

**Proposal  
for  
Mega Program 7:**

***Climate Change, Agriculture and Food Security***



**Lead Center: Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture – CIAT)**

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## Preface

This proposal was prepared by the team leading the CGIAR Challenge Program on Climate Change, Agriculture and Food Security (CCAFS), in partnership with contact points from 15 CGIAR Centers and numerous research and development partners.

The MP7 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<sup>1</sup> and a closed three-day planning meeting<sup>2</sup> 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.<sup>3</sup>

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 MP7 CCAFS activities have been completely integrated, and with the initiation of MP7 the entire research for development initiative will be managed as an integrated whole.

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<sup>1</sup> [http://www.ccafs.cgiar.org/sites/default/files/pdf/CCAFS\\_Conference\\_Report\\_May\\_2010\\_.pdf](http://www.ccafs.cgiar.org/sites/default/files/pdf/CCAFS_Conference_Report_May_2010_.pdf)

<sup>2</sup> [http://www.ccafs.cgiar.org/sites/default/files/pdf/CCAFS\\_MP7\\_Planning\\_Workshop\\_Report\\_May\\_2010\\_0.pdf](http://www.ccafs.cgiar.org/sites/default/files/pdf/CCAFS_MP7_Planning_Workshop_Report_May_2010_0.pdf)

<sup>3</sup> <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 Mega Program (MP7) 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, MP7 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 MP7 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.

MP7 will become a hub that facilitates collective action across multiple Centers/MPs. 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 sustainable food security in the face of climate change.

The over-arching objectives of MP7 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 technologies, practices and policies, and will enhance partnerships, 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 MP7, ensures effective engagement of rural communities and institutional and policy stakeholders, grounds MP7 in the policy context, and provides downscaled analyses of, and tools for, future climates. Much of the place-based work will be integrated within target regions, with activities starting in West Africa, East Africa and the Indo-Gangetic Plains in 2011 and extending to eight regions by 2013.

MP7 will make a lasting difference through a strategic, fully embedded focus on capacity building. MP7 research will improve understanding of the underlying drivers of social differentiation and gender disparities as influenced by climate change, then formulate strategies to tackle these and provide inclusive access to emerging investments (e.g. carbon payments), tools 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, and build the science around these. Specific activities and procedures are planned to ensure coherence among Themes, to ask the same research questions and produce syntheses across regions and Themes, and to build links across all MPs. Integration is crucial as major synergies between adaptation and mitigation have to be exploited. 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 MP7 will consist of a Lead Center (and its Board), Independent Scientific Panel, Program Leader and Program Management Committee. Theme Leaders and Regional Facilitators will help coordinate activities. There will be a small coordinating unit for MP7.

A total budget of US\$63.7 million in 2011 is proposed, of which US\$39.5 million is requested from the CGIAR Fund. The budget is allocated to 14 Centres and multiple partners, with 34% allocated to partnership and collaboration. A large amount is allocated to cofinancing other MPs to deliver climate relevant technologies and practices. Partner contributions are expected to be considerable.

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## Introduction

### Background, rationale and challenges

#### Background

Climate change will have far-reaching consequences for agriculture<sup>4</sup> 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 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 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 between scientists and decision makers at all levels of society.

Mega Program (MP) 7 will address the increasing challenge of global warming and food security on agricultural practices, policies and measures. It will do so by building on the new strategic collaboration

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<sup>4</sup> The term agriculture is used inclusively to capture the wide range of productive uses of extensive and intensive farmland, rangelands and fisheries and their wider landscapes.

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. MP7 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 coping with and managing risk. Enhancing coping and adaptation 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 MPs. 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

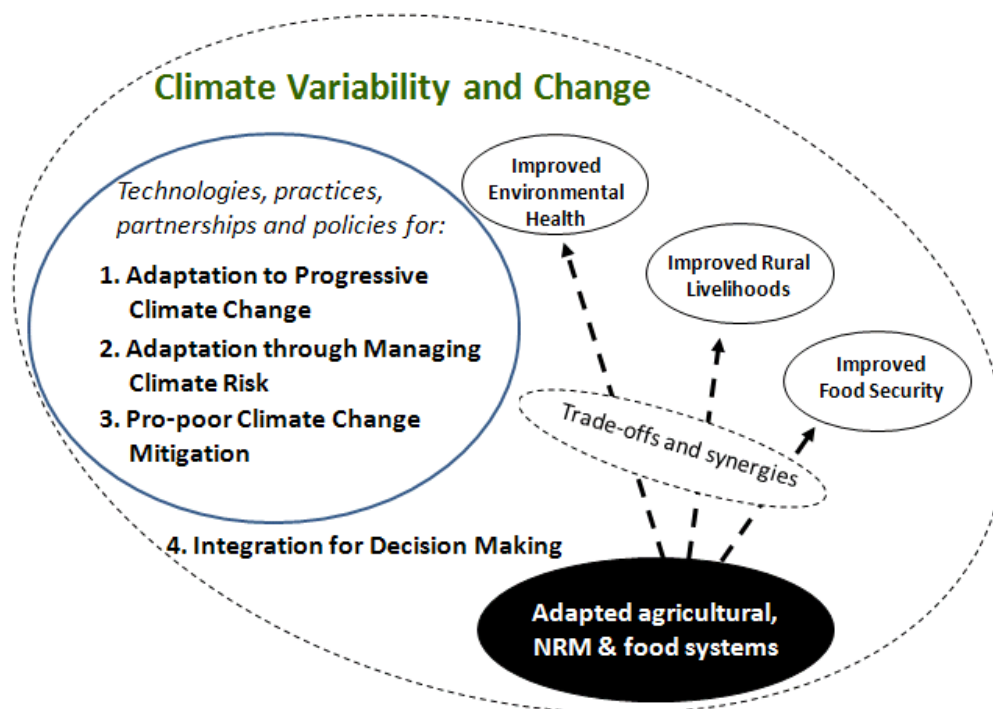
MP7 is designed to contribute to improved agricultural, natural resource management and food systems (Figure 1). It takes its mandate from the from the CGIAR vision<sup>5</sup>, namely *“To reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience through high-quality 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<sup>6</sup>. 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<sup>7</sup>. The three dimensions in which MP7 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 vulnerabilities, raised adaptive capacity and higher incomes. For impact on food security, MP7 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).

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<sup>5</sup> CGIAR Working Group on Visioning, Visioning the Future of the CGIAR, Report to the Executive Council (Washington, DC, CGIAR, 2008)

<sup>6</sup> **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).

<sup>7</sup> **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).

**Figure 1. Scope of MP7: Climate Change, Agriculture and Food Security**

By achieving impacts on livelihoods, hunger and environmental health, MP7 will contribute directly, along with the other MPs, to the Strategy and Results Framework (SRF) for the CGIAR, which establishes measurable targets.<sup>8</sup> MP7 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, help reduce poverty by 10%, increasing the incomes of hundreds of millions of people
- By 2020, contribute to a reduction in hunger, cutting the number of rural poor who are undernourished by 25%
- By 2020, help agriculture contribute to climate change mitigation by enhancing storage or reducing emissions, by 1000 Mt CO<sub>2</sub>-eq (considering all gases) below the “business-as-usual” scenario.

The vision of success for MP7 includes surpassing these impact targets, achieving the multiple outcomes of MP7 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, MP7 seeks to become a hub that facilitates collective action across all Centers and all MPs.

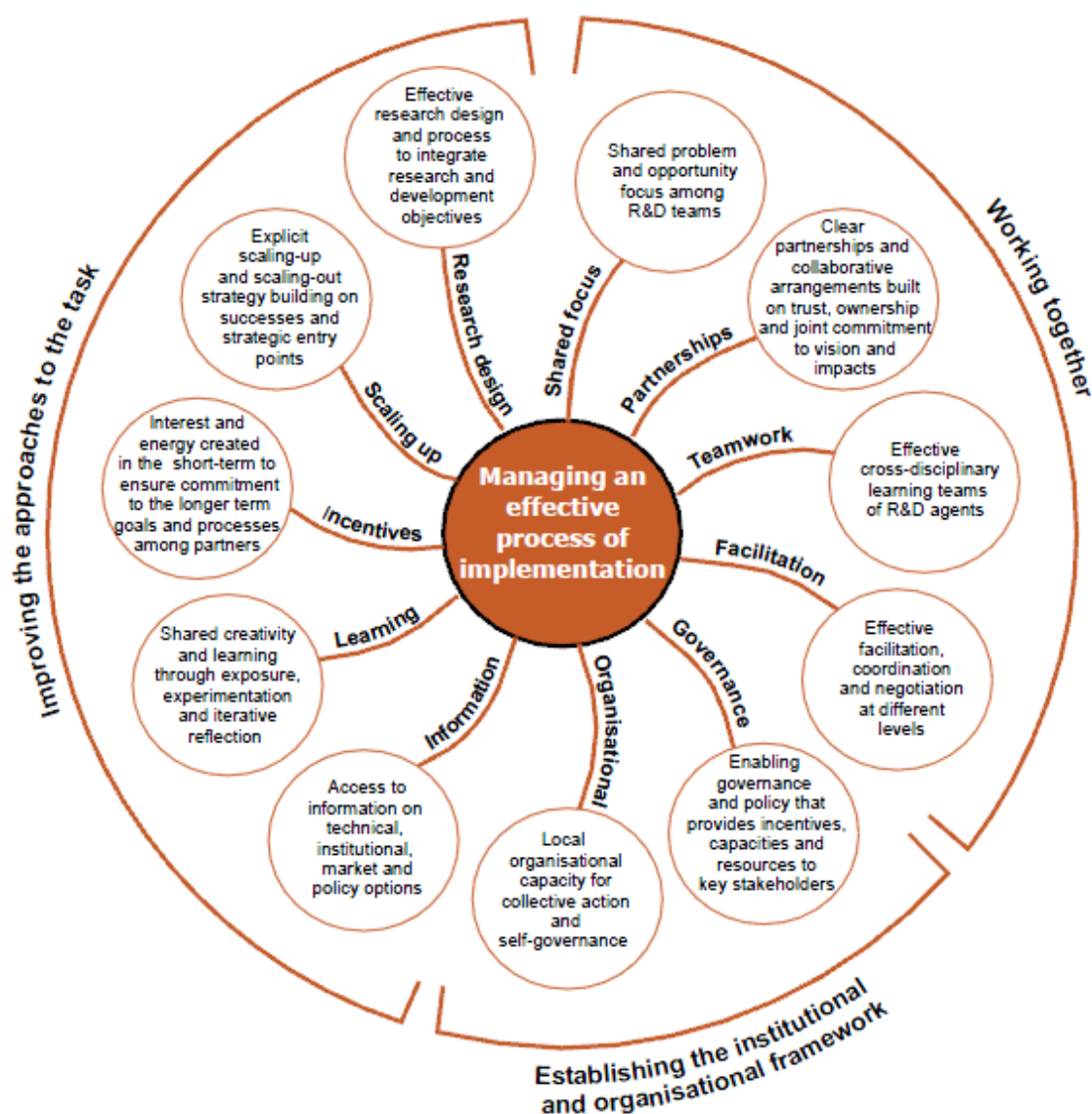
## Evidence that intended impacts can be achieved

Linear pre-determined pathways to impact are the exception rather than the rule (Biggs, 1990), and thus MP7 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 building and enabling governance and policy.

<sup>8</sup> 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.



**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, MP7 has planned for 12 key outcomes (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 MP7 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 9-13: impact pathways for different themes, for achieving outcomes from local to global levels).

**Table 1. Outcomes planned in each of the four Themes, over a 5–10-year time horizon**

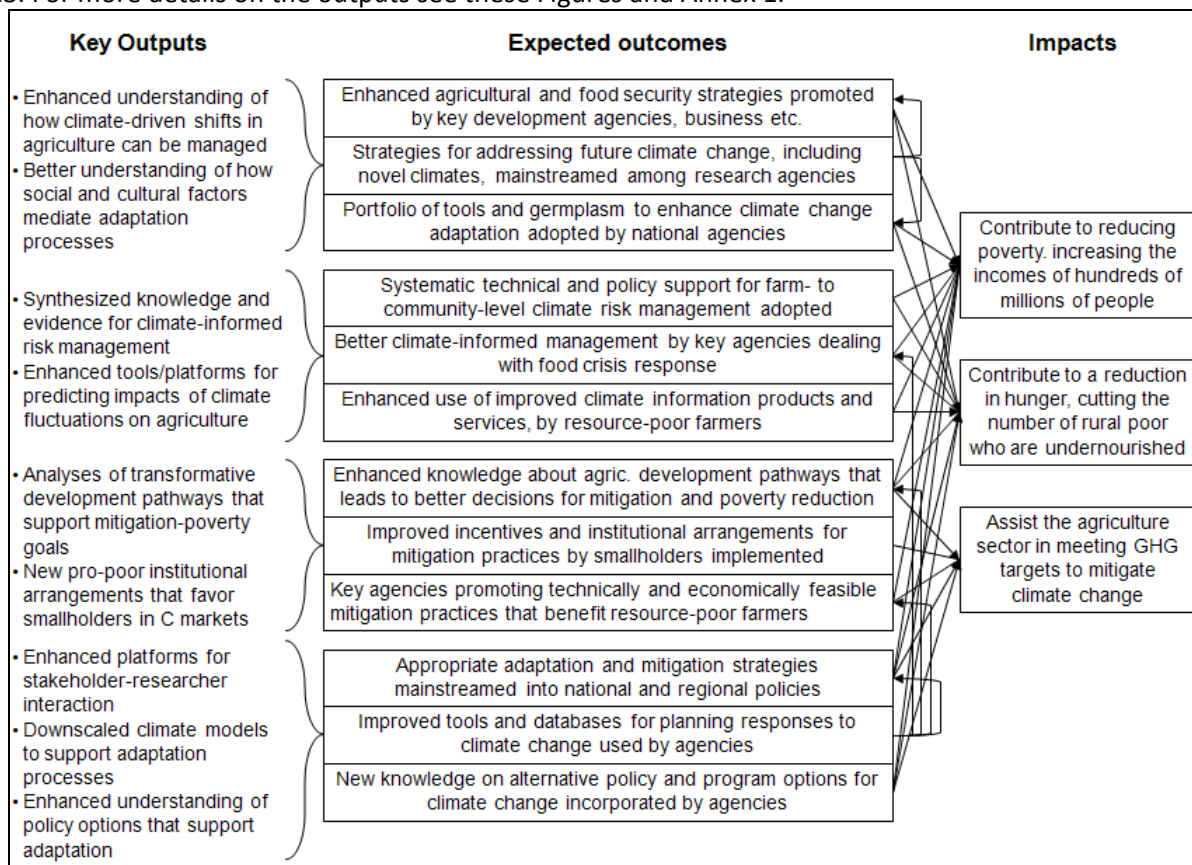
<b>Theme 1: Adaptation to Progressive Climate Change</b>
Outcome 1.1: Agricultural and food security strategies that are adapted towards conditions of predicted climate change promoted by the key development and funding agencies (national and international), civil society organizations and private sector 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 organization for the benefits of resource-poor farmers.
<b>Theme 2: Adaptation through Managing Climate Risk</b>
Outcome 2.1: Systematic technical and policy support for farm- to community-level agricultural risk management strategies 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.
<b>Theme 3: Pro-Poor Climate Change Mitigation</b>
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.
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 20 countries.
Outcome 3.3: Key agencies dealing with climate mitigation in at least 20 countries promoting technically and economically feasible agricultural mitigation practices that have co-benefits for resource-poor farmers, particularly vulnerable groups and women.
<b>Theme 4: Integration for Decision Making</b>
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 MPs, especially in relation to Outcomes 1.1, 2.1 and 3.3, where there will be considerable interaction with other MPs.<sup>9</sup> However, given that MP7 will be collaborating with numerous Centres/MPs in different regions, we believe that the outcomes can be achieved even if a few of the MPs fail to deliver on their outputs in specific locations. In addition, each of these outcomes has a considerable amount of research inputs from MP7 alone, so even in the face of failure of other MPs we should be able to

<sup>9</sup> See section on "Roles of CGIAR centers and integration with other MPs" for a description on collaboration and cofinancing. Also see Table 6 to show budget allocations for cofinancing.

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 MP7.** Outputs, outcomes and impacts have been simplified. See Table 1 for further details on outcomes. For more specific impact pathways see Figures 4, and 9-13. For more details on the outputs see these Figures and Annex 1.



MP7 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 MPs 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.

In order to reach the desired impacts, at a scale well beyond the sites where field trials and surveys will be undertaken, MP7 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, MP7 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, with a 10% increase assumed by 2020) 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 MP7, 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, 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<sub>2</sub>-eq. (considering all gases) below the “business-as-usual” scenario<sup>10</sup>. 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<sub>2</sub>-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 MP7. 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 shortages, poverty reduction also includes special attention to food security. 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 needs to include 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 natural disasters. There is therefore a need to understand and monitor poverty and poverty reduction over time, with involvement of the involvement of government and other development intermediaries.

## Strategic goals

The overall goal of MP7 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.

MP7 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

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<sup>10</sup> For original figures see: Smith et al. (2008).

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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 over-arching objectives of MP7 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.

## The proposed program

### Program design

MP7 is designed to help deliver impacts at global, regional and national levels cost-effectively, with a strong emphasis on capacity building, 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

MP7 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 technologies, practices and policies, and will enhance partnerships, that will 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; and will identify and prioritize institutional and policy options for overcoming obstacles to implementing these strategies at the scale of the development challenge. 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 MP7. It also ensures effective engagement of rural communities and institutional and policy stakeholders, and grounds MP7 in the policy context. MP7 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 MPs. 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 MP7, 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, and generation of hypotheses for fieldwork and macro analyses.

### **Beneficiaries**

The three dimensions in which MP7 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 higher incomes. For impact on food security, MP7 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.

MP7 will reach its ultimate beneficiaries through different sets of carefully selected proximate beneficiaries for each Theme and Objective.<sup>11</sup> 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 MP7 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. MP7 activities will be fully integrated with MP1 activities in target regions. While there are many regions in the developing world that warrant research investment, MP7 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;
- 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.

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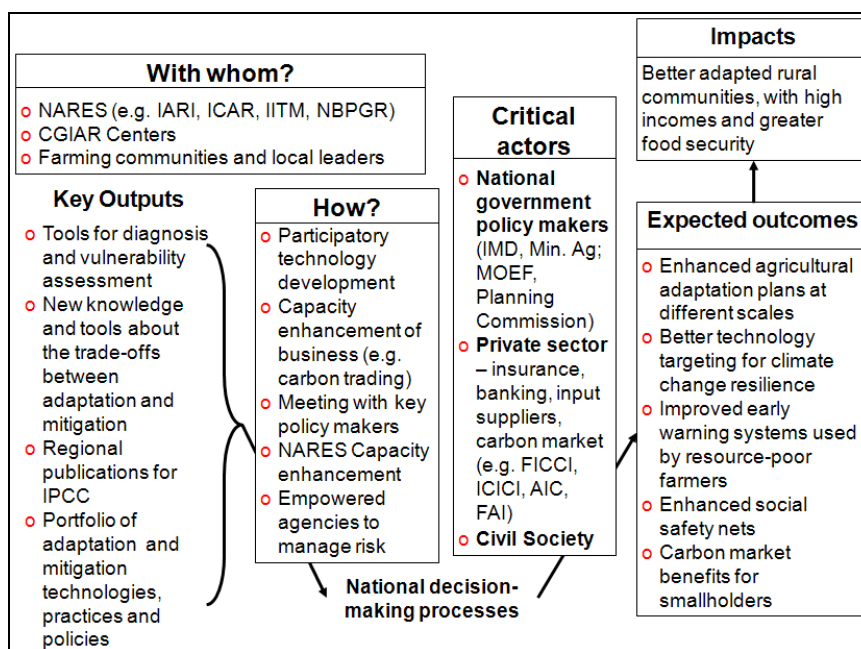
<sup>11</sup> For each of the four Themes there are four Objectives. These are detailed in the description of the MP7 portfolio.

A range of regional partners have been involved in the selection of field sites and countries within target regions.<sup>12</sup>

By early 2011 the initial vulnerability studies undertaken by Theme 4 (Objective 1)<sup>13</sup> will be complete, and will be used to help identify the regions to be initiated in 2012 and 2013. The stakeholder meeting in May (2010) identified the key criteria to be used in making the selection of future regions.<sup>14</sup> 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.

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<sup>15</sup>.

**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<sup>16</sup>



### 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

<sup>12</sup> 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.

