTS**
Objective 2.1 Identify and test innovations that enable rural communities to better manage climate-related risk and build more resilient livelihoods	Outcome 2.1 Systematic technical and policy support by development agencies for farm- to community-level agricultural risk management strategies and actions that buffer against climate shocks and enhance livelihood resilience in at least 20 countries	Output 2.1.1 Synthesized knowledge and evidence on innovative risk management strategies that foster resilient rural livelihoods and sustain a food secure environment
		Output 2.1.2 Analytical framework and tools to target and evaluate risk management innovations for resilient rural livelihoods and improved food security
		Output 2.1.3 Development; and demonstration of the feasibility, acceptability and impacts; of innovative risk management strategies and actions for rural communities
		Output 2.1.4 Tailor and disseminate research results for evidence-based policy and technical support for farm- to community-level risk management strategies
		Output 2.1.5 Identify and evaluate differential impact of agricultural risk management strategies on different social groups, particularly women and men, and communicate findings through technical and policy support activities
Objective 2.2 Identify and test tools and strategies to use advance information to better manage climate risk through food delivery, trade and crisis response	Outcome 2.2 Better climate-informed management by key international, regional and national agencies of food crisis response, post-crisis recovery, and food trade and delivery in at least 12 countries	Output 2.2.1 Enhanced knowledge of impacts of climate fluctuations on food security, and how to use advance information to best manage climate-related risk through food delivery, trade, crisis response and post-crisis recovery
		Output 2.2.2 Synthesized knowledge and evidence of the impacts of alternative risk management interventions within the food system on food security and rural livelihoods, to inform policy and practice
		Output 2.2.3 Platform and tools for sharing knowledge and fostering improved coordination among food crisis response, the market-based food delivery system, and agricultural research and development
		Output 2.2.4 Identify and evaluate differential impact of tools and strategies for climate risk management on different social groups, particularly women and men, and inject findings into support to agencies
Objective 2.3 Support risk management through enhanced prediction of climate impacts on agriculture, and enhanced climate information and services	Outcome 2.3 Enhanced uptake and use of improved climate information products and services, and of information about agricultural production and biological threats, by resource-poor farmers, particularly vulnerable groups and women, in at least 12 countries	Output 2.3.1 Improved climate information tools and products to support management of agricultural and food security risk
		Output 2.3.2 Synthesized knowledge and evidence on institutional arrangements and processes for enhancing climate services for agriculture and food security
		Output 2.3.3 Improved knowledge, tools, data sets and platforms for monitoring and predicting agricultural production and biological threats, and informing management, in response to climate fluctuations
		Output 2.3.4 Enhanced capacity of national and regional climate information providers, NARES and communication intermediaries to design and deliver climate information products and services for agriculture and food security management
		Output 2.3.5 Identify and evaluate differential impact of climate information services on different social groups, particularly women and men, and inject findings into support to farmers

- Mechanisms for sharing knowledge and improving coordination among food crisis response, the market-based food delivery system, and agricultural research and development;
- Synthesized knowledge, tools and evidence to tailor climate information for management of agricultural and food security risk;
- Improved knowledge, tools, data sets and platforms for monitoring and predicting agricultural production and biological threats, and informing management, in response to climate fluctuations; and
- Synthesized knowledge and evidence on institutional arrangements and processes that enhance the utility of climate services for agriculture and food security.

New content and innovation

Theme 2 targets emerging and integrated solutions for managing climate-related risk, which have not yet been fully exploited due to their newness, major knowledge gaps, climate information constraints, or dependence on effective coordination among actors. Combining analysis with participatory action research, it will develop integrated risk management solutions that combine rural communities' current knowledge and tactics; with innovations such as index-based risk transfer products, diversified farm and livelihood portfolio design, and adaptive management in response to seasonal forecast information; and evaluate them within a livelihood resilience framework. At the level of food systems, Theme 2 research will advance: the salience, accuracy and lead time of information about climate impacts; the timeliness and targeting of climate-informed food trade, delivery and crisis response decisions; and the coordination among actors within the food system. By bridging the climate, agriculture and food security communities, and overcoming bottlenecks to relevant climate services, Theme 2 will enable several innovative opportunities to manage agricultural risk better across scales.

Risks

Achieving outputs and outcomes will depend on the degree to which the Program can engage and influence the agendas of non-traditional CGIAR partners, particularly within the climate and the humanitarian response communities. Uptake of particular interventions may be constrained by farmers' resources and geographic context. Further, effective and equitable participation from rural communities and an open forum for dialog must be established with support of intermediaries for successful participatory research projects at benchmark locations. Several planned outputs depend on historic meteorological data; hence the need for good partnership with the meteorological services, regional climate centers and the WMO. For work on the delivery of climate services, institutional and technical capacity must be sufficient to support widespread delivery of climate services. The dependence on integration with the other CRPs mentioned below must be managed through appropriate governance structures that go beyond the Program. Silos among the Themes are also a risk; mechanisms to avoid these are discussed under the risks section for Theme 1.

Regional balance

Work on field- to community-level risk management (Objective 1) will span target regions, but is particularly relevant for rainfed agriculture in high-risk environments. Work on climate services (Objective 3) will also span target regions, and capitalize early on regional climate centers (i.e., ACMAD, ICPAC, AGRHYMET) and substantial investment in climate services (e.g., ClimDev-Africa) in sub-Saharan Africa. Objective 2 activities will be most prominent in sub-Saharan Africa, where the state of food insecurity and the scale of international humanitarian response are greatest. The work will be expanded to other regions as they are added, and in addition Objective 1 will include a global comparative element that cuts across all locations where the CGIAR operates.

Linkages to other CRPs

Work in this Theme is linked to CRPs 1, 2, 3, 5 and 6 (Table 14). Two-way interaction is expected with CRP1 on diversification of farming systems and its impact on risk and vulnerability. Theme 1 will interact with CRP2 in the areas of information delivery; risk management through off-farm livelihood diversification, insurance, collective action; and managing risk through the food delivery system. CRP3 will contribute to climate-resilient crop germplasm and seed systems, and will benefit from analyses of the risk implications of cultivar and crop mixes. Climate information can feed into CRP5 to provide information on soil and water management, while CRP5 will provide options for reducing climate risk through better water and land management. The Theme will draw on advice from other CRPs on agricultural enterprises that best work after extreme events (e.g. salt-tolerant varieties after salt intrusion from tsunami, short-cycle crops to rapidly increase agricultural outputs) or to mitigate extreme events (e.g. drought tolerant crops). Cofinancing CRP1, CRP3 and CRP5 is envisaged, whereby promising options developed in those CRPs are tested and further developed in the context of holistic adaptation-mitigation strategies in the CRP7 targeted regions.

Theme 2 Objective 1: Enable rural communities to manage risk and build resilient livelihoods

Rationale and research questions

The purpose of this Objective is to enable several promising innovations for managing climate-related agricultural risk, and understand their impact on the resilience of rural livelihoods. For example, within an enabling environment, seasonal climate prediction offers farmers and local market institutions opportunities to exploit favorable conditions and more effectively protect themselves from long-term consequences of adverse extremes. There is a rapid resurgence of interest in insurance as a pro-poor climate risk management tool, in part because of the innovations that base payouts on an Objective index (e.g., rainfall) that is correlated with losses, and thereby overcome long-standing obstacles associated with asymmetric information. Improving diversification – at the levels of cultivars, farm enterprises and rural livelihood portfolios – is a promising means of reducing risk. Some indigenous community risk management innovations are likely to be transferrable and scalable. These innovations face important knowledge gaps related to targeting, design, institutional arrangements needed, and the special needs of marginalized groups including women. There are numerous technical options for better managing seasonal risks, which need further development and testing. Research will build on and contribute to our understanding of determinants of vulnerability to climate, and identify promising pathways to reduce climate vulnerability and enhance resilience in the longer term.

Research questions include:

- How effectively do rural communities manage climate-related risk, and what strategies hold promise for transferring and upscaling?
- How can index-based financial risk transfer products be best targeted and implemented to reduce vulnerability to climate shocks and alleviate climate-related constraints to improving rural livelihoods?
- How and under what circumstances can seasonal climate prediction be successfully employed to take advantage of favorable seasons, and to improve coping responses in adverse seasons?
- What combination of livelihood diversification, intensification, innovation and risk transfer has the best prospect for building resilience and reducing the long-term climate vulnerability of rural communities?

Table 14. Interaction of CRP7 Theme 2 with other CRPs (Priority activities are indicated in bold).

CRP7 Objective # and Title	CRP1 – Integrated Systems	CRP2 - Policies, Institutions and Markets	CRP3 – Sustainable Production	CRP5 – Water, Land and Ecosystems	CRP6 – Forests and Trees
2.1 Enable rural communities to manage risk and build resilient livelihoods	*In CRP7:* Development and evaluation of improved risk management through diversification and sustainable intensification. *In CRP1:* Pilot and evaluate climate risk management. ***Cofinancing:*** **Coordinated set of trial sites in target regions for testing options.**	*In CRP7:* Evaluation and development of innovations in weather-index insurance mechanisms by small farmers under the value chain component. This could also include combination of insurance and access to credit to reduce the risks faced by farmers. *In CRP2:* Analyses of rural financial services and appropriate rural service provision for markets through information hubs and institutional innovations under the value chain component *Collaboration:* Rural institutions and delivery of weather-index insurance mechanisms	*In CRP7:* Development of improved risk management and climate-resilience through sustainable intensification. *In CRP3* Evaluation of improved germplasm under climate change conditions. ***Cofinancing:*** **Testing options for improved risk management of food system**	*In CRP7:* Provide climate info relevant to water and soil mgmt *In CRP5:* Provide technical/policy options for reducing risk through water mgmt ***Cofinancing:*** **Testing options for improved risk mgmt of food system**	
2.2 Managing climate risk through food delivery, trade and crisis response	*In CRP7:* Use of climate-related info to manage risk through food security safety nets, food reserves and trade *In CRP1:* Address needs for safety nets, food reserves and diversifying markets *Collaboration:* Joint priority setting for research on improved risk management of food system	*In CRP7:* Work with humanitarian community on crisis response and recovery *In CRP2:* Evaluation of social protection interventions for shocks *Collaboration:* Social protection, including humanitarian response, and its links to ag development.	*In MP7:* Improve use of climate-related information to manage risk *In MP3:* Address productivity increases and policy needs for safety nets, food reserves and diversifying markets *Collaboration:* Opportunity for collaborative research on evidence-based policy and practice		
2.3 Enhanced prediction of climate impacts, and enhanced climate services	*In CRP7:* Improved prediction of climate impacts and enhanced climate services *In CRP1:* Use of climate impact information in CRP1 research and development	*In CRP7:* Improvement and evaluation of climate information services and delivery mechanisms *In CRP2:* Improvement and evaluation of market information services and delivery mechanisms through ICTs *Collaboration:* Opportunity for synergies in developing rural information delivery mechanisms	*In CRP7:* Improved prediction of climate impacts and enhanced climate services *In CRP3:* Use of climate impact information in CRP3 research and development	*In CRP7:* Improved prediction of climate impacts and enhanced climate services *In CRP5:* Use of climate impact information in CRP5 research and development	*In CRP7:* Improved prediction of climate impacts and enhanced climate services *In CRP6:* Use of climate impact information in CRP6 agroforestry research and development

Activities

A network of participatory pilot demonstrations; which will engage rural communities and other local stakeholders at benchmark locations to identify, develop and evaluate suites of agricultural risk management strategies; will form the foundation of the Objective's research. Community-level surveys will assess the current use, unmet demand and bottlenecks to climate-related information for local-scale agricultural risk management in order to inform interventions to improve rural climate services (under Objective 3). Replicating the participatory pilot demonstrations across farming systems and environments will enhance the transferability of knowledge and evidence. The Objective will develop a robust framework and decision tools for designing and targeting risk management innovations, and evaluating their impact on livelihood resilience of rural households. Integrating bioeconomic modelling with participatory evaluation of risk management innovations will ensure that the analytical framework and tools are robust and useful to inform policy and practice, and provide a mechanism for transferring knowledge and scaling up successful interventions beyond benchmark locations. Knowledge of promising opportunities to improve management of climate-related risk – climate-resilient agronomic and natural resource management technologies, farm and livelihood diversification, climate-informed adaptive management, index-based risk transfer products, successful strategies that rural communities already employ – will be synthesized from critical reviews of literature and work across the CGIAR and its partners. Work under this Objective will pay particular attention to understanding and overcoming gender-based inequities in risk management interventions and the institutional services that support management of climate-related risk. Knowledge-sharing platforms will link knowledge and evidence produced under this Objective, with relevant policy and institutional stakeholders to foster support for improved agricultural risk management. The Objective will work closely with partners in governments, development agencies and the private sector to ensure that the research is demand-driven and provides practical, replicable outputs and outcomes.

Outputs/milestones

- Synthesized knowledge and evidence on risk management innovations that foster resilient rural livelihoods: climate-resilient production technology, diversification, climate-informed adaptive management, index-based insurance, and successful strategies that rural communities already employ.
- An analytical framework and tools to design, target and evaluate risk management innovations for resilient rural livelihoods.
- Methodology and tools for designing comprehensive risk management portfolios for particular farming systems and contexts; and evaluating their impact on livelihood resilience.
- Demonstrated feasibility, acceptability and impacts of innovative risk management strategies and actions with rural communities at benchmark locations.
- Knowledge-sharing platforms to link research results with evidence-based policy and technical support for farm- to community-level risk management (with Themes 1 and 3).
- Synthesized knowledge and evidence of differential impact of agricultural risk management interventions on different social groups, particularly women and men; and guidelines for ensuring equitable participation and distribution of benefits.

Partner roles

Rural communities, other local agricultural stakeholders, and research partners (NARES, CG, universities) will partner in identifying, designing and evaluating context-relevant opportunities to improve risk management; and in co-learning. Farmer associations and strong development NGOs (e.g., CARE, Oxfam) will help facilitate interactions with rural communities, and will ensure that research is responsive to the needs of women and other vulnerable groups and that it builds on existing knowledge. Work on index-

based financial risk transfer products will involve national financial institutions, and coordination with the international research and development community that is working on this area (e.g. BMGF, WB, I4, IRI, CARE, Oxfam). Work on the use of climate-related information will interface with Objective 3, and engage national and regional climate service providers; communication intermediaries such as agricultural extension, development NGOs, and organizations focused on communication through Information and communication technology (ICT) and the media; and a range of local private- and public-sector end users.

Impact pathways for target environments

Co-learning among researchers, institutional partners and rural communities will provide a foundation of knowledge and evidence to inform systematic technical and policy support for more effective farm- to community-level agriculture risk management. Concerted effort will be invested in capturing and sharing experiences with promising existing community-based risk management strategies. Participatory research with rural communities, with particular attention to the effective participation of women and socially marginalized groups, will provide evidence of the feasibility, acceptability and livelihood impact of current community-based risk management practices and new innovations. Key NARES and development NGOs will participate in the design, pilot implementation and evaluation of local risk management interventions. A range of communication channels will inform adaptation and development funders and organizations, the CGIAR, and NARES about the long-term impacts of alternative risk management actions, leading to better-targeted investment in agricultural development and adaptation, and ultimately to farming systems and rural livelihoods that are more secure in the face of a variable and changing climate. A combination of direct participation, aggressive outreach, and knowledge sharing platforms will foster widespread uptake of results by a range of public and non-governmental development agencies.

Theme 2 Objective 2: Managing climate risk through food delivery, trade and crisis response

Rationale and research questions

Decisions made within the food system influence constraints and opportunities that rural communities face, and influence food security in urban areas. There is substantial scope to use climate-related information to better manage grain storage, trade and distribution; and to better target timely assistance during food crises. Safety nets that provide well-targeted assistance in times of crisis can protect productive assets, encourage investment, and stimulate development of the value chain for agricultural products. Early response is essential to effective food crisis management, as delay can greatly increase the humanitarian and livelihood costs; and the availability of quality early warning information is a precondition. The use of advance information to manage regional trade and storage to stabilize prices is a promising component of food security management, as climate-related price fluctuations can lead to acute food insecurity for the relatively poor who spend the majority of their incomes on food, even if total food availability is sufficient to meet a region's needs. Improving the use of climate-related information is expected to improve targeting of safety net interventions, and improve the lead time of decisions within the food system. This Objective links closely with CRP2 in the areas of long-lead climate, market and early warning information and improved climate-informed management of safety nets and price volatility in the output value chain.

Research questions include:

- To what degree can advanced information about climate inform estimates of the determinants of food security (i.e., availability, accessibility and utilization)?
- What is the feasibility and best strategy to use advanced information to target and initiate safety net interventions and responses to climate-related market fluctuations and emerging food crises?
- How can agricultural development and humanitarian response activity and resourcing be coordinated most effectively?

- How can food delivery, crisis response and post-crisis recovery be best managed to reduce climate vulnerability and improve resilience of rural communities?

Activities

Work under this Objective will engage key international and national organizations involved in food delivery, trade and humanitarian crisis response in CCAFS focus regions; to improve management responses to climate fluctuations based on long-lead prediction; and to enhance coordination among actors within the food system. Informed by empirical analysis of impacts of climate fluctuations on the components of food security (food production, transport, prices, incomes, consumption, humanitarian assistance), participating stakeholders will work with climate service providers to design information products and decision tools to support innovative response strategies. Research will use longitudinal household survey data and economic modeling to understand the livelihood impacts and equitability (based on gender and social status) of current and alternative policies for managing climate-related safety net interventions and responding to food crises and price volatility. Direct engagement with key organizations within the food system and a web-based knowledge-sharing platform will foster co-learning, adoption of improved responses to improved information, and enhanced coordination.

Outputs/milestones

- Enhanced knowledge of the impacts of climate fluctuations on food security, and the use of advance information to best manage climate-related risk via food delivery, trade, crisis response and post-crisis recovery.
- Synthesized knowledge and evidence of the impacts of alternative risk management interventions within the food system, on food security and rural livelihoods, to inform policy and practice.
- Stakeholder engagement, platform and tools for sharing knowledge and fostering improved coordination among food crisis response, the market-based food delivery system, and agricultural research and development.
- Identification and evaluation of differential impact of interventions for dealing with climate fluctuations within the food system, on different social groups, particularly women and men, and injection of findings into food system policy and practice.

Partner roles

Key food security response (e.g., WFP, IFRC, World Vision, bilateral humanitarian assistance programs) and food trade organizations will engage in evaluation of promising improvements to response mechanisms. Work on improving the use of climate-related information will engage national and regional climate service providers, and crop forecasting and food security early warning organizations. IFPRI, other CG Centers working within CRP2 and appropriate ARIs will participate in analyses and development of response guidelines. A range of food trade organizations, food security early warning (e.g., FEWSNet, JRC) and humanitarian response organizations (e.g., WFP), information providers (e.g., the NMS and regional climate centers involved in the Regional Climate Outlook Forum process) and ministries of agriculture will participate in platforms to share knowledge and improve coordination.

Impact pathways for target environments

Critical actors in the food system will identify and evaluate promising strategies for using climate-related information to manage price volatility, respond to emerging food crises, and implement safety nets. Improved advance information about climate impacts on food production and food security will be designed with their participation, and disseminated through existing information providers and a range of forums. Dissemination through workshops, reports and policy briefs will complement the direct engagement of key food trade and humanitarian relief organizations in the development and evaluation of

improved response strategies. More timely and better targeted food crisis response will decrease long-term livelihood impacts of crises, reduce disincentives to agricultural producers and markets, and reduce cost of assistance. More timely and effective management of food trade, storage and delivery will reduce the adverse impacts of climate fluctuations on availability and accessibility of food, and on incentives to producers and market institutions.

Theme 2 Objective 3: Enhanced prediction of climate impacts, and enhanced climate services

Rationale and research questions

This Objective deals with the design and delivery of climate-related information products and services to support more effective management of agricultural and food security risk. Several opportunities to better manage climate-related risk depend on information about climate (historic, monitored, predictive) and its impacts on agriculture, but progress in implementing them at the scale of the development challenge is constrained in part by a substantial gap between current operational climate information services and the needs of development. If climate information services are to contribute fully to efforts to adapt agriculture to a variable and changing climate, several gaps need to be addressed in parallel, such as: data availability, design of salient information products and services, modeling frameworks to estimate impacts on agricultural and biological systems, delivery mechanisms, enabling policy, and capacity to respond. Understanding current use of climate information, any obstacles to accessing or responding to information, and underexploited opportunities to use information to manage risk, are prerequisites to developing more effective services. Partnering with emerging initiatives (such as the Global Framework for Climate Services that was endorsed by the World Climate Conference-3 and the ClimDev-Africa joint program of the AU, UN-ECA and AfDB) enhances the prospect of overcoming information bottlenecks that have limited opportunities to manage agricultural risk.

Research questions include:

- To what degree can available climate and environmental information be used to anticipate and manage variations in crop and forage production, biological threats, and food security outcomes?
- What combination of new products, services, delivery mechanisms and institutional arrangements offers the best opportunity to deliver useful, equitable, transferable and scalable rural climate services?

Activities

This Objective will engage climate information providers and key users – from farmers to food security humanitarian organizations – to design new or enhanced products and services for risk management applications (identified in Objectives 1 and 2); and overcome technical and institutional bottlenecks to the production and delivery of useful information products and services. Building on investment in seasonal prediction and reconstructing historic meteorological observations, and synthesis of existing prediction and early warning systems; research under this Objective will develop value-added information in the form of methodology, data sets, predictive and decision tools, and platforms for monitoring and predicting impacts of climate fluctuations on agricultural production and biological threats. Work on institutional arrangements and processes for enhancing climate services will be informed by critical reviews of strengths, gaps and opportunities of current climate services in each focus region; and by engagement with farmers and other local agricultural decision-makers at benchmark locations (Objective 1), and key actors within the food system (Objective 2). The work will pay particular attention to understanding and overcoming inequitable access and benefits from climate services, due to gender and social marginalization. This Objective aims to develop a consensus "roadmap" with critical actors in the climate and user communities, for improving the utility of climate services for agricultural and food security risk

management. Research and methodology development will be co-designed with national and regional climate information providers, NARES and communication intermediaries to deliver climate information products and services for agriculture and food security management.

Outputs/milestones

- Improved, tailored climate information products (reconstructed historic climatology, downscaled seasonal forecasts) and decision tools to support management of agricultural and food security risk;
- Improved knowledge, data sets, tools and platforms for monitoring and predicting impacts of climate variations on agricultural production, rangeland conditions and biological threats, for a range of early warning and risk management applications;
- Synthesized knowledge and evidence on institutional arrangements and communication processes for climate services; addressing relationships among climate and agricultural institutions, ICT-based and other innovative information delivery mechanisms, and protocols for communicating complex climate information effectively; leading to regional roadmaps for enhancing the utility of climate services for agriculture and food security;
- Enhanced capacity of national and regional climate information providers, NARES and communication intermediaries to design and deliver and support the use of climate information products and services for agriculture and food security management; including training and curriculum development for overcoming sparse historic observations, downscaling and tailoring seasonal forecasts for local agricultural decisions, and communicating climate information with farmers; and
- Synthesized knowledge and evidence on differential accessibility and benefits of climate information services among different social groups, particularly women and men, and approaches to overcoming inequities.

Partner roles

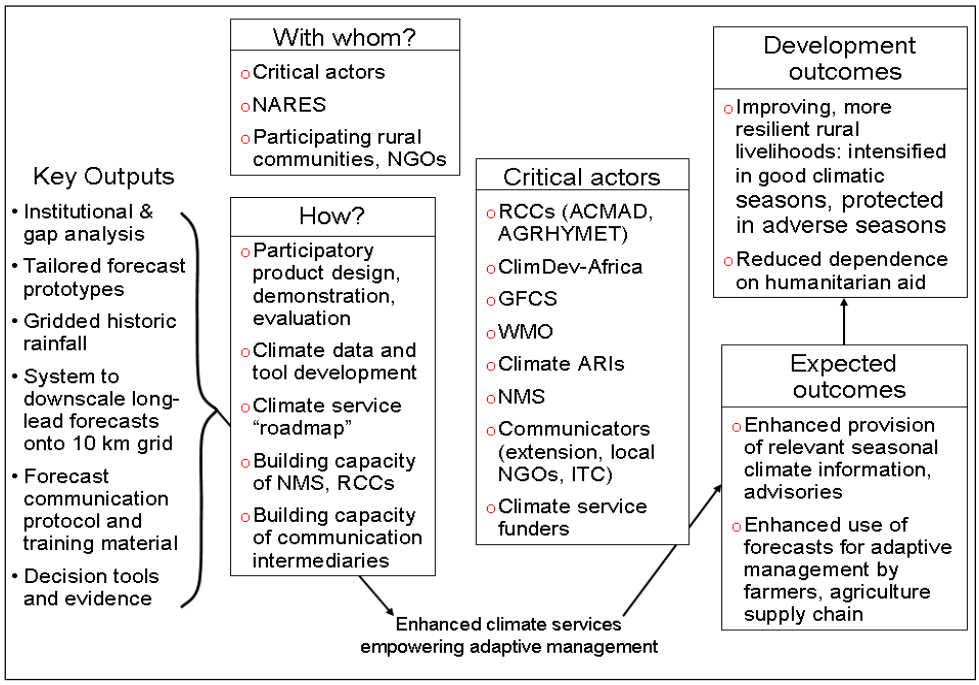
Key information providers (WMO, NMS and regional climate centers in Africa: ACMAD, ICPAC, AGRHYMET) and local- to regional-level users will participate in the evaluation and improvement of climate information products and services. Development of platforms to translate climate information into agricultural production and biological threat impacts will involve a range of partners such as FAO, NARES, CIRAD, JRC, FEWSNet and AGRHYMET. Scaling up the results will require coordination with international climate organizations and initiatives such as WMO, GFCS and ClimDev-Africa. Information intermediaries (NARES, development NGOs, media, firms and NGOs involved in rural ICT) will be involved in evaluating and developing strategy to improve and upscale information delivery mechanisms. Participation and feedback from representatives of agriculture (e.g., farmer associations, development NGOs, agribusiness), trade and food security response communities will be vital for guiding and evaluating improvements to climate services. Research will require partnership with the ESSP, in addition to CGIAR, NARES and agricultural ARIs.

