

Initial Concept Note for a Challenge Programme on Climate Change, Agriculture and Food Security

The 15 Centres supported by the CGIAR have recently decided, through their Alliance Executive, to develop a large-scale collaborative research programme on climate change, agriculture and food security with the global environmental change (GEC) community. The Chairs and Directors of the four international GEC programmes and their joint projects¹ have likewise formally approved the preparation of a collaborative research programme with the Alliance Centres.

Both the Alliance Executive and the GEC Chairs and Directors decided that the preparation of such a collaborative programme includes, as a first step, a scientific workshop. The main purpose of this workshop is to identify the research priorities, themes and research activities that need to be undertaken collaboratively and that will constitute the scientific backbone of this proposed challenge programme (CP)². The dates for the workshop (February 21-23) were agreed upon before the timeline for submitting concept notes was known. Given the number of institutions concerned it proved impossible to change the dates of this workshop at short notice.

In order not to preclude the outcomes of the workshop whilst nevertheless answering the request for a concept note, the Alliance and the ESSP are submitting the following text. A short addendum to this concept note will be submitted just after the conclusion of the scientific workshop, to relay the main research priorities which the workshop will identify.

1. Significance and urgency of the problem

More than 800 million people in tropical and sub-tropical countries are currently food insecure. Their situation is expected to worsen, and the number of food insecure people is likely to increase, as changes in extreme weather events, inter-annual variability and mean climate parameters will negatively affect crop and animal yields and agro ecosystem resilience. Sea level rise and ocean changes will also threaten food production and livelihoods in coastal areas. Climate predictions and analyses of past and current trends indicate that small-scale farming households in tropical and sub-tropical areas will be exposed to increased climate risks and will become more and more vulnerable to these risks, unless drastic measures are implemented to increase their capacity to adapt to climate change. In the absence of measures at the local, regional, national and international levels to better adapt agriculture to the effects of climate

¹ These are: DIVERSITAS, the programme specializing in biodiversity and agrobiodiversity, the IGBP (International Geosphere Biosphere Programme), specializing in biogeochemical cycles, the WCRP (World Climate Research Programme), specializing in climate science and the IHDP (International Human Dimension programme), specialising in institutional, socio economic and policy issues regarding global change. These four GEC programmes have come together under the banner of the Earth System Science Partnership ([ESSP](#)) to promote international and interdisciplinary research, including in cross-cutting areas (carbon, food, water and health).

² The main objectives of the workshop are: (i) To identify those research questions concerning climate change and agriculture (FAO definition) that are priority research areas for the CGIAR and GEC communities, that fill key knowledge gaps and that can only be addressed by the two communities working together (result in new synergies), (ii) To identify the type of partnerships needed for implementing such research and propose ways of implementing these partnerships 'on the ground' through joint research programmes and (iii) To identify possible sources of funding for such programmes.

change, and where appropriate to mitigate climate change with different agricultural practices, food insecurity in tropical and sub-tropical areas will increase and the fulfilment of the Millennium Development Goals will be further delayed

The Millennium Ecosystem Assessment (2005) established that agricultural intensification has met the rising demand for food in most parts of the world, but that significant trade offs have been associated with these increases. In particular, the water cycle, nutrient cycling, biodiversity and carbon sequestration have been negatively affected, whilst the emission of greenhouse gas and habitat fragmentation have increased. In turn, this environmental degradation exacerbates some of the drivers of climate change and further undermines the sustainability of agriculture.

The IPCC Climate Change 2001 Assessment stresses that most of the research on agriculture and climate change has focussed on the impacts of climate change on crop yields. This has provided an excellent foundation for assessing how climate change may affect crop productivity in different regions. The linkages between these analyses and the broader issues of sustainable development and food security in countries suffering from extreme poverty and malnutrition are, however, not sufficiently understood. These include the linkages between the impacts of climate change on agricultural productivity, natural resources and ecosystem and agro ecosystem resilience in tropical and sub-tropical countries.