<sup>13</sup> See "Description of Program Portfolio"

<sup>14</sup> The workshop report is available at [ccafs.cgiar.org/content/planning-workshop-report](http://ccafs.cgiar.org/content/planning-workshop-report)

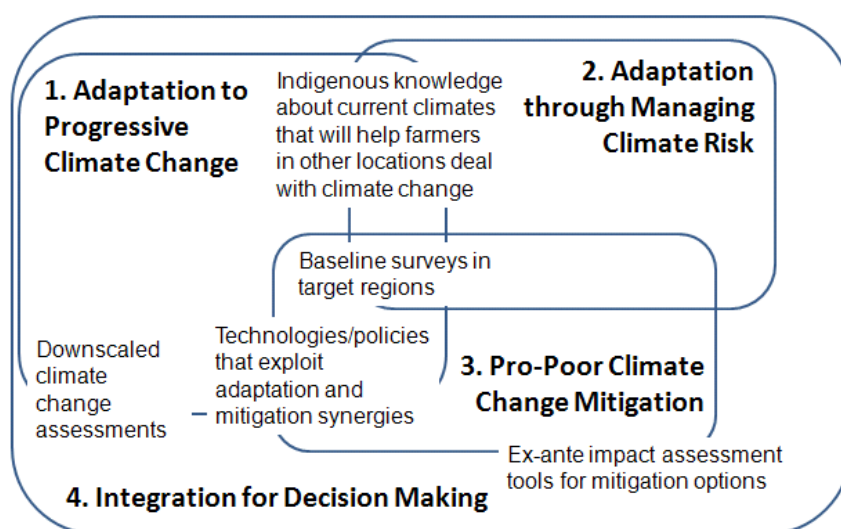
<sup>15</sup> The impact pathways shown in Figures 4, and 9-13, have been developed with stakeholder inputs from the Nairobi (2010) meeting and from follow-up regional consultations. The displayed impact pathways are illustrative, with others developed for particular sub-themes and national contexts.

<sup>16</sup> See list of acronyms for expansions of all acronyms in figures.



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. 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 in the latter 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.

**Figure 5. Coherence among MP7 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 (Theme 4, Objective 1). Identifying viable technological and policy options to improve food security in the face of climate and other environmental changes requires improved dialogue between researchers, the policy process 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 communications and capacity building and will help build regional science and policy teams who can take the MP7 outputs forward. Scenario-building carried out under MP7 will also inform decision-making in the other MPs.

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 MP7 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. MP7 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.

MP7 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, Climate–Agriculture Policy Letters<sup>17</sup> and journal articles), and dialogue among stakeholders (events, webinars, blog). Particular effort will be put into a dynamic Agriculture and Rural Development Day (ARDD) at the annual UNFCCC Conference of Parties (COP), aimed at raising the visibility of agriculture and food security in the global climate dialogue<sup>18</sup>. Materials for communication will go beyond MP7 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.

Communication beyond research circles requires highly relevant research in accessible and tailored formats. An early task for MP7 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);
- New practical systems for measuring GHG emissions at farm level, relevant to resource-poor farmers wishing to participate in carbon markets (Theme 3);
- New vulnerability characterization of agricultural systems for the global tropics to enhance targeting (Theme 4).

## Roles of CGIAR Centers and Integration with other Mega Programs

The cross-Center and cross-MP collaboration and alignment of research on agriculture and climate change will be a fundamental aspect of MP7. All Centers will participate in MP7<sup>19</sup>; and MP7 will work closely with all other MPs. This cross-Centre and cross-MP 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 (CIFOR<sup>20</sup>, CIMMYT, CIP, ICARDA, ILRI, WorldFish); (b) climate change modeling impacts on agriculture and livelihoods (Bioversity, CIAT, CIP, ICARDA, ICRISAT, IFPRI, ILRI, IWMI, World Agroforestry Center); (c) informatics tools for selecting germplasm with desired traits for future climates (Bioversity, CIP, ICARDA); (d) mitigation

<sup>17</sup> Once a quarter, 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.

<sup>18</sup> ARDD 2009 was regarded as highly successful:

[www.cgiar.org/pdf/Collective%20Action%20News\\_December2009.pdf](http://www.cgiar.org/pdf/Collective%20Action%20News_December2009.pdf)

<sup>19</sup> CIFOR will not draw a budget from MP7 but will fully collaborate with MP7

<sup>20</sup> See list of acronyms for expansions of all acronyms in bracketed lists.

options (CIAT, CIFOR, CIP, ICRISAT, IFPRI, ILRI, IWMI, World Agroforestry Center); (e) responses of pests and diseases to climate change (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, World Agroforestry Center).

The relationships between MP7 and other MPs are summarised in Table 2 and Figure 6, and further details are provided for each MP7 Theme in Tables 9, 10, 11 and 12. MP7 research products will make a significant input to other MPs, most importantly in providing the climate change context for activities in other MPs. MP7 has a major role to play in mainstreaming climate-related research into all the MPs.

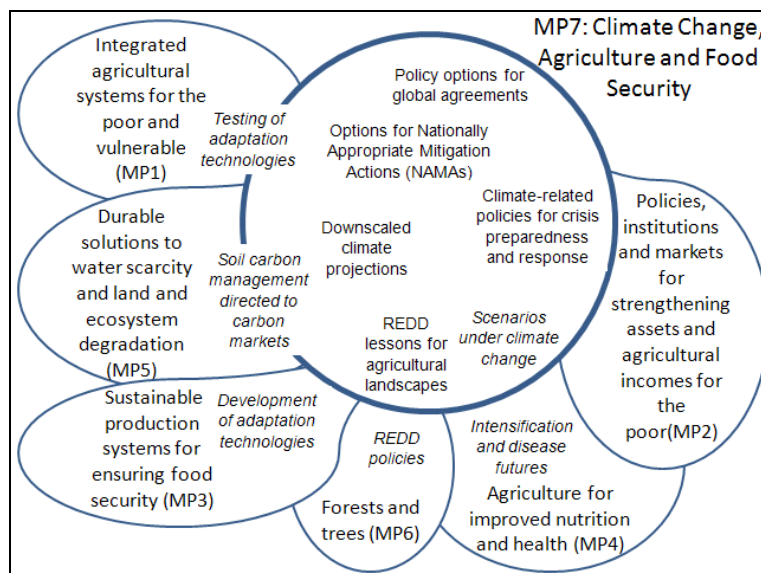
Other MPs will provide significant inputs to MP7. In particular, MPs 1, 3, 5 and 6 will develop a portfolio of technologies and integrated systems that will be assessed for their relevance in target regions and then tested in the context of integrated climate change strategies.

Interactions with other MPs follow two major models (many examples are given in Tables 9-12):

- *Collaboration*, in which MP7 interacts with other MPs on specific topics that need to be jointly addressed. This can involve priority setting, research on institutional and technical options, capacity building and communication/outreach activities.
- *Cofinancing*, where MP7 finances activities in other MPs. This approach is particularly important in the case of technology testing, where technologies developed in other MPs are tested both in the field and through modelling and simulation for their application with respect to climate change adaptation and mitigation. Significant cofinancing has been allocated to MP1, MP3, MP5 and MP7 (see Table 6 and budget discussion), but smaller co-financed activities are envisaged with the other MPs (e.g. joint workshops, joint scoping studies).

MP7's contribution to other MPs involves four areas of activity: (a) providing tools, methods and data that can be used in climate-related work in all the MPs (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 MPs (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 MPs that relate to climate change (e.g. synthesizing the state of knowledge on mitigation options that are developed as part of other MPs); and (d) providing the partnerships and opportunities for MPs to deliver results that are relevant to the climate change agenda (e.g. hosting UNFCCC side-events to which other MPs contribute).

**Figure 6. Mainstreaming climate-related research into all CGIAR MPs – some illustrative activities/products in MP7 – some part of other MPs and co-financed by MP7 (in italics)<sup>21</sup>, while others being part of MP7.**



The other MPs provide technologies and information highly relevant to MP7. The technologies that will be developed in other MPs that have relevance to climate change include drought and heat tolerant germplasm, conservation agriculture practices that increase farming system resilience, water and land management strategies, and the development of multiple disease and insect pest-resistant crop germplasm. MP7, in association with MP1 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 MP1, given that program’s system- and place-based focus (e.g., work in the Brahmaputra–Ganges–Megna focus region of MP1 will be integrated with MP7 work in IGP). Box 1 suggests how MP1 and MP7 can interact in terms of field testing options. Similarly, technological options and practices developed in MP3, MP5 and MP6 will be selected for testing in the context of integrated adaptation-mitigation strategies, through cofinancing.

**Table 2. Interaction of MP7 with other CGIAR Mega Programs and Services**

Thematic Area/ MPs/Services (with which MP7 will interact)	Work to be undertaken in other MPs that is relevant to MP7	Work to be undertaken in MP7 that is relevant to other MPs
1. <i>Integrated agricultural systems for the poor and vulnerable</i> . Initially work will be conducted with MP1.1 (Drylands) in East and West Africa, and with MP1.3	MP1 will provide opportunities for developing climate-proofed technologies and practices (e.g. water-efficient management systems, conservation farming), Modeling and decision-support tools developed within MP7 will be tested and validated within MP1 (Box 1 suggests how MP1 and MP7 can	For specific regions, MP7 will provide downscaled assessments of the agricultural and livelihood impacts of climate change. MP7 will provide modeling and decision-support tools. MP7 will support MP1 in working with partners to define possible agricultural development scenarios under climate change. MP7 will provide research methods to ensure that cross-regional comparisons with respect to climate change are

<sup>21</sup> Titles of MPs are likely to undergo further change.

<p>(Coastal and Aquatic Ecosystems) in the Indo-Gangetic Plains. Future work with these MPs will be expanded to other regions (see section “the regional approach”)</p>	<p>interact in terms of field testing).</p>	<p>possible (e.g. technologies currently being tested in one region may be useful for future climates in other regions). MP7 will provide opportunities for achieving outcomes and impacts related to climate change policy. MP7 will test technologies and practices in the context of integrated adaptation-mitigation strategies derived from MP1, through cofinancing.</p>
<p><i>2. Policies, institutions and markets for strengthening assets and agricultural incomes for the poor</i></p>	<p>MP2 will promote work on collective action through developing approaches and tools. MP2 will undertake research on strengthening the capacity and incentives of implementing organizations.</p>	<p>MP7 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). MP7 will use results generated in MP2 to enhance the effectiveness of organizations implementing climate change actions.</p>
<p><i>3. Sustainable production systems for ensuring food security (3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7)</i></p>	<p>MP3 will feed technologies (e.g. drought, water-logging or heat stress tolerant varieties and germplasm), and information into MP7.</p>	<p>MP7 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. MP7 will work with MP3 partners to define phenotyping and breeding targets for future climates. MP7 will offer opportunities for testing MP3-derived technologies in the context of integrated adaptation-mitigation strategies.</p>
<p><i>4. Agriculture for improved nutrition and health</i></p>	<p>MP4 will produce scenarios of intensification and disease futures that will inform MP7’s work on development scenarios that balance the trade-offs among adaptation and mitigation strategies.</p>	<p>MP7 will produce downscaled climate and development scenarios for targeted regions. MP7 will bring MP4 outputs into the broader climate community.</p>
<p><i>5. Durable solutions to water scarcity and land and ecosystem degradation</i></p>	<p>MP5 will develop and test appropriate adaptive water and land management strategies to address climate change. MP5 will provide a link to the broader water and land communities.</p>	<p>MP7 will collaborate on protocols for carbon, methane and other GHG measurements in agricultural landscapes and provide downscaled climate change scenarios. MP7 will offer opportunities for testing MP5-derived technologies and practices in the context of integrated adaptation-mitigation strategies through cofinancing. MP7 will provide MP5 the link to the broader climate communities.</p>
<p><i>6. Forests and trees</i></p>	<p>MP6 will develop and test agroforestry and forestry technologies and policies to enhance climate change mitigation and to enhance local and societal resilience to climate change. MP7 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.</p>	<p>MP7 will offer opportunities for testing MP6-derived technologies and practices in the context of broader adaptation-mitigation strategies through cofinancing. MP7 will provide access for MP6 to the key stakeholders in the agricultural community to advance forest protection through strategies that promote agricultural intensification rather than forest clearance.</p>
<p><i>7. Genomics and</i></p>	<p>GIB Service plans to establish a multi-</p>	<p>MP7 will help design the database so as to ensure</p>

<i>Integrated Breeding Service (GIB Service)</i>	partner/centre database of stations where field testing on major crops takes place (a one-stop web-based portal to crop-specific information, applications, genetic stocks, and the pre-breeding materials)	that the data can be used as a source of cross-site comparative data for future climates. MP7 will work with GIB Service partners to define breeding strategies for future climates.
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### Box 1: Working Relationships Between MP7 and other MPs, as illustrated for MP1

Step 1: **Get agreement on goals that serve both MP1 and MP7**, with CGIAR Centers and partners. This includes conducting scenario analyses of visions for the future.

Step 2: **Data collection** in MP1 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 MPs at regional level.

Step 3: **Sharing data with modeling community**. Carrying out of modeling in MP7 using various climate change and development scenarios to identify possible mitigation and adaptation interventions.

Step 4: **Joint analysis**, between MP1 and MP7 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**. MP1 and MP7 will translate the proposed scenarios into real integrated production possibilities: e.g. cereal-pulse rotations, crop-livestock mixtures (e.g. large and small ruminants, non-ruminants, forages, crops), management (e.g. feed menus: organic crop waste, forage needs, rangeland contribution), cropping specifics (e.g. conservation agriculture options, tilling, resting, role of fallows), fishery specifics, and agro-forestry components. MP1 will test possible options, with cofinancing from MP7. MP7 will provide the expertise for climate-specific components where needed (e.g. climate risk insurance methods, improved climate 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 MP1 and MP7 and partners.

## Partnership strategy

MP7 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.

MP7 recognizes policy as dynamic and polycentric. The domains that MP7 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, MP7 will focus effort both on formal government policies (e.g. NAMAs and NAPAs) and on the much wider set of informal norms and procedures, including the strategies of producer organizations, local governance structures, and businesses. Many of the most effective managers of agricultural systems under climate change, particularly women, may be excluded from formal policy processes and thus working only with formal agencies may entrench inefficient and inequitable arrangements at a time when transformational institutional change may be needed to deal with climatic uncertainty. Therefore MP7 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 MP7 and decision-makers. MP7 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 MP7**

	MP7 Program strategy	Research implementation	Communications & outreach	Uptake of data & tools	Impact on policy & practice
MP7 & CGIAR	✓	✓	✓	✓	
Other MPs	✓	✓		✓	
ESSP	✓	✓	✓	✓	
ARI, NARES & NMS	✓	✓	✓	✓	
National & local govts, NAMAs & NAPAs	✓		✓	✓	✓
IPCC & global assessments			✓	✓	✓
Farmers' organisations	✓	✓	✓		✓
Development & food security agencies	✓		✓	✓	✓
Industry platforms & carbon market			✓	✓	✓
Mitigation & adaptation funds				✓	✓
CSOs, CBOs & media		✓	✓		✓

Given the regional focus of much of the place-based work, MP7 will engage key regional research, development and policy organizations in agriculture and climate change (e.g. ACMAD, AGHYMET, ASARECA, FARA, ICPAC, CORAF/WECARD, SAARC, SDMC and RWC). 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 and a full list of partners is available from CCAFS).

On the global level, MP7 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<sup>22</sup>: scientific assessment secretariats and their technical support units, sponsors and managers of adaptation and mitigation funds, global development and food security agencies, farmers'

<sup>22</sup> At the Nairobi planning workshop, May 2010

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 (including FAO, GFAR, Global Donor Platform for Rural Development, IFAD, IFAP), which will be developed further towards future ARDDs. The role of these global partners will be to provide accountability to the ultimate beneficiaries of MP7, 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.

MP7 has an innovative feature in its formal alliance with the ESSP community<sup>23</sup>. The marriage of CGIAR (whose comparative advantage lies in developing new varieties 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). MP7 plans to establish and contribute to exciting platforms and opportunities for allowing exchange and engagement between the CGIAR and ESSP communities. Linking local, regional and global agricultural development and food security futures scenarios/assessments is a unique and exciting challenge that MP7 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 “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).<sup>24</sup>

## Management mechanisms<sup>25</sup>

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)<sup>26</sup>. 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.”<sup>27</sup> MP7 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 MP7 have an Independent Scientific Panel (ISP), 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 MP7 coordinating unit. Theme Leaders and Regional Facilitators will be responsible for aspects of MP7 implementation. CGIAR Climate Change Contact Points will help ensure MP7 is appropriately linked to all Centers and MPs.

The **Independent Scientific Panel (ISP)** will have an advisory role on priority setting, partnerships and on the strategic allocation of resources, to ensure that the needed set of partners and Centers participate in MP7 in order to achieve the goals and over-arching objectives of MP7. MP7 has the opportunity to drive budget allocations by foresight analysis and *ex ante* impact assessments, since a major component of the research

<sup>23</sup> 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

<sup>24</sup> [www.globalresearchalliance.org](http://www.globalresearchalliance.org)

<sup>25</sup> We thank governance expert Markus Palenberg for his advise.

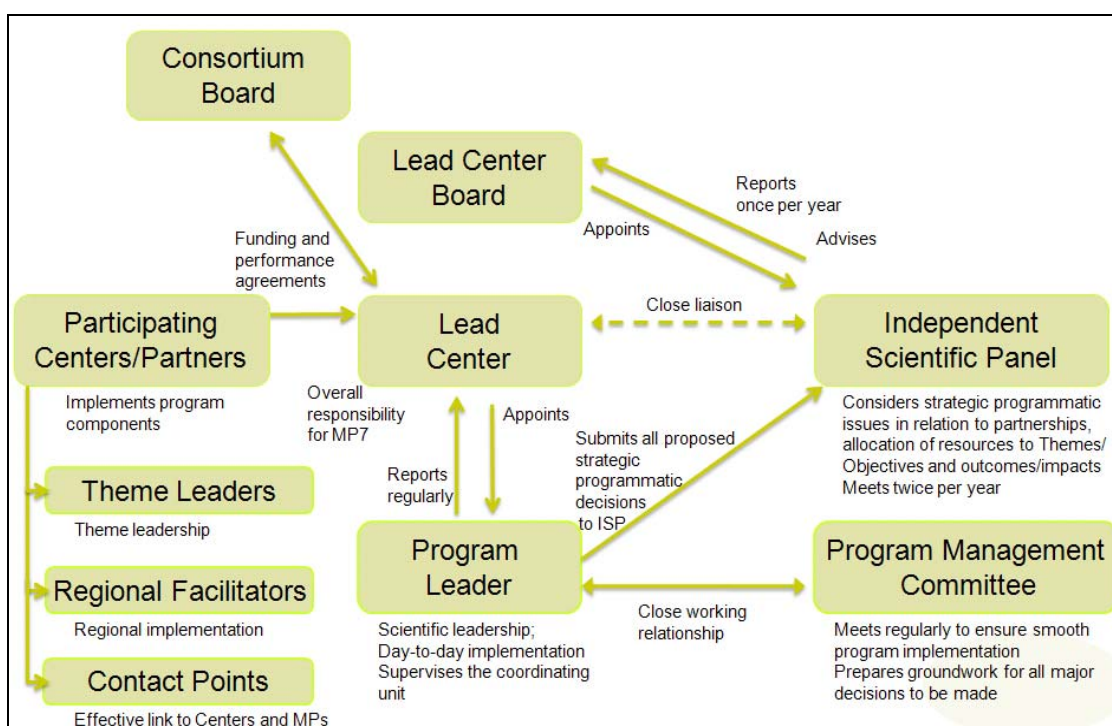
<sup>26</sup> E.g. Woolley et al. 2009; CGIAR Science Council, 2008.

<sup>27</sup> CGIAR Science Council and CGIAR Secretariat, 2007.