Impact pathways for target environments

While the design and evaluation of climate information products and services will be led largely by rural communities at pilot locations (under Objective 1) and key actors in the food delivery system (Objective 2), NMS and international providers of climate services will participate in the process of developing and evaluating improvements to products and services. Results will be disseminated among the climate community through a range of forums including international programs (WMO, WCRP) and initiatives surrounding climate services (e.g., GFCS, ClimDev-Africa, regional climate outlook forums). The outreach process will include training and capacity enhancement for key information providers. Participating regional climate centers and NMS will improve information and services tailored to the needs of agriculture and food security. Partnering with initiatives such as ClimDev-Africa offers a mechanism to upscale improvements in climate information services. Improving climate information products and removing communication bottlenecks will enable improved management of agricultural risk at multiple levels, which

will contribute to more resilient farming systems, more secure rural livelihoods, and more effective and less costly safety net interventions (Figure 11).

Figure 11. Impact pathway for working with partners to enhance climate services for adaptive management – example from West Africa, using outputs from Theme 2, Objective 3.



Theme 3: Pro-Poor Climate Change Mitigation

Rationale

Agriculture contributes considerably to climate change by producing 10–12% of total global anthropogenic emissions of greenhouse gases (Smith et al., 2007). Agricultural practices can significantly reduce emissions by sequestering carbon in the soil or above ground biomass (for example in agroforestry or woodlots, or by reducing nitrous oxide or methane emissions), especially if large numbers of farmers take up these practices. However, many of the world's poorest also depend on agriculture and related natural resources to meet their basic needs. If the poor are to contribute to climate change mitigation, there is a need for mitigation options that have a positive impact on livelihoods, otherwise unacceptable trade-offs may occur. Carbon markets are unlikely to provide significant benefits to smallholder farmers in the near run and are highly uncertain, but livelihood options that produce mitigation co-benefits and carbon finance schemes that provide additional incentives should help farmers to meet both livelihood and environmental objectives.

The focus of this Theme is on how mitigation can benefit poor farmers and to understand trade-offs among different dimensions of poverty and different groups of the poor (including between men and women). Two windows of opportunity exist for pro-poor mitigation. The first is the design of low net emissions agricultural development pathways, i.e., options for securing food that minimize emissions of greenhouse gases and sequester additional carbon. These will need to be transformational alternatives that ensure future livelihoods and uses of land while simultaneously reducing people's impact on climate change. Past growth-based models of agricultural development have contributed to increased emissions and not always been environmentally or socially sustainable. Yet, food production will need to increase. As society gives

more emphasis to stability and resilience and compromises on economic growth as resource limits are reached, what options exist for agricultural development? What is the carbon footprint of these alternatives? How can we lower the carbon footprint of intensified agriculture? Countries will need such information to produce national mitigation strategies and manage larger food security, energy and biodiversity implications. For these to work, we need to understand how farmers may be able to combine mitigation and adaptation synergies and handle trade-offs. Agricultural development strategies should include how mitigation finance can be used to support adaptation. Strategies should also consider landscape-level impacts on conserved areas, such as forests and rangelands, which may have high mitigation impacts at low cost.

The second window of opportunity is the effective capacity of the poor to benefit from carbon financing, for example, the carbon market. Mitigation markets will commodify carbon and formalize rights to land, trees and carbon, both of which may marginalize the poor. Smallholders in developing countries are not currently competitive in these markets and carbon prices are inherently risky. Smallholders usually cannot afford the up-front costs of project development, data is often not available, and farmers manage diversified mixed crop-livestock systems. Furthermore, transparency and accountability are often poor among both government and private entities. Many farmers manage common-pool resources (rangelands, community forests, coastal zones) where boundaries, rights to benefits and collaborative management may be unclear, contested or complex. Benefits are often captured by elites or other actors in trading systems. Capacity for precise measurement of GHGs is often non-existent.

Yet, the largest potential for agricultural mitigation is among smallholders in developing countries. The combined value of markets for GHG emission reduction is more than US$100 billion, agriculture has been largely excluded from formal and informal carbon markets due to high uncertainty in the measurements of mitigation potential, the impermanence of agricultural practices and the transaction costs associated with smallholder agriculture. Similarly, the potential of aquatic system carbon sinks (‘blue carbon’, IUCN, 2009) has been little explored, and the possibilities for coastal resource users to act as ecosystem stewards for coastal and ocean carbon sinks have only been speculated upon.

Supportive future-looking institutional and incentive mechanisms will be necessary to encourage adoption of mitigation practices. Increasing the accuracy of estimates of carbon sequestration potential; designing low-cost measurable, reportable and verifiable monitoring, reporting and verification (MRV) standards; and investigating innovative methods to reduce other transaction costs and induce permanence are all necessary steps to enable smallholder farmers’ to earn performance –based payments. Understanding the impacts of carbon markets and other mitigation incentives and interventions on poverty and designing pro-poor institutional arrangements will be important to assure sustainable outcomes. Channeling benefits directly to farmers may be less effective for long-term development than investing proceeds in public infrastructure and educational or health. The feasibility of alternative approaches needs to be tested, and there is a need to learn lessons from schemes for payments for environmental services (PES), Reduced Emissions from Deforestation and Forest Degradation (REDD+), and the Clean Development Mechanism (CDM) to both reform these mechanisms to incorporate agriculture and to build new institutional arrangements.

Both the development of low net emissions pathways and participation of the poor in the carbon finance schemes require a sound technical understanding of the emissions associated with different land uses, farming practices, livelihoods and food system value chains to understand mitigation impacts. While much technical knowledge is available (much of which has been produced by the CGIAR), there is a need to link this knowledge to action on farms and landscapes. Information for developing country contexts is weak. There is a need for simple methodologies and protocols that are cost effective in developing country contexts. The allometric equations for different mitigation practices need to be refined and methods need to be integrated at landscape scales.

These three concerns—low net emissions agricultural development pathways, incentives and institutions for participation by the poor in mitigation markets, and on-farm mitigation—suggest the three research Objectives for this Theme (see below). For each research Objective, the Theme will seek to understand

synergies and trade-offs among poverty, food security and mitigation, while ensuring environmental sustainability to inform policy and decision-making. Synergies among these multiple outcomes are possible; for example, increasing soil organic matter in pastures or crop fields can sequester carbon while improving water retention and soil fertility. Practices that decrease methane production in livestock often result in better feed-use efficiency. Trees on farms can significantly raise biomass production and provide environmental benefits and income diversification. Conservation of coastal mangrove forests captures and stores carbon and also buffers against coastal erosion, storm-surges and impacts of sea-level rise, in addition to enhancing fisheries production and supporting diverse coastal livelihoods. For each Theme, an understanding of power dynamics and gender relations will be necessary to understand who wins and who loses in the food system and across the landscape.

Objectives

The aim of Theme 3 is to identify mitigation strategies that reduce poverty among the rural poor in developing countries. Special attention will be given to the trade-offs and synergies of mitigation, food security and poverty alleviation, while ensuring the health of water, land and ecosystems at different scales (e.g., farm, landscape, seascape, food value chain). The Objectives (Table 15) are to:

- Inform decision makers about the impacts of alternative agricultural development pathways
- Identify institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to reduce GHG emissions and improve livelihoods
- Test and identify desirable on-farm practices and their landscape-level implications

Research approach to international public goods

The Theme will produce the following international public goods (IPGs):

- Analysis and identification of transformative agricultural development pathways that best support mitigation, poverty alleviation and food security
- Enhanced tools, data and analytic capacity in regional and national policy and research organizations to analyze the implications of different development scenarios and mitigation strategies
- Analysis of the gender and social differentiation implications of alternative agricultural pathways and findings built into communications and capacity building activities
- New pro-poor institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to benefit from carbon finance and reduce GHG emissions
- Improved knowledge about the bundling of incentives for mitigation with payments for other environmental services such as water quality and biodiversity
- New methods and systems for GHG monitoring and accounting at farm, landscape and food supply chain levels
- Testing and demonstration, of the feasibility of agricultural mitigation that yields significant benefits for smallholders in developing countries
- Enhanced knowledge about the practice of reduced tillage, agroforestry, community forestry, low input aquaculture, managing aquatic ecosystems, residue management, nutrient management, improved feeding practices and other practices on GHG fluxes at the landscape level
- Scientific knowledge and validated simulation models about the trade-offs and synergies among GHG mitigation, food security, well-being and environmental health for alternative mitigation practices to inform policies and investments

- Platform for exchange and synthesis of information about innovations in agricultural mitigation, including participation of the poor, multi-level governance, landscape-based approaches to mitigation and MRV, low net emissions agricultural practices in different farms and agroecosystems, institutions and incentives for participation by the poor in carbon markets, carbon labeling, and mitigation financing for adaptation
- Analysis of impacts of on-farm and landscape level practices on women and poor farmers

Table 15. Objectives, Outcomes and Outputs for Theme 3 for Phase 1 (Year 1-5) (the full list of milestones is given in Annex 1). Outputs to be achieved by Year 5, Outcomes by Year 10.

Theme 3. Pro-Poor Climate Change Mitigation		
OBJECTIVES	**OUTCOMES**	**OUTPUTS**
Objective 3.1 Inform decision makers about the impacts of alternative agricultural development pathways	Outcome 3.1: Enhanced knowledge about agricultural development pathways that lead to better decisions for climate mitigation, poverty alleviation, food security and environmental health, used by national agencies in at least 20 countries	Output 3.1.1 Analysis of agricultural development pathways and the trade-offs among mitigation, poverty alleviation, food security and environmental health
		Output 3.1.2 Enhanced tools, data and analytic capacity in regional and national policy and research organizations to analyze the implications of different development scenarios and mitigation strategies
		Output 3.1.3 Analysis of the gender and social differentiation implications of alternative agricultural pathways and findings built into communications and capacity building activities
Objective 3.2 Identify institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to reduce GHGs and improve livelihoods	Outcome 3.2: Improved knowledge about incentives and institutional arrangements for mitigation practices by resource-poor smallholders (including farmers' organizations), project developers and policy makers in at least 10 countries	Output 3.2.1 Evidence, analysis and trials to support institutional designs, policy and finance that will deliver benefits to poor farmers and women, and reduce GHG emissions
		Output 3.2.2 Improved capacity to increase the uptake and improve the design of incentives mechanisms and institutional arrangements to deliver benefits to poor farmers and women
Objective 3.3 Test and identify desirable on-farm practices and their landscape-level implications	Outcome 3.3: Key agencies dealing with climate mitigation in at least 10 countries promoting technically and economically feasible agricultural mitigation practices that have co-benefits for resource-poor farmers, particularly vulnerable groups and women	Output 3.3.1 Analysis of mitigation biophysical and socioeconomic feasibility for different agricultural practices and regions, and impacts on emissions, livelihoods and food security
		Output 3.3.2. Methods developed and validated for GHG monitoring and accounting at farm and landscape level to contribute to compliance and voluntary market standards
		Output 3.3.3 Synthesis of understanding about the direct and indirect economic and environmental costs and benefits from agricultural mitigation
		Output 3.3.4 Analysis of impacts of on-farm and landscape level practices on women and poor farmers

New content and innovation

Theme 3 innovates through synthesis linked to global processes and a clear, analytical focus on the trade-offs and synergies between mitigation and food security, poverty alleviation and environmental health (Outputs 3.1.1., 3.3.1). It will bring information on pro-poor mitigation into international and regional climate policy arenas and take carbon finance into new territories (Output 3.2.1). In addition, the three Objectives bring specific innovations to add value:

- Objective 1: Integration of CGIAR (regional- to local-scale data and partners, with social science, economic and applied technical capacities) with ESSP community (global and large-scale regional analyses, largely in the biophysical domain) to enhance research outcomes (e.g. enhance spatially-explicit modeling).
- Objective 2: Involving smallholder farmers and common-pool resource users in institutional design. Identifying incentives for local actors. Identifying multi-scale governance arrangements.
- Objective 3: GHG monitoring systems from ESSP linked to on-farm and landscape-level practices and outcomes. Linking emissions data and technologies to practical mitigation actions. Global comparative work across regions using benchmark sites (agree on common methods, plan for synthesis, trade-off analysis).

Risks

The major risk is that mitigation measures implemented by the rural poor are shown to be neither feasible nor cost-effective in contributing to reducing GHG levels or making a meaningful contribution to livelihoods. Operational and institutional risks include weak extension agencies, lack of viable carbon market, under-supported local capabilities, lack of incentives, complicated or expensive methods required to monitor, and unreliable governance. If policies and incentives do not exist for adopting agricultural mitigation, may be difficult to find partners to test innovations. There is a political risk of mobilization from politicians and civil society organizations against agricultural mitigation by smallholders on grounds of national needs for food security or global social justice. Internally, there are risks associated with management of the Theme across several continents with diverse agro-ecological, socio-economic and political conditions. Silos among the Themes are also a risk; mechanisms to avoid these are discussed under the risks section for Theme 1.

Linkages to other CRPs

The main impact of agricultural practice on carbon sequestration capacity in agricultural landscapes is likely to be via intensification of production that frees up land for restoration and carbon storage in biomass. Therefore a key strategic link will be with CRP6 (Forests and Trees), particularly in terms of work at the landscape level , given the close causal links between agricultural management and availability of land for forest cover, and trees on farms (Table 16). The Theme will also contribute to CRP1, situating mitigation within broader agricultural and other food production systems, CRP5 in its work on soil carbon, and CRP3, including methane reduction from rice systems and intensification of potato production to limit expansion into carbon-rich grasslands. CRP1, CRP3 and CRP5 will be the main CRPs where new mitigation technologies are developed and tested, and CRP7 aims to cofinance the testing of promising technologies in its target regions, where an integrated approach will be taken to adaptation and mitigation strategies, from farmers' field to policy levels. Within this Theme there is some focus on common property institutions for managing landscape emissions – this will link to the work on collective action in CRP2.

Table 16. Interaction of CRP7 Theme 3 with other CRPs (Priority activities are indicated in bold).

CRP7 Objective # and Title	CRP1 – Integrated Systems	CRP2 - Policies, Institutions and Markets	CRP3 – Sustainable Production	CRP4 – Nutrition and Health	CRP5 – Water, Land and Ecosystems	CRP6 – Forests and Trees
3.1 Inform decision makers about the impacts of alternative agricultural development pathways	*In CRP7:* Development of low-carbon ag. scenarios *In CRP1:* Development of farming systems that meet adaptation and intensification requirements *Collaboration:* Research on synergies between adaptation and intensification	*In CRP7:*Life cycle analysis of food supply chains *In CRP2:* Investigation of policy, investment and enabling environment for pro-poor growth *Collaboration:* Trade-offs among mitigation, food security and livelihoods of low emission food supply chain and ag. options.		*In CRP7:* Development of low-carbon ag. scenarios *In CRP4:* Reducing impacts of intensification on human and animal health *Collaboration:* Understanding implications of low-carbon scenarios for human/animal health	*In CRP7:* Assess trade-offs of low emission options on environ. services *In CRP5:* Test tradeoffs of biomass use for food/energy/ feed/soils *Collaboration:* Impacts of soil/water mgmt on mitigation	*In CRP7:* Identifying options for ag. intensification that reduce GHG emissions (e.g. agroforestry). *In CRP6:* Forest-based mitigation (e.g. REDD+). *Collaboration:* Reducing ag. expansion as a driver of deforestation
3.2 Identify institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to reduce GHGs and improve livelihoods	*In CRP7:* Testing the feasibility of payments for mitigation by smallholders. *In CRP1:* Technical development of mitigation options in systems *Collaboration:* Linking incentives to new integrated technical options.	*In CRP7:* Identify institutions/tenure/ incentives that enable smallholders to benefit from C markets; role of collective action in aggregating small-holders into C markets *In CRP2:* Models/ tools to understand institutional, market and policy impacts; work on collective action. *Collaboration:* Inclusion of mitigation in modeling food security impacts	*In CRP7:* Testing the feasibility of payments for mitigation by smallholders on farms *Collaboration:* Linking incentives to new technical options		*In CRP7:* Testing bundling of C payments with other environ-mental service payments. *In CRP5:* Valuing and assessing environmental goods and services; *Collaboration:* Payments for C as incentives for mitigation	*In CRP7:* Identifying opportunities for pro-poor mitigation payment schemes *In CRP6:* Developing institutional arrangements for mitigation payments through agroforestry and forestry *Collaboration:* Testing institutional arrangements.
3.3 Test and identify desirable on-farm practices and their landscape-level implications	*In CRP7:* Testing the economic/ technical feasibility of mitigation options; aggregating at the landscape and farm levels *In CRP1:* Technical development of integrated mitigation options. ***Collaboration:*** **Verifying GHG budgets** ***Cofinancing:*** **Testing technologies**	*In CRP7:* Testing the economic and technical feasibility of mitigation options *In CRP2:* Understanding policy and market impacts on livelihoods *Collaboration:* Assessing role of policies and markets on the feasibility of mitigation options	*In CRP7:* Testing the economic and technical feasibility of mitigation options *In CRP3:* Integration of mitigation options into development of new technologies ***Collaboration:*** **Verifying GHG budgets** ***Cofinancing:*** **Developing technologies to enhance mitigation**		*In CRP7:* Testing potential for water mgmt and soil C-based mitigation options; *In CRP5:* Developing water and soil mgmt options. *Collaboration:* Developing protocols for C measurement. ***Cofinancing:*** **Developing technologies that enhance mitigation from land and**	*In CRP7:* Testing technical/ economic feasibility of mitigation options *In CRP6:* Methodological issues in managing and estimating carbon stocks associated with land use change National-level measurement and monitoring technical and institutional capacity Approaches for reducing

	that enhance mitigation.		**from specific commodities**		**water mgmt**	emissions from forests and peatlands ***Cofinancing:*** **Landscape-based approaches for mitigation and related MRV, including approaches that reduce forest degradation and deforestation**

Regional balance

The Theme will examine the research questions for a) areas where poverty is extreme and scenarios indicate populations to be most vulnerable to climate change (e.g., SSA and South Asia) and b) areas where the highest potential for mitigation and benefits to the rural poor exist (e.g., Southeast Asia, Amazon Basin). The aim is to understand to what extent people in the regions most vulnerable to climate change can contribute to benefits from mitigation, but also to know where investments in mitigation are likely to have the highest impacts. Emphasis will be placed on integrated approaches to mitigation and livelihood systems across landscapes.

Theme 3 Objective 1. Inform decision makers about the impacts of alternative agricultural development pathways

Rationale

The purpose of this Objective is to explore transformational agricultural development pathways that reduce net emissions and to compare their impacts. Increased needs for food production in an era of dwindling natural resources will require strategies for agricultural intensification, while also maintaining and enhancing the flow of ecosystem services from non-agricultural landscapes used by the rural poor (forests, grasslands, coasts and wetlands). The challenge will be how to do this sustainably with positive impacts on food, poverty and the environment. Intensification is associated with higher emissions at the farm level, but not necessarily at landscape level. We need to therefore look across the rural landscape at agriculture, forestry and degraded lands to understand drivers of land-use change. Higher energy costs and sources of energy will require strategies for energy conservation and efficiency that could lead to new configurations of the rural landscape, and new market opportunities. In addition, the push for biofuels could change farming landscapes and have negative impacts on food security. More variable temperatures and precipitation will require adaptation strategies to help farmers adjust to different growing conditions. Forest conservation and REDD+ will have implications for agricultural expansion. Better knowledge is needed about the mitigation implications of these policy choices. Understanding the REDD+ policy development process is likely to yield lessons that can help position agriculture in the global negotiations.

Research questions

- What are the implications of current mitigation policies and programs for poverty alleviation and resilience of the food system at different scales?
- What are alternative trajectories for low net emissions agricultural development and what are their likely impacts on FPE?
- To what extent can current food production be maintained under mitigation scenarios?

- How can agricultural production be intensified sustainably, while also contributing to climate change mitigation across agriculture-forest landscapes?
- What is the carbon footprint of different adaptation strategies?
- What are the synergies and trade-offs between climate change adaptation and mitigation in different regions?
- Where would investments in agriculture yield the greatest returns? (Output 3.1.2, and associated milestones)
- How do different pathways affect marginal and vulnerable populations, including women? (Output 3.1.3 and associated milestones)

Activities

- Develop alternative scenarios (including quantitative and qualitative techniques) and strategies for transformative agricultural mitigation with diverse stakeholders, including organizations advocating for women farmers' well-being. (Output 3.1.1)
- Analyze the potential emissions reductions from technical options compatible with maintaining food supply
- Compare the net emissions of a) agricultural intensification through high input agriculture (water, energy) with conservation agriculture; b) landscapes where intensified agriculture enables more land to be left as forest or degraded land to be restored with high levels of aboveground biomass; and c) non-agricultural landscapes that provide multiple ecosystems services, including food provision – e.g. wetlands, coastal zones, grasslands
- Analyze the mitigation implications of alternative adaptation strategies
- Produce synthesis report comparing results of different pathways
- Support science-policy dialogue on alternative agricultural development futures
- Provide tools, data and analytic capacity in regional and national policy and research organizations to analyze the implications of different development scenarios and mitigation strategies (Output 3.1.2)
- Strengthen capacity of 300 decision makers in use of appropriate tools and data in three initial regions
- Analyze the gender and social differentiation implications of alternative agricultural pathways and findings built into communications and capacity building activities (Output 3.1.3)
- Involve stakeholders and decision makers at multiple levels throughout this process, to share ideas about innovative agricultural development alternatives, scenarios, and consideration of their impacts

Outputs/milestones

Products will include a synthesis of: a) alternative transformative agricultural development pathways that are sustainable and analysis of their trade-offs for food security, poverty, and the environment; b) methods for the multi-stakeholder analysis of alternative agricultural development pathways; and c) products from science-policy dialogue identifying different stakeholder interests. Additional outputs will include capacity enhancement via a series of policy maker and researcher workshops. Results will be shared through websites, policy briefs and scientific articles. Given the need for detailed adaptation information in this Objective, work will be closely conducted with Themes 1 and 2, while some of the needed tools will be

derived from Theme 4.

Partner roles

This Objective will target partners involved in multiple levels of planning of and investment in agricultural development, including the World Bank, IFAD and other donors; agriculture, forestry and land use (AFOLU) ministries and planning agencies; local governments, women's organizations and NGOs; and the private sector, for instance the consortium members of the Sustainable Food Lab and SAI. This research will also work with partners, such as NARES, CARE and Oxfam, to develop practical strategies for farmers' livelihood options, with special attention to women's needs. In addition to the stakeholders participating in the formulation and implementation of this research, results will be shared with stakeholders concerned with agriculture, food security, and climate change, for example, the Subsidiary Body for Scientific and Technological Advice (SBSTA) Working Group and other high-level scientific and policy bodies. Alternative pathways will be integrated with Theme 4's modeling activities.

Impact pathways for target environments

Key users, such as national agencies, will be involved in research, design and implementation to identify plausible scenarios and evaluate desirable development pathways. Results should help decision makers to design well-targeted investments and incentives at nested levels of governance and development intervention. Results will be shared widely with development organizations to shape their strategies for intervention. Capacity will be built via workshops, a global platform and a set of carefully targeted policy communications to national and global policy makers on specific scenarios, trade-offs and options. To bring impacts on a greater scale, the focus will be on communications and interactions with key decision makers in global and regional public bodies and large-scale development NGOs, with outreach beyond the agriculture sector. Targeted information will also be delivered to intellectual leaders in the climate change arena (e.g. Potsdam Institute for Climate Impact Research or PIK, Tyndall, etc.) on specific topics.

Theme 3 Objective 2. Identify institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to reduce GHGs and improve livelihoods

Rationale

A number of finance mechanisms and incentives exist or are likely to be developed to support agricultural mitigation. In addition, incentive systems developed for REDD+ may be able to drive behaviors in agriculture. To what extent can smallholder farmers in developing countries benefit from these incentive mechanisms, and to what extent will these incentives be effective and efficient in achieving mitigation? Carbon markets exist and offer real benefits, yet smallholders and those who depend on community-managed forests and other carbon-capturing ecosystems have not been able to participate effectively in Clean Development Mechanisms (CDMs) or voluntary markets to date, due to high transaction costs, a lack of information and a lack of interest among project developers. Consumers are increasingly interested in low net emissions food and may be willing to pay a premium, however the standards and benefits available to farmers remain unclear. The implications of financial returns for carbon per unit land, carbon per unit food product, and carbon per organizational unit responsible for the mitigation activity need to be tested for their impacts on incentives and subsequent impacts on food security, poverty reduction and the environment. Similarly, practice-based versus output-based monitoring need to be tested for their economic feasibility and trade-offs between cost and robustness in the measurement of GHGs. Experience with payments for environmental services suggests that trade-offs are likely between mitigation effectiveness and poverty alleviation. The distribution of projects and Certified Emission Reductions (CERs) has been geographically uneven, and weak collective action has allowed the wealthiest to accumulate the benefits. Resource tenure may also be a limiting factor. The most likely certain incentives will be to incorporate carbon benefits into existing promising livelihood options, making carbon a co-benefit.

This Objective will investigate which institutional arrangements and incentives are best suited to achieving positive impacts on food security, poverty and the environment. Important institutional arrangements and incentives to test will include how to: a) group farmers together so that viable quantities of carbon can be sold in the carbon market; b) ensure that benefits are accessible and shared fairly among the rural poor who supply environmental services; c) provide sufficient incentives to adopt sustainable agriculture, livestock, and land and coastal management; and d) create links across multiple levels of governance to ensure coordinated policy action and nested levels of incentives for livelihood and food resilience.

Research questions

- What incentives, institutions, market-based mechanisms and policies at project and national scales would enable smallholder farmers in developing countries to produce verifiable carbon credits and improve their livelihoods, including (i) carbon as co-benefit to more productive agricultural practices, (ii) carbon markets, (iii) corporate social responsibility technical assistance, (iv) carbon labeling
- What lessons can be learned from REDD+, CDM and PES? What lessons can be learned about benefit distribution from microfinance experiences?
- How can the poor, especially women, participate in the design of and gain better access to the benefits available from carbon finance?
- What are promising incentives and institutions for integrative practices such as conservation agriculture, sustainable land management and agroforestry?
- What underlying factors affect sustainable land management practices, as practices most likely to yield both food security and mitigation?