- Climate change and increased climate variability is inevitable, is occurring and will likely accelerate over the next 50 years. Its impact will be felt worldwide, but those impacts will be most severe in the developing world where impoverished and vulnerable communities are already struggling to deal with current climatic hazards.
- Adaptation to climate change is therefore no longer a secondary and long-term response option only to be considered as a last resort. It is now prevalent, and for those rural communities in the developing world already vulnerable to the impacts of present day climate hazards, an urgent imperative.
- Within the framework of the Millennium Development Goals, policies and innovations to enhance adaptation to climate change cannot be viewed in isolation from current development priorities: indeed many key stakeholders recognize the need to focus on 'climate resilient' policies and innovations that address both current development priorities as well providing greater livelihood resilience in the face of future climate change.
- National and international policy makers have often stated that they lack the knowledge necessary to confront the issues climate change will raise.

2. Major knowledge gaps

These challenges require a new type of research strategy and approach. The proposed Challenge Programme will address this requirement by focusing on major knowledge gaps.

Key knowledge gaps include the linkages between impacts of climate change and adaptation and mitigation options, and in particular the scaling issues linking information at the plot, farming system, landscape/watershed, regional and global scales. Research has shown that there are important ecological processes and geochemical processes which interact at these different scales (e.g., carbon cycle, water cycle,). Furthermore previous research has demonstrated that the lack of effectiveness of the international policy regime regarding climate change is attributable, in part at least, to the fact that this regime clashes with many local, regional and national policy mechanisms. This range of geochemical and ecological processes, along with economic, policy and institutional processes need to be understood and managed across relevant spatial and

temporal scales in order for adaptation and mitigation options to be effective for tropical and sub-tropical small-scale farmers.

A further acknowledged gap in climate change and agriculture research concerns the insufficient cross-fertilisation and integration of approaches between the natural and the social sciences (e.g., valuation of ecosystem services affected by climate change). Research is needed on how to translate research findings into policies that are effective in minimising the human and economic costs of climate change for small-scale farming households in the tropics and sub-tropics. Approaches focusing on the relationship between rural livelihoods and ecosystem services, including risk management and enhancing adaptive capacity for adaptation to climate change are required. This will also need to include an international perspective, as local, regional and national measures will have to be linked to international mechanisms. Some of the current challenges include understanding how carbon markets can function effectively, including ways in which they link tropical developing regions to the climate regime through the Clean Development Mechanism; the implications of rapid climate change (rather than a gradual warming) for managed and unmanaged ecosystems; the scientific and policy challenges of valuation and payments for ecosystem services; the new proposals for an international adaptation regime; and the emerging debates about the carbon and water embodied in traded food and materials.

3. Some potential priority areas, themes and research activities

The scientific workshop will identify, within these two areas of knowledge gaps, those priority research questions that are of relevance to both the CGIAR and ESSP. It is envisaged that not more than **4 or 5 priority areas will be identified for joint research focus**. The workshop will specify the scope of the priority areas in the CP, as well as the themes within priority areas, the set of common research objectives and complementary contributions of the CGIAR and the GEC communities within each theme and agreed upon geographical location of sites for field and modelling work

At this stage we can only provide examples of possible priority areas, as an illustration, viz.:

- Improving use of climate information and agroecosystem modelling to forecast changes in crop/livestock/fish/forest productivity and agro ecosystem resilience at a range of spatial and temporal resolutions –from global to local. This will help to determine potential impacts on human welfare and vulnerability and regional food security.
- Assessing changes in carbon, nitrogen and water dynamics in tropical forests and agroecosystems driven by emerging rural livelihood opportunities based on increasing production of ecosystem-based renewable energies (biofuels).
- Development of water-saving technologies and natural resources management systems that contribute to high water-use efficiency in agriculture and the energy sector and which minimise disruption to the global biogeochemical cycles.
- Climate change may render parts of the world less / more suitable for agriculture and shifts in major production areas may occur. Implications of these shifts for investments in water infrastructure and agricultural water management need to be investigated.
- Linking genetic improvement to management strategies to enhance the capacity to adapt to climate change for small-scale farmers in developing countries.
- Developing tools, with stakeholders at various levels, to better understand analyse and inform policy decisions for adaptation to climate change, including options for streamlining adaptation and mitigation strategies in national development policies and sectoral economic planning. Emphasis could be on assessing the net impacts of climate

change on rural livelihoods in developing countries and developing adaptation scenarios and likely outcomes for vulnerable countries. This would result in the development of generic principles for adaptation policies and strategies and wide dissemination for global and regional levels, as well as detailed policy reform options for countries and regions, to address the current clash between these different policy levels.