(Theme 4, Objectives 1 and 2)<sup>28</sup> 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 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 MP7 is in meeting its outcome and impact goals. Having an ISP ensures independence of the MPs 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 \$100,000 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 all Centers. The ISP will have a Chair, nine members, and three observers (one from the ESSP, one from the Lead Center Board, and one representative from the Centers). The membership will consist of internationally recognised scientists in the field of climate change and food security, as well as representatives from peak bodies (e.g. International Federation of Agricultural Producers). 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 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 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. 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 MP7 progress and alert them to any emerging opportunities or threats that are of significance. They will not have voting rights. The ISP Chair will communicate regularly with the Director-General of the

<sup>28</sup> "Objectives" are fully described in "Description of program Portfolio"

Lead Center. 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 **Lead Center** will be the main contracting body for MP7. Centers wishing to lead MP7 were asked to prepare an Expression of Interest (EOI). Five such EOIs were received and were evaluated by the CCAFS Steering Committee. On this basis CIAT was selected as the Lead Center. The Lead Center will sign the performance contract for MP7 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 MP7 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 MP7 management policies. MP7 activities will be reported by the respective Centers in their audited financial statements. The MP7 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, 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 MP7 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 MP7. 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 MP7 staff members, who shall comprise the MP7 coordinating unit. This unit will oversee the implementation of MP7, in particular the coordination of activities across Centers, MPs and other partners; coordinating strategic foresight, planning, and reporting at the MP7 level; preparing the annual work plans and budgets; interfacing between MP7 and the Consortium Office and CGIAR Fund on budgets, contracts and financial reporting; preparing funding proposals and leading fundraising; compiling annual reports and monitoring indicators; producing synthesis products; overseeing MP7 capacity building; 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 MP7 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 24 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 MP7. A key role will be to assist in ensuring coherence across Centers, MPs and partners, through strategic planning, and reporting at the MP7 level. The Program Management Committee will comprise 8 individuals, namely key individuals implementing components of MP7, at least one of which is from the Lead Center. These

individuals will be drawn from the Theme Leaders and Regional Facilitators.<sup>29</sup> 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 MP7 will be Participating Centers. A number of significant partners that play a leadership role in the themes will also be recognised 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 amongst 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 MPs 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.

**Regional Facilitators:** In each of the target regions, research activities of MP7 will be coordinated by Regional Facilitators. A key part of this role is partnership development and management. They will be responsible for ensuring coherence amongst themes from field to regional level, and will play a key role in achieving outcomes and impacts at national and regional levels. Regional Facilitators will also be responsible for facilitating the appropriate linkages to other MP 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.

**CGIAR Climate Change Contact Points:** Climate Change Contact Points from each Center and each MP will be established.<sup>30</sup> Their responsibility will be to ensure that climate change activities in Centers are appropriately integrated into MP7 and to ensure that the relationships between MP7 and other MPs are effective. They will be selected by the Director-Generals responsible for the specific Centers and MPs.

**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 MP7. 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 phases are recognized, phase 1 for six months, where the current system remains in place, but where preparations are made for phase 2, and phase 2 of an additional 24 months, where new elements are implemented and, where needed, recruitments are conducted. After 24 months a governance and management review will be conducted, drawing on the experiences from this Program and other fast-tracked Programs.

**Conflict resolution mechanisms:** Conflicts amongst 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.

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<sup>29</sup> In selecting theme leaders and regional facilitators care will be taken to ensure balanced representation across disciplines, gender and diversity.

<sup>30</sup> CCAFS established contact points in all Centers. This will be expanded to ensure its membership covers representation of all MPs.

## Capacity building

MP7 will make a lasting difference through a strategic, fully embedded focus on capacity building. To achieve its overall goals, the two related areas in which MP7 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 building within MP7. The first is to add value through partnership, by complementing existing capacity-building 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 building 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-building activities, ensuring that development of new tools, knowledge and evidence within the research themes includes strategies and resources for building the capacity of researchers and stakeholders to use, adapt and critique these outputs.

Each of the four research themes includes attention to capacity-building 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).

In building researchers' capacity, MP7 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 MP7. 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, building 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 MP7's research themes, with positive discrimination towards women and nationals of the regions (all Themes).

MP7 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. MP7 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

MP7 has an explicit goal of gender impact. MP7 will be guided by the CG-wide gender strategy that is currently under development. The four Themes of MP7 will put effort into understanding the underlying drivers of gender inequalities, then formulating strategies to tackle these disparities and provide inclusive access to emerging investments, tools and policies that deal with climate change. It has strong implications for *how* the research is 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). This will require efforts towards seeing 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), the Gender, Environment and Sustainability Network, 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). Women manage many of the world's agricultural resources. Hence any effort to increase productivity must focus on the activities that women are responsible for and the assets they manage. Women are also likely to have primary responsibility for raising children. Activities that increase the productivity of women will also have beneficial spillovers on child well-being.

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 MP7. Our target will be that the first generation of female climate and agricultural professionals take up at least five positions within MP7, or are supported by partner organizations in their home countries by Year 10. We will also set appropriate gender participation targets with our partners and invest in enhanced female leadership and scientific capacity within local partner implementing agencies.

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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);
- 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. 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 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 MP will involve foresight studies, vulnerability assessment and *ex ante* impact assessment. These components will have a strong capacity-building component, ensuring persisting use of the methods beyond MP7, 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.<sup>31</sup> 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 MP7 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 MP7 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. MP7 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. Debate during the engagement process will inform priority setting. Theme 4 Objective

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<sup>31</sup> See "Description of Program Portfolio"

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 MP7 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). 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 is designed to address these gaps, many of which MP7 is uniquely placed to fill. This is a key innovation of MP7. 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 MP7 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 MP7 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. MP7 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 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 and reporting

The CGIAR envisages that monitoring and evaluation will be centrally coordinated across all MPs. MP7 will follow this CG-wide process. In addition, MP7 will undertake its own efforts to ensure rigorous appraisal and internal learning. The MP7 Program Leader and Program Management Committee will establish an annual monitoring system, with a set of indicators and an annual report. Reports will also indicate progress against the stated activities and outputs in the annual plans. 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 MP7 coordinating unit for deliberation by the ISP and Lead Center Board.

For all regions in which MP7 works, Regional Facilitators and Theme Leaders will work with partners to select and measure key indicators that can be used to monitor and evaluate MP7. A set of appropriate baseline indicators, on agricultural productivity, rural livelihoods, and biogeophysical attributes, will be collected in the study regions at the start, so that monitoring and *ex post* impact assessment can be carried out. Care will be given to ensuring that indicators capture cross-scale impacts. Towards Year 8, 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. As noted

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above, some of the indicators collected will be gender-specific, including statistics related to women's roles in agricultural decision-making and local and regional networks.

Self-monitoring and self-evaluation will complement the above formal activities. Inter-institutional programs that tackle such complex issues<sup>32</sup> 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. A professional facilitator, experienced in change management and the implementation of complex programs, will be employed to facilitate the exposure of weaknesses, the seizing of opportunities and, most importantly, the cohesion of the research and management team<sup>33</sup>. This activity will be conducted at least once per year and will allow for deep self- and team-reflection. MP7 needs to be implemented using adaptive management principles.

After 24 months a governance and management review will be conducted by independent evaluators, and after four years a comprehensive external evaluation of MP7 will be conducted.

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<sup>32</sup> Sayer and Campbell (2004).

<sup>33</sup> In the MP7 proposal development phase, two such facilitated meetings were conducted.



## Budget

### Budget summary

The projected MP7 budget (including all funds from the CGIAR Fund as well as other sources) is US\$63.7 million in 2011, rising to US\$74.2 million in 2013 (Table 4a). MP7 assumes a general 3% 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)<sup>34</sup>. In constructing the budget Centers provided 2009 audited figures plus 10% (for 2011 budget). The request to the CGIAR Fund for 2011 is US\$39.5 million (Table 4b).

**Table 4. Budget for MP7 showing (a) projected MP7 expenditures by year by cost categories (2011-2013), 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	Total MP7 Costs	Percent (2011)
1	Personnel costs	16.88	18.08	19.53	54.49	26%
2	Travel	2.48	2.63	2.81	7.92	4%
3	Operating expenses	8.45	8.92	9.42	26.79	13%
4	Training / Workshop	1.74	1.88	2.07	5.69	3%
5	Partners / Collaborator / Consultancy Contracts	21.96	23.86	26.25	72.07	34%
6	Capital and other equipment for project	1.13	1.20	1.27	3.61	2%
7	Contingency	0.84	0.88	0.93	2.65	1%
	<b>Total</b>	<b>53.49</b>	<b>57.46</b>	<b>62.28</b>	<b>173.23</b>	<b>100%</b>
8	Institutional Overhead	10.21	10.97	11.89	33.07	16%
	<b>Total Program expenditures</b>	<b>63.70</b>	<b>68.43</b>	<b>74.17</b>	<b>206.30</b>	<b>100%</b>

#### b) Projected source of program funding

Description	2011	2012	2013	Total MP7 Costs	Percent (2011)
<b>Funding</b>					
CGIAR Fund	39.50	45.31	55.33	140.15	62% 1
Current and Projected Restricted Donor Projects	22.87	21.73	17.38	61.99	36% 2
Other Income	1.32	1.39	1.46	4.16	2%
<b>Total Funding</b>	<b>63.70</b>	<b>68.43</b>	<b>74.17</b>	<b>206.30</b>	<b>100%</b>

Notes:

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

<sup>34</sup> In 2011 work will be initiated in three regions, two further regions will be added in 2012, and three further in 2013

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### **Budget categories**

Given the key roles that partners play in MP7, some 34% of the 2011 budget is allocated to partners and collaborators (Table 4a). Partners are expected to play significant roles in MP7, including representation as Theme Leaders and on the Program Management Committee. Projected expenditure on personnel is 26% (in 2011). The institutional overhead stands at 16%, this being a combination of 20% for Centre-managed funds and 5% for pass-through funds. The budget for training and workshops is 3%, but it is important to note that MP7 will mainstream capacity building into all research activities, so the bulk of capacity building funds fall under the 'partners and collaborators' budget line.

### **Sources of funding**

\$39.57 million is requested from the CGIAR Fund for 2011 (Table 4b). This amount rises through to 2013, 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 some of the current funding the Challenge Program receives will instead be channeled through the CGIAR Fund in 2011. At the time of writing the funding agency was not yet certain as to how its funds would be channeled in 2011. If they maintain their funds as restricted funding, then the request to the CGIAR Fund will decline.

In addition to the numbers 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 ESSP-associated research groups is many times greater than that going to the whole of the CGIAR. Through an active strategy to align agendas and develop joint activities, MP7 expects to leverage human capital and resources that will greatly magnify the funds coming direct to MP7.

### **Allocation to Centres**

Six Centers have total budgets over \$5million per annum in MP7 for 2011 (Table 5), namely ILRI, ICRAF, CIAT, CIMMYT, Bioversity and IWMI. IRRI, AfricaRice and IITA have budgets less than \$1.5 million, with the other Centers intermediate. In relative terms the following Centers are heavily dependent on the CGIAR Fund for their climate change work, with over 70% of their total climate change funding requested from the CGIAR Fund: ICARDA, IITA, CIMMYT. Some Centers will largely undertake their climate-related work with restricted funds in 2011, namely WorldFish and IFPRI, with less than 40% of their MP7 funds requested from the CGIAR Fund.

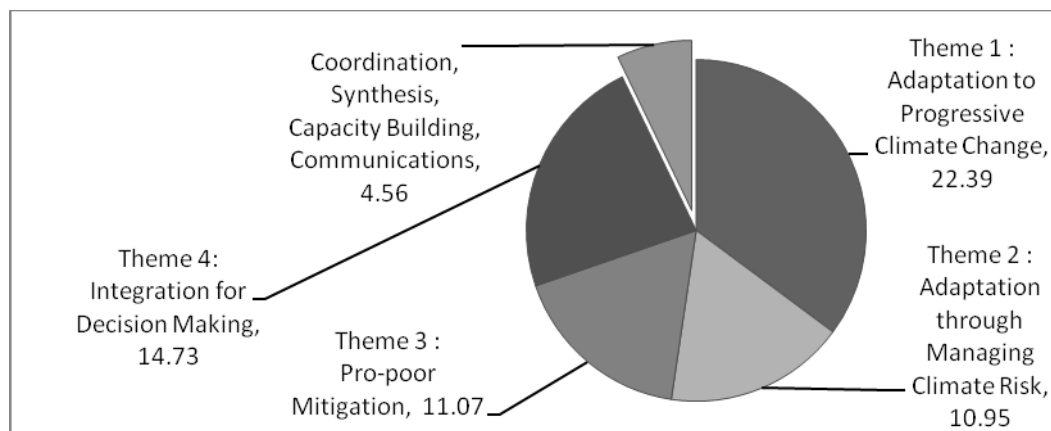
### **Allocation of funding amongst Themes and Objectives<sup>35</sup>**

The largest portion of the budget (Figure 8, Table 5) 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 MP7, and thus are not shown separately but are budgeted under each Theme.

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<sup>35</sup> See "Description of Program Portfolio" for detailed descriptions of each Objective.

**Figure 8. Distribution of funds amongst Themes (US\$ million, 2011).** Also shown is the allocation to “Coordination, Synthesis, Capacity building and Communications”



**Table 5. Projected MP7 Theme expenditures for 2011 by Centre (US\$ million), and projected source of Centre funding (US\$ million). The percentage of the Centre funds that are expected to come from the CGIAR Fund is also shown. In addition, the central funds for “coordination, synthesis, capacity building and communications are shown”.**

Centre	2011 Theme Budgets				Total Budget	Source of funds (2011)		% of Centre MP7 Budget from Fund	
	Theme 1: Progressive Climate Change	Theme 2: Climate Risk	Theme 3: Mitigation	Theme 4: Integration for Decision Making		CGIAR Fund	Current and Projected Restricted and Other Sources		
AfricaRice	0.17	0.23	0.37	0.02	<b>0.78</b>	0.58	0.21	73%	
Bioversity	5.51	-	-	-	<b>5.51</b>	3.66	1.85	66%	
CIAT	4.33	1.50	1.09	0.48	<b>7.40</b>	4.26	3.14	58%	
CIMMYT	1.97	2.13	0.91	0.47	<b>5.47</b>	4.18	1.29	76%	
CIP	0.89	0.44	0.74	0.89	<b>2.96</b>	1.78	1.17	60%	
ICARDA	1.25	0.44	0.06	0.26	<b>2.02</b>	1.91	0.11	95%	
ICRAF	0.94	0.47	3.86	2.82	<b>8.09</b>	4.11	3.98	51%	
ICRISAT	2.11	1.33	0.70	0.66	<b>4.80</b>	3.40	1.40	71%	
IFPRI	0.63	0.54	0.54	2.62	<b>4.32</b>	1.70	2.62	39%	
IITA	0.25	-	0.25	0.49	<b>0.98</b>	0.81	0.17	83%	
ILRI	1.83	0.97	1.29	4.31	<b>8.41</b>	5.00	3.41	59%	
IRRI	0.45	0.03	0.59	0.03	<b>1.09</b>	0.74	0.35	68%	
IWMI	1.60	2.26	0.44	1.00	<b>5.30</b>	3.77	1.53	71%	
WorldFish	0.45	0.62	0.24	0.68	<b>2.00</b>	0.53	1.47	27%	
<b>Total</b>	<b>22.39</b>	<b>10.95</b>	<b>11.07</b>	<b>14.73</b>	<b>59.14</b>	<b>36.44</b>	<b>22.69</b>		
Coordination, Synthesis, Capacity Building, Communications						<b>4.56</b>	3.06	1.50	67%
<b>Total Program costs</b>						<b>63.70</b>	<b>39.50</b>	<b>24.19</b>	<b>62%</b>

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

Within Theme 1 the largest budget goes to Objective 1.1 (Adapted farming systems to changing climate conditions) (Table 6). This is where the bulk of CGIAR activity has been in the past. Over \$4 million in 2011 is allocated to cofinancing MP1, MP3, MP5 and MP6, where technologies developed by those MPs will be tested and further developed in the context of holistic adaptation-mitigation strategies.<sup>36</sup>

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. Over \$3 million is allocated to co-financing MP1 and MP3.

For Theme 3, the largest Objective is 3.3 (On-farm mitigation practices and landscape implications). This is also an Objective where a large amount of funds are allocated to cofinancing for the testing of mitigation technologies and practices developed in other MPs (over \$3 million to MP1, MP3, MP5 and MP6).

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.

Over all Themes, the largest co-financing goes to MP3 and MP1, with smaller amounts to MP5 and MP6. While there is collaboration with MP2 and MP4, no major amounts of cofinancing are envisaged.

**Table 6. Projected MP7 Theme expenditures (US\$ million) in 2011 for the different Objectives in each Theme. Shown is the projected expenditure for core MP7 activities (i.e. those that don't involve cofinancing) as well as projected expenditure on cofinancing activities with other MPs.**

Theme	Objectives	Expenditures on core MP7 activities	Cofinancing of other MPs				Total
			MP1	MP3	MP5	MP6	
Theme 1	1.1 Adapted farming systems to changing climate conditions	7.41	1.68	1.24	0.67	0.75	11.76
	1.2 : Breeding strategies for future climatic conditions	3.15					3.15
	1.3 Species and genetic diversity for climate change	6.90	0.35	0.24			7.49
Theme 2	2.1 Managing climate risk and building resilient livelihoods	4.23	0.97	1.37	0.90		7.46
	2.2 Managing climate risk through food delivery, trade and crisis response	1.67					1.67
	2.3 Prediction of climate impacts, and enhanced climate services	1.82					1.82
Theme 3	3.1 Low-carbon agricultural development pathways	2.58				-	2.58
	3.2 Institutional arrangements and incentives for mitigation	2.72					2.72
	3.3 On-farm mitigation practices and landscape implications	2.49	0.21	1.82	0.05	1.20	5.77
Theme 4	4.1 Linking knowledge with action	5.20					5.20
	4.2 Data and tools for analysis and planning	6.61					6.61
	4.3 Refining frameworks for policy analysis	2.91					2.91
<b>Total</b>		<b>47.69</b>	<b>3.21</b>	<b>4.66</b>	<b>1.63</b>	<b>1.94</b>	<b>59.14</b>

Notes: 1. Further descriptive notes on co-financing can be found in Tables 9-12.

### ***Program coordination, Synthesis, Capacity Building and Communications***

Seven percent of the overall budget for 2011 is allocated to this function (US\$4.56 million) (Table 7). This covers the work of the coordinating unit, that includes management and governance structure, cross-theme and cross-regional integration workshops, administrative support, the MP7 external

<sup>36</sup> For further details on cofinancing see section "Roles of CGIAR Centers and Integration with Other MPs" and Tables 9, 10, 11 and 12.

communications work (especially that linking into global processes such as UNFCCC), overseeing capacity building activities throughout MP7 and synthesis activities. Given that 15 Centres will contribute to MP7 a strong unit for integration and synthesis, and for facilitating the connections amongst Centres and MPs, is crucial. The budget is allocated to CIAT as the Lead Centre, 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.

**Table 7. Projected expenditure in 2011 (US\$ millions) for Coordination, Synthesis, Capacity Building and Communications broken down by cost category**

Cost category	Description	2011 Amount (US\$)
1	Personnel costs	0.45
2	Travel	0.02
3	Operating expenses	0.05
4	Training / Workshop	0.05
5	Partners / Collaborator / Consultancy Contracts (pass through)	1.89
6	Capital and other equipment for project	0.01
7	Contingency	0.05
	<b>Total</b>	<b>2.51</b>
8	Institutional - 5% on total pass through funds received from CGIAR	1.73
	Overhead Fund passed through to other Centers/Partners.	
9	- 20% on CIAT-administered portion of funds.	0.31
10	<b>Total Program costs</b>	<b>4.56</b>

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 building initiatives that cut across all Themes/Regions

5. Partners/Collaborator/Consultancy contracts. This is the major contract to University of Copenhagen to run the coordinating unit, and a smaller contract (\$270,000) to University of Oxford to synthesise scenario development across regions (see Theme 4, Objective 1 description). Note that the University of Copenhagen will take no overhead on the funds. This portion of the budget will cover the costs of three staff members - \$450,000 – to cover contracts management, synthesis, capacity building, communications). The unit will have funds to develop partnerships for synthesis (\$200,000); 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 meetings (US\$100,000); Travel (US\$90,000); Communications, websites and data management (US\$305,000); and for support services and operating costs (\$US\$150,000). Operating costs includes hiring the services of consultants for specific administrative tasks, phones, special audits.

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

### **Additional Budget Scenario**

The “baseline” budget scenario shown above is based on the 2009 audited budgets from the Centres (+10% to bring it to 2011). In doing the budgeting for MP7 we decided to use a conservative budgeting projection, and to base budgeting on current levels of funding rather than optimistic funding scenarios.

We have, in addition, provided a further funding scenario involving a 20% reduction in the request to the Fund on the 2011 level, leading to a similar reduction on the 2013 request. That is, for 2011 the Fund request goes from US\$39.5 million to US\$31.6 million (Table 8); while for 2013 it goes from US\$ 55.3 million to US\$42.9.