Activities

- Identify promising incentives, finance instruments, policies and institutional arrangements
- Organize expert consultation to identify the design and monitoring requirements of finance and institutional arrangements to better benefit poor farmers and women
- Pilot institutional arrangements, incentive mechanisms and MRV protocols for reduced emissions and carbon sequestration from agriculture, including both potential project developers and aggregators (including supermarket supply chains, producers of high-value export crops, NGOs and farmers' organizations) as aggregators and disseminators of management system changes. Test in areas where mitigation potential may be low, but local farmers are vulnerable and poor (e.g., semi-arid areas of Africa and India). Compare with areas where mitigation potentials are high (e.g., the Amazon Basin and Southeast Asia)
- Analyze underlying factors affecting mitigation for sustainable land management practices
- Assess barriers to entry and factors affecting benefits from carbon finance for different social groups, including women, and the range of emerging institutional arrangements and incentives for better inclusion and benefits
- Develop methods and build capacity to understand socioeconomic baseline conditions where farmers are participating in the carbon market, and assess the distribution of benefits over time

Outputs/milestones

Key products will be research outputs that identify finance, incentives, policies and institutional arrangements that can improve access of the poor to mitigation benefits, with empirical indications of the impacts of these benefits on poverty alleviation and GHG emissions. Alongside research outputs will be

targeted communications products for the strategic partners named above, and capacity enhancement events and workshops to increase the uptake and improve the design of incentive mechanisms and institutional arrangements. Results will be shared through websites, policy briefs and scientific articles.

Partner roles

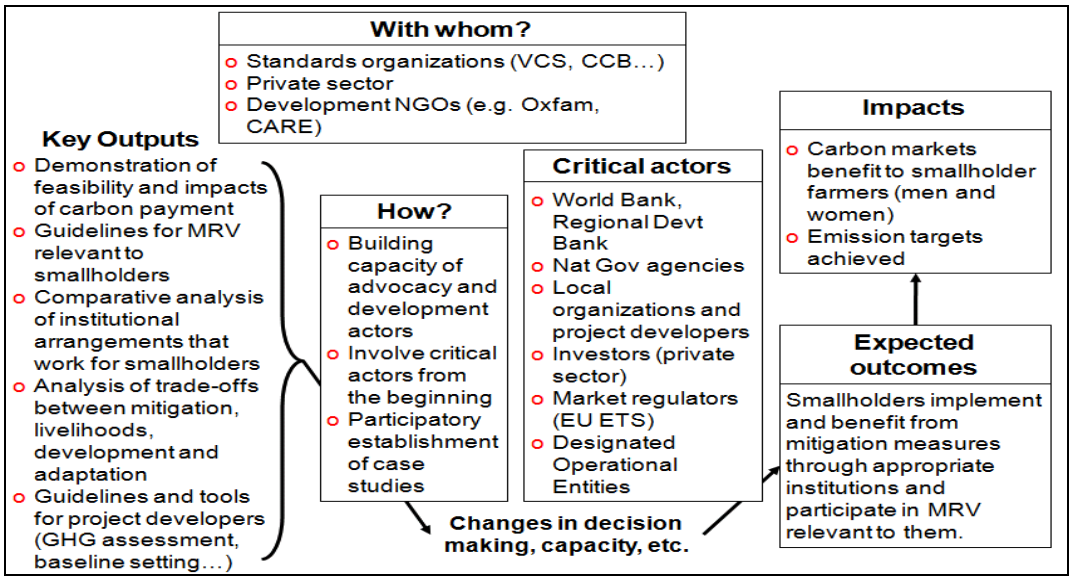
This Objective will work closely with project developers, the World Bank, regional development banks, local and project investors, farmers' organizations, and intermediaries such as the Nature Conservation Research Center (Ghana), BRAC (Bangladesh and Uganda) and Pradan (India), to develop and test innovative institutional arrangements and incentive mechanisms. Partners for research and policy impact will include international and national policy research organisations such as EcoAgriculture and Instituto de Pesquisa Ambiental da Amazônia (IPAM). Capacity enhancement will focus on development of understanding of carbon markets, and negotiation and advocacy skills for farmers' interests, including advocacy for women's interests. We will work with the private sector to identify consumer demand, standards for carbon labeling, and lifecycle analyses of food products. The intended users of this research include the World Bank Biocarbon Fund, the Voluntary Carbon Standard, the Climate, Community and Biodiversity Alliance and the Sustainable Food Lab. Some aspects of this work will be conducted through case studies where a range of partners will be engaged for different roles. For example, a case study from Kenya includes: Care International, Care Kenya, VI Agroforestry, AATF, EAFF, CAMCO (carbon financing consulting firm), Equity Bank.

Impact pathways for target environments

This Objective will increase carbon market opportunities for small-scale producers and reduce transaction costs by working with three sets of participants in the carbon value chain: 1) aggregator organizations (producer groups, farmers' organizations, natural resource management associations, etc.); 2) intermediary organizations; and 3) private sector players in the voluntary carbon market. Impacts will be enhanced by use of carbon market list serves and forums and regional policy forums, as well as regional farmer associations to reach broader research and practitioner audiences. Targeting specific groups, particularly women farmers and farmers in specific geographic localities, will enable more effective outcomes for poverty alleviation.

An example impact pathway for the global level is shown in Figure 12. Working with farmers' organizations, government agencies, intermediaries and the private sector to market the 'bundles of environment services' that are delivered by poor rural households will increase the reach of these products among the rural poor.

Figure 12. Impact pathway for influencing how carbon markets serve smallholder farmers. The key outputs listed would be derived largely from Theme 3, Objective 3, but also from other Objectives.



Theme 3 Objective 3: Test and identify desirable on-farm practices and their landscape-level implications

Rationale

This Objective investigates the potential for mitigation accruing from agricultural practices and tests the feasibility of using specific mitigation practices on farms and landscapes from the farmers' perspective. The IPCC's AR4 is ambivalent on the potential of agricultural sequestration, largely because different practices vary in outcome. For example, some studies show that reduced or no-till agriculture does not always result in soil carbon gains in locations that already have high soil carbon content, and that the net effects of reduced or no-till practices on N_2O are inconsistent, depending more on soil and climatic conditions. Furthermore, there may be either synergies or trade-offs for local livelihoods, landscape-level environmental sustainability, and wider-scale knock-on effects. Thus more research is needed to establish the actual impacts of what appeared to be technically desirable on-farm practices. Secondly, it is important to assess the full economic costs and benefits of agricultural mitigation. Many sustainable land management (SLM) practices are beneficial for both agricultural adaptation and mitigation. Furthermore, the mitigation value of agricultural practices may be less in terms of direct impacts on GHG emissions and much more in terms of indirect impacts at the landscape level, for example agricultural intensification that frees up land for forest conservation or grasslands. Thus, costs and benefits need to be assessed at the local, national, and global levels. Even where data exist, effort will be needed to link this data to mitigation actions through stakeholder involvement.

Standards for monitoring and accounting of GHGs in smallholder systems and across agriculture-forest landscapes in developing countries also need to be developed. These will need to be effective and efficient. Capacity building will be coordinated with forest-related efforts to develop integrated Agriculture, Forestry and Land Use Change (AFOLU) approaches.

Research questions

- What is the technical and economic feasibility of agriculturally based mitigation among smallholders in developing countries?
- What are the impacts of agriculturally based mitigation on smallholder poverty, food security and on greenhouse gas emissions?

- What is the GHG abatement potential (full net–net GHG accounting) of promising carbon sequestration and non-CO_2 GHG emissions reduction technologies and management practices?
- What technologies and management systems can deliver GHG sequestration and emissions reduction cost-effectively with maximum benefits to poverty alleviation, food security and environmental health at the landscape level?
- How do different technologies and management practices affect men and women, or the poor and larger farmers differently? (Output 3.3.4)
- What accounting methods would provide a robust and cost-effective standard for monitoring, reporting and verification of GHGs in rural landscapes?
- What kind of stakeholder involvement and communication is necessary to link emissions knowledge to mitigation actions? (Linked to Output 4.1.3)

Activities

- Test and identify the carbon sequestration and GHG abatement potential of a variety of natural resource management approaches in 9 benchmark sites
- . Target practices where CRP7 can contribute to possible win–win outcomes through new partnerships and novel analytical techniques. These practices may include livestock management, agroforestry, fertilizer management and reduced tillage, among others
- Measure GHG fluxes, working with partners in the Global Environment Change (GEC) community, and assess impacts on poverty alleviation, food security and environmental health at multiple scales
- Develop and test accounting methods that provide a robust and cost-effective standard for monitoring, reporting and verification of GHGs in rural landscapes and are appropriate for small holders and integrated farming systems (agricultural systems and agricultural-forest landscapes for terrestrial carbon). (Output 3.3.2 and associated milestones)
- Assess technical and institutional capacity for national-level measurement and monitoring
- Analyze issues in estimating and managing carbon stocks in rural landscapes through participatory, community-based monitoring
- Develop training material and online tutorials on estimating and managing carbon stock
- Develop project design and monitoring guidelines for smallholder agriculture in developing countries produced and contributing to global standards
- Organize workshop with standard-setting bodies (VCS, ACR, etc) to share proposed methods standards for smallholder agriculture in developing countries
- Use field results and simulation models to identify the technologies and management systems that best deliver bundles of benefits at the household and landscape levels for both men and women. Analytical approaches may include a range of technology assessment methods, including economic surplus analyses that simulate different market conditions, technology adoption processes, research spillovers, and trade policy scenarios within a global partial equilibrium model.
- Organize science workshop and synthesis report on impact of different approaches and potential for synergies to identify strategies for implementation
- Analyze findings from field trials on social differentiation impacts of mitigation options initiated in 9 CCAFS benchmark sites
- Organize workshop for national agencies to review mitigation options and their impact
- Work with field-based partners to develop user-friendly ways of communicating data that farmers

and decision makers can use to change their land-use practices and create a global communication platform for exchange and synthesis of information about innovations in agricultural mitigation.

Outputs/milestones

This Objective will deliver an evaluation of potential direct and indirect economic and environmental costs and benefits from agricultural and rural landscape mitigation, and identification of technologies and management systems that can deliver agricultural mitigation and rural landscape options. A wide range of options will be tested, ranging from those that increase soil carbon to water management tools for reduction of GHG emissions from wetlands and tropical reservoirs. A PhD student network will be formed to support this work and facilitate capacity enhancement. In addition, this Objective has three methodological outputs: a) developing the data and methods to for GHG monitoring and accounting at farm and landscape level to contribute to the development of global GHG standards; b) validating simulation models that can be used to identify the mitigation potential of different options; and c) methods for assessing social impacts and trade-offs. Results will be shared through websites, policy briefs and scientific articles.

Partner roles

The CGIAR and FAO with local partners will establish a complementary set of agricultural mitigation sites in representative agroecosystems. Common methods will be employed to enable comparability. The research will integrate and add value to CG expertise in different agricultural sectors (e.g., livestock, rice, irrigation and water, aquaculture, fruit crops, staple cereals, agroforestry, forestry). The research will link local-level emissions data and land use change emissions to the Land Use Change research planned by the Global Carbon Project. On-farm testing, in collaboration with CRP1, will take place with local level partners connected to international entities that can scale-up impacts, such as EcoAgriculture and CARE. National planning and AFOLU agencies will be primary advisors and direct beneficiaries of the research, as will international development agencies.

Impact pathways for target environments

The expected impact is that agricultural development will occur in a sustainable fashion that addresses food needs, reduces poverty and results in climate change mitigation. Research results will be shared by involving research users in generating information about likely and alternative agricultural development options, as well as through annual workshops and the final workshop for policy makers. The final workshop will be targeted for wide participation and media coverage, materials will be available on the project website (and that of partners), and policy briefs and briefing notes will be designed to communicate ideas in the most efficient way. The longer technical reports, workshop proceedings and research reports will be targeted to appropriate journals, conferences and general meetings of agricultural scientists, agricultural mitigation fora, and policymakers, for maximum exposure.

Theme 4: Integration for Decision Making

Rationale

The goal of achieving sustainable food security is already under unprecedented pressure from population and income growth. Climate change will exacerbate the challenge, with the potential for highly heterogeneous impacts across space and time. At the same time, interactions between climate change and other drivers of change in agricultural systems (and development generally) remain largely unknown. While broad trends may be discernible, more location-specific detail is required about the impacts of climate

change (positive and negative) on food security and the preservation of ecosystem services needed for the long-term sustainability of global agriculture, effects on livelihoods, and options that increase the well-being of people dependent on natural resources.

The research undertaken in this Theme provides an analytical and diagnostic framework for the whole of CRP7 that is grounded in the policy environment, incorporates biophysical effects, quantifies uncertainty where possible, and ensures effective engagement of rural communities and institutional and policy stakeholders. It will address the need for methods, models, databases and system metrics aimed at two broad challenges: a) enhanced assessment of the likely impacts of climate change on agricultural systems, particularly in the context of other social and economic changes; and b) improved methodologies to assess the likely impacts of different policy and program interventions to foster adaptation and mitigation in terms of poverty alleviation, food security and environmental health. To address specific climate challenges with best-bet options, policy makers need quantified assessments of impacts and the consequences of policy changes. While much is known about some components, there are gaps and uncertainties in the knowledge, processes, model capacity and databases needed for these analyses. The work proposed here is designed to address these gaps, many of which can be filled uniquely by CGIAR researchers and the ESSP. The integrated framework will also form the basis for a monitoring and evaluation system to allow *ex post* impact assessment of research to be carried out in relation to a baseline set of key indicators at study sites.

This Theme also provides an integrative function for CRP7 stakeholder engagement from local to global levels, both in terms of setting research agendas and providing forums for discussing emerging results and options for action. In addition, Theme 4 will pull together the information at multiple scales that is needed to address the research questions of Themes 1 to 3 of CRP7. Climate and socio-economic outputs from global models will need to be downscaled to the local level to allow appropriate analysis of options to be carried out. At the same time, research results from study sites will need to be upscaled to broader, regional and cross-regional domains, so that research impacts can be appropriately magnified. The work in this Theme will be both demand and supply-driven; demand-driven through the needs identified by the place-based Themes and other CRPs, and supply driven by the early recognition of challenges that comes with sophisticated forward looking analyses that are supported by novel data collection and fusion.

Objectives

Theme 4 provides a critical integrative function for CRP7. In response to demand from policy makers in countries in the regions and at global level, it will generate standardized global datasets with location-specific elements through a multi-site data collection effort, collate and disseminate existing and new global datasets and undertake scenario research to provide plausible futures and guide the development of new technologies and policies in the other Themes of CRP7. It will also create mechanisms to integrate work conducted by Themes 1–3 at regional and global levels and act as a major conduit for two-way information flow between CGIAR institutions, the ESSP and other international research organizations. Finally, it will provide methods to involve stakeholders more in agenda setting for Themes 1–3 and communicate their individual and integrated outputs. Its research Objectives (Table 17) are to:

- Explore and jointly apply approaches and methods that enhance knowledge to action linkages with a wide range of partners at local, regional and global levels
- Assemble data and tools for analysis and planning;
- Refine frameworks for policy analysis.

Table 17. Objectives, Outcomes and Outputs for Theme 4 for Phase 1 (Year 1-5) (the full list of milestones is given in Annex 1). Outputs to be achieved by Year 5, Outcomes by Year 10.

Theme 4. Integration for Decision Making		
OBJECTIVES	**OUTCOMES**	**OUTPUTS**
Objective 4.1 Explore and jointly apply approaches and methods that enhance knowledge to action linkages with a wide range of partners at local, regional and global levels	Outcome 4.1 Appropriate adaptation and mitigation strategies mainstreamed into national policies in at least 20 countries, in the development plans of at least five economic areas (e.g. ECOWAS, EAC, South Asia) covering each of the target regions, and in the key global processes related to food security and climate change	Output 4.1.1 For each region, coherent and plausible futures scenarios to 2030 and looking out to 2050 that examine potential development outcomes under a changing climate and assumptions of differing pathways of economic development; developed for the first time in a participative manner with a diverse team of regional stakeholders
		Output 4.1.2 Global and regional maps, tables and associated syntheses, showing current vulnerable agricultural and fishing populations in relation to food security to 2030 and 2050
		Output 4.1.3 Evidence on, testing and communication of, successful strategies, approaches, policies, and investments contributing to improved science-informed CC-ag development-food security policies and decision making
		Output 4.1.4 Analyses providing evidence of the benefits of, strategies for, and enhanced regional capacity in, gender and pro-poor climate change research approaches that will increase the likelihood that CCAFS-related research will benefit women and other vulnerable as well as socially differentiated groups
		Output 4.1.5 Mainstreaming adaptation strategies into national policies, agricultural development plans, and key regional and global processes related to agriculture and rural development, food security and climate change
		Output 4.1.6 Building of capacities to engage in global policy making processes and adopt risk management strategies
Objective 4.2 Assemble data and tools for analysis and planning	Outcome 4.2 Improved frameworks, databases and methods for planning responses to climate change used by national agencies in at least 20 countries and by at least 10 key international and regional agencies	Output 4.2.1 Integrated assessment framework, toolkits and databases to assess climate change impacts on agricultural systems and their supporting natural resources
		Output 4.2.2. Socially-differentiated decision aids and information developed and communicated for different stakeholders
Objective 4.3 Refine frameworks for policy analysis	Outcome 4.3 New knowledge on how alternative policy and program options impact agriculture and food security under climate change incorporated into strategy development by national agencies in at least 20 countries and by at least 10 key international and regional agencies	Output 4.3.1 Tools developed and climate change impacts assessed at global and regional levels on agricultural systems (producers, consumers, natural resources), national/regional economies, and international transactions
		Output 4.3.2 Likely effects of specific adaptation and mitigation options, national policies (natural resource, trade, macroeconomic, international agreements) analyzed
		Output 4.3.3 Differential impact on social groups (gender, livelihood category etc) of climate change adaptation and mitigation options identified, evaluated and communicated
		Output 4.3.4 Likely effects of specific adaptation and mitigation options and national policies (including for socially differential groups) communicated to key local, national and regional agencies and stakeholders

Research approach to international public goods

The Theme will produce the following IPGs:

- An enhanced analytical framework, drawing upon research and products available at CG centers such as IFPRI and ILRI and from selected ESSP researchers, that provides a suite of tools and infrastructure that enable stakeholders to understand, diagnose and communicate vulnerability as well as target and assess the likely impacts of adaptation, mitigation and policy interventions on socially-differentiated groups. Particular focuses will be on the development of *ex ante* impact assessment tools at different levels, and on the development and use of decision aids and information for different groups of stakeholders. A "farm vulnerability" index will be devised to complement the UN's Human Development Index, so as to focus attention on the farming sector.
- Globally consistent, multi-site and publicly accessible data sets on climate change, current agricultural practices, performance characteristics of existing plant and animal germplasm and management practices, and related variables needed for assessing climate change impacts and opportunities for cost-effective adaptation and mitigation, including vulnerable populations and probabilistic projections of climate impacts under a set of different development scenarios.
- Evidence of feasibility, acceptability and impacts (related to food security, livelihoods and the environment) of comprehensive climate change adaptation strategies and mitigation opportunities locally and regionally.

New content and innovation

The work proposed in this Theme has several innovative features:

- It will provide a broad food-security perspective on vulnerability to climate change and other drivers; something that almost all global assessments and scenario development exercises conducted to date have not addressed fully (Wood et al., 2010). The food system perspective will also foster the transition within the CGIAR from a commodity focus to a more integrated approach.
- The work will mainstream a dynamic approach to vulnerability within the CGIAR through the use of scenario development at global and regional levels and modeling to project possible future vulnerability in relation to plausible storylines of changes in multiple drivers, including feedback loops from proposed interventions.
- It will contribute to an integrated, landscape approach to mitigation across agriculture and forestry
- The work will build a much stronger partnership between the CGIAR and the global change communities worldwide, providing them with common research goals.

Risks

The success of capacity enhancement and uptake of the research will depend on continued global political attention to the impacts of climate change on agriculture and food security. The research proposed in the Theme is highly integrative – across the other Themes of the CRP, across the CRPs as a whole, across disciplines and across research communities – and as such will require strong relationships, particularly in the formulation of mutually agreeable research agendas, as well as good access to data, tools and methods. Silos among the Themes are also a risk; mechanisms to avoid these are discussed under the risks section for Theme 1.

Regional balance

Several aspects of the research in the Theme are of a generic nature, and will draw on data and skills worldwide. One of the early outputs is to identify 'hotspots' of vulnerability beyond the initial three target

regions, where development, demonstration and evaluation of adaptation and mitigation pathways will be addressed in particular agro-ecological and socio-economic contexts. The baseline indicator data collection will occur in the target regions, and the scenarios work will also be focused in the target regions.

Linkages to other CRPs

This Theme contributes large-scale research on climate change vulnerability and the modeling of impacts, which will set the framework for work in all the other CRPs (Table 18). The Objective on linking knowledge with action provides platforms for other CRPs to interface with the ESSP and the wider climate change community. The focus of Theme 4 on vulnerability and downscaled assessments of the impacts of climate change will create and necessitate strong links with CRP1 (Integrated agricultural systems for the poor and vulnerable). Modelling and decision-support tools developed within this Theme will be tested and validated within CRP1, CRP3, CRP5 and CRP6. This Theme and CRP2 (Policies, institutions, and markets for enabling agricultural incomes for the poor) will share *ex ante* assessment of policies and programs (with this Theme particularly focused on such assessments in the context of climate change). The scenarios of intensification and disease futures for CRP4 will be informed by the climate and development scenarios evaluated in this Theme.

Table 18. Interaction of CRP7 Theme 4 with other CRPs (Priority activities are indicated in bold).

CRP7 Objective # and Title	CRP1 – Integrated Systems	CRP2 - Policies, Institutions and Markets	CRP3 – Sustainable Production	CRP4 – Nutrition and Health	CRP5 – Water, Land and Ecosystems	CRP6 – Forests and Trees
4.1 Linking Knowledge with Action	*In CRP7:* Vulnerability assessments for targeting; Mainstreaming CC strategies into key regional and global food security processes; **Access to key stakeholders in the climate community**	*In CRP7:* Identify institutional arrangements that benefit smallholders and women; **Access to key stakeholders in the climate community.** *In CRP2:* Identify innovative governance arrangements to strengthen property rights, assets, rural services *Collaboration:* Institutional, collective action and boundary spanning approaches to science into action	*In CRP7:* Developing plausible future food security scenarios under climate change; **Access to key stakeholders in the climate community; Regional scenarios teams working with policymakers.** *In MP3:* Development of plausible scenarios of crop production in target regions derived from biophysical and socio-economic settings *Collaboration:* Sharing of data and results relevant to future scenarios.	*In CRP7:* Enhanced regional capacity in gender and climate change research; **Access to key stakeholders in the climate community.** *In CRP4:* Mitigating impacts of intensification on human/ animal health *Collaboration:* Scenarios of intensification and disease futures	*In CRP7:* Developing plausible future food security scenarios under climate change; **Access to key stakeholders in the climate community.** *Collaboration:* Boundary spanning approaches that enhance uptake of improved NRM	*In CRP7*: Vulnerability assessments for targeting; Mainstreaming CC strategies into key regional and global food security processes

4.2 Assembling data and tools for analysis and planning	*In CRP7:* **Setting the climate change context.** Vulnerability analyses; **down-scaled climate change info;** tools for ex-ante analysis. *In CRP1:* Methods and tools for analysis / improvement of agricultural systems in target regions *Collaboration:* Data assembly, scoping studies on, and testing, tools and methods	*In CRP7:* **Setting the climate change context.** Develop tools for ex-ante impact assessment, at multiple levels *In CRP2:* Strengthen capacity in ex-ante impact assessment, priority setting, and targeting *Collaboration:* Sharing approaches and datasets	*In CRP7:* **Setting the climate change context.** Large scale research on climate change vulnerability and priority setting; **downscaled climate change info** *In CRP3:* Data on status and trends of crops etc.; crop simulation models and scenarios on crop technology development *Collaboration:* Developing tools and data sharing; Training on data and modelling approaches to crop, livestock and fish performance	*In CRP7:* **Setting the climate change context.** Quantification of sustainable development pathways *In CRP4:* Global assessment of agriculture-associated disease *Collaboration:* Evaluation of agriculture-associated disease under different development pathways	*In CRP7:* **Setting the climate change context. Downscaled climate change info.** Tools for ex-ante assessment of adaptation options. *In CRP5:* Development of soil/water/eco-system info systems *Collaboration:* Water basin hydrology and ag. water utilization modelling	*In CRP7*: **Down-scaled climate change info**. Tools for ex-ante assess-ment of adaptation options. In *CRP6:* Develop-ment of landscape models
4.3 Refining frameworks for policy analysis		*In CRP7:* Climate change as an additional challenge to designing pro-poor technologies. *In CRP2:* Research to assess most effective policy and program interventions. *Collaboration:* Better incorporation of climate change impacts on productivity into models.	*In CRP7:* Assessing the policy and program environment of potential crop and farming system innovations to climate change *In CRP3:* Development of new technologies *Collaboration:* Potential new crop, livestock and aquaculture fish characteristics and evaluation of policies to develop and disseminate		*In CRP7:* Assess policy reforms to enhance land/ Water mgmt under climate change *In CRP5:* Technologies and data on sustainable land/ water mgmt *Collaboration:* Policy options for improving soil mgmt under climate change; Co-design of water-access policies to address water stresses	

Theme 4 Objective 1: Linking knowledge with action

Rationale and research questions

Food security in the coming decades will be threatened by a number of factors whose future trends are uncertain. These uncertainties pose major challenges to research, to policy formulation and to resource management related to food security. Agricultural production and resource management under climate change demand new ways of thinking about risk, about vulnerability and about resilience. It requires us to question what is needed in terms of policies, institutions and governance to support these changes, rather

than to maintain the status quo. A powerful approach to help decision makers start addressing these transformational challenges is to run **participatory scenarios exercises**. These help to enhance decision making under uncertainty through the development of a structured range of plausible futures within which analyses of policy and technical interventions can be undertaken. They also provide an effective mechanism for involving a range of both public and private sector stakeholders and for facilitating debate and communication among them. The whole process of stakeholder engagement and debate about plausible futures will contribute to CRP7's foresight analysis and feed into priority setting (see "Foresight, priority setting and impact assessment"). This Objective will be conducted at local, regional and global levels. At the regional level, qualitative scenarios or 'storylines' will be developed by regional teams trained in this approach, that was developed and before now used only at the global level. These teams will then be given access to e initial quantitative global scenarios developed by CG researchers and others to enrich them further through empowering the regional storyline teams, and linking them to ongoing global scenarios model results and processes in an iterative process, by Year 3 the result will be more relevant qualitative scenarios where internal plausibility is maintained with quantitative modeling, and the global modeling will, for the first time, more appropriately deal with strategic regional food security, agricultural development and climate-related issues as defined by key regional players.