Potential themes and research activities: Initial internal discussions among Alliance centres led to expressions of interest from some centres in more specific themes and research activities. These, as well as the above priority areas, will be discussed by the scientific workshop. They are provided here as indications of potential research activities.

Theme 1 - Impact Assessment: Determine impacts of climate change on agricultural livelihoods and assess adaptation options

Climate change is a global phenomenon with locally variable impacts. This variation breeds uncertainty about the nature of change, preventing people at all levels from making the critical decisions that are necessary to adapt. If future impacts are better anticipated, they are also more manageable. Initial estimates of how climate change will affect agricultural systems will set the research challenges, identifying the scale and nature of the problem that global change represents to rural communities. This would include obtaining more reliable estimates of the impact of climate change on water resources, crops and livestock at global, regional, national, and local levels. Research activities would couple the latest global circulation models with socio-economic and biophysical models of crop productivity and farming systems.

Theme 2 - Crop Adaptation: Develop crop cultivars and management strategies resilient to climate change impacts

Future cropping systems will have to be more resilient to a variety of abiotic stresses to cope with the direct and indirect consequences of climate change. Higher temperatures will cause heat stress in some regions and seasons, will alter precipitation patterns and will lead to rising sea levels. More significant over the short to medium term is the projected increase in the frequency and magnitude of extreme climatic events such as heat waves, droughts and floods. Plant breeding can significantly enhance heat, drought, submergence and salinity tolerance, while crop management can be adjusted to minimize losses or take advantage of rising CO₂ levels and -- in some regions -- eventual improvements in climatic conditions. The existing knowledge on damage mechanisms of abiotic stresses can be used to develop screening tools for the identification of improved germplasm on a large scale. Recent advances in functional genomics can accelerate development of improved germplasm through marker-aided breeding system and candidate gene isolation. Crop management can be improved using advanced decision support tools to optimize yields and resource use efficiency under climate change scenarios. Breeding efforts as well as natural resource management research will benefit from synergies with the Challenge Programs Generation, Harvest+ and Water and Food.

Theme 3- Crop adaptation within the context of ecosystems, including water, land and forests

Mitigation and adaptation strategies for increasing food security in the face of climate change encompass specific resource management options that focus on water and terrestrial carbon pools. To deal with the increasing frequency and magnitude of water-related disasters and their impacts on food security, for instance, aquatic ecosystem management and conservation and water allocation mechanisms may in many areas restore lost food and ecosystem capacity (e.g. environmental flows and wetland restoration could provide a base for adaptation). Likewise, reducing emissions and managing terrestrial carbon pools may in a number of areas be achieved through specific forest management options. Integrated approaches are needed to bridge the trade-offs between improved livelihoods and stopping deforestation, resulting in reduced impacts of land-use change and the greenhouse gas emissions it causes. Work under this theme would include the development of standardized, widely accepted and scientifically sound methodologies for compensating reduced emissions from deforestation and other land-use change.

Theme 4: Strategies and Policies to Adapt to Climate Change

Responses to climate change need to encompass several levels, including crop and farm-level adaptations, national-level agricultural and supporting policies and investments, and regional and global policies and investments. Analysis of adaptation strategies for increased food security under climate change must take into account the relevant hydrologic, agronomic, economic, social, and environmental processes at the global and regional, national, basin, and local levels. Emphasis would be on developing adaptation scenarios and likely outcomes for rural livelihoods in developing countries based on the assessed net impacts of climate change. Research activities would include implementation of socioeconomic farm-household production and vulnerability surveys to estimate crop production and farm-level adaptation strategies; modelling of response options and adaptation strategies at the basin and national level based on alternative adaptation and agriculture and complementary sector investment strategies; and assessment of regional and global trade and economy-wide policies and adaptation strategies to climate change. For each type and level of adaptation strategies, distributional impacts would be estimated, to identify pro-poor adaptation options.