With this budget scenario, we plan to make the major reductions in activities through reduced sites, countries and regions. This option is preferred over reducing activities within a site, so that holistic multi-disciplinary research and intervention is not sacrificed. For the 20% reduction we would only add one further region in 2012, and one further region in 2013. In terms of outcomes we would reduce our proposed 20-country outcome targets (Table 1) to 14-country targets. Given that centres provided 2009 audited figures plus 10% for their 2011 budget, a 20% budget reduction essentially means a reduction in their current portfolio or if they maintain their current Centre budgets, then a shift away from MP7 to other MPs.

It should be noted that the baseline budget is more-or-less business as usual for Centres in terms of funding levels, given that the baseline budget is based on 2009 budget levels. If budget were to increase 20%, the number of regions, countries and sites can be broadened, and the number of activities in each site could be increased. Potential areas for expansion of MP7 include even greater engagement with the broader global change community (ESSP) through partner funds. A detailed budget is not provided, but could be upon request.

**Table 8. Budget for MP7 for a 20% reduction on the request to the CGIAR Fund compared to the budget in Table 4, showing (a) projected MP7 expenditures by year by cost categories (2011-2013), 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	Total MP7 Costs	Percent (2011)
1	Personnel costs	14.00	14.88	15.81	44.69	26%
2	Travel	2.10	2.22	2.35	6.68	4%
3	Operating expenses	7.15	7.53	7.93	22.62	14%
4	Training / Workshop	1.50	1.60	1.71	4.81	3%
5	Partners / Collaborator / Consultancy Contracts	17.40	18.67	20.00	56.07	33%
6	Capital and other equipment for project	0.91	0.96	1.02	2.89	2%
7	Contingency	0.68	0.72	0.75	2.16	1%
	<b>Total</b>	<b>43.75</b>	<b>46.59</b>	<b>49.57</b>	<b>139.92</b>	<b>100%</b>
8	Institutional Overhead	9.09	9.68	10.30	29.06	17%
	<b>Total Program expenditures</b>	<b>52.84</b>	<b>56.27</b>	<b>59.87</b>	<b>168.98</b>	<b>100%</b>

**b) Projected source of program funding**

Description	2011	2012	2013	Total MP7 Costs	Percent (2011)
<b>Funding</b>					
CGIAR Fund	31.55	35.38	42.88	109.81	60%
Current and Projected Restricted Donor Projects	20.79	19.75	15.80	56.34	39%
Other Income	1.08	1.13	1.19	3.40	2%
<b>Total Funding</b>	<b>53.42</b>	<b>56.27</b>	<b>59.87</b>	<b>169.56</b>	<b>100%</b>

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## Description of Program Portfolio

### 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 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 countries in SSA make no explicit mention of food security in NAPAs. 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 goal 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 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 and natural resources management approaches;
- Develop strategies for addressing abiotic and biotic stresses induced by breeding for future climate change climatic conditions, variability and extremes, including novel climates. 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 twin goals 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.

## 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 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 other Themes in MP7, and to the other MPs. 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 appropriate governance structures that go beyond MP7.

### **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 MPs**

This Theme is not designed to individually develop new adaptation technologies. Rather, it is designed to add value to technology development from other MPs (MP1, MP3, MP5, MP6) by providing the climate change context for those MPs and taking a holistic view to agricultural development plans and strategies under a changing climate. This will require close collaboration with all MPs (Table 9), including:

- MP 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;
- MP 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;
- MP 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 MP3 for their efficacy in adapting to a 2030 world;
- MP 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;
- MP 5: Testing and evaluation of water and land management options for potential in enabling adaptation;
- MP 6: Building on the lessons of forest-based mitigation and coupling mitigation plans with adaptation processes in forest margins and agroforestry systems.

**Table 9 Interaction of MP7 Theme 1 with other MPs (Priority activities are indicated in bold).**

MP7 Objective # and Title	MP1 – Integrated Systems	MP2 - Policies, Institutions and Markets	MP3 – Sustainable Production	MP4 – Nutrition and Health	MP5 – Water, Land and Ecosystems	MP6 – Forests and Trees
<i>1.1 Adapted farming systems to changing climate conditions through the integration of tested technologies, practices and policies</i>	<i>In MP7:</i> Evaluation of the resilience of technologies, practices and policies under climate change. <i>In MP1:</i> Development of new practices, technologies and policies appropriate for specific systems. <i>Collaboration:</i> Priority setting for technology, practice and policy development. <b><i>Cofinancing:</i> Coordinated set of trial sites in target regions for technology testing.</b>	<i>In MP7:</i> Evaluation of sub-national level climate change and market policy options <i>In MP2:</i> Development of approaches for evaluating policies and impacts on the poor. <i>Collaboration:</i> Organisation of value-chain partnerships for holistic adaptation; development of models for evaluating adaptation policy options.	<i>In MP7:</i> Priority setting for new technologies, provision of tools to address climate context. <i>In MP3:</i> Development of new crop, livestock and fisheries varieties and management technologies. <b><i>Cofinancing:</i> Testing of new technologies out of MP3 with other agricultural practices, policies and technologies to develop holistic adaptation strategies.</b>	<i>In MP7:</i> Evaluation of future human and animal health challenges in food systems <i>In MP4:</i> Health-related development of analytical approaches for food systems <i>Collaboration:</i> Evaluation of health implications in adaptation options.	<i>In MP7:</i> Priority setting for new soil/water mgmt options under climate change <i>In MP5:</i> Development of new soil/water mgmt options <b><i>Cofinancing:</i> Testing of developed strategies and technologies with other agricultural practices, policies and technologies to develop holistic adaptation options.</b>	<i>In MP7:</i> Evaluation of resilience of agroforestry systems to future climate changes, provision of tools. <i>In MP6:</i> Agroforestry technology development. <b><i>Cofinancing:</i> Testing of developed technologies with other agricultural practices, policies and technologies to develop holistic adaptation options.</b>
<i>1.2 Breeding strategies for addressing abiotic and biotic stresses induced by future climatic conditions, variability and extremes, including novel climates</i>		<i>In MP7:</i> Evaluation of new breeding technologies under climate change <i>In MP2:</i> Evaluation of new breeding technologies for impact under current climates and analysis of adoption constraints	<i>In MP7:</i> Modelling of virtual crops under a changing climate to identify future priority traits <i>In MP3:</i> Development of new crop technologies through breeding <i>Collaboration:</i> Setting of breeding priorities <i>Cofinancing:</i> Expert workshops, capacity building NARS	<i>In MP7:</i> Evaluation of new breeding technologies under future conditions <i>In MP4:</i> Biofortification of major staples <i>Collaboration:</i> Inclusion of human health-related challenges in virtual crop modelling		
<i>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</i>	<i>In MP7:</i> Scoping of promising genetic resources for adaption options <i>In MP1:</i> Evaluation of genetic resources for improving farming systems. <b><i>Cofinancing:</i> Trialling diversified systems in areas of high climate risk and evaluating benefits of diversity under future conditions.</b>	<i>In MP7:</i> Evaluation of changing policy needs for genetic resource access and benefit sharing under changed climate <i>In MP2:</i> Evaluation of current status and needs for genetic resource access and benefit sharing policies.	<i>In MP7:</i> Evaluation of potential neglected/under-utilised species for adapting to climate change. <i>In MP3:</i> Development of agricultural technologies. <b><i>Cofinancing:</i> Co-development of adaptation options that increase on-farm diversity through inclusion of neglected and underutilised genetic resources.</b>	<i>In MP7:</i> Evaluation of potential of neglected/under-utilised species for adapting food systems to climate change. <i>In MP4:</i> Evaluation of nutritional needs. <i>Collaboration:</i> Evaluation of nutritional benefits of identified adaptation options.		<i>In MP7:</i> Evaluation of benefits of diversity in adaptation. <i>In MP6:</i> Evaluation of tree use in increasing income and resilience. <i>Collaboration:</i> Identification of diversified agroforestry systems for climate change adaptation.

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**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, 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 MPs 3 and 5, while MP7, in conjunction with MP1, 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 holistic, geographically-explicit design processes and strategies to support adaptation of rural farming communities, development organizations and sub-national level bodies. MP7 will work closely with MP1 in the target regions, with MP1 leading the implementation of integrated R&D, and with MP7 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 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 MP, and put into the context of farming systems with MP1. 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 trialling 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.

### **Products**

- 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.

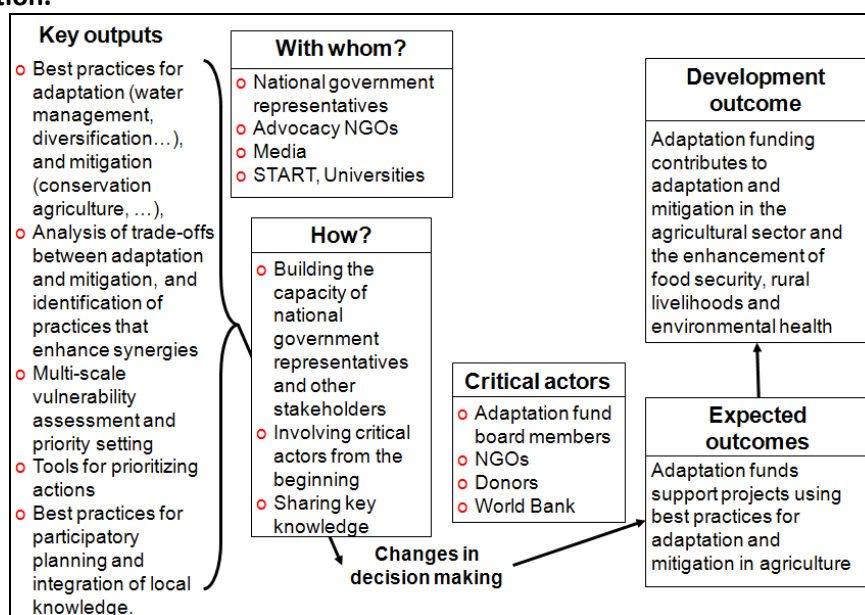
### **Partner roles**

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) 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).

**Figure 9. Impact pathway for how MP7 Theme 1, Objective 1 proposes to engage with the global adaptation funds, to ensure that fund guidelines are based on best practice information.**



***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 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, Objective 1). 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 MP3 is required so that outputs from this Objective inform breeding programs for each of the MP3 components.

### Products

- 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 and fish production and the design of virtual crops;
- Global, regional and national policy briefs for investments in climate-proofed crop, livestock and fish 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 MP3, 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 MP a multi-stakeholder and cross-CGIAR high-level meeting will be conducted to build consensus amongst 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 genebanks) 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 MP1, 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 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 MP1, 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.

### Products

- *In situ* populations of priority gene pools 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 goal 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 are to:

- Identify and test innovations that enable rural communities 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, information products and services, and evidence that currently impede development of climate-resilient rural livelihoods and coordinated, adaptive decision-making in the food system. It will combine analytical research with participatory co-learning with rural communities and other key actors in the food system, across a range of agroecological and socioeconomic contexts, to provide international public goods such as:

- Synthesized knowledge and evidence to inform targeting and implementation of innovative, climate-informed risk management strategies at local to regional levels;
- A platform for sharing knowledge, tools, guidelines, curricula and evidence to support climate information services for agricultural decision-makers;
- Improved knowledge, tools, data sets and platforms for monitoring and predicting agricultural production and biological threats, and informing management, in response to climate.

### **New content and innovation**

Theme 2 targets emerging (e.g., index-based risk transfer products, adaptive management at multiple scales in response to advance information) and integrated solutions for managing climate-related agricultural risk, which have not been fully explored or mainstreamed within agricultural development due to their newness, major knowledge gaps, climate information constraints, or dependence on more effective coordination among actors. By bridging the climate, agriculture and food security communities, and overcoming bottlenecks to relevant climate-related information services, Theme 2 will enable several innovative opportunities to manage agricultural risk better across scales.

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**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. Several planned outputs depend on historic meteorological data; hence the need for good partnership with the meteorological services, regional climate centers and the WMO. The dependence on integration with the other MPs 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 MPs**

Work in this Theme is linked to MPs 1, 2, 3, 5 and 6 (Table 10). Two-way interaction is expected with MP1 on diversification of farming systems and its impact on risk and vulnerability. Theme 1 will interact with MP2 in the areas of information delivery; risk management through off-farm livelihood diversification, insurance, collective action; and managing risk through the food delivery system. MP3 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 MP5 to provide information on soil and water management, while MP5 will provide options for reducing climate risk through better water and land management. The Theme will draw on advice from other MPs 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 MP1, MP3 and MP5 is envisaged, whereby promising options developed in those MPs are tested and further developed in the context of holistic adaptation-mitigation strategies.

**Table 10 Interaction of MP7 Theme 2 with other MPs (Priority activities are indicated in bold).**

<b>MP7 Objective # and Title</b>	<b>MP1 – Integrated Systems</b>	<b>MP2 - Policies, Institutions and Markets</b>	<b>MP3 – Sustainable Production</b>	<b>MP5 – Water, Land and Ecosystems</b>	<b>MP6 – Forests and Trees</b>
<i>2.1 Enable rural communities to manage risk and build resilient livelihoods</i>	<i>In MP7: Development and evaluation of improved risk management through diversification and sustainable intensification. In MP1: Pilot and evaluate climate risk management. <b>Cofinancing: Coordinated set of trial sites in target regions for testing options.</b></i>	<i>In MP7: Evaluation and development of weather-index insurance mechanisms In MP2: Analyses of rural financial services Collaboration: Ryral institutions and delivery of weather-index insurance mechanisms</i>	<i>In MP7: Development of improved risk management and climate-resilience through sustainable intensification. In MP1: Pilot and evaluate climate risk mgmt. <b>Cofinancing: Testing options for improved risk management of food system</b></i>	<i>In MP7: Provide climate info relevant to water and soil mgmt In MP5: Provide technical/policy options for reducing risk through water mgmt <b>Cofinancing: Testing options for improved risk mgmt of food system</b></i>	
<i>2.2 Managing climate risk through food delivery, trade and crisis response</i>	<i>In MP7: Use of climate-related info to manage risk through food security safety nets, food reserves and trade In MP1: Address needs for safety nets, food reserves and diversifying markets Collaboration: Joint priority setting for research on improved risk management of food system</i>	<i>In MP7: Work with humanitarian community on crisis response and recovery In MP2: Evaluation of social protection interventions for shocks Collaboration: Social protection, including humanitarian response, and its links to ag development.</i>			
<i>2.3 Enhanced prediction of climate impacts, and enhanced climate services</i>	<i>In MP7: Improved prediction of climate impacts and enhanced climate services In MP1: Use of climate impact information in MP1 research and development</i>	<i>In MP7: Improvement and evaluation of climate information services and delivery mechanisms In MP2: Improvement and evaluation of market information services and delivery mechanisms Collaboration: Opportunity for synergies in developing rural information delivery mechanisms</i>	<i>In MP7: Improved prediction of climate impacts and enhanced climate services In MP3: Use of climate impact information in MP3 research and development</i>	<i>In MP7: Improved prediction of climate impacts and enhanced climate services In MP5: Use of climate impact information in MP5 research and development</i>	<i>In MP7: Improved prediction of climate impacts and enhanced climate services In MP6: Use of climate impact information in MP6 agroforestry research and development</i>

**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 climate vulnerability. 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 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?

### **Activities**

This Objective will create a platform to synthesize and exchange information about farmers' coping strategies and innovations for improving management of climate-related agricultural risk. Participatory research will characterize indigenous, community-based risk management strategies, and assess their transferability and potential for upscaling. A review of existing initiatives will identify priority knowledge and methodology gaps for targeting and implementing pro-poor risk transfer products such as index-based insurance, which will be addressed under this Objective. Community-level surveys will assess the current use, unmet demand and bottlenecks to climate-related information for local-scale agricultural risk management, with disaggregation by gender and wealth, in order to inform interventions to improve rural climate services (under Objective 3). A combination of livelihood asset analysis, bioeconomic modeling and participatory research will analyze the determinants and climate-sensitivity of existing cultivar, enterprise and farmer livelihood portfolios; which will inform research to exploit diversification to reduce climate vulnerability. Participatory research at pilot locations will engage rural communities and other local stakeholders to identify, enhance and test suites of agricultural risk management strategies. Using a global approach, the Objective will work on agronomic and natural resource management approaches for enhancing climate resilience, and will synthesize such work.

### **Products**

Theme research will provide a range of products to inform and guide support for more effective management of agricultural risk, such as documented information about climate-related risks and impacts of current risk management practices; a web-based clearinghouse on risk management innovations (with Themes 1 and 3); and synthesized knowledge and decision tools for targeting and supporting risk management innovations for particular contexts.

### **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, PRADAN) 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 strategies. 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 coping 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 adaptation strategies, 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.

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

### **Rationale and research questions**

Decisions made within the food system at a regional scale 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 MP2 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)?

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- 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**

This Objective will use longitudinal household survey data and economic modeling to understand the livelihood impacts of current and alternative policies for managing climate-related safety net interventions and responding to food crises and price volatility. Working with appropriate food trade and humanitarian response organizations, work under this Objective will explore and evaluate new response strategies based on long-lead prediction, and design improved information and decision tools to support improved strategies. Further, the Objective will analyze long-term impacts of alternative post-crisis recovery strategies on the climate-resilience of livelihoods.

### **Products**

Research products will include climate information and decision tools to inform safety net, food trade and crisis response management; synthesized knowledge, guidelines and evidence to guide relief organizations to re-establish the agricultural sector following crises, vulnerability maps (with Theme 4) and guidelines to target crisis and post-crisis response; and enhanced platforms for coordinating information and action among response organizations.

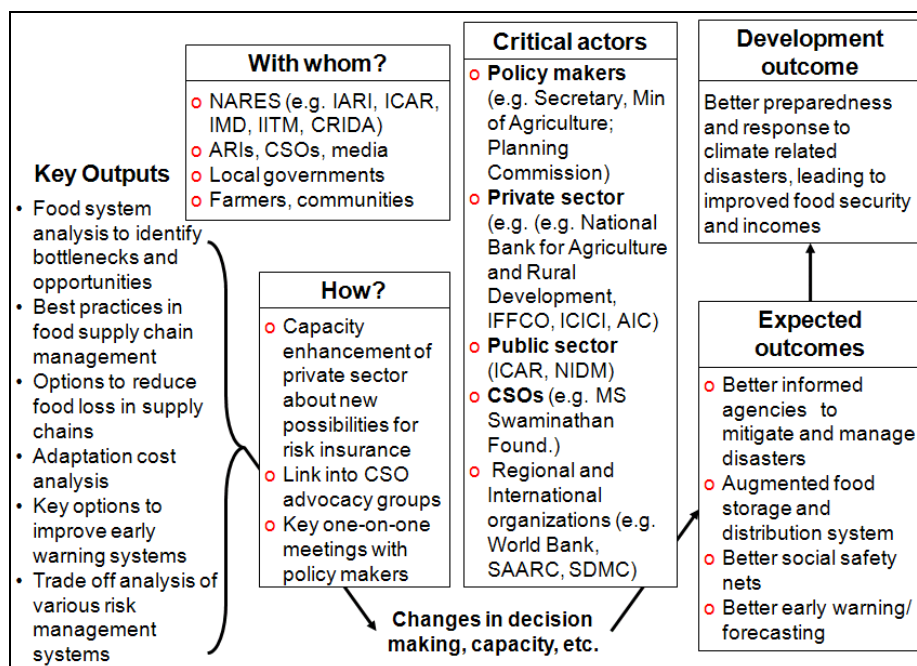
### **Partner roles**

Key food security response (e.g., WFP, food security NGOs, 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 MP2 and appropriate ARIs will participate in analyses, vulnerability mapping 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 the development of platforms to 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 (Figure 10).

**Figure 10. Impact pathway for working with agencies to improve preparedness and response to climate-related disasters – example from India, using outputs from Theme 2, Objective 2.**



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.

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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 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. The effort will be informed by review of current climate information products, services and delivery mechanisms in the focus regions; and assessment of constraints and opportunities for using seasonal climate prediction to manage agricultural risk. ICT-based and institutional models for communicating climate-related information with rural communities and for obtaining feedback will be assessed in terms of their effectiveness, equitability, relevance, transferability and scalability. Research under this objective will contribute methods and tools to improve the accuracy (at a given lead time) and lead time (at a target level of accuracy) of predictions of the response of crops, rangelands, and agricultural pests and diseases to climate variations. It will inventory climate-sensitive pest and disease modeling and early warning systems, and develop a strategy for enhancing their use for agricultural and food security risk management.

### **Products**

Research will produce tools and evidence to guide improvements in climate information services for and food security; a strategy for enhancing and upscaling delivery of information services for agriculture and food security; and platforms, tools and data sets for monitoring and predicting crop and pasture production and biological threats.