Tools for linking knowledge with action are increasingly tested and applied by interdisciplinary, multi-organizational research-for-development teams (Kristjanson et al., 2009). Examples include participative mapping of impact pathways (Douthwaite et al., 2007, Reid et al., 2009), negotiation tools informed by research (van Noordwijk et al., 2001), social network analysis, innovation histories, cross-country analyses and game-theory modeling (Spielman et al., 2009). But there is much yet to discover about means to improve the links between knowledge and action, and, critically for climate change approaches, about the interactive linkages between science and policy. We know that strategic and participatory engagement, communication and capacity building efforts, particularly those aimed at 'spanning boundaries' between the diverse actors and institutions key to farming household risk management, adaptation and mitigation measures, are critical (Clark et al., 2010). Efforts aimed at increasing the knowledge and capacities of farmers' organizations to innovate, along with strengthening of networks and alliances to support, document and share lessons on farmer-led innovation are also needed. Research as to the effectiveness of different ways of communicating uncertainty around climate predictions to different audiences, and testing of new (e.g. cell phone-based) communication methods for communicating improved weather information to smallholders, will help ensure CRP7 science translates into action. Other needs include innovative engagement and communication strategies to ensure that scientific results inform international policy processes (e.g. UNFCCC), regional (e.g. adaptation funds) and national processes (e.g. NAPAs and NAMAs) – these different audiences will likely require different strategies to elicit effective responses.

This Objective will provide an integrating forum for the intersection of all the work in CRP7, from regional research priority setting to bringing key outputs from CRP7 into the stakeholder processes. The means of engagement, and not just the development of tools, will be key to nurturing an on-going and evolving dialogue with a range of stakeholders. Interfacing closely with policy processes and identifying policy 'windows of opportunity' at global and regional levels and in the countries selected for detailed work will be key impact strategies. In so doing this Objective will work closely with Objective 3.

Research questions include:

- What are the plausible futures encompassing interactions between changes in climate and other key drivers of agricultural systems and food security?
- What are the key factors causing vulnerability to climate change and climate variability among agricultural and food systems and the people who depend on them, and how may this vulnerability change in the future?
- What boundary-spanning objects and actions (e.g. partnership-building and policy engagement processes, communications and capacity-building approaches) can improve the likelihood that CCAFS-generated knowledge will result in actions that contribute to sustainable poverty reduction?

- What are the main options to deal with climate change impacts, where are the key policy opportunities, and who are the key decision makers?

Activities

A major activity under this Objective will be the development of a structured range of plausible futures within which analyses of policy and technical interventions can be undertaken. Similar work will be conducted at more local levels (e.g. within the benchmark sites or at national levels as part of national processes). Here the emphasis will be on understanding the key issues faced by farmers in relation to climate change and understanding what options are feasible in specific national contexts. Capacity enhancement and empowerment of local and regional scenarios teams is key, as CRP7 will facilitate their engagement in key global processes (e.g. those driven by the UNFCCC, IPCC and G8).

Another activity will be to carry out multi-scale vulnerability assessments, building on what has already been done and identifying who is vulnerable and why, what are existing practices, and how vulnerability and food security may change in the future in relation to multiple stressors, including climate change. These will be valuable for improved targeting of research for all the CRP's, and considerable efforts will go into widely communicating these vulnerability maps and analyses and engaging with policymakers at different levels (local, regional, national and international) so that they are both useful to, and used in, national and regional agricultural development strategies (e.g. EAC, ECOWAS, COMESA, CAADP).

Outputs/milestones

- A plausible set of scenarios to 2030 and 2050 for each target region and globally, which examines potential development under a changing climate and differing pathways of economic development;
- Enhanced regional capacity to engage with key policy makers and use CCAFS research outputs to inform national adaptation and mitigation plans, regional agricultural development and food security strategies, as well as to engage with, and inform, global climate and food security processes as to critical regional interests/concerns. Regional capacity enhanced and gender-responsive research on regionally-identified climate adaptation and mitigation priorities undertaken in 3 regions.
- Maps, reports and policy briefs about vulnerability that can be used to inform the targeting of research activities in the other Themes of CRP7 and in other CRPs;
- Major events at global level linked to products that are targeted to ongoing international processes (Agriculture and Rural Development Day at COP16 and COP17; targeted side events to help develop the UNFCCC workplan for agriculture).

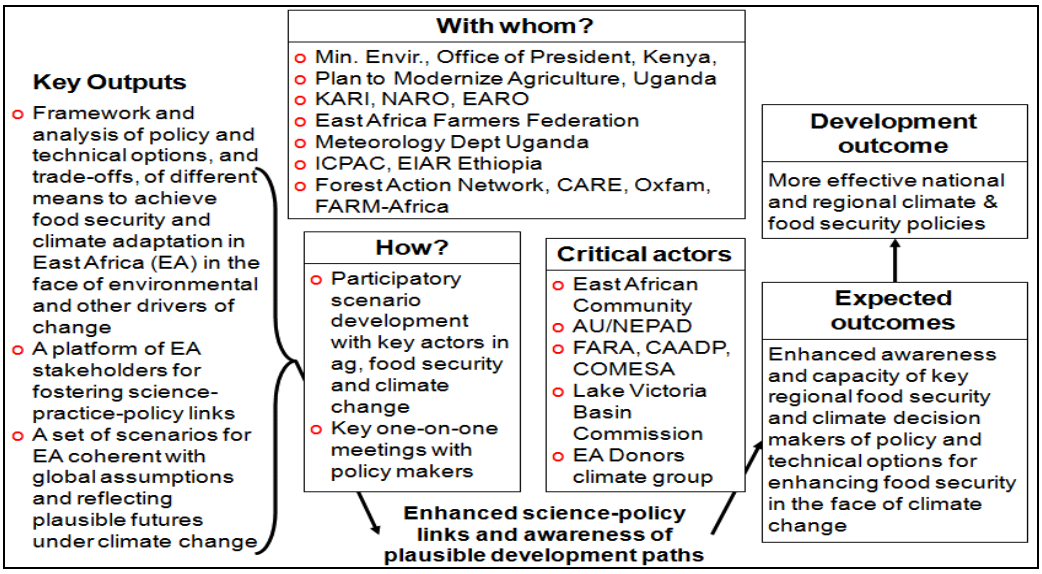
Partner roles

The scenario and vulnerability mapping activities will be conducted working closely with the ESSP and numerous regional and national stakeholders in each of the target regions. These will form an important aspect of communications and capacity enhancement and will help build regional science–policy teams who can take CRP7 outputs forward. At the global level, key partners initially are the Canadian International Development Agency (CIDA), IDRC, the UK's Department for International Development (DFID), the European Union (EU), FAO, IFAD, the Global Forum on Agricultural Research (GFAR), the Global Donor Platform for Rural Development, the International Federation of Agricultural Producers (IFAP) and the World Bank.

Impact pathways for target environments

By creating accessible yet scientifically robust storylines, the scenarios will create a platform for CRP7 to engage with policy-makers, development agencies and business strategists in the regions (Figure 13). The scenarios will form the basis for vulnerability and trade-off analyses throughout CRP7 and will guide the targeting and development of appropriate adaptation and mitigation strategies in the target regions. As such it will use the tools developed under Objective 2, including the *ex ante* assessment tools. The work on vulnerability will be conducted with the key actors that drive adaptation investments, so that the approach achieves widespread acceptance among such actors. The results will be displayed using innovative communication tools linked to Google Maps. It is expected that the results will help drive future investments in terms of their focusing on climate change "hotspots".

Figure 13. Impact pathway for enhancing awareness and capacity about regional options for agriculture under climate change, through participatory scenario development: An example for the East Africa region. The key outputs listed would be derived largely from Theme 4, Objective 1, but would rely on Outputs from all other Objectives



Theme 4 Objective 2: Assembling data and tools for analysis and planning

Rationale and research questions

No comprehensive framework currently exists to analyze the implications, both positive and negative, of human responses to the climate challenge in terms of regional food security and the preservation of important ecosystem services, upon which the long-term sustainability of global agriculture must be based. There are key gaps and uncertainties in knowledge concerning some processes, in model capacity, and in appropriate high-resolution databases. Just two examples of many are the large uncertainties that surround CO_2 effects on crop growth in developing countries, and the impacts of a changing climate on rangelands and livestock productivity. The work under this Objective will address some of these gaps and will be focused particularly on data and tools for genuinely integrative ex ante assessment, thereby combining adaptation and mitigation agendas, and exploring synergies and trade-offs among outcome targets. These assessments will be done at different scales. For example, the IMPACT model, initially developed at IFPRI and now being enhanced with work at several other centers, will be applied at the global and regional levels to assess the impacts of different human interventions to address the climate change challenge. Different sets of tools will be developed and applied to evaluate impacts at household and landscape levels, to assess viability and performance of different adaptation and mitigation options, which can subsequently be tested in farmers' fields. Key research questions for this sub-theme are as follows: what are the critical knowledge and data gaps and how can these gaps be filled effectively? Should

existing models such as IMPACT be further expanded, and if so, how? Does a complementary approach to developing different tools make most effective use of scarce resources?

Activities

A first step is to collect information on the existing situation in the CGIAR, ESSP and elsewhere about datasets, tools, methods and infrastructure that can be used for vulnerability assessment. A series of scoping studies will identify critical gaps. Some of these can already be anticipated; for example, downscaling climate model outputs to temporal and spatial scales that are appropriate for biophysical and socio-economic modeling, making improvements in crop modeling and coordinating site-specific data collection approaches using standard data protocols and reporting mechanisms.

Another important initial step will be to critically review what knowledge the ESSP community has to offer the agricultural research for development and food security community and vice versa. For example, the Global Carbon Project, Global Environmental Change and Food Systems project, agroBIODIVERSITY project and Global Land Project each have very obvious areas of mutual interest, and the Earth System Governance Project and the International Human Dimensions Programme are areas where information exchange and joint future project development (e.g. in regions where ESSP has not been active) could very significantly inform and add value to CRP7.

One group of activities will be focused on climate science, including the identification of climate trends and variability in the target regions, and assessment of methods for downscaling climate change information for agriculture and natural resources management. There are also crucial information gaps concerning near-term climate prediction, for which there is great user demand for information.

Another group of activities relates to database development and collation. An early activity in CRP7 at the regional sites will be site characterization and baseline data collation, building as far as possible on existing sites, databases and information. These baselines will also form the basis for *ex-post* evaluation of research activities in later years.

A third group of activities relates to making improvements to biophysical and socio-economic models and the interactions among them. CRP7 will work on enhancing the geographic precision of agricultural impact models for more targeted analysis, so that policymakers, researchers and farmers can make decisions with a greater understanding of the interactions between local conditions, national policies and programs, and international developments, in the face of multiple drivers of change. Work during the first year will involve several scoping studies on agricultural impact model gaps and needs, bringing together the key global players to decide on how these gaps and needs can be addressed most effectively. Integration of models and databases to generate the information needed will be achieved not through tight coupling but through loose aggregation. In this way, different tools and models with different strengths and sensitivities can be used in parallel to address the major questions and ensure that the impacts of multiple stressors (of which climate change is but one) on livelihood systems and natural resources can be appropriately taken into account.

Outputs/milestones

This work will result in a framework and set of modeling tools and databases to analyze the implications, both positive and negative, of human responses to the climate challenge in terms of regional food security and the preservation of important ecosystem services, upon which the long-term sustainability of global agriculture must be based. Products will include cutting-edge and innovative climate model outputs that can be utilized in the other Themes and by others, decision aids and information packs that can be used to help build capacity of key users and socially-differentiated groups, considerably enhanced agricultural impact and global economic models, downscaled models that allow much higher resolution predictions of climate and agricultural impacts within regions, and new high-quality databases that are accessible to inputs and utilization by national agencies. The *ex ante* impact assessment tools produced in this Objective will help in priority setting in future years, as well as being available to other agencies needing *ex ante* assessments.

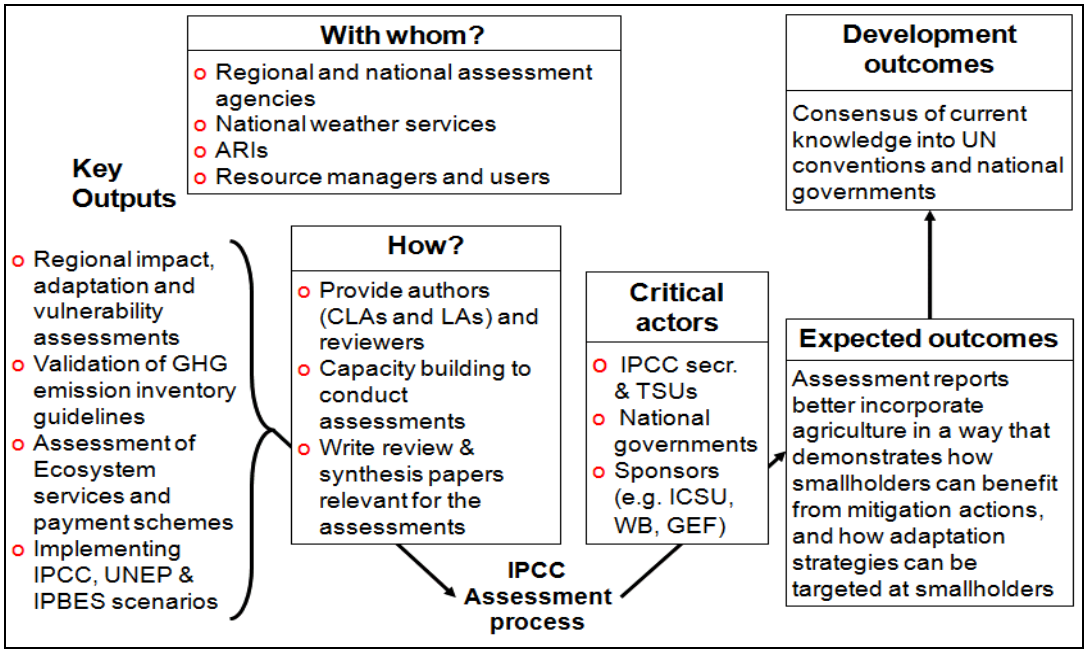
Partner roles

These activities will be conducted through an extensive array of partners. The international climate science community will be engaged to bring cutting-edge climate science to CRP7. The ESSP, the CGIAR (through the Consortium for Spatial Information (CSI), the IMPACT modeling environment of IFPRI and other initiatives), and regional and national stakeholders in each of the target regions, will contribute to database collation, building on the considerable amount of information that already exists. Work will build on earlier International Geosphere-Biosphere Programme (IGBP) (Ingram, 1996) and other climate change crop modeling efforts and directly involve the international agricultural impacts modeling community through ARIs (e.g. IIASA, the Netherlands Environmental Assessment Agency) and key players such as the International Consortium for Agricultural Systems Applications (ICASA) and the recently launched Agricultural Model Intercomparison and Improvement Project (AgMIP). NARES researchers will be partners in improved model development and will also be supported for capacity development as needed.

Impact pathways for target environments

The key intended users of the tools and datasets will be the numerous agencies involved in planning for and researching climate change impacts on agriculture, food security and natural resource management, NGOs and the private sector. The program will target these users by engaging the dozen or so key agencies that drive the agenda on climate change information provision and by making available the tools and datasets in appropriate formats. Arming the next generation of agricultural researchers and the public with state-of-the-art agronomic, environmental and policy-related information sets will result in important spin-off benefits in areas of the world where these may be the only practicable sources of quantitative information that can be used to help make decisions. This Objective will target the IPCC, among others (Figure 14).

Figure 14. Impact pathway for bringing CRP7 data and analysis into the IPCC process. The key outputs listed would be derived from Theme 4 and Theme 3 activities.



Theme 4 Objective 3: Refining frameworks for policy analysis

Rationale and research questions

There is a wide range of policy and program options for dealing with climate change effects; however there has been little analysis of the trade-offs and synergies possible among the environmental, livelihood and food security aspects. Furthermore, a wide range of technology and policy options relating to risk management, adaptation and mitigation are being pursued or considered in different regions. Systematic analyses of these interactions and strategic engagement with partners along with investments in communication efforts to share the results will lead to better policy and program choices.

Research questions include:

- What are the consequences of international, national and local policy and program options for improving environmental benefits, enhancing livelihoods and boosting food security in the face of a changing climate?
- Given the plausible futures in specific regions, what are the promising policy and program options to support adaptation and mitigation?
- Who are the key policy-makers in the climate-agriculture-food system nexus, what kinds of information do they require and use (or not) to make decisions, and how would they like to have this information communicated to them?

Activities

The principal set of activities in this Objective is to carry out *ex-ante* assessment of a wide range of technology and policy options related to risk management, adaptation and mitigation, and to evaluate the trade-offs and synergies among the environmental, livelihood and food security aspects. These analyses, carried out over a range of time and spatial scales, will include quantification of the uncertainties associated with the methods used, and will reflect the information needs of different stakeholders. Of equal importance is providing the tools to do this type of assessment to a wide range of stakeholders.

Working with coherent sets of scenarios that describe global and regional development pathways and estimates of vulnerability impacts into the future (Objective 1) and the quantitative modeling tools developed in Objective 2, one key activity to address this Objective is integrated assessment modeling at different scales, using a suite of tools and datasets to permit more precise understanding of the consequences of technology, policy and program choices made by national governments and international institutions, with a focus on the potential for CGIAR research. They will be based upon unprecedented integration between biophysical and socioeconomic modeling of global agriculture and natural resource systems. Research will deepen our understanding of the complex linkages between socioeconomic and environmental change and the functioning of agricultural systems and human well-being.

The product will be a comprehensive modeling environment integrating socioeconomic, biophysical and technological responses to global, regional and local consequences of policy choices, from agricultural technology investments to property rights, trade and macroeconomic policies. It will provide an improved platform to assist international agricultural research centers, development agencies and national governments in strategic planning and in making investment decisions as they confront the coming challenges of climate change. Both analytic and communication effort will be put in to make sure that the quantitative models are accessible, transparent and readily usable by policy communities.

Early on in CRP7 implementation, integrated assessment will be focused on *ex-ante* analysis to help set in place systems for monitoring and evaluating CRP7 research activities. In later years, the framework and data collected will be used for *ex-post* assessment of the research outputs and outcomes, in relation to a baseline set of key indicators measured at the start of the work in the target regions and case-study sites.

Another set of activities to address this Objective is analysis of policy-maker information needs and the most effective ways to foster two-way communication and ensure that final CRP7 outputs are appropriate

and useful. There is considerable need to enhance the two-way flow of information between end-users and scientists. To start this process, workshops with policy makers in government and other sectors will be held early on in target regions, applying 'Linking Knowledge with Action' tools that will help to build effective information networks and to set the agenda for CRP7 work in the regions, bringing together policy and science priorities. These will build on the regional teams involved in the scenarios activities, and outputs from scenario analyses and integrated assessment will be fed into stakeholder dialogues via these networks in subsequent years.

Outputs/milestones

The activities undertaken as part of this Objective will result in global and regional assessments of climate change impacts on agricultural systems and food security, and ultimately will result in a set of detailed information products on promising adaptation and mitigation policy options, including assessments of the potential returns to investments in various breeding and management activities, and extension activities. It will also highlight the needed complementary investments such as rural roads, irrigation systems and market infrastructure.

Partner roles

These activities will be conducted with an extensive array of partners, including the CGIAR, the international ESSP research community and regional bodies and climate change-related programs and networks (e.g. ASARECA, WECARD, CORAF, Clim-Dev, AfricaAdapt) and national stakeholders (NARES, NGOs, farmer organizations, etc.) and the private sector in each of the target regions.

Impact pathways for target environments

This work will provide information on alternative strategies and scenarios that can be used by agencies to implement adaptation and mitigation strategies. It will engage key actors to ensure that climate variability and climate change issues are mainstreamed appropriately into national, regional and international agricultural development strategies and institutional agendas. Policy outputs will be delivered through coalitions of policy partners and decision makers, researchers, regional information networks, pro-poor civil society organizations and development agencies that have been engaged through efficient private-public partnership processes. Outputs will inform the ongoing negotiations of the UNFCCC and the assessment processes of the IPCC by conducting comprehensive integrated assessments that quantify vulnerability reduction, food security enhancement and environmental health in target regions.

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Acronyms and Abbreviations

AATF	African Agricultural Technology Foundation
ACMAD	African Center of Meteorological Application for Development
AFOLU	Agriculture, forestry and land use
AGRA	Alliance for a Green Revolution in Africa
AGRHYMET	Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle
AIC	Agricultural Insurance Company of India
ANAFE	African Network for Agriculture, Agroforestry and Natural Resources Education
AR4	Fourth Assessment Report of the IPCC
ARDD	Agriculture and Rural Development Day
ARI	Advanced Research Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AWARD	African Women in Agricultural Research and Development
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BCAS	Bangladesh Centre for Advanced Studies
BMGF	Bill and Melinda Gates Foundation
CAADP	Comprehensive Africa Agriculture Development Programme
CARE	Christian Action Research and Education
CB	Consortium Board
CCAFS	Climate Change, Agriculture and Food Security
CCB	Climate, Community and Biodiversity Standards
CDM	Clean Development Mechanism
CER	certified emission reductions
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture)
CIDA	Canadian International Development Agency
CIFOR	Center for International Forestry Research
CIMMYT	International Center for the Improvement of Maize and Wheat
CIP	International Potato Center
CIRAD	La recherche agronomique pour le développement
CLA	Coordinating Lead Author (in the IPCC assessment process)
ClimDev-Africa	Climate for Development in Africa Programme

COMESA	Common Market for Eastern and Southern Africa
COP	Conference of the Parties
CRIDA	Central Research Institute for Dryland Agriculture, India
CSI	Consortium for Spatial Information
CP	Challenge Program (of the CGIAR)
CRS	Catholic Relief Services
CTA	Technical Centre for Agricultural and Rural Cooperation
DFID	Department for International Development (UK)
EAFF	Eastern Africa Farmers Federation
ECOWAS	Economic Community of West African States
EIAR	Ethiopian Institute of Agricultural Research
ESSP	Earth System Science Partnership
EU	European Union
FAI	Fertiliser Association of India
FAO	Food and Agriculture Organization (of the United Nations)
FARA	Forum for Agricultural Research in Africa
FICCI	Federation of Indian Chamber of Commerce and Industry
GEF	Global Environment Facility
GIB Service	Genomics and Integrated Breeding Service
GCM	Global climate model
GCCRP	Global Crop Monitoring Project
GCP	Generation Challenge Program
GCTE	Global Change and Terrestrial Ecosystems Program
GDP	Gross Domestic Product
GEC	Global Environment Change
GECAFS	Global Environment Change and Food Systems
GenderCC	Gender and Climate Change Network
GFAR	Global Forum on Agricultural Research
GFCS	Global Framework for Climate Services
GHG	Greenhouse gas
GIS	Geographic information systems
GLAM	General large area model
I4	Index Insurance Innovation Initiative
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICASA	International Consortium for Agricultural Systems Applications

ICCCAD	International Centre for Climate Change and Development, Bangladesh
ICICI	Lombard Insurance Company
ICPAC	IGAD Climate Prediction and Applications Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and communication technology
ICSU	International Council of Scientific Unions
IFAD	International Fund for Agricultural Development
IFAP	International Federation of Agricultural Producers
IFPRI	International Food Policy Research Institute
IGAD	Intergovernmental Authority on Development
IGBP	International Geosphere-Biosphere Programme
IGP	Indo-Gangetic Plains
IIASA	International Institute for Applied Systems Analysis
IIED	International Institute for Environment and Development
IITA	International Institute for Tropical Agriculture
IITM	Indian Institute of Tropical Meteorology
ILRI	International Livestock Research Institute
IMD	India Meteorology Department
IMPACT	Climate model developed by IFPRI
IPAM	Instituto de Pesquisa Ambiental da Amazônia
IPBES	International Panel for Biodiversity and Environmental Services
IPCC	Intergovernmental Panel on Climate Change
IPG	International public good
IRI	International Research Institute for Climate and Society
IRRI	International Rice Research Institute
ISP	Independent Scientific Panel
ISPC	Independent Science and Partnership Council
IWMI	International Water Management Institute
KARI	Kenyan Agricultural Research Institute
LA	Lead Author (in the IPCC assessment process)
M&E	Monitoring and evaluation
MOEF	Ministry of Environment and Forests, Govt of India
CRP	Consortium Research Program
MRV	measurable, reportable and verifiable
NAPA	National Adaptation Plan of Action
NAMA	Nationally Appropriate Mitigation Actions
NARC	Nepal Agricultural Research Council

NARES	National agricultural research and extension system
NARO	National Agricultural Research Organization, Uganda
NBPGR	National Bureau of Plant Genetic Resources, India
NCAR	National Center for Atmospheric Research
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental organization
NIDM	National Institute of Disaster Management, India
NMS	National meteorological services
NWCF	Nepal Water Conservation Foundation
PRADAN	Professional Assistance for Development Action
PIK	Potsdam Institute for Climate Impact Research
RCM	Regional climate model
RF	Rockefeller Foundation
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
RWC	Rice Wheat Consortium
SAARC	South Asian Association for Regional Cooperation
SAUs	State Agricultural Universities
SBSTA	Subsidiary Body for Scientific and Technological Advice
SC	Science Council
SDMC	South Asian Disaster Management Centre
SLM	Sustainable land management
SRF	Strategy and Results Framework (of the CGIAR)
SSA	Sub-Saharan Africa
START	Global change System for Analysis, Research and Training
TSU	Technical Support Unit (of the IPCC)
UoC	University of Copenhagen
UCAR	University Corporation for Atmospheric Research
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNREDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
VCS	Voluntary Carbon Standard
WECARD	West and Central African Council for Agricultural Research and Development
WEDO	Women's Environment and Development Organization
WEF	World Economic Forum
WFP	World Food Programme
WMO	World Meteorological Office

Annex 1: Logframe for CRP7 for Phase 1 (Year 1-5).