4. How does this proposed CP address the SC criteria?

This proposed CP brings together two international scientific communities, each with a solid track record, that have not worked very closely together before. This is expected to generate more significant outputs and impacts through synergies and complementarities. As shown above, the issue addressed by this CP is recognised internationally as being of overwhelming significance at the global, regional and sub-regional levels. The results will be, de facto, international public goods.

The centres of the CGIAR have un-matched expertise and experience in tropical agricultural research, in particular in genetics, breeding, natural resource management and food policy research; they also hold the largest germplasm collection of food crops. With food security at the core of the CGIAR mandate, it is urgent that the centres address the challenges of the emerging threats brought about by climate change. At the same time, a comprehensive research agenda on Climate Change, Agriculture and Food Security will ultimately rely on expertise beyond the genuine research domain of the CGIAR.

CGIAR-ESSP programme collaboration on the cross-cutting issues of climate change, agriculture and food security will enable each community to add value to its current research agenda. For the CGIAR agenda, relating work on adaptation of systems at the crop, farm and landscape level to the broader context of global biogeochemical and policy processes will increase the effectiveness of the options devised. This should, in turn, lead to greater impact on the ground. For the GEC community, linking global level and regional level studies to local and landscape level work, will increase relevance and strengthen models, as well as better frame the GEC agenda within the context of sustainable development in the tropics and sub-tropics. Finally, for both communities, better integration of biophysical and socio-economic approaches, especially when undertaken across relevant spatial scales, will result in policy and technical options that are more robust, flexible, self-correcting and based upon social learning processes that enhance adaptive capacities of stakeholders.

This proposed CP cuts across all the System Priorities and will reinforce and strengthen on-going work on these priorities by providing a dynamic and forward looking dimension. Depending upon the specific priority areas identified by the workshop, the relative emphasis on the different Systems Priorities may vary of course.

Climate change alters the state of biodiversity (e.g., changes in ecosystem boundaries, changes in genetic make-up). Research on agrobiodiversity conservation (**priority 1**) must take into consideration the impacts of climate change on the conservation of plant, animal and aquatic

genetic resources of relevance to agriculture and food production. The proposed CP will therefore increase the relevance of the work under priorities **1A, 1B, 1C, and 1D**. At the same time, conservation of agrobiodiversity is an effective option for decreasing the vulnerability of small-scale farmers in developing countries to climate change.

Work on genetic improvements (**priority 2**), in particular on breeding for reduced evapotranspiration (**priority 2A**) and tolerance to abiotic stresses such as droughts and floods (**priority 2B**) can directly support, and at the same time benefit from the proposed CP, resulting in more robust germplasm options for farmers and crop management strategies that enhance farmers' capacity to adapt to climate change.

The proposed CP will address the issue of the diversification of farming systems, as a strategy to increase their overall resilience and adaptation to climate change, and will thus contribute to research under **priority 3A** (diversification of farming systems) and **3D** (diversification of systems including trees and forests). Research on improving drought resilience through integration of fisheries and aquaculture into farming systems will also contribute to priority 3C (enhancing incomes through increased productivity of fisheries and aquaculture).

Work under **priority 4** has strong connections to the proposed CP. Climate change directly impacts water quantity and quality, the state of forests, land and soil degradation and changes in land uses (e.g., deforestation, afforestation, pastures) can lead to increased greenhouse gas emissions. The proposed CP will draw upon, and feed into research on integrated land, water and forest management at the landscape scale (**priority 4A**, including by addressing issues of governance of natural resources). Research on the management of fisheries and aquatic ecosystems (**priority 4B**) will include research on the impacts of basin level processes, including climate change, on the productivity and value of these resources and on adaptation and reduction of vulnerability in fishery dependent communities. Research on improving water productivity (**priority 4C**) is essential under predicted water stress for most of the tropics and sub-tropics, as well as under conditions of increased flooding. Research on agroecological intensification to overcome soil degradation (**priority 4D**) is particularly important in the context of Africa where soil degradation is predicted to increase.

Finally, policies for sustaining reduction of poverty and hunger (**priority 5**) need to explicitly account for the extreme vulnerability of small-scale farmers in developing countries to climate change. Work on options to reduce this vulnerability (**priority 5D**) will be directly concerned by the proposed CP. Research on carbon markets would have a direct bearing on work on making international and domestic markets work for the poor (**priority 5B**).