### **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-building 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 offer 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.

### **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 influence climate change, but 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 also reduce poverty, otherwise unacceptable trade-offs may occur.

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 carbon agricultural development pathways. These will need to be transformational alternatives that ensure future livelihoods and uses of land rather than increase 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 participation of the poor in the carbon market. Mitigation markets will commodify carbon and formalize rights to land, trees and carbon, both of which may marginalize the poor. Carbon prices are inherently risky. Smallholders in developing countries are not currently competitive in these markets. They usually cannot afford the up-front costs of project development, data is often not available, and farmers practice diversified mixed crop-livestock. 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 market 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 (MRV) procedures; and investigating innovative methods to reduce other transaction costs and induce permanence are all necessary steps to enable smallholder farmers' participation in carbon markets. Understanding the impacts of carbon markets on poverty and designing pro-poor institutional arrangements will be important to assure sustainable outcomes. Feasibility 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 carbon pathways and participation of the poor in the carbon market 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 carbon 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. 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 overall goal 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 are to:

- Inform decision makers about the impacts of alternative agricultural development pathways
- Test and identify institutional arrangements and incentives that enable smallholder farmers and users of common-pool resources (rangelands, community forests, coastal zones) to participate effectively in carbon markets and reduce GHG emissions.
- 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
- 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 carbon 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

- New methods and systems for GHG monitoring and accounting at farm, landscape and food value chain levels
- 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 to inform policies and investments
- Testing, and if relevant, demonstration, of the feasibility of agricultural mitigation that yields significant benefits for smallholders in developing countries.
- New pro-poor institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to participate effectively in carbon markets 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 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. It will bring information on pro-poor mitigation into international and regional climate policy arenas and take carbon markets into new territories. 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: 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).
- Objective 3: Involving smallholder farmers and common-pool resource users in institutional design. Identifying incentives for local actors. Identifying multi-scale governance arrangements.

### **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 and making a meaningful contribution to livelihoods. Operational and institutional risks include weak extension agencies, under-supported local capabilities and unreliable governance. There is a political risk of mobilization from politicians and civil society organizations in the South against agricultural mitigation by smallholders on grounds of 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 MPs

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 MP6 (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 11). The theme will also contribute to MP1, situating mitigation within broader agricultural and other food production systems, MP5 in its work on soil carbon, and MP3, including methane reduction from rice systems and intensification of potato production to limit expansion into carbon-rich grasslands. MP1, MP3 and MP5 will be the main MPs where new mitigation technologies are developed and tested, and MP7 aims to cofinance the testing of promising technologies in a climate change context. 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 MP2.

**Table 11. Interaction of MP7 Theme 3 with other MPs (Priority activities are indicated in bold).**

MP7 Objective # and Title	MP1 – Integrated Systems	MP2 - Policies, Institutions and Markets	MP3 – Sustainable Production	MP4 – Nutrition and Health	MP5 – Water, Land and Ecosystems	MP6 – Forests and Trees
<i>3.1 Inform decision makers about potential low-carbon agricultural development pathways and their impacts</i>	<i>In MP7:</i> Development of low-carbon ag. scenarios <i>In MP1:</i> Development of farming systems that meet adaptation and intensification requirements <i>Collaboration:</i> Research on synergies between adaptation and intensification	<i>In MP7:</i> Life cycle analysis of food supply chains <i>In MP2:</i> Investigation of policy, investment and enabling environment for pro-poor growth <i>Collaboration:</i> Trade-offs among mitigation, food security and livelihoods of low carbon food supply chain and ag. options.		<i>In MP7:</i> Development of low-carbon ag. scenarios <i>In MP4:</i> Reducing impacts of intensification on human and animal health <i>Collaboration:</i> Understanding implications of low-carbon scenarios for human/animal health	<i>In MP7:</i> Assess trade-offs of low carbon options on environ. services <i>In MP5:</i> Test tradeoffs of biomass use for food/energy/feed/soils <i>Collaboration:</i> Impacts of soil/water mgmt on mitigation	<i>In MP7:</i> Identifying options for ag. intensification that reduce GHG emissions. <i>In MP6:</i> Forest-based mitigation (e.g. REDD). <i>Collaboration:</i> Reducing ag. expansion as a driver of deforestation
<i>3.2 Institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to participate effectively in carbon markets and reduce GHGs</i>	<i>In MP7:</i> Testing the feasibility of payments for mitigation by smallholders. <i>In MP1:</i> Technical development of mitigation options in systems <i>Collaboration:</i> Linking incentives to new technical options.	<i>In MP7:</i> Identify institutions/incentives that enable smallholders to benefit from C markets; role of collective action in aggregating smallholders into C markets <i>In MP2:</i> Models/tools to understand institutional, market and policy impacts; <i>Collaboration:</i> Inclusion of mitigation in modeling food security impacts	<i>In MP7:</i> Testing the feasibility of payments for mitigation by smallholders on farms <i>In MP3:</i> Integration of mitigation options into testing of new varieties and mgmt options <i>Collaboration:</i> Linking incentives to new technical options		<i>In MP7:</i> Testing bundling of C payments with other environmental service payments. <i>In MP5:</i> Valuing and assessing environmental goods and services; <i>Collaboration:</i> Payments for C as incentives for mitigation	<i>In MP7:</i> Identifying opportunities for pro-poor mitigation payment schemes <i>In MP6:</i> Developing institutional arrangements for mitigation payments through agroforestry and forestry <i>Collaboration:</i> Testing institutional arrangements.

<p>3.3 On-farm mitigation practices and their landscape-level implications</p>	<p><i>In MP7:</i> Testing the economic/ technical feasibility of mitigation options; aggregating at the landscape and farm levels <i>In MP1:</i> Technical development of mitigation options. <b>Collaboration: Verifying GHG budgets</b> <b>Cofinancing: Testing technologies that enhance mitigation.</b></p>	<p><i>In MP7:</i> Testing the economic and technical feasibility of mitigation options <i>In MP2:</i> Understanding policy and market impacts on livelihoods <i>Collaboration:</i> Assessing role of policies and markets on the feasibility of mitigation options</p>	<p><i>In MP7:</i> Testing the economic and technical feasibility of mitigation options <i>In MP3:</i> Integration of mitigation options into testing of new technologies <b>Collaboration: Verifying GHG budgets</b> <b>Cofinancing: Developing technologies to enhance mitigation from specific commodities</b></p>	<p><i>In MP7:</i> Testing potential for water mgmt and soil C-based mitigation options; <i>In MP5:</i> Developing water and soil mgmt options. <i>Collaboration:</i> Developing protocols for C measurement. <b>Cofinancing: Developing technologies that enhance mitigation from land and water mgmt</b></p>	<p><i>In MP7:</i> Testing technical/ economic feasibility of mitigation options <i>In MP6:</i> Approaches for reducing emissions from forests <b>Cofinancing: Landscape-based approaches for mitigation, including those that reduce forest degradation and deforestation</b></p>
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**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 potential low-carbon agricultural development pathways and their impacts**

**Rationale**

The purpose of this objective is to explore transformational low carbon agricultural development pathways and to compare the impacts of alternatives. 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 landscape 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.

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### Research questions

- What are alternative trajectories for low carbon agricultural development and what are their likely impacts on FPE? How can agricultural production be intensified sustainably, while also contributing to climate change mitigation?
- What are the synergies and trade-offs between climate change adaptation and mitigation in different regions?
- What are the synergies and trade-offs between agriculture and forestry?
- What are the synergies and trade-offs between bioenergy and food production?
- How does low carbon agricultural development affect the resilience of the food system at different scales?
- How do different pathways affect marginal and vulnerable populations, including women?

### Activities

- Identify options and needs for low carbon agricultural development from stakeholders, including livelihood focused NGOs (such as CARE and Oxfam), government planning agencies, and ESSP scientists.
- Develop alternative scenarios (including quantitative and qualitative techniques) and suitable strategies for agricultural intensification with diverse stakeholders, including organizations advocating for women farmers' well-being. Includes comparing 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.
- Support science-policy dialogue on alternative agricultural development futures.
- Analyze the mitigation implications of alternative adaptation strategies.
- Clarify the trade-offs between biofuel and food production in different contexts.
- Analyze the mitigation implications of alternative forest-agriculture landscapes and their associated institutions.
- 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.

### Products

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 building 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. Research will be conducted in collaboration with GECAFS. 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. Institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to participate effectively in carbon markets and reduce GHGs***

#### **Rationale**

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 carbon 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 mitigation practices need to be tested for their economic feasibility and trade-offs with measurement precision 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. Carbon markets may provide incentives for farmers to adopt sustainable agriculture and land management techniques. However, until it becomes cost effective, the poor will have little incentive to participate.

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

- How can the poor, especially women, participate in the design of and gain better access to the benefits available through the trade of carbon and other GHGs?
- How can the poor benefit from carbon labeling on food products and mitigation in other elements of the food system?
- What kinds of institutional arrangements or architecture are needed to enable carbon credits produced by agriculture in developing countries to be sold and traded by smallholders?
- What kinds of incentives are needed to encourage farm practices among smallholders that enhance mitigation?
- How can common-pool resource users participate effectively and benefit from carbon markets through their landscape/seascape stewardship activities?
- What lessons can be learned from PES, CDM, or REDD? What lessons can be learned about benefit distribution from microfinance experiences?

### Activities

- Assess barriers to entry and factors affecting benefits from the carbon market for different social groups, including women, and the range of emerging institutional arrangements and incentives for better inclusion and benefits.
- Pilot institutional arrangements, incentive mechanisms and MRV protocols for carbon trade, 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.
- Identify promising market-based instruments, policies and institutional arrangements.
- Test the feasibility of carbon market participation and benefits 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).
- 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.

### Products

Key products will be research outputs that identify market-based instruments, 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-building 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

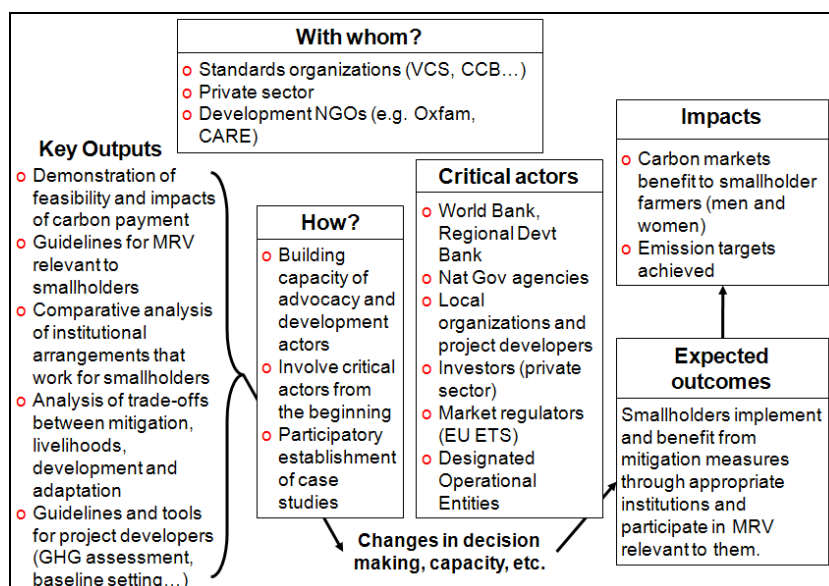
This objective will work closely with project developers, the World Bank, regional development banks, local and project investors, farmers’ organizations, and intermediaries such as the Nature Conservation Research Center (Ghana), BRAC (Bangladesh and Uganda) and Pradan (India), to develop and test innovative 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 building 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 listservs 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 11. 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 11. 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.



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**Theme 3 Objective 3: On-farm mitigation 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<sub>2</sub>O 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. 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.

**Research questions**

- What is the technical and economic feasibility of agriculturally based mitigation among smallholders in developing countries?
- What is the GHG abatement potential (full net-net GHG accounting) of promising carbon sequestration and non-CO<sub>2</sub> GHG emissions reduction technologies and management practices?
- What are the potential direct and indirect economic and environmental costs and benefits from agricultural GHG sequestration and emission reduction?
- How do different technologies and management practices affect men and women, or the poor and larger farmers differently?
- 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?
- What are the impacts of agriculturally based mitigation practices on local livelihoods, welfare and institutions?
- What kind of stakeholder involvement and communication is necessary to link emissions knowledge to mitigation actions?

**Activities**

- Create a global communication platform for exchange and synthesis of information about innovations in agricultural mitigation.
- Identify the carbon sequestration and GHG abatement potential of a variety of natural resource management approaches. Identify a set of target practices where MP7 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 and develop MRV procedures, working with partners in the Global

Environment Change (GEC) community, and assess impacts on poverty alleviation, food security and environmental health at multiple scales.

- 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.
- 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.
- Explore technical frontiers in carbon markets – e.g. ‘blue carbon’.
- Provide information to developers of carbon projects and standards (e.g., CCBA) on social impact assessments to ensure livelihood benefits.

### **Products**

This objective will deliver an evaluation of potential direct and indirect economic and environmental costs and benefits from agricultural mitigation, and identification of technologies and management systems that can deliver agricultural mitigation 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 Ph.D. student network will be formed to support this work and facilitate capacity building. In addition, this objective has three methodological outputs: a) developing and assessing systems for GHG monitoring and accounting at farm and landscape level; 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 will establish a complementary set of agricultural mitigation sites in representative agroecosystems of the developing world. 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, fisheries, fruit crops, staple cereals, agroforestry). 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 MP1, will take place with local level partners connected to international entities that can scale-up impacts, such as EcoAgriculture, IIED, 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.

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## Theme 4: Integration for Decision Making

### Rationale

The goal of achieving sustainable food security is already under unprecedented pressure from population 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 MP7 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. Quantifying impacts and the consequences of policy changes is a critical aspect of identifying trade-offs and thus best-bet options for addressing specific climate challenges. 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 MP7 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 MP7. 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.

### Objectives

Theme 4 provides a critical integrative function for MP7. 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 MP7. 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 are to:

- Build platforms and methods to link knowledge with action;
- Assemble data and tools for analysis and planning;
- Refine frameworks for policy analysis.

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### 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. A particular focus will be on the development of *ex ante* impact assessment tools. A “farm vulnerability” index will be devised to complement the UNs 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 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.
- 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 building 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 MP, across the MPs as a whole, across disciplines and across research communities – and as such will require strong relationships. 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 MPs

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 MPs (Table 12). The Objective on linking knowledge with action provides the platforms for other MPs to interface with the 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 MP1 (Integrated agricultural systems for the poor and vulnerable). Modelling and decision-support tools developed within this Theme will be tested and validated within MP1, MP3, MP5 and MP6. This Theme and MP2 (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 MP4 will be informed by the climate and development scenarios evaluated in this Theme.

**Table 12 Interaction of MP7 Theme 1 with other MPs (Priority activities are indicated in bold).**

MP7 Objective # and Title	MP1 – Integrated Systems	MP2 - Policies, Institutions and Markets	MP3 – Sustainable Production	MP4 – Nutrition and Health	MP5 – Water, Land and Ecosystems	MP6 – Forests and Trees
4.1 Linking Knowledge with Action	<i>In MP7:</i> Developing plausible future food security scenarios under climate change; <b>Access to key stakeholders in the climate community</b>	<i>In MP7:</i> Identify institutions that benefit smallholders; <b>Access to key stakeholders in the climate community.</b> <i>In MP2:</i> Identify innovative governance arrangements to strengthen property rights, assets, rural services <i>Collaboration:</i> Institutional & collective action approaches	<i>In MP7:</i> Developing plausible future food security scenarios under climate change; <b>Access to key stakeholders in the climate community.</b> <i>Collaboration:</i> Sharing of data and results relevant to future scenarios.	<i>In MP7:</i> Developing plausible future food security scenarios;; <b>Access to key stakeholders in the climate community.</b> <i>In MP4:</i> Mitigating impacts of intensification on human/ animal health <i>Collaboration:</i> Scenarios of intensification and disease futures	<i>In MP7:</i> Developing plausible future food security scenarios under climate change; <b>Access to key stakeholders in the climate community.</b>	<i>In MP7:</i> Developing plausible future food security scenarios under climate change;
4.2 Assembling data and tools for analysis and planning	<i>In MP7:</i> <b>Setting the climate change context.</b> Vulnerability analyses; <b>downscaled climate change info;</b> tools for ex-ante analysis. <i>In MP1:</i> Methods and tools for analysis / improvement of agricultural systems in target regions <i>Collaboration:</i> Data assembly, scoping studies on, and testing, tools and methods	<i>In MP7:</i> <b>Setting the climate change context.</b> Develop tools for ex-ante impact assessment, at multiple levels <i>In MP2:</i> Strengthen capacity in ex-ante impact assessment, priority setting, and targeting <i>Collaboration:</i> Sharing approaches and datasets	<i>In MP7:</i> <b>Setting the climate change context.</b> Large scale research on climate change vulnerability and priority setting; <b>downscaled climate change info</b> <i>In MP3:</i> Data on status and trends of crops etc. <i>Collaboration:</i> Developing tools and data sharing; Training on data and modelling approaches to crop, livestock and fish performance	<i>In MP7:</i> <b>Setting the climate change context.</b> Quantification of sustainable development pathways <i>In MP4:</i> Global assessment of agriculture-associated disease <i>Collaboration:</i> Evaluation of agriculture-associated disease under different development pathways	<i>In MP7:</i> <b>Setting the climate change context. Downscaled climate change info.</b> Tools for ex-ante assessment of adaptation options. <i>In MP5:</i> Development of soil/water/eco-system info systems <i>Collaboration:</i> Water basin hydrology and ag. water utilisation modelling	<i>In MP7:</i> <b>Downscaled climate change info.</b> Tools for ex-ante assessment of adaptation options. <i>In MP6:</i> Development of landscape models
4.3 Refining frameworks for policy		<i>In MP7:</i> Climate change as an additional	<i>In MP7:</i> Assessing the policy and program		<i>In MP7:</i> Assess policy reforms to enhance land/	

analysis		challenge to designing pro-poor technologies. <i>In MP2:</i> Research to assess most effective policy and program interventions. <i>Collaboration:</i> Better incorporation of climate change impacts on productivity into models.	environment of potential crop and farming system innovations to climate change <i>In MP3:</i> Development of new technologies <i>Collaboration:</i> Potential new crop, livestock and fisheries characteristics and evaluation of policies to develop and disseminate		Water mgmt under climate change <i>In MP5:</i> Technologies and data on sustainable land/ water mgmt <i>Collaboration:</i> Policy options for improving soil mgmt under climate change; Co-design of water-access policies to address water stresses	
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**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 stakeholders and for facilitating debate and communication among them. The whole process of stakeholder engagement and debate about plausible futures will contribute to MP7’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 using initial quantitative global scenarios developed by CG researchers and others to provide guidance. By Year 3 an iterative process between regional storyline and global scenarios will result in both more relevant qualitative scenarios where internal plausibility is maintained with quantitative modeling and global modeling will more appropriately deal with regional scenario issues.

This Objective will provide an integrating forum for the intersection of all the work in MP7, from priority setting to bringing key outputs from MP7 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 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. Scenario work will also be conducted at the global level and will be linked to 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 may change in the future in relation to multiple stressors. An attempt will be made to produce a simple “farm vulnerability” index.