Outputs to be achieved by Year 5, Outcomes by Year 10 (* = milestones carried forward from current Center activities; some will be phased out while others will be brought into line with the overall CRP7 strategy as implementation proceeds)

Theme 1. Adaptation to Progressive Climate Change

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Objective 1.1 Analyze and design processes to support adaptation of farming systems in the face of future uncertainties of climate in space and time				
Outcome 1.1: Agricultural and food security strategies that are adapted towards predicted conditions of climate change promoted and communicated by the key development and funding agencies (national and international), civil society organizations and private sector in at least 20 countries				
Output 1.1.1 Development of farming systems and production technologies adapted to climate change conditions in time and space through design of tools for improving crops, livestock, and agronomic and natural resource management practices				
Milestone 1.1.1.1 Platform established for multi-location trials of technologies and genotypes for GxE interaction analysis and the calibration and evaluation of crop models. (2011)	Number of unique geographic locations, where individual and multi site trials are carried out; assessment of related information and metadata collected; and exchange of derived information	Task report; CCAFS website/ AMKN platform	Willingness of partners to carry out the trials and share the trial data	CIAT and other CGIAR centers, CIRAD, JIRCAS, NARES (e.g. EIAR, KARI, NARO, IARI, CRIDA, BARC, BARI NARC, CILSS, etc) and other ARI institutions involved in agricultural trials
Milestone 1.1.1.2 Robust methods developed for calculating spatial and temporal analogues of climate. Partner co-authored peer-reviewable method(s) developed and tested codes using pattern-scaled HadCM3 climate output. (2011)	Methods developed and made publicly available through developed communication platforms	CCAFS website/ AMKN platform ; documentation for annual reporting	Robustness of testable methods using only climate model output (i.e. pattern-scaled HadCM3)	University of Reading, with guidance from University of Leeds + local partners (IGP) involved in the implementation phase and web interface development + CIAT
Milestone 1.1.1.3* One to five flagship technologies identified, developed and demonstrated in each of the 3 initial target regions which would directly enhance the adaptive capacity of the farming systems to the climate change conditions. Launch through high level engagement with key stakeholders at a key international meeting (2015)	Technologies developed and made publicly available. Positive feedback and increased demand of new technologies by the clientele. Field validation and assessment during field visits by different stakeholders made as a part of 2015 visits	CCAFS website; documentation for annual reporting	Willingness and interest of local partners in nominating candidate technologies and managing the trials at pilot sites	CGIAR centers in collaboration with other themes in the MP, NARES, ARIs, CIRAD, NGOs, national governments, Farmers' organisations
Milestone 1.1.1.4* Practices developed that enhance the efficiency of water use in aquaculture and small scale irrigation (eg, increased productivity per unit use of water; increased irrigable area with same amount of water) Time series differential productivity and irrigated area analysis (2012)	Practices developed and made publicly available	CCAFS website; documentation for annual reporting	Existence of aquaculture farms and terrestrial agriculture in close proximity; Recyclable use of water between aquaculture and field agriculture, including tree crops	WorldFish, NARES, ARIs, IWMI, ICRAF

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 1.1.1.5 Methodological framework developed for assessing the impact of new technologies which are adapted to climate change conditions; suitable framework selected by partners / an international panel. (2013)	Framework developed, reviewed and made publicly available	CCAFS website. Framework and review documents. Panel evaluation reports	Availability of frameworks and selection / composition of a generic one for the purpose allowing the flexibility in the implementation procedures	CGIAR Centers which are involved in the above activities and their NARES partners
Milestone 1.1.1.6*Tools and guidelines developed to support the selection (and / or maintenance) of the most appropriate water storage options and/ or their combinations for river basin development planning under conditions of increasing climate variability; Reviews of tools and guidelines, including links to individual guidelines and access to tools (2013)	Tools and guidelines developed, reviewed and made publicly available	CCAFS website; review documents	Willing uptake of tools and guidelines; sufficiently accurate predictions of future water storage deficits and needs	IWMI,WRI-Ghana,PIK,ZEF, MRC
Milestone 1.1.1.7*(2012) Assessment of the potential for exploitation of ground water for crop production in at least three basins	Maps demonstrating the potential for groundwater exploitation, which take adequate account of uncertainty	Report, and potentially peer-reviewed paper	Sufficient groundwater available for exploitation at least some sites	IWMI, WRI-Ghana, PIK, ZEF, MRC, OSS
Output 1.1.2 Building of regional and national capacities to produce and communicate appropriate adaptation and mitigation strategies for progressive climate change at the national level (e.g. through NAPAs)				
Milestone 1.1.2.1*New knowledge developed on (1) the potential application domains for agricultural practices, technologies and policies (including maps), and (2) best means of transferring these technologies and ensuring their adoption; findings synthesized and presented in report and journal articles (2012)	Synthesis report and journal articles completed and disseminated	CCAFS website; Journal publishers' websites	Availability of sound climate projections to 2030 and beyond	CGIAR Centers, ESSP (e.g. Leeds University), NARES and ARIs
Milestone 1.1.2.2 Community-based holistic adaptation options trialed in at least three sites, in order to understand the social, cultural, economic and institutional barriers to effective adaptation; outcomes presented in summary report (2014)	3 trials implemented; summary report completed and disseminated	CCAFS website; documentation for annual reporting	Ability to generalize from local-level participatory analyses	CGIAR centers, local NGOs, local government
Milestone 1.1.2.3 Training workshop(s) organized and videos produced on the use of the Analogue methodology (for examining both spatial and temporal analogues based on multiple climate projections; see 1.1.1.2). Engagement of key IGP stakeholders such as national universities, NARC, ICAR (DWR), BARC, NGOs; Farmer exchanges convened among analogue sites (2011, 2012)	Two trainings (2011, 2012) delivered engaging 25 participants; min 2 videos produced; exchanges convened engaging farmers in 2 regions	CCAFS website; documentation for annual reporting; participant lists for film showings, trainings and exchanges		National universities, ICAR, BARC, NARC, NGOs

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 1.1.2.4 Regional training workshop on approaches and methods for evaluating cost/benefit of adaptation strategies on a national scale (2013)	Two trainings delivered engaging 25 participants total	CCAFS website; documentation for annual reporting; participant lists for trainings		Ministries of Agriculture and Environment, national NGOs, local government
Output 1.1.3 New knowledge-synthesizing institutional arrangements, policies and mechanisms for improving the adaptive capacity of agricultural sector actors and those involved in managing the food system				
Milestone 1.1.3.1*Document produced that synthesizes institutional arrangements, policies and mechanisms for improving the adaptive capacity of agricultural sector actors (addresses what is working where, how and why, with disaggregation by gender and other social strata) (2011)	Document completed and disseminated	CCAFS website	Partners have sufficient incentives to engage and people trained remain in local institutions	African & South Asian University networks; development NGOs (e.g. CARE, Oxfam, ICCCAD), government, regional bodies
Milestone 1.1.3.2 Web-based platform established (Adaptation and Mitigation Knowledge Network) to share and exchange knowledge, linking farmers' realities and experiences on the ground with multiple and combined research outputs (2011)	Platform developed and made publicly available (cf http://www.sac.ac.uk/climatechange/farmingforabetterclimate/) Number of unique geographic locations, where individual and multi site trials are carried out; assessment of related information and metadata collected; and exchange of derived information	CCAFS website; documentation for annual reporting		
Milestone 1.1.3.3*Adaptation option portfolio (tool box) for aquaculture systems, options identified and disseminated in Vietnam, tool box disseminated in Bangladesh. Building capacity by creating information and working in partnerships. (2011)	Toolbox available and disseminated	Partners' documentation		WorldFish, MCD Vietnam, Cantho University ESSP partners IHDP/ZEF University of Bonn or/and SEA START RC
Output 1.1.4 Testing of participatory methods that are sensitive to gender, livelihoods categories and other social differentiators, to apply globally				
Milestone 1.1.4.1 Socially disaggregated participatory methods tested for grounding climate change model results to community-level decision making processes that address food security issues (2014)	Methods tested and disseminated	CCAFS website	Cross-site and cross-continent applicability.	CIAT, Oxfam, CRS, Learning Alliance, Sustainable Food Lab, SAI
Milestone 1.1.4.2 Video testimonials produced on gender-specific farmer adaptation and mitigation strategies (including indigenous knowledge, coping mechanisms and current challenges) in 1-3 sites in each of the 3 initial target regions (2011, 2012)	Video testimonials produced and disseminated through the website	CCAFS website		

Objective 1.2 Develop breeding strategies for addressing abiotic and biotic stresses induced by future climatic conditions, variability and extremes, including novel climates				
Outcome 1.2: Strategies for addressing abiotic and biotic stresses induced by future climate change, variability and extremes, including novel climates mainstreamed among the majority of the international research agencies who engage with CCAFS, and by national agencies in at least 12 countries				
Output 1.2.1 Understanding and evaluating the response of different varieties/crops to climate change in time and space, and generating comprehensive strategies for crop improvement through a combination of modelling, expert consultation and stakeholder dialogue				
Milestone 1.2.1.1 Research and policy organizations actively engaged in setting research priorities; one regional breeding strategy workshop involving regional decision-making and priority setting bodies delivered in each of 3 initial target regions (2011)	Workshops held engaging 10-15 participants representing major regional and international breeding organizations and decision-making and priority setting bodies. List of research and policy organisations that have commented on, and contributed to, the research design	CCAFS website; workshop agendas and participant lists; documentation for annual reporting	Willingness of crop breeding institutions to participate in the program; inclusion of women's and men's crops in the program	Crop-breeding institutes (CG Centers, ARIs, NARES), GCP, regional decision-making and priority setting bodies (ASARECA, FARA, WECARD), donors, national governments
Milestone 1.2.1.2 Crop breeding institutions coordinated in development of climate-proofed crops for a 2030-2050 world; Document written jointly by CCAFS and crop breeding institutions outlining coordinated plans for breeding. (2012)	Plan document completed and disseminated	CCAFS website	Willingness of crop breeding institutions to adjust priorities based on priority setting results, and donor coordination in funding of future breeding programs	Crop-breeding institutes (CG Centers, ARIs, NARES), regional decision-making and priority-setting bodies (ASARECA, FARA, WECARD, SAARC), donors, national governments/National Biosecurity Agencies
Milestone 1.2.1.3 Range of crop modeling approaches (to inform breeding) developed and evaluated for biotic and abiotic constraints for the period 2020 to 2050; findings presented in summary report and at key stakeholders' meetings ; *including modelling approaches to evaluate the impacts of climate change and the effects of adaptation technologies such as supplemental irrigation and water harvesting on water availability for crops and their productivity under decadal futures from 2020 to 2050 (2013)	Report completed and disseminated	CCAFS website	Robust climate projections (i.e. uncertainty does not dominate) and sufficient data on abiotic and biotic interactions with climate. Current crop models are capable of adequately simulating G*E*M interactions	Crop-based components of MP3, GCP, molecular and breeding platforms, ICARDA and other CG Centers, NARES, ARI breeding institutes, private sector breeding companies, Leeds University
Milestone 1.2.1.4 Detailed crop-by-crop strategies and plans of action for crop improvement developed, incorporating portfolio of national, regional and global priorities; findings presented in summary report (2015)	Report completed and disseminated	CCAFS website	Robust climate projections (i.e. uncertainty does not dominate) and sufficient data on abiotic and biotic interactions with climate	CG Centers, ARI modelling groups (e.g. Leeds University), NARES scientists

Milestone 1.2.1.5 Set of "virtual crops" designed and assessed for their efficacy in addressing the likely future conditions in terms of the economic, social and cultural benefits expected; findings presented in summary report and journal article. Engagement of ARI modelling groups (e.g. Leeds University), NARES scientists (2014)	Report completed and disseminated; journal article published	CCAFS website; Journal publishers' websites	Robust climate projections (i.e. uncertainty does not dominate) and sufficient data on abiotic and biotic interactions with climate	CG Centers, ARI modelling groups (e.g. Leeds University), NARES scientists
Milestone 1.2.1.6 Set of breeding strategies identified and widely shared with partners including funding bodies, national and international organizations, universities and other actors; findings presented in summary report and policy briefs (including percentage of total food crop production (in recent history) accounted for by set of breeding strategies) (2015)	Report and policy briefs completed and disseminated and downloaded 200 times from web portal	CCAFS website	Willingness of crop breeding institutions to adjust priorities based on priority setting results, and donor coordination in funding of future breeding programs	Crop-breeding institutes (CG Centers, ARIs, ANRES), regional decision-making and priority-setting bodies (ASARECA, FARA, WECARD, SAARC), donors, national governments
Output 1.2.2 Breeding strategies disseminated to key national agencies and research partners				
Milestone 1.2.2.1 High-level meetings held with key stakeholders resulting in mainstreaming of new breeding strategies in work plans and existing breeding programs (2015)	Meetings held engaging minimum 30 individuals representing breeding institutions, key regional decision-making and priority setting bodies; breeding strategies adopted by existing breeding programs	CCAFS website; documentation for annual reporting; Publications and reports of existing breeding programs	Willingness of crop breeding institutions to participate in the program; inclusion of women's and men's crops in the program	Crop-breeding institutes (CG Centers, ARIs, NARES), GCP, regional decision-making and priority setting bodies (ASARECA, FARA, WECARD, SAARC), donors, national governments
Milestone 1.2.2.2 Global, regional and national policy briefs produced to guide best-value investments in climate-proofed crop breeding initiatives (2015)	Policy briefs completed and disseminated across global, regional and national levels	CCAFS website	Willingness of crop breeding institutions to adjust priorities based on priority setting results	Crop-breeding institutes (CG Centers, ARIs, NARES), regional decision-making and priority-setting bodies (ASARECA, FARA, WECARD, SAARC), donors, national governments
Milestone 1.2.2.3 (2015) One policy briefing meeting per region, based on the briefs in 1.2.2.2.	Attendance at meetings	Brief meeting report	Willingness of relevant organisations to attend	
Output 1.2.3 Differential impact on different social groups of strategies for addressing abiotic and biotic stresses induced by future climate change, variability and extremes are identified, evaluated and disseminated				
Milestone 1.2.3.1 Policy recommendations provided to national agencies, policy makers and key actors in the agricultural sector on how to target strategies to enable equitable access to breeding materials and strategies by different social groups (e.g. pastoralists, fishers, urban farmers) and by women and men (2015)	Report completed and disseminated at 3 major international meetings; Report and policy briefs downloaded 200 times from web portal	CCAFS website; indigenous knowledge survey		

Objective 1.3 Identify and enhance deployment and conservation of species and genetic diversity for increased resilience and productivity under conditions resulting from climate change				
Outcome 1.3: Portfolio of information sources, guidelines and germplasm available for using genetic and species diversity to enhance adaptation and resilience to changing climate are adopted and up-scaled by national agencies in at least 20 countries and by international organization for the benefits of resource poor farmers				
Output 1.3.1 New knowledge, guidelines and access to germplasm are provided for using genetic and species diversity to enhance adaptation, productivity and resilience to changing climate				
Milestone 1.3.1.1*Accessions identified with potential adaptive traits for climate change adaptation for at least 5 priority crops using innovative methods. Methodology to select genebank material adapted to local current climate conditions and future climate shifts developed and tested and crop suitability atlases for priority crops (as defined by fraction of total production accounted for) produced; findings presented in reports and journal articles (2011, 2014)	Reports completed and disseminated. Journal articles published. Lists produced (e.g., adapted local varieties conserved in genebanks; newly and already collected domesticated and wild germplasm adapted to climate change). Methodology developed and made publicly available	CCAFS website; journal publishers' websites	Adaptation traits easily identifiable and availability of sufficient data. Good Georeferenced data for accessions are available. Exchange of germplasm supported by participating countries. Sufficient data points and comparative conditions to compare the resilience of diversified as compared to simpler systems in the face of variable and changing conditions. Local seed providers ready to participate and collaborate with the project. Policy framework in place for sharing of information. Sufficient cross-site similarity for transfer of lessons, germplasm and tools. Genetic resources policy permits movement of germplasm to pilot sites	International Center for Tropical Agriculture (CIAT), Colombia; Institute of Biodiversity and Conservation, Ethiopia; National Agricultural Research Institute, Papua new Guinea (PNG); Institut d'Economie Rurale, Mali; Indian Council Agricultural Research, India; Millennium Seed Bank, UK; Botanic Garden Conservation International (BGCI), UK; members of the Musa Taxonomy Advisory Group; University of Philippines Los Banos (UPLB), Philippines; KULeuven, Belgium; CIALCA partners; Semongok Agriculture Research Centre (ARC), Sarawak Malaysia; PROINPA, Bolivia
Milestone 1.3.1.2*Approaches, methods and tools for participatory assessment of where and when biodiversity rich practices facilitate adaptation to climate change reviewed ; findings summarized in report (2011)	Consultation workshops; report completed and disseminated. number of communities and individuals surveyed, number of methods and tools tested	CCAFS website; documentation for annual reporting; workshop agendas and participant lists		International Union for Conservation of Nature (IUCN), Switzerland; PROINPA, Bolivia; LI-BIRD, Nepal; MS Swaminathan Research Foundation, India; German experts (incl. Prof. K. Hammer); FAO, the International Treaty on Plant Genetic resources for

				Food and Agriculture (ITPGRFA), Italy; University of Perugia, Italy; University of Basilicata, Italy; Regione Abbruzzo and Regione Basilicata, Italy)
Milestone 1.3.1.3.*Evaluation of germplasm of cereals and food legumes for resistance to insect pests and diseases under variable temperature regime; strategy for targeted collection for sampling landraces and wild relatives in dry and hot areas (ICARDA) (2012)	Evaluation and strategy published	ICARDA website		
Milestone 1.3.1.4. Methods and tools for participatory monitoring of deployment of biodiversity and knowledge by communities for climate change adaptation tested out in at least 5 countries (including community surveys); findings synthesized in report (2012) Multi location trials of identified local varieties carried out (2014)	Surveys conducted. Report completed and disseminated. Methods and tools developed and made publicly available	CCAFS website		Institute of Biodiversity and Conservation, Ethiopia; National Agricultural Research Institute, PNG; Institut d'Economie Rurale, Mali; Indian Council agricultural Research, India; LI-BIRD, Nepal; MS Swaminathan Research Foundation, India; PROINPA, Bolivia
Milestone 1.3.1.5. Knowledge developed on distribution of local seed material (seed systems) and its effectiveness in climate change adaptation strategies; findings summarized in reports, case study narratives and seed system maps. (2013)	Reports and case study narratives completed and disseminated; seed system maps developed and made publicly available	CCAFS website		REMERFI Partner (Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama); Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey-Calavi, Benin
Milestone 1.3.1.6. Assessment of the contribution of crop, livestock, fish diversity to climate change adaptation carried out; findings summarized in reports, case study narratives (2015)	Reports and case study narratives completed and disseminated	CCAFS website		Institute of Biodiversity and Conservation, Ethiopia; International Livestock Research Institute (ILRI) Ethiopia (TBC)
Milestone 1.3.1.7 Climate change impact on key global commodities (major Musa groups, cocoa, coconut) and selected pest and diseases modelled and reviewed by commodity network country partners and possible response strategies identified (2015)	Base model available and adapted to specific commodities; findings verified by stakeholders	web site, scientific articles, electronic tools with dynamic user interface		MUSALAC, BARNESA, BAPNET (including participating countries by region: LAC -Costa Rica, Brazil, Colombia, Panama; ESA - Uganda, Rwanda, Kenya; WCA Ghana, Nigeria, Cote d'Ivoire, Cameroon; APO - India, China, Taiwan, Australia, Indonesia); CIRAD; International Center for Tropical Agriculture (IITA), Nigeria; CIAT, Colombia; University of Western Australia; Queensland Department of Primary Industries, Australia; CacaoNet, COGENT (including participating countries by

				region: LAC - Costa Rica, Brazil, Trinidad, Mexico; SSA - Cote d'Ivoire, Ghana, Nigeria, Cameroon, Tanzania; APO - India, Sri Lanka, Indonesia, Philippines, Malaysia), Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), France; IITA, Nigeria; CIAT, Colombia; Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Costa Rica; South Pacific Commission (SPC), Fiji; United States Department of Agriculture (USDA), USA; University of Queensland, Australia; Reading University, UK; World Cocoa Foundation; APCC
Output 1.3.2 New information, knowledge, guidelines and germplasm are made available to farmers, breeders, local communities and scientists and promoted through knowledge sharing, peer reviewed articles, information systems and media				
Milestone 1.3.2.1. Germplasm (wild and domesticated) with traits important for adapting to climate change conserved in local, national and regional ex situ collections and made available to target users; findings presented in peer-reviewed journal articles and genebank reports; databases augmented (2013)	Collections and databases expanded and made publicly available; reports completed and disseminated; journal articles published	Germplasm collection records; CCAFS website; Journal publishers' websites; documentation for annual reporting	Partners willing to share germplasm and knowledge; Farmers are willing participate in household surveys; local seed suppliers are willing to adopt locally adapted varieties; Rural radio partners are a credible source of information. Farmers have access to radios	Institute of Biodiversity and Conservation, Ethiopia; National Agricultural Research Institute, PNG; Institut d'Economie Rurale, Mali; Indian Council agricultural Research, India; Millennium seed bank; BGCI; members of the Musa Taxonomy Advisory Group
Milestone 1.3.2.2. Farmers' traditional knowledge on use of diversity and climate change adaptation documented and made available in at least 3 countries; findings presented in databases, reports and peer- reviewed article (2013)	Databases produced and made publicly available; reports completed and disseminated; journal articles published	CCAFS website; Journal publishers' websites; documentation for annual reporting		Institute of Biodiversity and Conservation, Ethiopia; National Agricultural Research Institute, PNG; Institut d'Economie Rurale, Mali; Indian Council agricultural Research, India
Milestone 1.3.2.3. Research and development partners (especially young scientists) in at least 11 countries trained in using new monitoring and modelling tools for climate change adaptation for different crops including underutilized species; outcomes summarized in report (2013)	Reports completed and disseminated; training materials developed and delivered	CCAFS website		Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), Uganda; International Foundation for Science (IFS), Sweden; African Network for Agriculture, Agroforestry and Natural

				Resources Education (ANAFE), Kenya; Institut de Recherché et de Développment sur la Biodiversité des Plantes Cultivées, Aromatiques et Médicinales (IRDCAM), Benin; Plant Genetic Resources Research Institute (PGRRI), Ghana; University of Nairobi, Kenya; LI-BIRD, Nepal; MS Swaminathan Research Foundation, India; PROINPA, Bolivia
Milestone 1.3.2.4. Guidelines for enhanced seed systems to accelerate adaptation and for building up community-based participatory monitoring of conservation and use of agricultural biodiversity at community level in the IGP region and East Africa produced and disseminated (2013)	Guidelines developed and disseminated	CCAFS website		LI-BIRD, Nepal; MS Swaminathan Research Foundation, India; PROINPA, Bolivia
Milestone 1.3.2.5. Germplasm information integrated in global information systems including: (1) Databases of priority collections augmented with georeferenced passport data and trait information useful to the diversity analysis for climate change impacts and adaptation effectively linked to global system, (2) Accession level information with quality georeferences, (3) Data on duplication to global collection and important trait information published in GENESYS, (4) complementary data sources on wild species identified through GBIF, (5) training materials, (6) list of and information on newly and already collected germplasm (domesticated and wild) adapted to climate change; Materials of interest safely duplicated in Global Collection and made available (2015)	Databases, accession information, data, training materials, lists developed and made publicly available. Databases of priority collections augmented with georeferenced passport data and trait information useful to the diversity analysis for climate change impacts and adaptation effectively linked to global system; accession level information with quality georeferences; data on duplication to global collection and important trait information published in GENESYS; complementary data sources on wild species identified through GBIF; training materials. List of and information on newly and already collected germplasm (domesticated and wild) adapted to climate change	CCAFS/other websites; technical reports, Genebank catalogues; databases		Global Crop Diversity Trust; priority national/ regional Collections; CGIAR genebanks; EURISCO partners; PGR networks; the International Treaty on Plant Genetic resources for Food and Agriculture (ITPGRFA), Italy; United States Department of Agriculture (USDA), USA; Global Diversity Information Facility (GBIF), Denmark; BioGeomancer Research consortium; Sud Experts Plantes members (IRD/AIRD), France; Botanic Garden Conservation International (BGCI), UK; Generation Challenge Programme, Mexico; International Musa Testing Programme partners
Output 1.3.3 Policies to enable access to and use of genetic resources for climate change adaptation research, and diffusion of adapted germplasm				
Milestone 1.3.3.1* Baseline survey and analysis of centers' and partners' acquisitions, and distributions of adapted germplasm carried out; Comparative survey and analysis conducted; findings summarized in reports (2011, 2014)	Reports completed and disseminated. Survey documents developed, Data collected Draft reports circulated or approval/comment Publication of reports	CCAFS website		CGIAR Centers; Institute of Biodiversity and Conservation, Ethiopia; National Agricultural Research Institute, PNG; Institut d'Economie Rurale, Mali; Indian Council Agricultural Research, India

Milestone 1.3.3.2*Policy guidelines produced for centers and partners to address challenges associated with obtaining, using and distributing germplasm as part of climate change related research (with particular focus on addressing challenges associated with access and benefit sharing, IPR, biosafety policies and laws) (2012)	Guidelines finalized and distributed to centers and partners	CCAFS website; documentation for annual reporting	Local seed providers ready to participate and collaborate with the project. Supportive government policies. Willingness of international bodies to revise policies related to germplasm access	CGIAR Centers; Semongok Agriculture Research Centre (ARC), Sarawak Malaysia; PROINPA, Bolivia
Milestone 1.3.3.3 Case studies documented of potential role of informal seed systems for diffusion of adapted germplasm; Analysis of institutions and policies that impact on the flow of adapted materials through those seed systems; National strategies developed to implement the International Treaty's Multilateral system on Access and Benefit-Sharing in 4 countries; Policy options produced at national, provincial and community levels to improve existing policies, local management and seed systems to facilitate diffusion and uptake of adapted germplasm (2013, 2015)	Case studies, analysis, national strategies and policy options developed and disseminated	CCAFS website		EMBRAPA, Brazil; Kenyan Agricultural Research Institute (KARI), Kenya; University of Malaya, Malaysia; Instituto Nacional de Investigaciones Agricola (INIA), Peru; MS Swaminathan Research Foundation, India; Local Initiative for Biodiversity, Research and Development (LI-BIRD), Nepal; PROINPA, Bolivia; Institute of Biodiversity and Conservation, Ethiopia; National Agricultural Research Institute, PNG; Institut d'Economie Rurale, Mali; Indian Council Agricultural Research, India
Milestone 1.3.3.4*Technical contributions to international processes support the development of international policies enabling access to and use of genetic resources in climate change research and adaptation strategies; Background papers and policy briefs developed for intergovernmental meetings including the CGRFA, ITPGRFA, CBD; journal article published on options to reform international policies to reflect increased interdependence of countries on GRFA as a result of climate change; Book published on assessing international policy options to support collective pooling and facilitated use of GRFA published (2011, 2013, 2015)	Papers, policy briefs, Journal article and book published	CCAFS website; Journal and book publishers' websites		CGIAR Centers; representatives of regional groups attending intergovernmental fora, secretariats of relevant international agreements

Milestone 1.3.3.5. Policy paper developed on strategies for creating an enabling policy environment in support of self-sustainable monitoring of diversity and use of agricultural biodiversity (including impact on role of participatory monitoring of livelihood and conservation strategies in target countries) (2015)	Policy paper completed and disseminated	CCAFS website		MS Swaminathan Research Foundation, India; Local Initiative for Biodiversity, Research and Development (LI-BIRD), Nepal; PROINPA, Bolivia; Institute of Biodiversity and Conservation, Ethiopia; National Agricultural Research Institute, PNG; Institut d'Economie Rurale, Mali; Indian Council Agricultural Research, India
Output 1.3.4 Identification and evaluation of the differential roles of women and men, and other social groups, in strategies for conservation and use of species and genetic diversity; and the impact of those strategies on those different groups, are integrated into knowledge sharing and other activities to achieve outcomes				
Milestone 1.3.4.1. Data gathered on how communities enhance conservation and use of local biodiversity within the climate change context, disaggregated by gender and other social strata; findings summarized in technical reports, factsheets and journal articles (2013)	Technical reports, fact sheets completed and disseminated; journal articles published	CCAFS website; Journal publisher's website		MS Swaminathan Research Foundation, India; Local Initiative for Biodiversity, Research and Development (LI-BIRD), Nepal; PROINPA, Bolivia
Milestone 1.3.4.2. Gender-sensitive and socially differentiated strategies developed for conservation and use of local biodiversity within the climate change context; findings presented in strategy document, journal article (2014)	Strategy document completed and disseminated; journal article published	CCAFS website; Journal publisher's website		MS Swaminathan Research Foundation, India; Local Initiative for Biodiversity, Research and Development (LI-BIRD), Nepal; Semongok Agriculture Research Centre (ARC), Sarawak Malaysia; PROINPA, Bolivia
Milestone 1.3.4.3. Researchers and development agents trained on socially sensitive strategies for the conservation and use of local biodiversity within the climate change context (2014)	Trainings held engaging at least 20 R&D agents representing at least 5 organizations from 3 countries (Nepal, Bolivia and India)	Training participant lists; documentation for annual reporting		MS Swaminathan Research Foundation, India; Local Initiative for Biodiversity, Research and Development (LI-BIRD), Nepal; PROINPA, Bolivia; Semongok Agriculture Research Centre (ARC), Sarawak Malaysia
Milestone 1.3.4.4. Roles of gender and different social groups in adaptation strategies for climate change analyzed in target countries and highlighted through fact sheets, project briefs and technical articles. Approaches, methods and outcomes of supportive interventions promoted through collaborative projects and shared with the broader stakeholder community through relevant meetings, conferences and journal articles (2015)	Summary report completed and disseminated; journal articles published	CCAFS website; Journal publisher's website		MS Swaminathan Research Foundation, India; Local Initiative for Biodiversity, Research and Development (LI-BIRD), Nepal; PROINPA, Bolivia; Institute of Biodiversity and Conservation, Ethiopia; National Agricultural Research Institute, PNG; Institut d'Economie Rurale, Mali; Indian Council Agricultural Research, India

Theme 2. Adaptation through Managing Climate Risk

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Objective 2.1 Identify and test innovations that enable rural communities to better manage climate-related risk and build more resilient livelihoods				
Outcome 2.1: Systematic technical and policy support by development agencies for farm- to community-level agricultural risk management strategies and actions that buffer against climate shocks and enhance livelihood resilience in at least 20 countries				
Output 2.1.1 Synthesized knowledge and evidence on innovative risk management strategies that foster resilient rural livelihoods and sustain a food secure environment				
Milestone 2.1.1.1 Report of priority knowledge and methodology gaps produced for index-based risk transfer products; and Program value-addition and partnership strategy (2011)	Report and journal article completed and disseminated	CCAFS website; Journal publisher's website	Effective, equitable participation of rural communities, support of intermediaries. Stakeholders identify context-relevant risk management strategies, and participate in their improvement and testing. Capable NGOs partner. Access to relevant work across CG Centers and targeted NARES. Uptake of results by key agencies. Relevant information products, services, and uses can be engaged in each region. Partners willing to share findings through platform. Will be replicated in other research locations as they are established in each region. Value addition to other index insurance initiatives; resource-poor farmers have access to index-based risk transfer products	Key CG (ILRI, IFPRI, CIAT) and other organizations (e.g., WF, WB-CRMG, USAID BASIS CRSP) working on insurance for agriculture, regional (e.g. ECOWAS, IGAD in WA, AIC, ICAR in IGP) and national policy decision makers (CNEDD-Mali, CONEDD-BF, CSE-Senegal, ANE-Mali in WA)
Milestone 2.1.1.2 Synthesis report produced on options and approaches for reducing risk and enhancing livelihood resilience through cultivar, farm and livelihood diversification; modeling tool developed. *Documentation of how agro-pastoralists are coping with climate risk in West and Southern Africa, and piloting options as to how they may cope with increased climate risk in the future (ILRI) *Review of adaptation experiences and options in coastal and aquatic food production systems (WorldFish) * Characterization of climate-related risk, and survey of current formal and informal responses to risk with potential for transfer and up scaling; Upgrade to the ICARDA Agroclimate Tool (ICARDA) (2012)	One report and functional modeling tool completed and disseminated; Earthscan book chapters (WorldFish)	CCAFS websit; Earthscan website		Bioversity International & partners (TBD); ICRAF & partners (VI; CARE; RF; CAS; BMZ; ZALF; COMART); CIMMYT & partners (NARS in Ethiopia, Kenya, India, Bangladesh, Nepal; SIMLESA project, IRRI; Cereal Systems Initiative for South Asia); * PIK, University of Kassel, IER (Mali), IIAM (Mozambique), IFPRI; USDA ARS Lubbock, NARS of Cyprus, Egypt, Ethiopia, Syria

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 2.1.1.3 Synthesis of ongoing work on agronomic and NRM technologies for enhancing resilience of agriculture to climate variability reported. *Historical records on rice yield losses compiled for droughts (India, Thailand) and cyclones/ typhoons (Bangladesh, Philippines) (IRRI) (2012)	Report completed and disseminated	CCAFS website		Multiple CG Centers TBD; NARES in India, Bangladesh, Thailand, and the Philippines
Milestone 2.1.1.4 Report produced characterizing climate-related risks to key crops and farming systems (2012)	Report completed and disseminated	CCAFS website		CIP & partners (NARIS in target countries, U. Missouri); ICRAF & partners (KARI; WB; GEF; PRESA; VAAS; ZALF; PIK; TMA); IRRI & partners (NARES in India, Bangladesh, Thailand, Philippines);
Milestone 2.1.1.5 Current strategies for managing climate-related risk in agriculture synthesized in a report and journal paper; *Tools and guidelines to support the selection (and / or maintenance) of the most appropriate water storage options and/ or their combinations for river basin development planning under conditions of increasing climate variability (IWMI) (2012)	Report and journal article completed and disseminated	CCAFS website; Journal publisher's website		ILRI & partners (PIK, U. Kassel, IER (Mali), IIAM (Mozambique), IFPRI); CIMMYT & partners (IFPRI Global Futures Project, SIMLESA project (Africa) CSISA project (IGP), IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway)* WRI- Ghana, PIK, ZEF, MRC
Milestone 2.1.1.6 Report produced and journal article published on institutions and economic incentives that would allow the poor to gain more access and to better manage water across uses, space and time in the IGP (2012)	Report and journal article completed and disseminated	CCAFS website		IFPRI & partners (Departments of fisheries, Fresh Water Fisheries Research Center, Chinese Academy of Fishery Science, Inland Consortium in Mali, Ministry of Fisheries in Vietnam)
Output 2.1.2 Analytical framework and tools to target and evaluate risk management innovations for resilient rural livelihoods and improved food security				
Milestone 2.1.2.1 Framework report produced and prototype farm household modeling tools developed for evaluating impacts of climate risk and risk management interventions on livelihood resilience (2011)	Framework report and prototype tools completed and disseminated	CCAFS website	Same as Output 2.1.1	Resilience Alliance, ILRI, CIP, WorldFish
Milestone 2.1.2.2 Analytical methodology and robust tools developed for evaluating impacts of climate risk and risk management interventions on rural livelihood resilience (2012)	Functional modeling tools completed and disseminated	CCAFS website		Household bioeconomic modeling expertise TBD

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 2.1.2.3 Methodology for incorporating technology, diversification, climate-informed adaptive management, financial risk transfer and safety net interventions into comprehensive agricultural risk management portfolios that target particular farming systems and contexts (2014)	Methodology embodied in tools, outlined in report and disseminated	CCAFS website		Household bioeconomic modeling expertise TBD, relevant NARES
Output 2.1.3 Development; and demonstration of the feasibility, acceptability and impacts; of innovative risk management strategies and actions for rural communities				
Milestone 2.1.3.1 Participatory pilot demonstrations initiated to develop and evaluate current and improved risk management strategies and actions with rural communities at benchmark locations in 2 countries each in EA, WA and IGP (2011)	Pilot demonstration sites and partners in 6 countries	Monitoring and evaluation reports from demonstration sites; progress reviewed in annual reporting	Same as Output 2.1.1	Pilot demonstration project teams (NMS, NARS, other research partners, development NGOs, farmer associations) to be developed for each benchmark location
Milestone 2.1.3.2 Current strategies and actions for managing climate-related risk documented for rural communities at benchmark locations in EA, WA and IGP (2011)	Documentation completed and disseminated	CCAFS website		Pilot demonstration project teams at benchmark locations; ILRI & partners (PIK, U. Kassel, IER (Mali), IIAM (Mozambique), IFPRI); CIMMYT & partners (IFPRI Global Futures Project, SIMLESA Project, CSISA project, IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway), IRD-France
Milestone 2.1.3.3 Participatory pilot demonstrations to develop and evaluate current and improved risk management strategies with rural communities at benchmark locations initiated in 6 additional countries (2012)	Pilot demonstration sites and partners in 6 countries	M&E reports from demonstration sites & progress reviewed in annual reporting		Pilot demonstration project teams (NMS, NARS, other research partners, development NGOs, farmer associations) to be developed for each benchmark location
Milestone 2.1.3.4 Participatory evaluation of risk management interventions at initial set of pilot demonstrations at benchmark locations in EA, WA and IGP presented in report and journal paper (2013)	Report completed and journal paper published and disseminated	CCAFS website; Journal publisher's website		Pilot demonstration project teams at benchmark locations; CIMMYT & partners (NARS: EIAR (Ethiopia), KARI (Kenya), SIMLESA project, ICAR (India), BARI (Bangladesh), Nepal Agric. Res. Council; IRRI, Cereal Systems Initiative for South Asia)
Milestone 2.1.3.5 Model-based evaluation of impact of risk management interventions on household livelihood resilience within pilot demonstrations in EA, WA and IGP presented in report and journal paper (2014)	Report completed and journal paper published and disseminated	CCAFS website; Journal publisher's website		Pilot demonstration project teams, relevant bioeconomic modeling expertise TBD

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 2.1.3.6 Participatory evaluation of risk management interventions at second set of participatory pilot demonstrations presented in report and journal paper (2015)	Report completed and journal paper published	CCAFS website; Journal publisher's website		Pilot demonstration project teams (NMS, NARS, other research partners, development NGOs, farmer associations) to be developed for each benchmark location
Output 2.1.4 Tailor and disseminate research results for evidence-based policy and technical support for farm- to community-level risk management strategies				
Milestone 2.1.4.1 Knowledge-sharing platform developed with active participation of other relevant initiatives working on agricultural risk management (2012)	Electronic platform completed with engagement by minimum 50 participants from the agricultural R&D community	CCAFS website; results summarized in annual reporting	Same as Output 2.1.1	Knowledge sharing expertise TBD
Milestone 2.1.4.2 Web-based platform to synthesize and exchange information about farmers' strategies for managing climate-related agricultural risk, closely coordinated or combined with platform developed in Theme 1 (2013)	Web-based platform publicly available	CCAFS website		Knowledge sharing expertise TBD
Milestone 2.1.4.3 Policy-oriented workshop delivered and summary report produced on scaling up pilot participatory action research activities and partnerships (2013)	Workshop held; 12-15 participants from NARS and agricultural development organizations; summary report completed and disseminated	Workshop agenda and participant lists; CCAFS website		Pilot demonstration project teams, others TBD
Milestone 2.1.4.4 Curriculum developed on targeting and evaluating comprehensive agricultural risk management strategies for rural communities (2015)	Curriculum completed, tested and disseminated	CCAFS website		Training and bioeconomic modeling expertise TBD
Output 2.1.5 Identify and evaluate differential impact of agricultural risk management strategies on different social groups, particularly women and men, and communicate findings through technical and policy support activities				
Milestone 2.1.5.1 Guidelines developed for ensuring equitable participation of women and other socially disadvantaged groups in participatory action research on climate-related risk management. (2011)	Guidelines completed and disseminated	CCAFS website	Same as Output 2.1.1	Gender expertise TBD through competitive call
Milestone 2.1.5.2 Summary report of gender and social differentiation of current risk management strategies and access to associated information and services at benchmark locations in 2 countries each in EA, WA and IGP (2013)	Report completed and disseminated	CCAFS website		Gender consultant TBD; Pilot demonstration project teams for each benchmark location
Milestone 2.1.5.3 *Assessment framework to understand gender differences in climate risk perception, aversion and their influence on risk management (2015)	Framework completed and disseminated	CCAFS website		WorldFish & partners (Bangladesh Agric. U., Bangladesh Dep't. Fisheries, Integrated Coastal and Fisheries Governance, (ICFG) Project for Western Region of Ghana, Institut d'Economie Rurale Mali)

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Objective 2.2 Identify and test tools and strategies to use advance information to better manage climate risk through food delivery, trade and crisis response				
Outcome 2.2: Better climate-informed management by key international, regional and national agencies of food crisis response, post-crisis recovery, and food trade and delivery in at least 12 countries				
Output 2.2.1 Enhanced knowledge of impacts of climate fluctuations on food security, and how to use advance information to best manage climate-related risk through food delivery, trade, crisis response and post-crisis recovery				
Milestone 2.2.1.1 Report and journal article on impacts of climate variability on components (e.g., production, prices, rural incomes, consumption, trade, humanitarian assistance) of food security; and review of policies to mediate impacts in EA, WA and IGP (2011)	Report completed and journal paper published and disseminated	CCAFS website; Journal publisher's website	Capable food security and trade organizations available to participate. Adequate market, climate and livelihood data are available	TBD through competitive call
Milestone 2.2.1.2 Analysis of drivers and impacts of food price volatility reported for 2 countries each in EA, WA, and IGP (2012)	One report for each CCAFS region (3) completed and disseminated	CCAFS website		TBD through competitive call
Milestone 2.2.1.3. Food security organizations engaged to explore and develop new response strategies based on long-lead prediction (2012)	Network of food security response organizations (3-5) in each CCAFS region (3)	Feedback from engaged organizations documented in annual reporting		Key food security (WFP, FAO, CARE, FEWSNet) and trade organizations, locally-relevant actors in food trade and crisis response, Tufts U.
Output 2.2.2 Synthesized knowledge and evidence of the impacts of alternative risk management interventions within the food system on food security and rural livelihoods, to inform policy and practice				
Milestone 2.2.2.1 Report and policy brief on the costs associated with timing and targeting of alternative food crisis interventions (2011)	Report and policy brief completed and disseminated	CCAFS website	Same as Output 2.2.1	WFP, IRI
Milestone 2.2.2.2 Policy brief synthesizing state of knowledge on policy approaches for managing food crises and price volatility for key staple crops in EA, WA and IGP (2012)	Report completed and disseminated	CCAFS website		CIMMYT & partners (IFPRI Global Futures Project, SIMLESA Project, CSISA project, IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway)
Milestone 2.2.2.3 Three response strategies tested and evaluated with partner crisis response organizations in selected areas in each CCAFS region; summarized in project report (2013)	3 response strategies tested in each CCAFS region; summary report completed and disseminated	Feedback from engaged organizations documented in annual reporting		Key food security response organizations TBD
Milestone 2.2.2.4 Report produced synthesizing evidence of impacts of national to regional-level food security and food market interventions on household-level food security and livelihoods, and on incentives for local agricultural market development, presented to relevant line ministries and international agencies working on food security in 6 CCAFS countries (2013)	Report completed and shared with target audiences	CCAFS website; feedback from engaged ministries and organizations documented in annual reporting		TBD through competitive call

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Output 2.2.3 Platform and tools for sharing knowledge and fostering improved coordination among food crisis response, the market-based food delivery system, and agricultural research and development				
Milestone 2.2.3.1 Report and policy brief of an international food system stakeholder consultation to develop a collaborative strategy for improving intervention, coordination, capacity to respond to improved climate-related information (2011)	Report completed and disseminated	CCAFS website	Same as Output 2.2.1	Relevant international food security early warning and response organizations, Tufts U.
Milestone 2.2.3.2 Study and stakeholder consultation on regional agricultural and food security contingency planning processes, current and potential use of climate-related information, and strategy for improving planning and coordination in EA, WA and IGP (2011)	3 workshops each engaging at least 10 participants; Study report completed and disseminated.	CCAFS website		Relevant regional and national food security, food trade, climate information, early warning and agricultural planning organizations
Milestone 2.2.3.3 Knowledge-sharing platform to foster partner engagement and coordination among actors on key issues/problems related to crisis response, food delivery, and agricultural R&D (2012)	Electronic platform completed with engagement by minimum 50 participants from the crisis response, food delivery, and agricultural R&D communities	CCAFS website; correspondence archived and summarized for annual reporting		Knowledge sharing expertise TBD
Milestone 2.2.3.4 Workshops held in two focus regions to develop a consensus roadmap for enhancing coordinated response of food delivery, trade, and crisis and post-crisis management, to climate fluctuations; strategy for maintenance of electronic platform developed (2014)	2 workshops held each with participation by at least six organizations; report on sustainability strategy completed and disseminated	CCAFS website		Relevant regional and national food security, food trade, climate information, early warning and agricultural planning organizations
Output 2.2.4 Identify and evaluate differential impact of tools and strategies for climate risk management on different social groups, particularly women and men, and inject findings into support to agencies				
Milestone 2.2.4.1 Review paper produced on food security, social differentiation, and climate risk management with policy advice on how to enable equitable access for different social groups (2013)	Report completed and disseminated	CCAFS website	Same as output 2.2.1	TBD through competitive call

Objective 2.3 Support risk management through enhanced prediction of climate impacts on agriculture, and enhanced climate information and services				
Outcome 2.3 Enhanced uptake and use of improved climate information products and services, and of information about agricultural production and biological threats, by resource-poor farmers, particularly vulnerable groups and women, in at least 12 countries				
Output 2.3.1 Improved climate information tools and products to support management of agricultural and food security risk				
Milestone 2.3.1.1 Historic gridded daily rainfall dataset, combining observations and satellite images, developed and evaluated for 1 country each in EA and WA (2011)	Dataset for 2 countries completed and disseminated; evaluation report completed and disseminated	CCAFS website; results presented in annual reporting	Review will identify suitable opportunities to enhance early warning and management of strategic climate-sensitive biological threats. Institutional and technological capacity is sufficient to support widespread delivery of climate services. NMS and regional climate centers participate and share data. Full set of METEOSAT images processed and available. Availability of data. Participatory evaluation (under Objectives 1 and 2) will identify demand, relevant uses for climate-related information. Effective collaboration with food security early warning organizations. Uptake by key food security, trade and index insurance users. Demonstrated feasibility of forecasting strategically important biological threats	U. Reading (TAMSAT), IRI, AGRHYMET, Ethiopia Nat'l Met. Authority
Milestone 2.3.1.2 Prototype seasonal forecast information products tailored and evaluated for local agricultural decision-making in 2 countries each in EA, WA (2011)	Tailored products developed for benchmark locations in 2 countries and made publicly available	CCAFS website; results presented in annual reporting		Senegal Met. Authority, AGRHYMET, ACMAD, IRI, CEREGE, ICRISAT & partners (Zimbabwe Met. Dep., AGRITEX, NGOs)
Milestone 2.3.1.3 Historic gridded daily data set of meteorological variables required for agricultural modeling applications, developed, calibrated and evaluated in 1 country each in EA and WA (2012)	Dataset completed and evaluated for 2 countries and disseminated	CCAFS website; results presented in annual reporting		TBD through competitive call, relevant NMS
Milestone 2.3.1.4 System developed for downscaling seasonal forecast products onto gridded daily meteorological dataset for local agricultural decision-making in EA, WA (2014)	Tools and methodology made available for use by NMS and regional climate centers	Feedback from decision-makers documented in annual reporting		ACMAD, AGRHYMET, IRI, CEREGE
Output 2.3.2 Synthesized knowledge and evidence on institutional arrangements and processes for enhancing climate services for agriculture and food security				
Milestone 2.3.2.1 Report and journal article produced on synthesis and program strategy for needs, constraints and opportunities for enhancing climate services, and institutional and ICT-based information delivery	Report completed and journal paper published	CCAFS website; Journal publisher's website	Same as Output 2.3.1	ACMAD, IGP consultants, IRI

mechanisms for agricultural risk management (2011)				
Milestone 2.3.2.2 Prototype climate information delivery mechanisms demonstrated and evaluated with rural communities at 2 benchmark locations each in EA, WA and IGP (2012)	Demonstration in 2 benchmark locations	Monitoring and evaluation reports from demonstration sites; progress reviewed in annual reporting		ICT partners, pilot demonstration project teams (NMS, NARS, NGOs, farmer association, research partners) to be developed for each benchmark location
Milestone 2.3.2.3 Protocols for communicating probabilistic climate forecast and early warning information demonstrated, refined and evaluated with rural communities at 2 benchmark locations each in EA, WA and IGP (2012)	Demonstration in 2 benchmark locations	Monitoring and evaluation reports from demonstration sites; progress reviewed in annual reporting		Pilot demonstration project teams for each benchmark location, IRI, ICRISAT, Emory U.
Output 2.3.3 Improved knowledge, tools, data sets and platforms for monitoring and predicting agricultural production and biological threats, and informing management, in response to climate fluctuations				
Milestone 2.3.3.1 Proof-of-concept on remote sensing data assimilation for crop and rangeland production forecasting reported (2011)	Report completed and disseminated	CCAFS website	Same as Output 2.3.1	NASA-JPL, IRI, ICRISAT, IER (Mali)
Milestone 2.3.3.2 Predictability of crop production and prices from climate information in the IGP reported (2011)	Report completed and disseminated	CCAFS website		BARC, NARC, ICAR
Milestone 2.3.3.3 Synthesis report on climate-sensitive pest and disease modeling and early warning systems for agricultural and food security risk management (2011)	Report completed and disseminated	CCAFS website		Kansas State U.
Milestone 2.3.3.4 Crop and rangeland production forecasting platform, documentation and training materials developed (2013)	Electronic platform publicly available; summary document and training materials completed and disseminated	CCAFS website		FAO, JRC, ILRI, IRI, other partners TBD
Milestone 2.3.3.5 Report and journal article on accuracy and lead time of improved crop forecasting methods (2013)	Report completed and journal paper published	CCAFS website; Journal publisher's website		NARS, NMS in relevant country; FAO, JRC, IRI, other partners TBD
Milestone 2.3.3.6* Early warning systems developed for 2 major biological threats to agriculture (2013)	Early warning systems operational in 2 regions, in cooperation with 6 partner organizations	Results presented in annual reporting		CIP & partners (EMBRAPA, MP3-RTB, IITA, ICIPE-International Centre for Insect Physiology and Ecology); Others TBD through competitive call
Output 2.3.4 Enhanced capacity of national and regional climate information providers, NARES and communication intermediaries to design and deliver climate information products and services for agriculture and food security management				
Milestone 2.3.4.1 Training and facilitation for NMS to develop and evaluate daily gridded historic rainfall data from station observations and satellite products upscaled in EA and WA (2012)	2 trainings, each delivered to 8-12 participants each	Training participant lists; Results documented in annual reporting	Same as Output 2.3.1	NMS, WMO, U. Reading, IRI