### Products

- 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;
- Maps, reports and policy briefs about vulnerability that can be used to inform the targeting of research activities in the other Themes of MP7 and in other MPs;
- 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

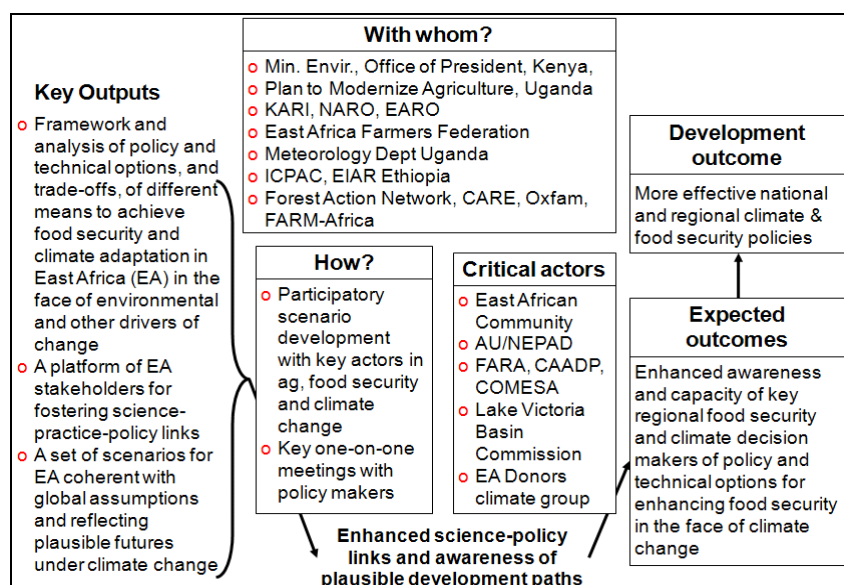
The scenario activities will be conducted working closely with the ESSP and with regional and national stakeholders in each of the target regions. These will form an important aspect of communications and capacity building and will help build regional science–policy teams who can take MP7 outputs forward. At the global level, key partners initially are the Canadian International Development Agency (CIDA), 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 MP7 to engage with policy-makers, development agencies and business strategists in the regions (Figure 12). The scenarios will form the basis for vulnerability and trade-off analyses throughout MP7 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 12. Impact pathway for enhancing awareness and capacity about regional options for agriculture under climate change, through participatory scenario development.** 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**

The IMPACT model, initially developed at IFPRI and now being enhanced with work at several other centers, is the most comprehensive framework available 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. However, this model has 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<sub>2</sub> 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 (e.g. combining adaptation and mitigation agendas, and exploring synergies and trade-offs among outcome targets). A key research questions is: what are the critical knowledge and data gaps and how can these gaps be filled effectively? Should the IMPACT model be further expanded? 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 MP7.

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 MP7 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. MP7 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.

### **Products**

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, 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.

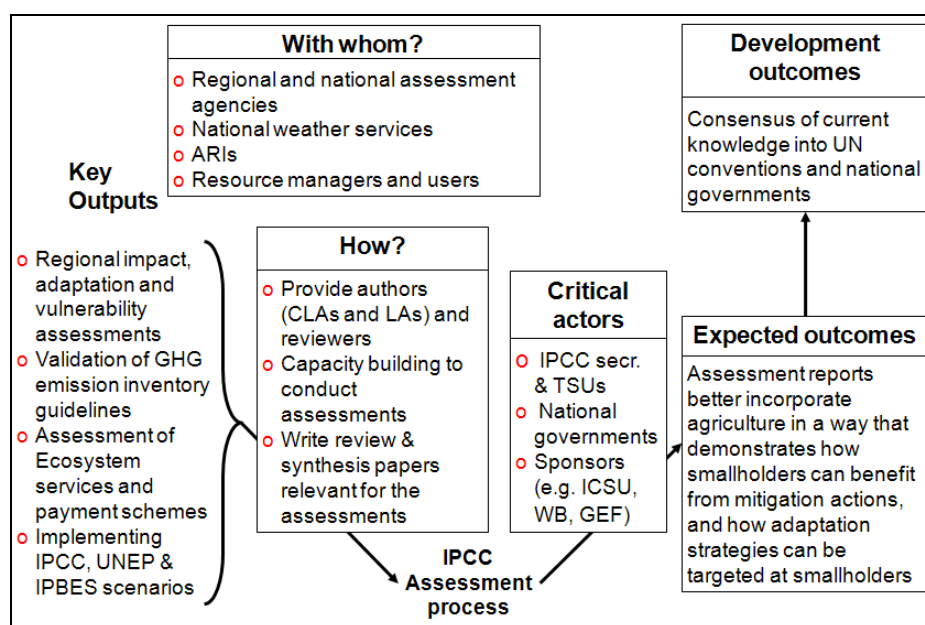
### **Partner roles**

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 MP7. 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 Global Crop Modeling Project (GCMP). 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, amongst others (Figure 13).

**Figure 13. Impact pathway for bringing MP7 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 security 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?

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## 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.

Early on in MP7 implementation, integrated assessment will be focused on *ex-ante* analysis to help set in place systems for monitoring and evaluating MP7 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 MP7 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 MP7 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.

## Products

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 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

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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.

## References

- Barrett, C.B. (2010). *Measuring food insecurity*. Science 327 (5967), 825 (February 2010). [DOI: 10.1126/science.1182768].
- Beddington, J. (2010). *Food security: Contributions from science to a new and greener revolution*. Philosophical Transactions of the Royal Society 365: 61–71.
- Below, T., Artner, A., Siebert, R. and Sieber, S. (2010). *Micro-level practices to adapt to climate change for African small-scale farmers*. International Food Policy Research Institute (IFPRI) Discussion Paper 00953.
- Biggs, S.D. (1990). *A multiple source of innovation model of agricultural research and technology promotion*. World Dev 18(11): 1481–1499.
- Burke, M.B., Lobell, D.B. and Guarino, L. (2009). *Shifts in African crop climates by 2050, and the implications for crop improvements and genetic resources conservation*. Global Environmental Change 19 (3): 317–25.
- Campbell, B.M., Hagmann, J., Stroud, A., Thomas, R., Wollenberg, E. 2006. Navigating amidst complexity: Guide to implementing effective research and development to improve livelihoods and the environment. Center for International Forestry Research (CIFOR), Bogor, Indonesia. 82 pp.
- Campbell, B.M. (2009). Beyond Copenhagen: REDD+, agriculture, adaptation strategies and poverty. Global Environmental Change 19: 397–399.
- Cash, D.W., Adger, W., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L. and Young, O. (2006). *Scale and cross-scale dynamics: Governance and information in a multilevel world*. Ecology and Society 11(2):8. (<http://www.ecologyandsociety.org/vol11/iss2/art8/>)
- Challinor, A.J., Ewert, F., Arnold, S., Simelton, E. and Fraser, E. (2009). *Crops and climate change: Progress, trends and challenges in simulating impacts and informing adaptation*. Journal of Experimental Botany 60 (10): 2775–2789.
- Challinor, A.J., Wheeler, T.R., Slingo, J.M., Craufurd, P.Q. and Grimes, D.I.F. (2004). *Design and optimisation of a large-area process-based model for annual crops*. Agricultural and Forest Meteorology 124: 99–120.
- CGIAR Science Council and CGIAR Secretariat (2007). *Lessons Learnt from Selection and Implementation of the CGIAR Challenge Programs*. Science Council Secretariat.
- CGIAR Science Council (2008) *The role of systemwide initiatives in implementing the CGIAR's research agenda: An assessment of current systemwide and ecoregional programs (SWEPs)*. Science Council Secretariat, February 7, 2008.
- Ericksen, P.J. 2008. Conceptualizing food systems for global environmental change research. *Global Environmental Change* 18:234-245.
- Food and Agriculture Organization of the United Nations (FAO) (1996)
- FAO (2009a). *Harvesting Agriculture's Multiple Benefits: Mitigation, Adaptation, Development and Food Security*. FAO Policy Brief. (<ftp://ftp.fao.org/docrep/fao/012/ak914e/ak914e00.pdf>)
- FAO (2009b). *Food Security and Agricultural Mitigation in Developing Countries: Options for Capturing Synergies*. (<http://www.fao.org/docrep/012/i1318e/i1318e00.pdf>)
- Federoff, N.V., Battisti, D.S., Beachy, R.N., Cooper, P.J.M., Fischhoff, D.A., Hodges, C.N., Knauf, V.C., Lobell, D., Mazur, B.J., Molden, D., Reynolds, M.P., Ronald, P.C., Rosegrant, M.W., Sanchez, P.A., Vonshak, A. and Zhu, J.K. (2010). *Radically rethinking agriculture for the 21st century*. Science 327 (5967), 833-834. [DOI: 10.1126/science.1186834]
- Global Donor Platform for Rural Development (2009). *Agriculture in the Climate Negotiations*. Platform Issue Paper 6 (September 2009) ([http://www.donorplatform.org/component/option,com\\_docman/task,doc\\_view/gid,1142](http://www.donorplatform.org/component/option,com_docman/task,doc_view/gid,1142)).

- Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. and Toulmin, C. (2010). *Food security: The challenge of feeding 9 billion people*. *Science* 327 (5967), 812-818. [DOI: 10.1126/science.1185383]
- Howden, S.M., Soussana, J.F., Tubiello, F.N., Chhetri, N., Dunlop, M. and Meinke, H. (2007). *Adapting agriculture to climate change*. *PNAS*, 104(5), 19691–19696; ([www.pnas.org/cgi/doi/10.1073/pnas.0701890104](http://www.pnas.org/cgi/doi/10.1073/pnas.0701890104))
- Ingram, J.S.I. (Ed). (1996). *GCTE Focus 3 Wheat Network: 1995 Model and Experimental Metadata*. GCTE Report 2 Second Edition. GCTE Core Project Office, Canberra. 257 pp.
- Intergovernmental Panel on Climate Change (IPCC). (2008) *Climate Change 2007: Mitigation of Climate Change. Working Group III Contribution to the Fourth Assessment Report of the IPCC*. (Eds) B. Metz, O. Davidson, P. Bosch, R. Dave and L. Meyer. Intergovernmental Panel on Climate Change. Cambridge University Press. New York. ([www.cambridge.org/9780521880114](http://www.cambridge.org/9780521880114))
- Jackson, L.E., Pascual, U. and Hodgkin T. (2007). *Utilizing and conserving agrobiodiversity in agricultural landscapes*. *Agriculture, Ecosystems, and Environment* 121: 196–210.
- Jarvis, A., Lane, A. and Hijmans, R.J. (2008). *The effect of climate change on crop wild relatives*. *Agriculture, Ecosystems & Environment* 126 (1–2): 13–23.
- Jones, P.G. and Thornton, P.K. (2003). *The potential impacts of climate change on maize production in Africa and Latin America in 2055*. *Global Environmental Change* 13: 51–59.
- Kok, K., Biggs, R & M. Zurek. 2007. Methods for Developing Multiscale Participatory Scenarios: Insights from Southern Africa and Europe. *Ecology & Society* 13(1): 8 [online] URL: <http://www.ecologyandsociety.org/vol12/iss1/art8/>
- Kristjanson, P., Reid, R.S., Dickson, N., Clark, W.C., Romney, D., Puskur, R., MacMillan, S., and Grace, D. (2009). Linking international agricultural research knowledge with action for sustainable development. *PNAS* 106(13): 5047–5052 URL: [www.pnas.org/cgi/doi/10.1073/pnas.0807414106](http://www.pnas.org/cgi/doi/10.1073/pnas.0807414106)
- Lane, A. and Jarvis, A. (2007). Changes in climate will modify the geography of crop suitability: Agricultural biodiversity can help with *adaptation*. *Journal of Semi-arid Tropical Agricultural Research* 4(1) available online at (<http://www.icrisat.org/Journal/specialproject.htm>)
- Lobell, D., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P. and Naylor, R.L. (2008). *Prioritizing climate change adaptation needs for food security in 2030*. *Science* 319: 607–610.
- Nelson, G.C., Rosegrant, M.W., Koo, J., Robertson, R., Sulser, T., Tingju Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M. and Lee, D. (2009). *Climate Change: Impact on Agriculture and Costs of Adaptation*. Food Policy Report, 19. Washington, DC: IFPRI, 2009
- Parry, M. (2007). *The implications of climate change for crop yields, global food supply and risk of hunger*. *Journal of Semi-arid Tropical Agricultural Research* 4(1), available online at (<http://www.icrisat.org/Journal/specialproject.htm>)
- Royal Society of London (2009). *Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture*. Royal Society, London.
- Schmidhuber, J. and Tubiello, F.N. (2007). *Global food security under climate change*. *Proc. Natl. Acad. Sci. U.S.A.* 104: 19703–19708.
- Sayer, J. & Campbell, B. (2004). *The science of sustainable development: local livelihoods and the global environment*. Cambridge University Press, Cambridge.
- Smith, P. et al. (2008). Greenhouse gas mitigation in agriculture. *Phil. Trans. R. Soc. B* (2008) 363, 789–813
- Tester, M. and Langridge, P. (2010). Breeding technologies to increase crop production in a changing world. *Science* 327 (5967): 81–822.
- Thornton, P.K., Jones, P.G., Owiyo, T., Kruska, R.L., Herrero, M., Orindi, V., Bhadwal, S., Kristjanson, P., Notenbaert, A., Bekele, N. and Omolo, A. (2008). Climate change and poverty in Africa: Mapping hotspots of vulnerability. *African Journal of Agriculture and Resource Economics* 2(1): 24–44.

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- Tubiello, F., Schmidhuber, J., Howden, M., Neofotis, P.G., Park, S., Fernandes, E. and Thapa, D. (2008). *Climate Change Response Strategies for Agriculture: Challenges and Opportunities for the 21st Century*. Agriculture and Rural Development Discussion Paper 42. World Bank.
- UNDP Human Development Report 2007/2008. (2007). *Fighting Climate Change: Human Solidarity in a Divided World*. United Nations Development Programme. New York. Palgrave Macmillan, New York.
- Waddington, S.R., Li, X., Dixon, J., Hyman, G. and de Vicente, M.C. (2010). *Getting the focus right: production constraints for six major food crops in Asian and African farming systems*. *Food Security* 2 (1): 27–48.
- Wood, S., Ericksen, P.J., Stewart, B., Thornton, P.K. and Anderson, M. (2010). *Lessons Learned from International Assessments*. Chapter 1c in *Food Security and Global Environmental Change* (Eds. J.S.I. Ingram, P.J. Ericksen, D.M. Liverman). Earthscan, London.
- Wooley, J. Ribaut, J-M., Bouis, H. and Adekunle, A. 2009. *The CGIAR's Challenge Program Experiences: A Critical Analysis*. Unpublished report.
- World Economic Forum (WEF). (2008). *Global Risks 2008. A Global Risk Network Report*. A World Economic Forum Report in collaboration with Citigroup, Marsh & McLennan Companies (MMC), Swiss Re, Wharton School Risk Center and Zurich Financial Services. WEF. Geneva.
- World Bank. (2007). *Population Issues in the 21<sup>st</sup> Century: The Role of the World Bank*. Health, Nutrition and Population (HNP) Discussion Paper. The World Bank, Washington D.C. (<http://siteresources.worldbank.org/HEALTHNUTRITIONANDPOPULATION/Resources/281627-1095698140167/PopulationDiscussionPaperApril07Final.pdf>)
- World Bank. (2008). *World Development Report 2008: Agriculture for Development*. The World Bank, Washington, DC.
- World Bank (2009). *Global Economic Prospects 2009: Commodities at the Crossroads*. The World Bank, Washington, DC.



## 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	Center 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
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

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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
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
GCMP	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

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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
MP	Mega 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

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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
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: Products, users, outcomes and impacts

### Theme 1: Adaptation to Progressive Climate Change

Key final products	Intermediate users	Final users	Outcomes	Impacts
<b><i>Objective 1: Adapted farming systems to changing climate conditions through the integration of tested technologies, practices and policies</i></b>				
Design of adapted farming systems and technologies for changing climate conditions in space and time through the development of improved crops, livestock, agronomic practices, water management and natural resource management tools Building of regional and national capacities to produce high quality strategies, e.g. through NAPAs and NAMAs New knowledge-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	Policy makers at sub-national, national and international scales; international development NGOs, local development NGOs	Resource-poor farmers	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	Reduction of vulnerability to climate variability and change, and more resilient food systems
<b><i>Objective 2: Breeding strategies for addressing abiotic and biotic stresses induced by future climatic conditions, variability and extremes, including novel climates</i></b>				
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 modeling, expert consultation and stakeholder dialogue	Breeders, physiologists, biotechnologists, agronomists	Extension services, resource-poor farmers	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	Reduction of vulnerability to climate variability and change
<b><i>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</i></b>				
New knowledge, guidelines and germplasm available for using genetic and species diversity to enhance adaptation, productivity and resilience to changing climate	Breeders, extension services, farmers, agricultural development organizations, NARES, government agencies, conservation organizations	Resource-poor farmers	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	Reduction of vulnerability and sustained production despite climate variability and change

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

Year	Activities	Products	Assumptions	Target regions	Partners <sup>37</sup>
2011	Compilation of existing databases on crop performance related to climate from multiple sources (i.e. multi-site trial data of a range of crop varieties)	Platform for multi-site trials of technologies and varieties established for analysis of GxE interactions and calibration and validation of crop models	Willingness of partners to share multi-site trial data	West Africa, East Africa, Indo-Gangetic Plains New target regions added in subsequent years	CGIAR Centers, CIRAD, JIRCAS, NARES (e.g. EIAR, KARI, NARO, IARI, BARC, BARI, NARC etc) and other ARI institutions involved in agricultural trials
2011	Identification and establishment of technologies to be tested and developed across a range of pilot sites	New production system technologies developed which contribute directly to enhanced adaptive capacity in farming systems	Interest from local partners in managing pilot sites, willingness of partners to provide candidate technologies for trialing.	Pilot sites in target regions	CGIAR Centers in collaboration with other themes in the MP, NARES, ARIs, CIRAD.
2011	Development of gender-sensitivity participatory methods for grounding climate change model results to community level decision making processes that address food security issues	Tested methodology to apply globally	Cross-site and cross-continent applicability	Three countries in Central and South America; application in target regions	CIAT, Oxfam, CRS, Learning Alliance, Sustainable Food Lab, SAI
2011	Identify how integrated agriculture aquaculture can enhance adaptive capacity of farmers Analyze priority and methodological gaps for the assessment of impact of, and adaptation to, climate change in fisheries and aquaculture	Practices that enhance management of water use for aquaculture as well as improve small-scale irrigation; Methodological framework for economics of adaptation at the farm level	Win-wins between aquaculture and irrigation are possible	Africa and Asia	WorldFish, NARES, ARIs, IWMI
2012	Community-based trialling of holistic adaptation options to understand the social, cultural, economic and institutional barriers to effective adaptation	Appropriate suites of adaptation options	Ability to generalize from local-level participatory analyses	Target regions in Africa and Asia	CGIAR Centers, local NGOs, local government
2012	Surveys, modeling, inventory of storage types, economic analyses, and	Tools and guidelines to support the selection (and / or maintenance) of the most appropriate	Uptake of tools and guidelines; sufficiently accurate	West Africa and global	IWMI, WRI- Ghana, PIK, ZEF, MRC

<sup>37</sup> A full list of partners is available from CCAFS for the target regions.