Milestone 2.3.4.2 Training and facilitation to develop and evaluate daily gridded historic temperature from station observations and proxies in EA and WA (2012)	2 trainings, each delivered to 8-12 participants	Training participant lists; Results documented in annual reporting		NMS, WMO, research partners TBD through competitive call
Milestone 2.3.4.3 Tools and curriculum for meteorologists to produce downscaled seasonal forecast products tailored to needs of local agricultural decision-makers (2012)	Tools publicly available; Curriculum delivered to at least 2 organizations each in 3 regions	CCAFS website; Results documented in annual reporting		Training expertise TBD, ACMAD, AGRHYMET, IRI, CEREGE
Milestone 2.3.4.4 NMS, regional climate centers trained and equipped to produce downscaled seasonal forecast products for rural communities in 2 countries each in WA, EA and IGP (2013)	3 trainings delivered to 6-10 participants each	Training participant lists; Results documented in annual reporting		ACMAD, AGRHYMET, ICPAC, IRI, CEREGE
Milestone 2.3.4.5 Curriculum to train intermediaries to communicate probabilistic climate information with rural communities (2013)	6 trainings delivered to 12-15 participants each	Training participant lists; Results documented in annual reporting		Training and communication expertise TBD through competitive call
Milestone 2.3.4.6 Improved crop forecasting methodology incorporated into operational system in 2 countries (2014)	Methodology implemented in 2 national or regional operational crop forecasting systems	Review of inputs into regional forecasting system		National partners (NMS, NARS), ACMAD, AGRHYMET, CIRAD, FAO, others TBD
Milestone 2.3.4.7 Roadmap for improving climate information services for agriculture and food security in three initial target regions (2014)	Workshop and report completed for 3 regions and disseminated	CCAFS website		Regional climate centers, relevant national partners (NMA, farmer associations, NARES, food security planning, ICT4D), WMO, IRI
Output 2.3.5 Identify and evaluate differential impact of climate information services on different social groups, particularly women and men, and inject findings into support to farmers				
Milestone 2.3.5.1 Summary report on gender and social equity of climate information sources and delivery mechanisms and policy advice to enable equitable access (2012)	Report completed and disseminated	CCAFS website	Same as Output 2.3.1	Gender and communication expertise TBD
Milestone 2.3.5.2 Demonstration and evaluation of gender- and socially-equitable climate service delivery at 2 benchmark locations each in EA, WA, IGP (2013)	6 demonstrations in benchmark locations	Results documented in annual reporting		Pilot demonstration project teams for each benchmark location
Milestone 2.3.5.3 Curriculum developed for intermediaries on overcoming gender and social inequities in communicating climate information (2014)	Curriculum completed and disseminated	CCAFS website		Training and gender expertise TBD through competitive call

Theme 3. Pro-Poor Climate Change Mitigation

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Objective 3.1 Inform decision makers about the impacts of alternative agricultural development pathways				
Outcome 3.1: Enhanced knowledge about agricultural development pathways that lead to better decisions for climate mitigation, poverty alleviation, food security and environmental health, used by national agencies in at least 20 countries				
Output 3.1.1 Analysis of agricultural development pathways and the trade-offs among mitigation, poverty alleviation, food security and environmental health				
Milestone 3.1.1.1 Report on potential emissions reductions from technical options compatible with maintaining food supply (2011)	Report completed and disseminated	CCAFS website	Agricultural intensification will be necessary to meet future food demand. Mitigation will be possible among resource-poor farmers. Preliminary data ready from PhD network (Objective 2)	Winrock, Applied Geosolutions, BIDS, BCAS
Milestone 3.1.1.2*Report on potential emissions reductions from technical options compatible with maintaining food supply under alternative intensification scenarios. (2011)	Report completed and disseminated	CCAFS website		IFPRI, NARS in Ghana, Senegal, Mali, Uganda, Kenya, India, Nepal, Bangladesh
Milestone 3.1.1.3 Report on mitigation implications of alternative adaptation strategies (2013)	Report completed and disseminated	CCAFS website		Tender (NARS in Kenya, Ethiopia, Ghana, Senegal, Bangladesh, India, ASARECA, CORAF, Centre de Suivi Ecologique (CSE))
Milestone 3.1.1.4. Synthesis report and scientific article on transformative agricultural development pathways (2013)	Report and journal article completed and disseminated	CCAFS website		Winrock, Applied Geosolutions, BIDS, BCAS, Terrestrial Carbon Group, National agricultural research institutes
Milestone 3.1.1.5. Assessment report on regional and national agricultural development policies, mitigation policies and mitigation projects and their implications for mitigation, poverty alleviation and food security (2011)	Assessment report completed and disseminated	CCAFS website		ECOWAS, UEMOA, CILSS, CORAF, ASARECA, South Asia (TBC)
Output 3.1.2 Enhanced tools, data and analytic capacity in regional and national policy and research organizations to analyze the implications of different development scenarios and mitigation strategies				
Milestone 3.1.2.1 *Framework for comparison of environmental footprint of agricultural systems (ILRI) (2011)	Framework completed and disseminated	CCAFS website	Same as Output 3.1.1	TBC

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 3.1.2.2 *Synthesis reports on sectoral mitigation potentials and emissions factors for IPCC and national and regional bodies covering: (i) cereal-based intensive agriculture (CIMMYT); (ii) livestock, analyzed by country (ILRI); (iii) aquaculture sector, analyzed through supply chain (WorldFish)(2012)	Synthesis reports completed and disseminated, database available	CCAFS website, database on CCAFS or partner website		IFPRI (Global Futures Project), SIMLESA Project (Africa) CSISA project (IGP-Asia), IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway, IIAA, FAO
Milestone 3.1.2.3 *Options for mitigation in each sector identified and shared with policy makers, researchers and actors in the sector through consultations, workshop, analysis and syntheses (2013)	Consultations provided to 50 individuals. 3 workshops engage 100 participants.	CCAFS website; workshop agendas and participant lists; documentation for annual reporting		TBC, CARE, OXFAM
Milestone 3.1.2.4 Capacity building of 300 decision makers in use of appropriate tools and data in three initial regions (2012)	300 decision makers trained using tools	Monitoring and evaluation reports		START, WOCAN, FAO
Milestone 3.1.2.5 Cross-sectoral synthesis report and policy briefs completed and shared in major global fora on climate change and food security (2013)	Report and policy briefs disseminated at 3 major international meetings. Report and policy briefs downloaded 200 times from web	meeting agendas, web portal statistics		TBC (scenario experts and NARS)
Output 3.1.3 Analysis of the gender and social differentiation implications of alternative agricultural pathways and findings built into communications and capacity building activities				
Milestone 3.1.3.1 Global expert workshop on the impacts of alternative mitigation scenarios on women and marginalized farmers (2012)	Workshop held; 12-15 participants representing major regional and international organizations dealing with gender issues	workshop agenda; feedback from participants documented in annual reporting	Same as Output 3.1.1	FAO, WOCAN, ICRW
Milestone 3.1.3.2 Synthesis report on the impacts of alternative agricultural development scenarios on women and marginalized farmers (2013)	Synthesis report completed and disseminated	CCAFS website		FAO, WOCAN, ICRW
Milestone 3.1.3.3 Findings on differential impact incorporated in global forums, capacity building events and websites (2013)	Synthesis report disseminated at 3 major international meetings and included in at least 1 capacity building event in each region. Report downloaded 200 times from web portal	meeting agendas, M and E reports, web portal statistics		FAO, WOCAN, ICRW

Objective 3.2 Identify institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to reduce GHGs and improve livelihoods				
Outcome 3.2: Improved knowledge about incentives and institutional arrangements for mitigation practices by resource-poor smallholders (including farmers' organizations), project developers and policy makers in at least 10 countries				
Output 3.2.1 Evidence, analysis and trials to support institutional designs, policy and finance that will deliver benefits to poor farmers and women, and reduce GHG emissions				
Milestone 3.2.1.1 Reviews of promising incentives, institutions, market-based mechanisms and policies at project and national scales, in three initial target regions, including (i) carbon as co-benefit to more productive agricultural practices, (ii) carbon markets, (iii) corporate social responsibility technical assistance, (iv) carbon labelling, summarized in four articles, policy briefs and posted on webpage (2011)	4 policy briefs and scientific articles completed and disseminated. Webpage developed.	CCAFS website; Journal publisher's website	Carbon market participation and potential benefits will be uneven among regions and farmers. Likely positive benefits of conservation agriculture for mitigation. Resource-poor farmers will participate in carbon markets if incentives are sufficient. Investors see agriculture-based markets as profitable. Institutional arrangements, market-based instruments, policies and incentives exist and have had sufficient experience to show results	FAO, World Bank, BRAC, Pradan, Nature Conservation Research Centre, IIED, IFPRI, ICRA, EcoAgriculture Partners, Ecotrust, Sustainable Food Lab, Unilever, Vi Agroforestry, World Bank, and NARS
Milestone 3.2.1.2 Experts workshop to identify the design and monitoring requirements of finance and institutional arrangements to better benefit poor farmers and women (2011)	Workshop held; 12-15 participants representing major international and regional organizations dealing with gender issues; Expert consultation completed and summarized; report disseminated	CCAFS website		CarbonBenefits, FAO, Vi Agroforestry, CARE, Ecotrust, EcoAgriculture, World Bank, IIED, CLUA, NARS
Milestone 3.2.1.3 *In-depth analysis of the economic incentives and benefits to farmers for integrated practices (conservation agriculture, sustainable land management, and agroforestry) in three initial target regions, linked to Milestone 3.3.1.1 and 3.3.2.2(CIMMYT, IFPRI) (2012)	Journal article completed and disseminated	CCAFS website; Journal publisher's website		IFPRI (Global Futures Project), SIMLESA Project (Africa) CSISA project (IGP-Asia), IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway
Milestone 3.2.1.4 *Innovative institutional arrangements and incentive mechanisms developed and tested for 1000 smallholders in 9 benchmark sites, (together with testing of MRV methods in 3.3.2.2.) (ICRAF), (2013)	Contracts with 1000 farmers, summary document completed and disseminated; webpage developed; 1 workshop per CCAFS region	CCAFS website		Local research partners in benchmark site countries, Vi, CARE, TIST, Mali/Guinea/Asia partners

Milestone 3.2.1.5 *Synthesis report of underlying factors affecting sustainable land management across case study countries (including Kyrgyzstan, Nigeria, Mali, Southern Africa) with attention to gender issues, distribution of assets, and land markets (IFPRI) (2012)	Synthesis report completed and disseminated	CCAFS website+F11		INERA, CG Centers, Kyrgys Research Institute of Agriculture, SOFESCA, IER (Mali), PAC, NFDO, GRADE, NARO
Output 3.2.2 Improved capacity to increase the uptake and improve the design of incentives mechanisms and institutional arrangements to deliver benefits to poor farmers and women				
Milestone 3.2.2.1 Decision-makers in target regions better informed re options and policy choices for incentivizing and rewarding smallholders for GHG emission reductions (2013)	Consultations with 30 decision-makers across target regions	Workshop participation lists	Same as Output 3.2.1	Gov't agencies, University networks (RUFORUM, ANAFE, SCARDA)
Milestone 3.2.2.2 *Publication, story and films showcasing barriers to entry and factors affecting access to the carbon market for differentiated social groups, including women and the range of emerging institutional arrangements and incentives for better inclusion and benefits (ICRAF) (2012)	Publication, story and films completed with Vi, CARE, TIST	Publication, story and films on website with Vi, CARE, TIST		Vi, CARE, TIST, CarbonBenefits, FAO, Vi Agroforestry, CARE, Ecotrust, EcoAgriculture, World Bank, IIED, CLUA, NARS
Milestone 3.2.2.3 Training for project implementers on designing finance and institutional arrangements and safeguards specifically to benefit poor farmers and women (2013)	Workshops provide training to 50 individuals per CCAFS region (3)	Workshop participation lists		CarbonBenefits, FAO, Vi Agroforestry, CARE, Ecotrust, EcoAgriculture, World Bank, IIED, CLUA, NARS

Objective 3.3 Test and identify desirable on-farm practices and their landscape-level implications				
Outcome 3.3: Key agencies dealing with climate mitigation in at least 10 countries promoting technically and economically feasible agricultural mitigation practices that have co-benefits for resource-poor farmers, particularly vulnerable groups and women				
Output 3.3.1 Analysis of mitigation biophysical and socioeconomic feasibility for different agricultural practices and regions, and impacts on emissions, livelihoods and food security				
Milestone 3.3.1.1 *Assessment of feasibility and impacts of mitigation practices for (i) conservation agriculture and sustainable land management (CIMMYT, IFPRI) in rice-wheat and maize-legume systems in 3 target regions, (ii) rice production through improved irrigation and fertilizer management (IRRI), (iii) dryland cropping systems (ICRISAT), (iv) agroforestry and complex agro-ecosystems (ICRAF), (iv) livestock (ILRI), (v) potatoes and sweet potatoes (CIP), (vi) N20 emissions from land use change and peatland conversation to plantation agriculture in 3 target regions of SE Asia (CIFOR), (vii) charcoal as energy alternative (ICRAF) (2012)	Multi-year farm trials, datasets, 7 scientific articles, 7 policy briefs and dissemination	CCAFS and partners websites; journal website	Interest and willingness of partners to contribute findings to platform. Simple methods can be devised for widespread application. Improved carbon balances are possible in these food systems. Strong participation from all partners. Cost effective measures and MRV are possible. Sufficient data exists to validate simulation models. Practices that increase mitigation, livelihood benefits and environmental benefits are possible. Uptake of guidelines	NARES in India, Indonesia, Vietnam, and Philippines, ARI in Japan, Germany, USA, Australia; WWF; UNEP; MSU; CSU; CORNELL, VI Agroforestry; RF; CCAFS; CARE, IIASA, FAO, Ethiopian Institute of Agricultural Research (EIAR); Kenyan Agricultural Research Institute (KARI); Sustainable Intensification on Maize-Legume Systems in Eastern and Southern Africa (SIMLESA) project; Rutgers University, Indian Council for Agricultural Research (ICAR); Bangladesh Agricultural Research Institute (BARI); Nepal Agricultural Research Council; IRRI; Cereal Systems Initiative for South Asia (CSISA); Instituto Nacional de Investigación Forestal, Agrícol y Pecua, INERA, CG Centers, Kyrgys Research Institute of Agriculture, SOFESCA, IER (Mali), PAC, NFDO, GRADE, NARO, JKUA; DENR; UPLB; COMART, IFPRI (Global Futures Project), SIMLESA Project (Africa) CSISA project (IGP-Asia), IITA, ICARDA, ICAR, EIAR, UMB-USA, UMB-Norway, African Conservation Tillage Network (ACT), Global Research Alliance

Output 3.3.2 Methods developed and validated for GHG monitoring and accounting at farm and landscape level to contribute to compliance and voluntary market standards				
Milestone 3.3.2.1 Expert and stakeholder consultations on methods appropriate for smallholder farmers through one global workshop and workshops in each of the 3 initial target regions (2011)	Workshops engage 25 participants each. Consultations completed and summarized.	workshop agendas and participant lists; CCAFS website	Same as Output 3.3.1	U. of Aberdeen, Sustainable Food Lab, X-AGG, Duke University, CORAF, ASARECA, RWC, Global Research Alliance
Milestone 3.3.2.2 *Data and methods for carbon measurement and monitoring for integrated agricultural systems (complex landscapes, integrated agriculture, forestry and aquaculture, rangeland and livestock) (ICRAF, WorldFish, ICARDA, ILRI); includes equipment validation for soil carbon field assessments (CIP) (2013)	Data, methodologies, tools and guidelines shared through websites, policy briefs and scientific article	CCAFS website; Journal publisher's website		WWF; UNEP; MSU; CSU, Embrapa, Centre of Excellence on Environmental strategy for GREEN business (VGREEN-KU) Kasetsart University, Thailand; ARIs, NARS and universities in the CWANA region, Global Research Alliance, , Princeton University, German Marshall Fund
Milestone 3.3.2.3 Field research initiated at benchmark sites to assess trade-offs for different sectors of agricultural mitigation (livestock, soil carbon, agroforestry) based on biophysical and livelihood outcomes (2012)	Field trials in operation in 10 CCAFS benchmark sites across 3 initial target regions	Benchmark sites M and E reports		Partners at CCAFS benchmark sites
Milestone 3.3.2.4 Network of PhD students launched for studying GHGs in developing country agriculture to test methods and develop further innovations, linked to Milestone 3.3.2.2 and 3.3.2.3 (2011)	20 PhD students engaged in network per CCAFS region	M and E reports of research network		Copenhagen University, ASARECA, CORAF
Milestone 3.3.2.5 *Assessment reports on technical and institutional capacity for national-level measurement and monitoring in 3 target countries (CIFOR) (2012)	Assessment reports completed and disseminated	CCAFS website		CIFOR and NARS
Milestone 3.3.2.6 *Scientific papers and report on issues in estimating and managing carbon stocks in rural landscapes through participatory, community-based monitoring (CIFOR) (2012)	Report completed and journal articles published and disseminated	CCAFS website; Journal publisher's website		CIFOR and NARS
Milestone 3.3.2.7 *Training material and online tutorials on estimating and managing carbon stock provided in three target countries (CIFOR) (2013)	Training material completed and disseminated; online tutorial publicly available	CCAFS website		CIFOR and NARS
Milestone 3.3.2.8 Project design and monitoring guidelines for smallholder agriculture in developing countries produced and contributing to global standards (2013)	Guidelines completed and disseminated	CCAFS website		CIFOR, VCS, ACR, CAR
Milestone 3.3.2.9 Workshop with standard-setting bodies (VCS, ACR, etc) to share methods synthesis guidelines for smallholder agriculture in developing countries (2013)	Workshop engages representatives of 5 major offset markets	workshop participant lists		X-AGG, VCS, CCBA, Rainforest Alliance, Unilever

Output 3.3.3 Synthesis of understanding about the direct and indirect economic and environmental costs and benefits from agricultural mitigation				
Milestone 3.3.3.1 Analysis and report on direct and indirect economic and environmental costs and benefits from agricultural mitigation (2013)	Workshop and synthesis report completed and disseminated	CCAFS website	Same as Output 3.3.1	see 3.3.2.1. 3.3.2.2, 3.3.2.3
Milestone 3.3.3.2 Web-based communications platform and clearinghouse launched identifying mitigation impacts of on-farm practices and their landscape-level implications (2013)	Platform and clearinghouse developed and made publicly available	CCAFS website		FAO, University of Kansas, Global Research Alliance
Milestone 3.3.3.3 Workshop for national agencies to review mitigation options and their impacts (2013)	50 national agency personnel engaged in 1 workshops per CCAFS region	Workshop participant lists		FAO, Global Research Alliance
Output 3.3.4 Analysis of impacts of on-farm and landscape level practices on women and poor farmers				
Milestone 3.3.4.1 Research report on D38 (2013)	Report completed and disseminated	CCAFS website		Research partners in benchmark site countries and U Michigan

Theme 4. Integration for Decision Making

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Objective 4.1 Explore and jointly apply approaches and methods that enhance knowledge to action linkages with a wide range of partners at local, regional and global levels				
Outcome 4.1: Appropriate adaptation and mitigation strategies mainstreamed into national policies in at least 20 countries, in the development plans of at least five economic areas (e.g. ECOWAS, EAC, South Asia) covering each of the target regions, and in the key global processes related to food security and climate change				
Output 4.1.1 For each region, coherent and plausible futures scenarios to 2030 and looking out to 2050 that examine potential development outcomes under a changing climate and assumptions of differing pathways of economic development; developed for the first time in a participative manner with a diverse team of regional stakeholders				
Milestone 4.1.1.1 Capacity built among three regional teams of diverse stakeholders trained in scenarios approaches and engaging with policymakers in their countries/regions and in global CC processes and with the ESSP community; Methodological briefs, papers (2011)	Regional scenarios partners actively participating in regional food security debates and global CC processes (e.g. UNFCCC negotiations and COP). Number of partners using/citing scenarios; No. of regional partners trained in scenarios participating in regional FS debates and global CC processes	CCAFS and partner websites and reports; Newspaper and other media reports	Partners remain engaged and help communicate scenario research results widely and to inform key decision makers	Regional Ag Research Orgs (incl. NARS): ASARECA (EA); CORAF, AMCEN (WA); RWC (IGP); Regional policy orgs: NEPAD, CAADP; Int'l NGOs: CARE Int'l; Oxfam; Regional NGOs: Ecotrust (EA); SahelEco, AMEDD (WA); CEAPRED & FPRO (IGP); Private Sector: Katoomba Grp (EA); Technico Pty Limited (IGP); Farmers Orgs: EAFF (EA); ROPPA (WA), IFAP (Int'l); Regional Meteo Orgs: ACMAD, AGRHYMET, ICPAC
Milestone 4.1.1.2 Three sets of prototype regional scenarios produced (main regional uncertainties identified, initial regional storylines developed, reports and initial scoping for model analysis). Article on effectiveness of scenarios as a 'boundary object' (2011)	Scenarios reports for EA, WA and IGP available on CCAFS and partners websites; Local media reports from each region	CCAFS website; Newspaper and other media reports	Local media find futures scenarios worthy of reporting; local and regional partners actively participate	Regional Ag Research Orgs (incl. NARS): ASARECA (EA); CORAF (WA); RWC (IGP); Regional policy orgs: NEPAD, CAADP; Int'l NGOs: CARE Int'l; Oxfam; Regional NGOs: Ecotrust (EA); SahelEco, AMEDD (WA); CEAPRED & FPRO (IGP); Private Sector: Katoomba Grp (EA); Technico Pty Limited (IGP); Farmers Orgs: EAFF (EA); ROPPA (WA), IFAP (Int'l); Regional Meteo Orgs: ACMAD, AGRHYMET, ICPAC
Milestone 4.1.1.3 Larger public in the three CCAFS regions made aware of climate change and regional food security realities through communication efforts associated with scenarios (2012)	Development of a radio drama, newspaper articles, and brochures	Radio stations relay the drama	Local media find futures scenarios worthy of reporting; local and regional partners actively participate	CCAFS, Panos

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Output 4.1.2 Global and regional maps, tables and associated syntheses, showing current vulnerable agricultural and fishing populations in relation to food security to 2030 and 2050				
Milestone 4.1.2.1 Vulnerability assessment and maps from the three CCAFS regions published and widely disseminated in a paper, policy briefs, conference presentations, workshops, web materials, media stories, inputs to the ag work program/ UNFCCC negotiations, global and regional CC conferences (e.g. COP), contributing to strengthening regional climate and agricultural knowledge platforms/networks and improved CCAFS-related science-user information flows (2012-2013)	Rural ag and fishery community concerns included in UNFCCC negotiations. New regional CCAFS-related working groups and gov't units created in at least 3 regions. CCAFS outputs cited by partners at national, and regional levels. Number of downloads and requests from regional partners for CCAFS products. Number of partners/events in the 3 regions applying processes, tools, approaches bringing together CC-Ag-FS communities in dialogue; number of new projects/programs following these approaches	CCAFS website; Newspaper and other media reports. Partner reports citing CCAFS; presentations and media coverage at ARDD and Ocean Days at COP	Incentives against new interdisciplinary-cross gov't dep't CCAFS-oriented groups aren't too strong.	FANRPAN; START; Africa Acapt; WeAdapt; JotoAfrica; ICAR; BARC; NARC; CAN; CDKN; Harvard Sust. Science program; ICRAF
Output 4.1.3 Evidence on, testing and communication of, successful strategies, approaches, policies, and investments contributing to improved science-informed CC-ag development-food security policies and decision making				
Milestone 4.1.3.1 A new competitive small grants program established for gender-responsive CCAFS research, and funding going to regional female scientists doing research on CCAFS priorities (2011)	Competitive grants program announced on CCAFS and partners websites; female researchers in each region funded through CCAFS	CCAFS and G&D websites; newspaper and other media reports	Local institutions are supportive of female scientists doing CCAFS-related research	ASARECA, CORAF, Gender & CC network; CGIAR Gender & Diversity Program; START; RUFORUM and other regional Univ. networks
Milestone 4.1.3.2 Analysis of lessons learned in a synthesis paper re: Linking knowledge with action from various engagement and communications approaches tested in CCAFS (2012)	Number of downloads of synthesis paper, briefs, blogs; evidence of partners applying such approaches	CCAFS and partner websites; citations of paper, links on partner websites	Partners contribute lessons from being involved in various CCAFS-sponsored engagement processes	Univ. of Oxford, Harvard Univ, ASARECA, CORAF, ICAR, BCAS, CEAPRED, FPRO
Milestone 4.1.3.3 Drawing on Theme 1 and Theme 2, collation of current knowledge on poor farming households' adaptation strategies to climate risk and change in terms of improved crops, livestock, agronomic practices, water, agroforestry and natural resource management across CCAFS baseline sites in 3 regions. Synthesis report and journal article; policy briefs (2015)	Number of technological innovations adopted by farmers; Number of downloads of synthesis paper, policy brief; media reports	Through NARS, extension service agencies, media.	Farmers are willing to learn and adopt new ways to tackle climate change	CGIAR centers, NARES, local NGO and farming organization partners in all sites
Milestone 4.1.3.4 A global conference on synergies between adaptation, risk, and mitigation reflecting on socio-economic issues such as governance, social networks, land tenure, migration, and weather insurance and how they have helped reduce poverty and hunger is held (2012)	Special issue on socioeconomics of climate change, agriculture, and food security; and handbook on methods and indicators to measure poverty and hunger through a socio-economic lens	Special issue and handbook produced		CG Centers, IDS, IIED, FAO

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 4.1.3.5 Exchange of views on best practices of adaptation, risk management and mitigation between at least 15 farmers associations leading to awareness of farming practices around the world (2013)	6 films documenting how farmers adapt, manage risks, and participation in mitigation schemes which are shown through various farmers associations	Through farmers associations that show the film	Farmers are interested in learning about other farmers in different parts of the world	CGIAR Centers, Panos
Output 4.1.4 Analyses providing evidence of the benefits of, strategies for, and enhanced regional capacity in, gender and pro-poor climate change research approaches that will increase the likelihood that CCAFS-related research will benefit women and other vulnerable as well as socially differentiated groups				
Milestone 4.1.4.1 Drawing on Theme 3, CARE-CCAFS report on potential impacts on women and vulnerable groups of new carbon payment schemes; FAO/CCAFS report on gender & climate change issues across CCAFS regions, informing new CCAFS gender strategy (2011)	Number of downloads of CCAFS gender-related reports, briefs, blogs; CCAFS gender work cited in partners' reports/strategies and gender highlighted in national/regional climate, ag and food security strategies	CCAFS, CARE, FAO websites; links on partner websites	Partners able to inform and implement appropriate CC/gender analyses across sites in all CCAFS regions	CARE Int'l; FAO; CGIAR Gender & Diversity Program
Milestone 4.1.4.2 At least 15 partner dialogues on gender and CC issues held and evidence shared in partners' workshops (presentations, maps, papers contributed at their events) (2013)	Number of presentations at partner institutions, mentions of CCAFS-catalyzed information in their reports and websites	Partner events, websites, reports, media reports of national, regional and international CCAFS-related and influenced events	Partners invite CCAFS participation and help share knowledge generated through various means	Regional Ag Research Orgs (incl. NARS): ASARECA (EA); CORAF (WA); RWC (IGP); Regional policy orgs: NEPAD, CAADP; Int'l NGOs: CARE Int'l; Oxfam; Regional NGOs: Ecotrust (EA); SahelEco, AMEDD (WA); CEAPRED & FPRO (IGP); Private Sector: Katoomba Grp (EA); Technico Pty Limited (IGP); Farmers Orgs: EAFF (EA); ROPPA (WA), IFAP (Int'l); Regional Meteo Orgs: ACMAD, AGRHYMET, ICPAC
Milestone 4.1.4.3 A global conference on gender and climate change held pooling together work on gender and engagement in mitigation activities, abiotic stress, conservation of species, genetic diversity, risk management strategies, and impact of climate information in the three CCAFS regions (2012)	A book on gender, climate change, agriculture and food security	Published book	Gender will still be high on the agenda	CGIAR Centers, FAO
Output 4.1.5 Mainstreaming adaptation strategies into national policies, agricultural development plans, and key regional and global processes related to agriculture and rural development, food security and climate change				
Milestone 4.1.5.1 Twenty scenario and vulnerability-focused food security dialogues and new national and regional agricultural policies incorporating climate change (2013)	Number of new national and regional policies and agricultural sector strategies that incorporate CC concerns	National agricultural sector strategies, policy documents, regional partner strategy documents	Decision-makers are informed by, and empowered to use research results to inform new policies, programs and pro-poor and pro-environment strategies	ASARECA, CORAF, Ministries of Ag, CC-units, poverty units

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 4.1.5.2 A paper analyzing boundary processes, organizations and approaches tested in CCAFS to assess the extent to which partnerships have helped to link knowledge with action and mainstream strategies (2013)	A journal article analyzing the role of boundary organizations, processes and boundary objects that have been developed in the CCAFS program	Published article	There have been many multi-stakeholder platforms organized by CCAFS	CCAFS
Output 4.1.6 Building of capacities to engage in global policy making processes and adopt risk management strategies				
Milestone 4.1.6.1 Three trainings sessions are held for a wide variety of stakeholders on UNFCCC negotiation process and policy frameworks such as NAPAs and NAMAs (2011)	Numerous stakeholders are trained in at least 20 countries	Number of certificates of training given	NAPAs and NAMAs are still important policy frameworks	UNFCCC, UNDP, AMCEN
Objective 4.2 Assemble data and tools for analysis and planning				
Outcome 4.2 Improved frameworks, databases and methods for planning responses to climate change used by national agencies in at least 20 countries and by at least 10 key international and regional agencies				
Output 4.2.1 Integrated assessment framework, toolkits and databases to assess climate change impacts on agricultural systems and their supporting natural resources				
Milestone 4.2.1.1 Regional site characterization and baseline data collection completed and analysed in three target regions at three levels: household, village, and institution; Synthesis report presents results of baseline survey of farming households re: soil, land, water, livestock, fisheries and agroforestry management strategies for adapting to a changing climate, and climate-related information access, needs and uses, implemented across 12 countries in over 200 villages and 5,000 households. Synthesis report of institutional-level baseline work. (2011-2012)	13 site reports from baseline surveys made available on CCAFS and partner websites; baseline data shared widely and available on CCAFS website; synthesis CCAFS report and journal article submitted	CCAFS and partner websites	Trained local partners are not hampered by insecurity or other crises/unforeseen events and implement the survey	Univ. of Reading Statistical Group, ASARECA, CORAF, INSAH, ICRAF, ICRISAT, ILRI, IWMI, CEAPRED (Nepal), FPRO (India), BCAS (Bangladesh), CARE Int'l, NARS from Mali, Senegal, Burkina, Niger and Ghana; Univ of Dar & Salian Center (Tanz), Makarere Univ & NARO (Uganda); KARI (Kenya); Managing Risk for Improved Livelihoods (MARIL, Ethiopia)
Milestone 4.2.1.2. Priorities derived for downscaling needs based on an overview of current downscaling initiatives; New products based on innovative methods commissioned and tested, and methods compared and evaluated; Research reports produced on novel downscaling methods and their evaluation; at least one peer-reviewed paper published on comparison of different methods for agricultural impact modelling; * Proof of concept for climate downscaling methodology developed based on wavelets, multifractals and neural networks (CIP) (2012-2013)	Two new products tested and evaluated. Two research reports completed and disseminated. Peer-review paper published. Proof-of-concept completed and disseminated	CCAFS and partner websites; Journal publisher's website	Downscaling methods can be meaningfully evaluated and compared	CIAT, CIP, ILRI, University of Oxford, University of Cape Town, WCRP, IRI. University of California at Santa Barbara

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 4.2.1.3 Suite of downscaled climate data for the 2030s to 2090s, first from the AR4 climate models and then from CMIP5, for homogenized applications in the Program. *Online data repository of downscaled 1km present and future climate projections (CIAT) *Climate projection maps to evaluate future crop suitability (Bioversity) (AR4, 2011; CMIP5, 2012)	Datasets available for download via CCAFS website with appropriate documentation	CCAFS and partner websites	Appropriate CMIP5 data can be accessed and utilised	CIAT, ILRI, University of Oxford, University of Leeds, Waen Associates. *Stanford University, Generation Challenge Programme (GCP)
Milestone 4.2.1.4 Regional climate characterization and evaluation of global and regional climate model performance for the three initial target regions (2011)	Regional reports that evaluate different climate models, for the three initial target regions, from the perspective of agricultural impacts modelling	CCAFS and partner websites	Climate models can be evaluated appropriately on a regional basis	University of Oxford
Milestone 4.2.1.5 Regional climate characterization and evaluation of global and regional climate model performance for additional target regions. *Remote sensing databases and maps of vegetation conditions and recent historical changes in Africa developed (ICRAF) (2013)	Regional reports that evaluate different climate models, for additional target regions, from the perspective of agricultural impacts modelling	CCAFS and partner websites	Climate models can be evaluated appropriately on a regional basis	University of Oxford and others to be decided. *AFSIS
Milestone 4.2.1.6 Databases for soils, historical weather, agricultural systems, and natural resources in the target regions evaluated, gap-filled, collated and made available on the web, following the development and implementation of an appropriate data management policy. *Working version of crop production surfaces developed to model biophysical responses to environmental change (IFPRI). *Enhanced niche-based approaches developed and published for analysis of climate change impacts on major/minor crops (CIAT) *Simulation models on yields and emissions in rice production systems assessed for their use in decision support systems (IRRI) (2012-2014)	Data reports are written up and made available on CCAFS website, for the following: soils profile information; historical daily weather data; global agricultural systems data layers updated and refined; and agricultural systems data collected and collated for several hundred households at the CCAFS sites	Databases on CCAFS and partner websites	Data are accessible	CG centers, all regional partners, selected ARIs. *NARES in India
Milestone 4.2.1.7 Scoping studies undertaken on agricultural impact model gaps and needs, particularly at plot and landscape scales, and development and testing work commissioned and evaluated; Synthesis and research reports developed on key gaps and needs, and model documentation (2012-2013)	Model documentation, synthesis and research reports completed and disseminated	CCAFS and partner websites	Agreement can be reached on a global agricultural impacts modelling agenda	CG centers, ARIs, AgMIP (Agricultural Modelling Intercomparison and Improvement Project). *University of Leeds; World Bank
Milestone 4.2.1.8 Innovative decadal/near-term climate products developed to improve near-term climate prediction and needs and opportunities summarized in research reports (2015)	Model documentation, synthesis and research reports completed and disseminated	CCAFS and partner websites	New approaches to near-term climate prediction can be developed and implemented in appropriate tools	IRI, NCAR, UK Met Office, Universities of Oxford & Leeds;

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 4.2.1.9 A loosely-integrated assessment toolkit developed and implemented that can be used to analyze likely effects of specific adaptation and mitigation options in 3 initial target regions; high-level engagement with key users to build capacity in use of tools and data. Reports and meta-databases developed of available models, tools and data. *GLOBIOM-Livestock model used for global integrated assessment of livestock issues (ILRI). *Enhanced/interlinked set of data and quantitative tools including spatial databases, detailed mapping of food system characteristics and human welfare, detailed characterization of impact of changes and uncertainty on global food systems (IFPRI). Integrated assessment framework and toolkit for analyzing likely effects of specific adaptation and mitigation options in three target regions (ICRAF) (2013)	Reports and meta-databases completed and made publicly available	CCAFS and partner websites	A loose assemblage of models and tools can cater to different needs and users	All partners, CG centers, ESSP partners, ARIs. *IIASA, ZALF, FANRPAN, ASARECA, ARIs, NARS, PIK; ASB; UNEP
Output 4.2.2 Socially-differentiated decision aids and information developed and communicated for different stakeholders				
Milestone 4.2.2.1 Studies completed in selected sites in 3 initial target regions, using different methodologies including visualisation techniques, that outline the perceptions of different stakeholders on climate change and the impacts it has had and may have in the future on the resources that they have control over; Pilot study reports on target groups' perceptions of climate change and other drivers of change in their locations (2012)	Pilot study reports completed and disseminated	CCAFS and partner websites	Perceptions of different groups can be appropriately elicited with minimal bias	National and regional partners, CG centers, IUCN, AGRHYMET, OSS.
Milestone 4.2.2.2 Studies completed with selected stakeholder groups in 3 initial target regions to identify engagement strategies that may be effective in their utilising climate and impact information for decision making; Pilot study reports produced on effective engagement strategies for exchange of information with and between different target groups (2013)	Pilot study reports completed and disseminated	CCAFS and partner websites	Different engagement strategies are appropriate for different stakeholders, and these can be adequately elucidated	Partners to be identified working in the social sciences and the psychology of choice and decision-making
Milestone 4.2.2.3 Decision aids developed and tested in selected sites in 3 initial target regions that build on the information needs of socially-differentiated target groups, including by gender (2015)	Six decision packs developed for pilot communities and disseminated	CCAFS and partner websites; CCAFS records	Decision packs can be developed that speak to the needs and perceptions of different target groups	National and regional partners, CG centers, and partners to be identified working in the psychology of choice and decision-making

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 4.2.2.4. Collation of decision aids and tools for prioritizing adaptation and mitigation actions at national/sub-national scales, with pilot testing in IGP region (2015)	Decision aids and tools released and results of pilot testing shared among policy makers	CCAFS and partner websites; CCAFS records	Continued strong demand for these decision aids among national and sub-national decision-makers	National and sub-national governmental partners, NARS, CG and ESSP scientists
Objective 4.3 Refine frameworks for policy analysis				
Outcome 4.3 New knowledge on how alternative policy and program options impact agriculture and food security under climate change incorporated into strategy development by national agencies in at least 20 countries and by at least 10 key international and regional agencies				
Output 4.3.1 Tools developed and climate change impacts assessed at global and regional levels on agricultural systems (producers, consumers, natural resources), national/regional economies, and international transactions				
Milestone 4.3.1.1 Broad-scale modeling tools developed to assess climate change impacts on yields, production, trade, prices, and various human well-being measures developed or enhanced; models structure design vetted by experts. (2011)	Initial set of modeling tools completed and made publicly available	CCAFS and partner websites; CCAFS records	Modeling expertise and data available to estimate parameters	GLP scientists, CG centers, other ESSP scientists, NARS scientists
Milestone 4.3.1.2 Global and regional assessments of climate change impacts on agricultural systems, national and international food security completed; Findings included in papers, reports, chapters in global (e.g. IPCC, Biodiversity integrated assessment) and regional (e.g. African Union) assessments (2012)	Papers and reports completed and disseminated. Citations of CCAFS outputs in partners' reports. Chapters of global and regional assessment reports integrate findings	CCAFS and partner websites; Major global and regional assessment reports	Appropriate data, tools, methods can be assembled	Global Adaptation FUND, UNREDD, the World Bank, IPCC, UNFCCC/SBSTA, key bilateral donors developing adaptation and mitigation strategies, large international NGOs, key regional and national actors, research for develop agencies, national, regional, and international planning agencies, researchers on climate change impacts on agriculture and natural resource management
Output 4.3.2 Likely effects of specific adaptation and mitigation options, national policies (natural resource, trade, macroeconomic, international agreements) analyzed				
Milestone 4.3.2.1 Report produced identifying and evaluating specific adaptation and mitigation options for (1) relevance to major climate change impacts and GHG emissions, (2) likely effects on producers, consumers, natural resources, economies and rural livelihoods. (2012)	Report completed and disseminated	CCAFS and partner websites	Same as Milestone 4.3.1.2	
Milestone 4.3.2.2 Report produced identifying and evaluating relevant possible national policies (related to natural resource, trade, macroeconomic and international agreements) for their potential to support implementation of appropriate adaptation and mitigation options. (2013)	Report completed and disseminated	CCAFS and partner websites		

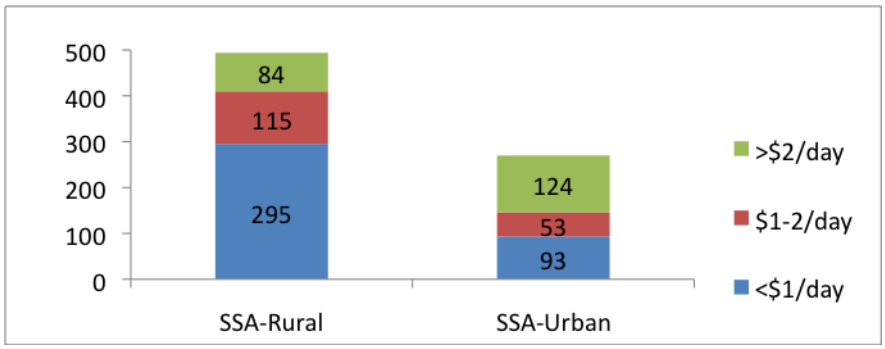
MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 4.3.2.3. Collation of toolkit for prioritizing adaptation and mitigation actions at national/sub-national scale and its pilot testing in IGP region (2015)	Toolkit released and results of pilot testing shared among policy makers	CCAFS and partner websites; CCAFS records		
Output 4.3.3 Differential impact on social groups (gender, livelihood category etc) of climate change adaptation and mitigation options identified, evaluated and communicated				
Milestone 4.3.3.1 Report produced identifying and evaluating adaptation and mitigation options and national policies for differential social impacts with recommendations to enable equitable access to technical and institutional assistance for adaptation and mitigation options (2014)	Report completed and disseminated	CCAFS and partner websites	Same as Milestone 4.3.1.2	
Output 4.3.4 Likely effects of specific adaptation and mitigation options and national policies (including for socially differential groups) communicated to key local, national and regional agencies and stakeholders				
Milestone 4.3.4.1 Set of information products developed and disseminated to key agencies and stakeholders including (1) research monographs and policy briefs on climate change; (2) enhanced, and interlinked datasets and quantitative tools such as spatial databases, detailed mapping of food systems and characterization of likely climate change impacts on agricultural systems, and (3) promising adaptation and mitigation options and tools; Publications and tools delivered to individuals responsible for regional policy programs and interventions that foster climate change adaptation and mitigation (2012)	Research monographs and policy briefs completed and disseminated. Datasets and quantitative tools produced and made publicly available. Information products used in regional programs and policy strategies	CCAFS and partner websites; Strategy and program documents	Viable set of adaptation and mitigation policy and program options	National and regional partners, other MPs, HarvestChoice, CSI
Milestone 4.3.4.2 Capacity building of 300 scientists and decision makers in use of appropriate tools in three initial regions including (1) training and workshops on crop, and IMPACT model; (2) capacity strengthening activities with NARS that reflect needs of targeted individuals and institutions for meeting agricultural development, poverty, hunger alleviation and natural resource management (2013)	300 decision makers trained in crop models and IMPACT model	Training agendas and participant lists; documentation for annual reporting		Ministries of Ag, Environment, Natural Resources in target regions, Universities in target regions, Research Institutions
Milestone 4.3.4.3 Synthesis of data and maps and distribution via climate change information networks and CCAFS or other web site; Improved curricula, learning materials, and delivery methods in strengthening capacity for climate change research and policy analysis through open learning resources (2015)	Data and maps publicly available. Curricula, materials and methods developed and disseminated.	CCAFS or other CG center websites, open learning resources, and networks	Building on existing networks and regional bodies	Ministries of Ag, Environment, Natural Resources in target regions, Universities in target regions, Research Institutions

MILESTONES (OUTPUT TARGETS)	PERFORMANCE INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS	PARTNERS
Milestone 4.3.4.4 Major report targeted to COP17, that lays out climate change impacts, adaptation and mitigation options and national policies; Research monographs and policy briefs on climate change adaptation and mitigation developed; Materials disseminated at Ag & Rural Development Day 2011 (2011) .* Input in the MP7 high level report on the agricultural work program; Platform to ensure coastal communities concern are included in UNFCCC negotiations (WorldFish) (2011)	Report, monographs, policy briefs completed and disseminated. Documentation of web traffic (http://webusage.cgnet.com/); citations in press and scholarly articles	CCAFS websites; Publications citing CCAFS.	Case studies available	CGIAR centers (CIP, CIAT, IFPRI, ICRISAT, CIMMYT, ICRAF, IWMI, ICARDA, WorldFish) HarvestChoice, CSI
Milestone 4.3.4.5 Scenario and food security dialogues and new information partnerships (new CG/non-CG partner teams jointly use a range of models; new networks and groups work collaboratively on food security issues) developed and documented in 3 initial target regions. (2012)	Dialogues meetings convened engaging 300 participants representing 30 organizations. Partnership projects incorporate CCAFS-produced models and tools	Documentation for annual reporting; participant lists collaborative meetings	Strong cooperation and dove-tailing with existing initiatives	National and regional research partners, and stakeholders
Milestone 4.3.4.6 To enable rural poor, women and men, to have better access to high value commodity markets for climate change mitigation and other environmental resources, support for up-scaling and follow-up investments including (1) implementation of household surveys, (2) development of modules to assess governance factors from the perspective of different value change actors, (3) identification of interventions to improve access to markets for climate change mitigation, (4) engagement with network or policy advisors, policy researchers and program implementers; (5) highlight the need to act on the climate challenge while supporting other important rural development and environmental goals through policy fora and dialogues (at Regional Fora and Launch Conference) (2015)	Surveys completed, summarized and results shared. Governance factor modules and interventions developed and disseminated. Briefings delivered to 300 individuals representing 30 organizations. CCAFS materials shared through 20 policy events	CCAFS website; documentation for annual reporting; Event agendas and participant lists.		National and regional research partners, and stakeholders

Annex 2: The profile of likely beneficiaries in sub-Saharan Africa[41]

The SSA population is estimated to have been over 760 million in 2005 with 65% (about 500 million) living in rural areas and 35% (270m) in urban areas. In urban areas, 146 million people live on less than US$2 per day, about two thirds of the rural figure (Figure A1). In rural areas, 60% (295m) live below the $1.25 per day threshold, and another 23% (115m) earn $1.25–2.00. This adds up to 410 million rural poor living below $2 per day.

Figure A1. Poverty in sub-Saharan Africa (total population 763m in 2005)



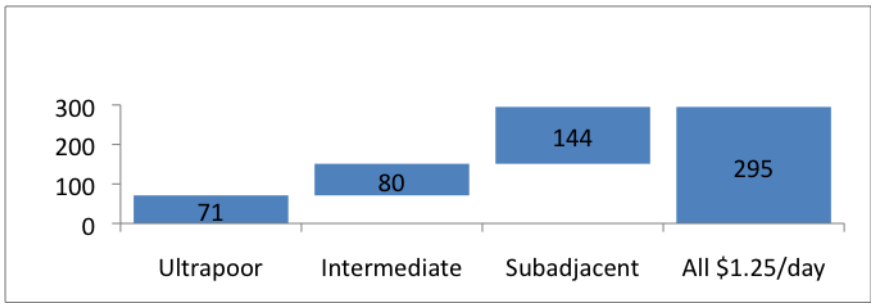
Looking deeper into the rural poor category, a preliminary analysis suggests they can be divided into three sub-groups (Figure A2):

- Subjacent: $0.75–$1.25 per day
- Intermediate: $0.50–$0.75 per day
- Ultra-poor: under $0.50 per day

Approximately 24% (71m) of the $1/day poor are ultra-poor and another 27% (80m) are in the intermediate category. It is important to note that ultra-poor (and to a lesser degree, the intermediate poor) are likely to have certain characteristics that make them more difficult to reach directly with the type of research outputs envisaged in this Program. While many of the rural ultra-poor are heavily involved in agriculture and derive a significant share of their income from agriculture, they typically have fewer productive assets than their less-poor counterparts. For example, we would expect the ultra-poor to have less land (and lower productivity), fewer livestock (and lower quality), less human capital, live in more marginal environments, have lower overall access to physical and knowledge inputs, and to be less well connected to markets. On a national level, countries with a higher prevalence of ultra-poor may have fewer overall natural resource endowments, and a policy environment that is comparatively less favorable to agriculture, rural populations, and the poor, or all of the above. All of this is further complicated by the fact that the poorest of the poor suffer from more frequent and greater intensity of hunger. For these groups much of the research envisaged will benefit them only indirectly, by lowering food prices and increasing employment opportunities if the technologies are labor-intensive.

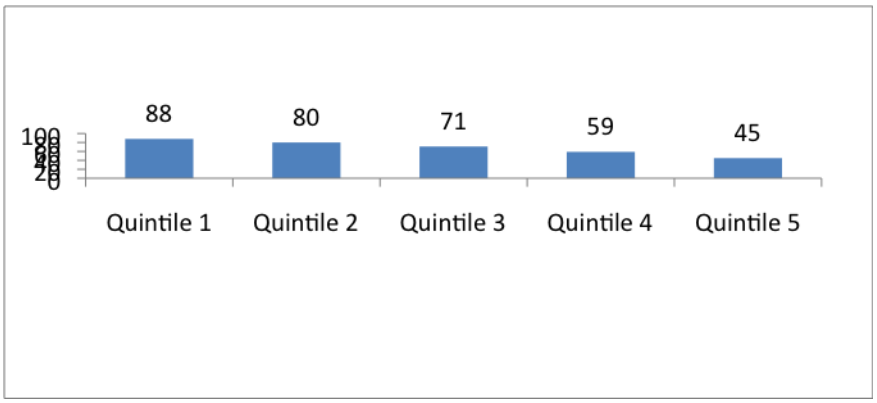
[41] This analysis of likely beneficiaries in SSA is drawn from personal communication from Stanley Wood and colleagues, IFPRI. CRP7 will put in place *ex ante* tools that will greatly enhance this kind of analysis for all regions.

Figure A2. Partitioning the poor into sub-groups



A key determinant of the potential for impact from agricultural investments is the extent to which households are engaged in the agricultural sector. The preliminary analysis reported in Figure A3 summarizes agricultural participation as reported by households in each income quintile. There is clearly significant engagement in agriculture, not only among the poorest of households (almost 90% average participation across countries) but even in the highest quintiles. However it is clear that participation in agriculture decreases as income rises. The poor rural households in SSA that participate in agriculture derive an average of over 80% of their income from it. However, this figure varies significantly across countries (e.g., 60% for Kenya and over 90% for Nigeria) and across households within countries.

Figure A3. Agriculture participation rates by households in Sub-Saharan Africa



In summary, there are 295 million poor in the rural sector in SSA who are potential beneficiaries of CRP7 (direct effects), with an additional 146 million urban poor and 115 million “poorest of the poor” who are likely beneficiaries via indirect effects.

Annex 3: Transition from the Challenge Program (CP) to CRP7

For the recommended transitional period (Table A1) it is proposed that:

- The current steering committee for the Challenge Program is converted, with modifications, into the ISP;
- The current CP Director becomes the interim Program Leader for the duration of his current contract;
- The University of Copenhagen (UoC), the host of the CP secretariat, continues to facilitate the implementation of activities under contract from the Lead Center. UoC plays no role in governance of the CP, and will not do so for CRP7 – it merely provides an administrative home. It charges no overhead. Where desirable some functions can be transferred to the Lead Center;
- The Program Management Committee is built from selected CP Theme Leaders and Regional Facilitators, with additional recruits where appropriate.[42]

Table A1. Key activities in the transitional periods

Period 1: CP structures continue	**Period 2: New structures initiated**			
Month 0–6	Month 6–12	Month 12–18	Month 18–24	Month 24-30
			Governance and management review based on initial experiences in CRP7 and fast-tracked CRPs	
CP Steering Committee to make proposals on key gaps in composition and to develop a transition plan, to be approved by the Lead Center Board		ISP fully functioning, with new recruits		Implement review recommendations that are accepted by Lead Center Board
New agreement between CP Secretariat (UoC) and Lead Center negotiated (current agreement is between the Alliance and UoC)	New arrangements fully functioning			Implement review recommendations that are accepted by Lead Center Board
Composition for Program Management Committee finalized; Program Management Committee selected (some current CP contracts renegotiated)	Program Management Committee fully functioning			Implement review recommendations that are accepted by the Lead Center Board.

[42] Current CP Theme Leaders come from CIAT, ICRAF, IFPRI, ILRI and the Universities of Columbia, Leeds and Vermont; Regional Facilitators come from ICRISAT, ILRI and IWMI.

Annex 4: Key Dates in the Implementation of CRP7

Month/Year	**Activity**
Month 1-12	Strategy process conducted for the selection of two new regions
Month 1-12	Baseline conditions assessed in all target regions
Month 13	Activities in two new regions initiated
Month 13-24	Baseline conditions assessed in the two new target regions
Month 15-18	Revisit site selection process to identify further regions
Month 18	Revision of impact targets with new ex-ante tools produced by Objective 4, Theme 2
Month 18	Governance and Management Review
Month 25	Activities potentially initiated in another three regions
Month 25-36	Baseline conditions assessed in the three new target regions
Year 4	Baseline indicators re-assessed for initial target regions
Year 5	CRP7 External Evaluation
Year 6	Potentially the start of Phase 2