Year	Activities	Products	Assumptions	Target regions	Partners <sup>37</sup>
	conceptualization	water storage options and/ or their combinations for river basin development planning under conditions of increasing climate variability	predictions of future water storage deficits and needs		
2012	Modeling methodologies to outscale the potential of individual adaptation options across a wide range of geographies (i.e. use of analogues in space and time)	Explicit knowledge of the potential application domains for agricultural practices, technologies and policies, and knowledge on best means of transferring these technologies and ensuring their adoption	Availability of sound climate projections to 2030 and beyond.	Developing countries	CGIAR Centers, ESSP (e.g. Leeds University), NARES and ARIs
2013	Characterization of climate adaptation options in target regions	Portfolio of adaptation options with potential for adapting production systems identified, developed and/or tested	Sufficient technologies tested in 2011 and 2012 and successful means of extrapolating application domains.	Sub-set of target regions representative of developing country conditions	CGIAR centers, development NGOs, national government, NARES (e.g. EIAR, NARO, KARI, CRIDA).
2013	Understanding of institutional arrangements, policies and mechanisms that enhance the adaptive capacity of resource-poor households to adopt new farming practices, strategies and behaviors that reduce their vulnerability in the face of a changing climate	Document synthesizing institutional arrangements, policies and mechanisms for improving the adaptive capacity of agricultural sector actors; what is working where, how and why, with disaggregation by gender and other social strata Building of regional and national capacities to produce high-quality NAPAs and NAMAs	Partners have sufficient incentives to engage and people trained remain in local institutions	West Africa, East Africa Indo-Gangetic Plains New target regions added in subsequent years	African & S.Asian University networks; development NGOs (e.g. CARE, Oxfam, ICCCAD), government, regional bodies

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

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Ensuring research and policy organizations are actively engaged from the early stages of the research in both design and post-project implementation of the strategies developed	High-level meetings with key stakeholders that result in mainstreamed strategies in workplans and existing breeding programs	Willingness of crop breeding institutions to participate in program; inclusion of women's and men's crops in the program	West Africa, East Africa Indo-Gangetic Plains New target regions added in subsequent years	Crop-breeding institutes (CG Centers, ARIs, NARES), GCP, regional decision-making and priority-setting bodies (ASARECA, FARA, WECARD), donors, national governments
2011	Development of a range of crop modeling approaches to model biotic and abiotic constraints under decadal futures from 2020 to 2050	Range of modeling approaches developed and validated for assessing future constraints to crop production and the design of virtual crops	Availability of climate projections and sufficient data on abiotic and biotic interactions with climate	Global	Crop-based components of MP3, GCP, molecular and breeding platforms CG Centers, NARES, ARI breeding institutes, private sector breeding companies, Leeds University
2012	Design of a set of "virtual crops" and assessment of their efficacy in addressing the likely future conditions in terms of the economic, social and cultural benefits expected	Detailed crop-by-crop strategies and plans of action for crop improvement developed, incorporating portfolio of national, regional and global priorities	Availability of models and data	Global	CG Centers, ARI modeling groups (e.g. Leeds University), NARES scientists
2013	Socialization of identified set of breeding strategies with funding bodies, national and international organizations, universities and other actors	Global, regional and national policy briefs for investments in climate-proofed crop breeding initiatives, and crop breeding institutions coordinated in development of climate-proofed crops for a 2030-2050 world.	Willingness of crop breeding institutions to adjust priorities based on priority setting results, and donor coordination in funding of future breeding programs.	West Africa, East Africa Indo-Gangetic Plains New target regions added in subsequent years	Crop-breeding institutes (CG Centers, ARIs, NARES), regional decision-making and priority-setting bodies (ASARECA, FARA, WECARD, SAARC), donors, national governments



**Plan for 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**

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Develop strategies (e.g. ICARDA's Focused Identification of Germplasm Strategy), tools and methodologies to rapidly identify candidate germplasm with traits useful for climate change adaptation and identification of threats to in situ material; carry out participatory evaluation trials with farmers	Methods and tools to facilitate targeted identification of ex situ and in situ germplasm with traits useful for climate change adaptation, including resistance to biotic as well as abiotic stresses and analyses of threats to priority in situ germplasm	Adaptation traits easily identifiable and availability of sufficient data.	East Africa; Asia; global	CG Centers (including Bioversity, ICARDA, CIAT), national genebanks, NARES (e.g. KARI, NBPGR), ARIs (e.g. agroBIODIVERSITY project of DIVERSITAS)
2011	Develop crop suitability atlas of identified local varieties conserved in genebanks based on genebank information and environmental conditions using Geographic Information system (GIS)	Crop suitability maps for priority crops developed	Good georeference data for accessions are available	East Africa	CG Centers, national genebanks, NARES
2011	Participatory research and cross-country learning on community-based management of crop and livestock genetic diversity	Tools and learning network developed for mobilization and upscaling of crop diversity and natural resource options under defined climatic scenarios for selected target traits and environments	Sufficient cross-site similarity for transfer of lessons, germplasm and tools	West Africa	ICRISAT, farmers' organizations, NARES. ARIs
2012	Participatory on-farm evaluation on a range of sites to test candidate material response in different climate conditions	Adaptive germplasm, suited for different future climate conditions, selected based on response and farmer preferences, and corresponding future production zones identified	Genetic resources policy permits movement of germplasm to pilot sites	Pilot sites in East Africa	CG Centers, national genebanks, NARES, Extension officers NGOs and local farmer organizations, Farmers,
2012	Documenting farmers' traditional knowledge of diversity assessment and its use in adapting to the changing climate and raising their awareness about the implications of climate change for agriculture and the role of genebanks in providing germplasm; associated capacity building	Database and management system to serve as a depository of traditional knowledge on farmers coping with climate change; public awareness (radio programs, posters/ brochures) materials produced	Rural radio partners are a credible source of information; Farmers have access to radios	East Africa	CG centers, NARES, National genebank, Media; Extension services, Farmers organizations, ICCCAD

2013	Evaluation of promising genebank accessions collected from areas with specific environmental conditions and phenotyping for gene discovery	Accessions identified with interesting traits important for climate change adaptation	Exchange of germplasm supported by participating countries	Asia Pacific-Oceania, Latin America and Caribbean, East and West Africa	National, regional, and international genebanks; advanced lab
2013	Developing a seed dissemination system for deployment of adapted (climate ready) local varieties to farmers; associated capacity building	Seed deployment mechanisms involving local seed systems	Local seed providers ready to participate and collaborate with the project	East Africa	Local seed providers; farmers cooperatives; Community genebanks; National Genebank; Extension services; Development agencies, Crisis response agencies (i.e. WFP)
2013	Evaluation and formulation of strategies needed to facilitate uptake, focusing on access to the material, its deployment and its management; associated capacity building	Policy guideline document on use of adapted germplasm from genebanks to adapt to climate change made available to policy makers; Strategies to improve existing policies, local management and seed systems to facilitate the deployment of adapted germplasm	Supportive government policies; Willingness of international bodies to revise policies related to germplasm access	East Africa; global	Ministries of Agriculture, National climate change fora; CG Centers, national genebanks
2013	National and global collections enriched with germplasm important for adapting to climate change and information about materials and their traits integrated into Information system; development of complementary conservation strategies for in situ materials	Genebank collections integrating germplasm specifically focused on climate change adaptation; information on climate adaptation traits integrated into information system; guidelines for complementary in conservation of priority gene pools	Policy framework in place for sharing of information	East Africa; global	CG Centers, national genebanks, NARES

2013	Development of participatory approaches and methods to assess the contribution of diversity in production systems for climate change adaptation; capacity building provided to collaborators	Assessment of the contributions of crop diversity in production systems to adapt to climate change	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	East Africa New target regions added in subsequent years, with additional funding	CG Centers, ministries of forestry, the environment and international and national conservation organizations, national genebanks, NARES, development agencies and local farmer organizations, ICCCAD
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## Theme 2: Adaptation through Managing Climate Risk

Key final products	Intermediate users	Final users	Outcomes	Impacts
<b>Objective 1: Enable rural communities to manage risk and build resilient livelihoods</b>				
Synthesized knowledge of how best to target and implement innovative risk management strategies for rural communities; evidence of their feasibility, acceptability and impacts	CGIAR, development funders, organizations concerned with insurance (e.g., BMGF, RF, AGRA), regional agriculture policy bodies (e.g., CAADP), NARES, rural finance sector, development NGOs	Rural communities, organizations of resource-poor farmers, agribusiness	Systematic technical and policy support for farm- to community-level agricultural risk management strategies that buffer against climate shocks and enhance livelihood resilience in at least 20 countries	Farming systems and rural livelihoods that are more secure in the face of a variable and changing climate
<b>Objective 2: Managing climate risk through food delivery, trade and crisis response</b>				
Enhanced knowledge of how to use advance information to best manage: a) climate-related market risk through food delivery and trade; and b) climate risk through food crisis response and post-crisis recovery. And evidence of the resulting impacts on rural communities and agricultural markets	a) Providers of climate and food security early warning information b) CGIAR, regional trade communities (e.g., ECOWAS, COMESA), climate and market information providers	a) Food security humanitarian response organizations and funders; b) National and regional trade organizations	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.	Enhanced food crisis response decreases long-term livelihood impacts, reduces disincentives to agricultural development, reduces cost of assistance; while more timely management of trade, storage and delivery reduces adverse impacts of climate fluctuations on food accessibility and incentives

<b>Objective 3: Enhanced prediction of climate impacts, and enhanced climate services</b>				
<p>a) Enhanced knowledge, products and evidence to support the development and delivery of climate information services</p> <p>b) Improved knowledge, tools, data sets and platforms for monitoring and predicting agricultural production and biological threats, and informing management, in response to climate</p>	<p>a) Global, regional and national climate service providers, communication intermediaries (e.g., NARES, development NGOs, media, ICT industry)</p> <p>b) CGIAR, NARES, regional climate services providers, early warning information, communication intermediaries</p>	<p>a) Rural communities, agricultural inputs and rural finance providers, agribusiness</p> <p>b) Agribusiness, food security humanitarian response donors and organizations, rural communities</p>	<p>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.</p>	<p>Enhanced use of advance information to manage climate-related risks leading to more resilient farming systems, more secure rural livelihoods, more effective and less costly crisis response</p>

### Plan for Theme 2, Objective 1: Enable rural communities to manage risk and build resilient livelihoods

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Analyze priority knowledge and methodology gaps for index-based risk transfer products, and formulate Program value-addition and partnership strategy	Scoping and strategy report on priority knowledge and methodology gaps for index-based risk transfer, Program advantages and strategy; Platform to coordinate research with other relevant initiatives.	Value addition to other index insurance initiatives; resource-poor farmers have access to index-based risk transfer products	Global	Institutions working on index insurance (e.g., I4, BMGF, RF, Oxfam, WFP, IRI, CIRAD); private sector (e.g. AIC, ICICI, FICCI)
2011	Create a platform to synthesize and exchange information about farmers' coping strategies, innovations for improving management of climate-related agricultural risk	Web-based platform and clearinghouse on farmers' coping strategies, innovations for improving management of climate-related agricultural risk	Partners willing to share findings through platform	Developing countries	Joint activity with Theme 3. Web developer to be determined.
2011	Characterize climate-related risk, and survey current formal and informal responses to risk with potential for transfer and upscaling	Report, media brief on responses to risk, including farmers' stories.	Effective, equitable participation of rural communities, support of intermediaries	E Africa, W Africa, IGP	CIRAD, NARES (e.g. EIAR, KARI, NARO, ICAR, IARI, BCAS, NARC, NWCF), ILRI, ICRISAT, ICCCAD

2011	Participatory pilot demonstration and evaluation of indigenous and new risk management strategies, e.g., use of climate and early warning information; diversification, index-based insurance	Stakeholder networks and workshops. Preliminary report on pilot activities	Stakeholders identify context-relevant risk management strategies, and participate in their improvement and testing. Capable NGOs partner.	E Africa, W Africa, IGP	Farmer associations, NARES, development NGOs (e.g., CARE, PRADAN), ICRISAT; ILRI, AfricaRice
2011	Develop guidelines on governance, institutions, and economic incentives for managing water quality under climate change	Institutions and economic incentives developed that allow the poor to gain more access and to better manage water (quality and quantity) across uses, space and time	Uptake of guidelines	Africa and Asia	IFPRI, IWMI, Departments of fisheries, FWFR, Chinese Academy of Fishery Science, Inland Consortium in Mali, MoF in Vietnam
2012	Synthesis and dissemination of on-going work on agronomic and natural resource management technologies for enhancing climate resilience, to inform targeting and Program strategy	Major synthesis report, with associated case studies from diverse agro-economic systems; Decision support tools or guidelines for matching and combining technologies for given context	Access to relevant work across CG Centers and targeted NARES. Uptake of results by key agencies	Global	CIRAD, relevant NARES and CG Centers (e.g., CIP, ICRISAT, IRRI, IWMI, ICARDA, CIMMYT, CIAT, IITA, WorldFish, AfricaRice), with appropriate links to other CG Programs
2012	Comparative analysis of livelihood strategies that help cope with climate variability to inform development strategy	Key synthesis paper prepared for top journal, and associated media release timed to COP17	Uptake of results by key agencies	Global	CIP, ICRISAT, IFPRI, WorldFish, ICARDA, ICCAD
2012	Survey current use, unmet demand and bottlenecks to use of climate-related information to manage	Report and journal article on demand, use, strategies to enhance use of climate-related information. Awareness	Uptake of results by key agencies	E Africa, W Africa, IGP	NMS (e.g. IMD), regional climate centers (e.g. ACMAD), IRI, IITM, CRIDA
2013	Analyze data, identify and mitigate impacts of existing, cultivar and	Report on current and potential improvements, website with farmers' stories; Media brief of Report and shared methodology	Uptake of results by key agencies	E Africa, W Africa, IGP and two	CIRAD, NARES (e.g. CRIDA), CG Centers and
2013	livelihood portfolios, and characterize climate-related risk and survey current formal and	cultivar and livelihood Report on current responses to risk, website with farmers' stories; Media brief of Report and shared methodology	Uptake of results by key agencies	new regions In the two new regions that are	Programs, Relevant NARES and CG Centers, IRI, ICCAD
2013	informal responses to scale out findings in initial target regions to newly added regions	stories; Media brief of Report and shared methodology	Relevant information products, services, and uses can be engaged in each region.	added New regions added in 2011/2	To be determined based on regions selected in 2011

2013	Synthesize results from participatory pilot demonstrations of local-level risk management strategies (e.g., index insurance, climate forecast use)	Report and journal article on improved local-level risk management strategies. Regional stakeholder workshops.	Will be replicated in other research locations as they are established in each region	E Africa, W Africa, IGP	To be determined, based on scoping study
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### Plan for Theme 2, Objective 2: Managing climate risk through food delivery, trade and crisis response

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Scoping study and stakeholder consultation on current use, emerging opportunities to incorporate advance information into management of climate-related food crises and food price fluctuations, to inform Program strategy	Scoping report and workshop on current state, trends, emerging opportunities to incorporate advance information into management of climate-related food crises and price fluctuations	Capable food security and trade organizations available to participate.	Global (food security); E. Africa, W. Africa, IGP (trade)	Cornell U, IRI., participating food security (e.g., WFP, CRS, World Vision)
2012	Analyze alternative rules to manage food crises and price volatility in response to current information, and potential lead time and accuracy improvements	Report, brief and journal article on approaches to manage food crises and price volatility. Workshop with food security and trade organizations	Capable food security organizations available to participate.	Global	IFPRI, WFP, participating food security response organization to be identified
2012	Analyze drivers and impacts of food price volatility	Report, brief and journal article on drivers and impacts of food price volatility	Adequate market, climate and livelihood data are available.	E Africa, W Africa, IGP	IFPRI, WFP
2013	Engage select food security organizations to explore, develop, evaluate new response strategies based on long-lead prediction; and design improved information	Journal article, policy brief, media on new response strategies based on long-lead prediction. Enhanced platform for coordinating information and action among response organizations.	Capable food security organizations available to participate.	Global	Cornell U., IFPRI, WFP, ICCCAD, food security response organizations to be identified

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

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Review current climate information products, services and delivery mechanisms; and constraints and opportunities for using seasonal climate prediction to improve management of agricultural risk	Journal paper and strategy brief on current climate services, opportunities and constraints for seasonal forecasts for risk management, including access by gender and social groups		E Africa, W Africa, IGP	ACMAD, IRI, ICRISAT, NMS (e.g. IMD)

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Inventory climate-sensitive pest and disease modeling and early warning systems, and develop Program strategy for enhancing their use for agricultural and food security risk management.	Report and strategy brief on biological threat early warning.	Review will identify suitable opportunities to enhance early warning and management of strategic climate-sensitive biological threats	Global	CIAT, IITA, CIP, ICARDA, ILRI
2011	Evaluate ICT-based and institutional information delivery models for effectiveness, equitability, relevance, transferability and scalability; and formulate Program strategy	Report on effectiveness, equitability, relevance, transferability and scalability of ICT based delivery systems	Institutional and technological capacity is sufficient to support widespread delivery of climate services.	Global	Kiwanja.net, UCAR, Microsoft Research
2011–2012	Develop and evaluate calibrated improved historic meteorological data sets for seasonal forecast, crop, pasture and biological threat forecasting applications	2011: Calibrated rainfall data and methodology paper; Proof of concept report for temperature and solar radiation 2012: Full validated data set; Journal paper	NMS and regional climate centers participate and share data. Full set of METEOSAT images processed and available.	E Africa, W Africa	AGRHYMET, NMA (Ethiopia), IRI, Reading U., CIP, others to be determined based on scoping study
2012	Quantifying losses in rice production caused by droughts and cyclones/ typhoons in regional case studies	Historical records on yield losses compiled for droughts (India, Thailand) and cyclones/ typhoons (Bangladesh, Philippines)	Availability of data	Asia	IRRI, NARES
2013	Assess needs for climate information; technical and institutional bottlenecks to the production and delivery of useful information; and potential for new or enhanced products and services for risk management	Report and brief on needs for climate information, technical and institutional bottlenecks, potential new products and services; Awareness and capacity-building events for climate information providers, intermediaries and users.	Participatory evaluation (Objectives 1 and 2) will identify demand, relevant uses for climate-related information.	E Africa, W Africa, IGP	IRI, WMO, ClimDev-Africa, NMS, ICRISAT; other CG, regional and national partners
2013	Develop improved methodology and a platform for climate-informed, long-lead forecasting of crop and forage production, and biological threats	Crop and forage monitoring and forecasting platform, documentation; validation report; training activity; journal article	Effective collaboration with food security early warning organizations; Uptake by key food security, trade and index insurance users.	Global	IRI, FAO, CIAT, ICRISAT, ILRI, CIP, other CG Centers working on crop forecasting, food security early warning providers, WFP

Year	Activities	Products	Assumptions	Target regions	Partners
2013	Prototype prediction tools and early warning platform for at least 2 strategically important, climate-sensitive biological threats to agriculture	Early warning tools, platform, documentation; validation report	Demonstrated feasibility of forecasting strategically important biological threats.		CIAT, IITA, ILRI, CIP; other CG Centers, early warning providers, WFP

### Theme 3: Pro-Poor Climate Change Mitigation

Key final products	Intermediate users	Final users	Outcomes	Impacts
<b>Objective 1: Inform decision makers about potential low-carbon agricultural development pathways and their impacts</b>				
New understanding about agricultural development pathways for balancing the trade-offs among mitigation, poverty alleviation, food security and environmental health. Enhanced capacity in regional and national policy and research organizations to analyze the implications of different development scenarios	SBSTA Working Group, IPCC, ESSP, academics, GECAFS, CARE, the World Bank, IFAD and other donors	AFOLU ministries, planning agencies, development organizations	Enhanced knowledge about agricultural investments that leads to better decisions for climate mitigation, poverty alleviation, food security and environmental health, used by national agencies in at least 20 countries.	Decision makers choose agricultural development strategies that create synergies between mitigation and other policy goals, with investment in agricultural development related to mitigation increasing by 10%
<b>Objective 2: Institutional arrangements and incentives that enable smallholder farmers and common pool resource users to participate effectively in carbon markets and reduce GHGs</b>				
Enhanced understanding about the institutional arrangements, market-based instruments, policies and incentives that can improve access for the poor to mitigation benefits, with empirical indications of the impacts of these benefits on poverty alleviation and GHG emissions	Organizations of resource-poor farmers, intermediaries and buyers in the carbon market, international and national policy research organizations such as EcoAgriculture and IPAM	World Bank Biocarbon Fund, Voluntary Carbon Standard, Climate, Community and Biodiversity Alliance, donors	Key agencies dealing with climate mitigation in at least 20 countries promoting new institutional arrangements and incentive systems that favor resource-poor farmers, particularly vulnerable groups and women	Participation by smallholders in Project areas increase by 25%, and overall distribution of benefits includes at least 25% of smallholders in project areas
<b>Objective 3: On-farm mitigation practices and their landscape-level implications</b>				
New understanding about the direct and indirect economic and environmental costs and benefits from agricultural mitigation, and systems developed for GHG monitoring and accounting at farm and landscape level	New understanding about the direct and indirect economic and environmental costs and benefits from agricultural mitigation, and systems developed for GHG monitoring	New understanding about the direct and indirect economic and environmental costs and benefits from agricultural mitigation, and systems	New understanding about the direct and indirect economic and environmental costs and benefits from agricultural mitigation, and systems developed for GHG monitoring and accounting at	New understanding about the direct and indirect economic and environmental costs and benefits from agricultural mitigation, and systems developed for GHG monitoring and accounting at



Key final products	Intermediate users	Final users	Outcomes	Impacts
Network of PhD students developed for studying GHGs in developing country agriculture	and accounting at farm and landscape level Network of PhD students developed for studying GHGs in developing country agriculture	developed for GHG monitoring and accounting at farm and landscape level Network of PhD students developed for studying GHGs in developing country agriculture	farm and landscape level Network of PhD students developed for studying GHGs in developing country agriculture	farm and landscape level Network of PhD students developed for studying GHGs in developing country agriculture

### Plan for Theme 3, Objective 1: Inform decision makers about potential low-carbon agricultural development pathways and their impacts

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Develop alternative scenarios for strategies for agricultural intensification and adaptation in different regions Clarify the trade-offs between biofuel and food production in different contexts. Analyze the mitigation implications of alternative forest-agriculture landscapes and their associated institutions.	Report on: a) the net emissions of different scenarios; b) mitigation implications of alternative adaptation strategies; and c) identification of promising options for climate mitigation, poverty alleviation, food security and environmental health, including understanding of access by different genders and social groups	Agricultural intensification will be necessary to meet future food demand; mitigation will be possible among resource-poor farmers	Global, E and W Africa, Indo-Gangetic Plains, Amazon Basin, SE Asia	CG Centers; ESSP; Global Carbon Project; agroBIODIVERSITY project; Universities of Vermont, Oxford, Leeds, Edinburgh; World Bank; CAR; EcoAgriculture; IIED; FAO; SAI, EIAR, NARO, KARI, ICAR, IARI, BARC, BARI, BCAS, NARC, NWCF, ICCCAD, Pradan
2012	Involve decision makers at multiple levels throughout process to share ideas, scenarios, models and consideration of alternative strategies	Synthesis report and scientific article on agricultural development pathways; capacity building of decision makers in use of appropriate tools		Global, E and W Africa, Indo-Gangetic Plains, Amazon Basin, SE Asia	CG Centers, ESSP, Global Carbon Project, Global Land Project, U of Vermont, EIAR, NARO, KARI, ICAR, IARI, FAI, FICCI etc.
2013	Assess impacts on poverty alleviation, food security and environmental health at multiple scales	Synthesis report shared in major global forums on climate change and food security	Preliminary data ready from PhD network (Objective 2)	Developing countries	CGIAR centers, ESSP, Global Carbon Project, University of Vermont, and numerous other partners to be identified
2013	Workshops with regional and national policy makers and researchers to analyze and discuss the implications of different agricultural	User-friendly website, capacity building events and workshops (one per region)		Global, East and West Africa, Indo-Gangetic Plain, Amazon	CGIAR centers, ESSP, agroBIODIVERSITY project, Global Carbon Project, University of Vermont, World Bank, IFAD, Ecoagriculture, IIED, FAO, START,

Year	Activities	Products	Assump-tions	Target regions	Partners
	development scenarios			Basin, SE Asia	AFOLU ministries

**Plan for Theme 3, Objective 2: Institutional arrangements and incentives that enable smallholder farmers and common-pool resource users to participate effectively in carbon markets and reduce GHGs**

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Assess barriers to entry and factors affecting benefits from the carbon market for differentiated social groups including women, and the range of emerging institutional arrangements and incentives for better inclusion and benefits	Report on differentiated access to carbon markets, and how different kinds of beneficiaries can be reached	Carbon market participation and potential benefits will be uneven among regions and farmers	Global, E and W Africa, Indo-Gangetic Plains, Amazon Basin, SE Asia	CG Centers, ESSP, Global Carbon Project, U of Vermont, World Bank, CARE, EcoAgriculture, IIED, FAO, SAI, ICCCAD
2011	Analyze economic incentives and benefits to farmers from adoption of conservation agriculture for mitigating, and adapting to, climate change	Research report and integration in policy processes	Likely positive benefits of conservation agriculture for mitigation	Africa	CIMMYT, IFPRI Global Futures Project, SIMLESA Project (Africa) CSISA project (IGP-Asia), IITA, ICARDA, ICAR, EIAR, KARI, BARI, NARC, NCAS, UMB-USA, UMB-Norway
2012	Identify promising market-based instruments, policies and institutional arrangements	Report, website, policy briefs and scientific article identifying promising institutions, market-based mechanisms and policies	Resource-poor farmers will participate in carbon markets if incentives are sufficient	Global, E and W Africa, Indo-Gangetic Plains, Amazon Basin, SE Asia	CG Centers, ESSP, Global Carbon Project, U of Vermont, World Bank, CARE, EcoAgriculture, IIED, FAO, SAI, ISEAL Alliance
2013	Pilot institutional arrangements, incentive mechanisms and MRV protocols for carbon trade, including potential project developers and aggregators (supermarket supply chains, producers of high-value export crops, NGOs and farmer organizations)	Synthesis report on institutional arrangements market-based Instruments, policies and incentives that can improve access for the poor to mitigation benefits, with empirical indications of the impacts of these benefits on poverty alleviation and GHG emissions		Target regions	CGIAR Centers (IFPRI, ICRAF, ILRI, CIAT), World Bank, CARE, EcoAgriculture, IIED, FAO, ISEAL Alliance
2013	Test the feasibility of	Feasibility analysis	Investors see	Target	CG Centers, ESSP,

Year	Activities	Products	Assumptions	Target regions	Partners
	carbon market participation and benefits in high and low mitigation potential areas	for different areas	agriculture-based markets as profitable	regions	Global Carbon Project, U of Vermont, World Bank, CARE, EcoAgriculture, IIED, FAO
2013	Workshops (one per region) and capacity development initiatives to increase the uptake and improve the design of incentive mechanisms and institutional arrangements	User-friendly website, capacity building events and workshops (one per region) for the design of incentive mechanisms and institutional arrangements	Institutional arrangements, market-based instruments, policies and incentives exist and have had sufficient experience to show results	Global, E and W Africa, Indo-Gangetic Plains, Amazon Basin, SE Asia	CG Centers, ESSP, Global Carbon Project, U of Vermont, World Bank, IFAD, EcoAgriculture, IIED, FAO, START, AFOLU ministries, developing country partners in target regions

### Plan for Theme 3, Objective 3: On-farm mitigation practices and their landscape-level implications

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Create a global platform for exchange and synthesis of information about innovations in agricultural mitigation	Web-based communications platform and clearinghouse identifying mitigation impacts of on-farm practices and their landscape-level implications	Interest and willingness of partners to contribute findings to platform	Developing countries	CGIAR centers, with a multitude of partners (e.g. EIAR, NARO, KARI, CRIDA, ICAR, IARI, SAI, Global Research Alliance on Agricultural Greenhouse Gases <sup>38</sup> )
2011	Establish a PhD network for studying GHG emissions; and develop a system for monitoring and accounting at farm level	Network established and methods guidelines produced	Simple methods can be devised for widespread application	Developing countries, with a focus on target regions	Advanced Research Institutes (University of Copenhagen, Cornell University, University of Oxford and others); southern Universities (e.g. Nairobi, Makerere, Witwatersrand)
2011	Life-cycle analyses for particular food production systems (e.g. tropical fruits and aquaculture) and exploration of technical limits of mitigation (e.g. with blue carbon)	Improved methodologies and analyses	Improved carbon balances are possible in these food systems	Asian and South American countries	WorldFish, CIAT, NARES, Kasetsart University and other ARIs
2012	Survey and consultation work among wide range of partners to provide robust assessment of emissions and	Report on carbon sequestration in livestock systems in developing countries Updated IPCC numbers	Strong participation from all partners	Global	ILRI, IIASA, FAO, NARES

<sup>38</sup> [www.globalresearchalliance.org](http://www.globalresearchalliance.org)

Year	Activities	Products	Assumptions	Target regions	Partners
	sequestration in the livestock sector	for greenhouse gas emissions from livestock systems by country			
2012	Measure GHG fluxes and develop MRV, working with partners in the ESSP	Synthesis of preliminary results	Cost effective measures and MRV are possible	Global, East and West Africa, Indo-Gangetic Plains, Amazon Basin, SE Asia	CG Centers (e.g. IWMI, CIAT, CIP, ILRI, ICRISAT, IRRI, ICRAF, CIMMYT), Global Research Alliance on Agricultural Greenhouse Gases) and numerous partners from PhD network
2013	Validated simulation models that can be used to identify the mitigation potential of different options	Validated simulation models that can be used to identify the mitigation potential of different options	Sufficient data exists to validate simulation models	Global	ARIs (to be selected in scoping study)
2013	Identify a set of target practices that produce win-win outcomes at the household and landscape level	Report, website, policy briefs and scientific article evaluating the potential direct and indirect socio-economic and environmental costs and benefits from agricultural mitigation	Practices that increase mitigation, livelihood benefits and environmental benefits are possible	Developing countries	CG Centers, ESSP, Global Carbon Project, U of Vermont, and numerous other partners
2013	Work with field-based partners to develop user-friendly ways of communicating data that can be used by farmers and decision makers to change their land-use practices	User-friendly website, capacity building events and workshops (one per region) for the design of incentive mechanisms and institutional arrangements		Developing countries	Global Carbon Project, U of Vermont, World Bank, CARE, IIED

#### Theme 4: Integration for Decision Making

Key final products	Intermediate users	Final users	Outcomes	Impacts
<b>Objective 1: Linking knowledge with action</b>				
For each region, coherent scenarios to 2030 and looking out to 2050 that examine potential development scenarios under a changing climate and differing pathways of economic development Global and regional	Other Themes in the Program, other CGIAR Programs, regional and ESSP partners	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	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	Food security enhanced for currently undernourished people, and emissions reduced in smallholder farming areas

Key final products	Intermediate users	Final users	Outcomes	Impacts
maps, tables and associated syntheses, showing current vulnerable populations in relation to food security to 2030 and 2050			regions, and in the key global processes related to food security and climate change	
<b>Objective 2: Assembling data and tools for analysis and planning</b>				
Integrated assessment framework, toolkit and databases to assess climate change impacts on agricultural systems and their supporting natural resources	Other Themes in the Program, other CGIAR Programs, regional partners	Research for development agencies, national, regional and international planning agencies	Improved frameworks, databases and methods for planning responses to climate change used by national agencies in at least 20 countries and by at least 15 key international and regional agencies.	Research efficiency increased, enhanced decision-making in planning agencies
<b>Objective 3: Refining frameworks for policy analysis</b>				
Climate change impacts assessed on agricultural systems and their supporting natural resources, and likely effects of specific adaptation and mitigation options, and trade and agricultural policies, analyzed and communicated to key stakeholders	Other Themes in the Program, other CGIAR Programs, regional partners	Agencies involved in planning for and researching climate change impacts on agriculture and natural resource management, key bilateral donors, large international NGOs, key regional and national actors	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 15 key international and regional agencies	Food security enhanced for currently undernourished people, and emissions reduced in smallholder farming areas

#### Plan for Theme 4, Objective 1: Linking knowledge with action

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Interactive stakeholder/partner-ship-building workshops held in the three regions	Workshop reports, strengthened climate change - agriculture – food systems networks with new partners	Sufficient incentives for full engagement on part of local partners	W Africa, E Africa, IGP	Farmers' orgs, NARES, NGOs, private sector, ARIs, regional bodies, networks, ICT experts (e.g. for IGP some of the India stakeholders are listed in Figure 4; Eastern Africa – Figure 12). Others include: Pradan, Reliance Retail, Centre for Global Change (Bangladesh), People Center Development Forum (PCPD), ICCCAD
2011	Regional scenario storyline	Prototype regional scenarios produced (main regional	Regional stakeholders and country	W Africa, E Africa, Indo-	National and regional partners (e.g. ACMAD, AGHRYMET, ASARECA, FARA, ICPAC,

Year	Activities	Products	Assumptions	Target regions	Partners
	development in the three regions	uncertainties identified, initial regional storylines developed, reports and initial scoping for model analysis)	partners	Gangetic Plains	CORAF/WECARD, SAARC, SDMC and RWC), GECAFS, ESSP
2011	Regional scenario storylines finalized for three initial regions	Regional scenarios produced	Regional stakeholders remain engaged	Original regions	National and regional partners, GECAFS, ESSP
2011	Regional quantitative scenario analyses	Interim analyses presented for IMPACT analysis	Regional teams able to interact effectively with research community worldwide	W Africa, E Africa, Indo-Gangetic Plains Global (2012)	National and regional partners, GECAFS, ESSP; IMPACT modellers
2011	Agriculture and Rural Development Day 2011 at COP17	High-level report on the agricultural work program for agriculture	UNFCCC accepts to have an agricultural work program in 2011	Global	Global Donor Platform for Rural Development, IFAD, IFAP, GFAR, FAO
2011	Develop methodologies to assess dynamic vulnerability in fisheries and aquaculture	Methodological briefs, toolkit manual, papers, capacity built among users	Adequate data and methodological options	Africa and Asia	FAO, ENDA/REPAO, Bangladesh & Zambia Department of Fisheries, ICFG, Bangladesh Ag University
2011	Vulnerability assessment	Vulnerability maps with up-to-date datasets from a food security and sustainability perspective; papers, policy briefs	Appropriate metrics are found to represent vulnerability dynamically	Global	National and regional partners, GECAFS, ESSP
2011	Regional policy and program choices identified	Policy paper and brief; raised capacity among policy makers to use tools to make policy and program decisions	Strong partnerships with policy making bodies in the regions	W Africa, E Africa, IGP	Climate and agriculture policymakers, regional bodies, national planning agencies
2012	Regional vulnerability assessment	Vulnerability maps with up-to-date datasets from a food security and sustainability perspective; papers, policy briefs	Appropriate metrics are found to represent vulnerability dynamically	All selected regions	National and regional partners, GECAFS, ESSP
2013	Regional scenario analyses expanded to	Coherent set of quantified development scenarios under a changing	Strong buy-in by stakeholders to scenario	Expanded list of regions	National and regional partners, GECAFS, ESSP, CGIAR, ARIs

Year	Activities	Products	Assumptions	Target regions	Partners
	additional regions	climate and differing pathways of economic development, used to identify livelihood opportunities and threats regionally	process and outputs		

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

Year	Activities	Products	Assumptions	Target regions	Partners
2011	Initiate baseline indicator framework and data collection	Regional site characterization and baseline data collation		W Africa, E Africa, IGP	National and regional partners, CG Centers
2011	Workshop for current and future regions to identify climate downscaling needs	Priorities derived for downscaling needs, including a set of papers on current downscaling initiatives	In-region demand for downscaling	Global, but focused on target regions	CG Centers (IWMI, CIAT, ILRI, CIP), HarvestChoice, Oxford & Leeds Universities
2011	Select and develop climate downscaling methodologies	New methods e.g. based on wavelets, multifractals and neural networks	Proof of concept possible	Global	CIP, other CG Centers, University of California at Santa Barbara, University of Cape Town
2011	Work with ESSP community to identify the best suite of climate data for the initial regions	Suite of downscaled climate data for the 2030s to 2090s, for homogenized applications in the Program	Weather and climate inputs to the Program are tightly defined	Global; W & E Africa, IGP	UK Met Office, Oxford & Leeds Universities, NCAR, PIK, IRI
	Using climate data available, prepare synthesis reports for each of the initial target regions	Regional climate characterization and evaluation of global and regional climate model performance for target regions	Climate models can be evaluated appropriately on a regional basis	Global; W Africa, E Africa, IGP	UK Met Office, Oxford & Leeds Universities, NCAR, PIK, IRI
	Compile all relevant data for the initial target regions	Databases for soils, weather, agricultural systems, natural resources	Data are accessible	Global, regional	All partners, CG Centers, ARIs, Global Land Project
	Investigate gaps in modeling tools	Scoping studies on agricultural impact model gaps and needs	Agreement reached on a global modeling agenda	Global	CG Centers, HarvestChoice, CSI, ARIs, GCMP, ICASA
2012	Investigate new ways of dealing with near-term climate change impacts	Decadal/near-term climate products	New approaches to near-term climate prediction implemented in appropriate tools	All target regions	UK Met Office, Oxford & Leeds Universities, NCAR, IRI

Year	Activities	Products	Assumptions	Target regions	Partners
	Extend data & model toolboxes to new regions	Regional characterization extended to more regions	Demand for outputs in new regions	All target regions	National and regional partners, CG Centers
2013	Integrated assessment framework and toolkit, with <i>ex ante</i> impact assessment capabilities	A functioning integrated assessment framework and toolkit that can be used to analyze likely effects of specific adaptation and mitigation options in target regions	Framework able to cater for differences by gender and social group	All target regions	All partners, CG Centers, ESSP, ARIs

### Plan for Theme 4, Objective 3: Refining frameworks for policy analysis

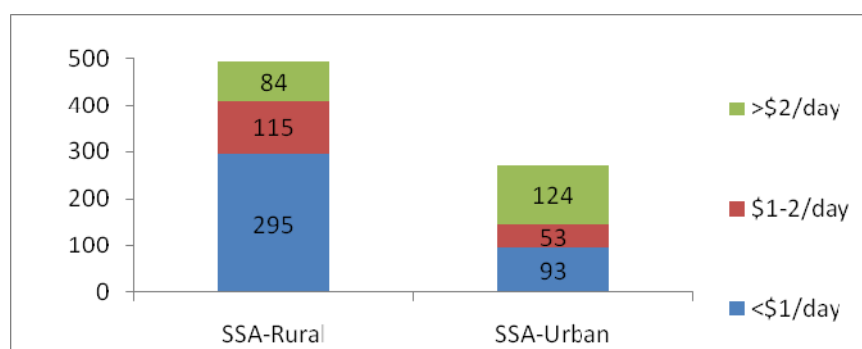
Year	Activities	Products	Assumptions	Target regions	Partners
2011	Initiate capacity development activities with national policy actors	Series of planned capacity development initiatives		W Africa, E Africa, IGP initially	IFPRI, National and regional research partners and stakeholders
2011	Information platform development, e.g. country-by-country food policy trend analysis	Synthesis of data and maps of existing climate change information networks and via IFPRI's Food Security Portal	Building on existing networks; regional bodies support this	W Africa, E Africa, IGP initially	National and regional research partners and stakeholders, IFPRI
2012	Synthesis of case studies on the impacts of climate change in diverse agricultural systems	Major synthesis report targeted to COP17, that lays out the policy options for adaptation	Case studies available	Global	CGIAR Centers (CIP, CIAT, ILRI, ICRISAT, IFPRI, IRRI, ICRAF, IWMI, ICARDA, WorldFish), HarvestChoice, CSI.
2012	Integrated assessment process continued	Global and regional assessments of climate change impacts on agricultural systems and food security	Appropriate data, tools, methods can be assembled	Global; W Africa, E Africa, IGP	National and regional partners (e.g. ACMAD, AGHYMET, ASARECA, FARA, ICPAC, CORAF/WECARD, SAARC, SDMC and RWC), other MPs; Global Land Project
2012	Information platform development	Scenario and food security dialogues and new information partnerships developed and documented	Strong cooperation and dove-tailing with existing initiatives	W Africa, E Africa, IGP initially	National and regional research partners and stakeholders
2013	Integrated assessment process continued	Set of information products on likely climate change impacts on agricultural systems, and promising adaptation and mitigation options	Viable set of adaptation and mitigation options	All regions	National and regional partners, other MPs (e.g. all MPs, HarvestChoice, CSI)



## Annex 2: The profile of likely beneficiaries in sub-Saharan Africa<sup>39</sup>

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)**

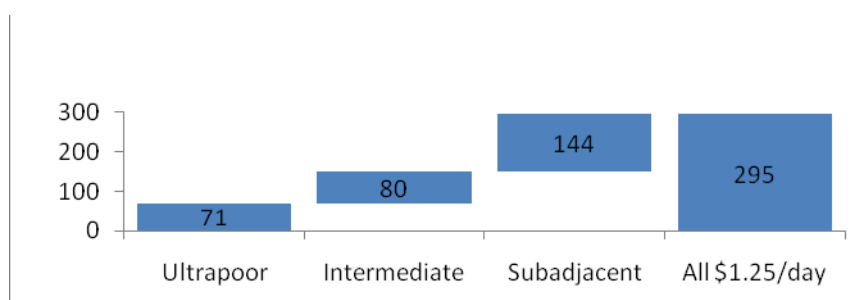


Looking deeper into the rural poor category, a preliminary analysis suggests they can be divided into three sub-groups (Figure A2):

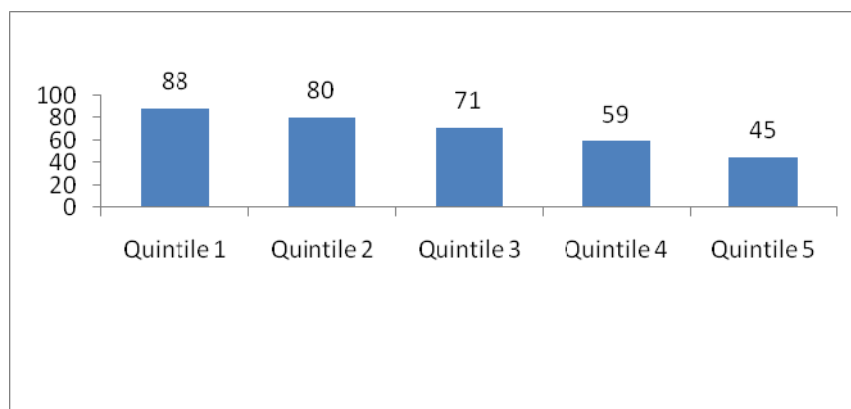
- Subjacent: \$0.75–\$1.25 per day
- Intermediate: \$0.50–\$0.75 per day
- Ultra-poor: under \$0.50 per day

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.

<sup>39</sup> This analysis of likely beneficiaries in SSA is drawn from personal communication from Stanley Wood and colleagues, IFPRI. MP7 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 MP7 (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 the Mega Program

For the recommended transitional phase (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 MP7 – 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.<sup>40</sup>

**Table A1. Key activities in the transitional phases**

Phase 1: CP structures continue	Phase 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 MP7 and fast-tracked MPs		
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.

<sup>40</sup> 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.



