

The Challenge of Climate Change

Research to Overcome its Impact on Food Security, Poverty, and Natural Resource Degradation in the Developing World

Challenge Program Pre-Proposal

by the

Consultative Group on International Agricultural Research
Inter-Center Working Group on Climate Change
(ICWG-CC)

Composed of

15 CGIAR Centers

Centro Internacional de Agricultura Tropical (CIAT)
Center for International Forestry Research (CIFOR)
Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)
Centro Internacional de la Papa (CIP)
International Center for Agricultural Research in the Dry Areas (ICARDA)
International Center for Living Aquatic Resources Management (ICLARM)
International Centre for Research in Agroforestry (ICRAF)
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
International Food Policy Research Institute (IFPRI)
International Institute of Tropical Agriculture (IITA)
International Livestock Research Institute (ILRI)
International Plant Genetic Resources Institute (IPGRI)
International Rice Research Institute (IRRI)
International Water Management Institute (IWMI)
West Africa Rice Development Association (WARDA)

and

Global Environmental Change and Food Systems (GECAFS)

[A joint project of the International Geosphere-Biosphere Programme (IGBP), the International Human Dimension Programme (IHDP) and the World Climate Research Programme (WCRP),
in research partnership with the CGIAR and in collaboration with FAO & WMO]

in collaboration with

The United Nations Environment Programme

and

The World Bank

Executive Summary

During recent decades, the national and international research community – and in particular the CGIAR - has successfully developed and implemented the genetic and environmental foundations to overcome poverty and food insecurity in the developing world. Climate change will impose additional stresses to already delicately balanced agro-ecosystems. It threatens to reverse the gains made by the Consultative Group of International Agricultural Research (CGIAR) and its partners in achieving food security, poverty reduction and environmental sustainability, and to limit future gains the CGIAR system could achieve. **The goal** of this challenge program is to develop the knowledge base to guide adaptation of agricultural systems that reduce the vulnerability of the developing world to the adverse effects of climate variability, improve rural livelihoods, and mitigate further climate change.

Climate change is the most significant environmental threat of the 21st century. Severe droughts are likely to be more frequent in Southern Africa, South-East Asia, the Mediterranean and Central Asia. Wetter climates and more floods are predicted for parts of East Africa and Latin America. Agricultural productivity in Africa, Asia and Latin America is expected to decrease by as much as 20%. The geographical boundaries of agro-ecosystems, as well as species composition and performance will change. Marine ecosystems, supplying protein for millions of the poor will continue to experience major migratory changes in fish stocks and mortality events in response to rising temperatures. In addition to longer-term, more permanent shifts in seasonal climatic patterns are near-term increases in the frequency and intensity of weather extremes. These are already disrupting agriculture, fisheries, and the natural resource base. Poorer countries with predominantly rural economies and low levels of agricultural diversification are at most risk. They have little flexibility to buffer potentially large shifts in their production bases.

The climate change challenge program (CP-CC) will work closely with NARS, NGO and ARI partners to define the impacts of climate change on key food production systems and to identify the most rural populations most at risk. It will develop and implement farm-level adaptation strategies in response to climate change that maximize food production and security, and minimise natural resource degradation. It will identify and demonstrate greenhouse gas mitigation options that promote sustainable development in the developing world. Research activities will be linked to develop farm-level production systems that reduce abiotic and biotic stresses, improve nutrient and water use efficiency, and manage carbon effectively.

At the core of the research and development effort within the CP-CC will be the development of a suite of linked agro-ecosystem models and aligned data structures to provide a systems framework for basic and applied research, predictive outputs, decision making, policy formulation and participatory activities across the CGIAR and its partners. The systems approach and research employed in the CP-CC will be made operational through regional case studies, exploiting the Genotype x Environment x Management interactions in target regions. The demand-driven regional agenda will focus on responding to the most critical science and development issues related to climate change, providing flexibility in the adaptation of food production systems and livelihoods to both near-term and longer-term changes in climate.

Impact assessment will focus on agricultural and fisheries production, on maintaining the biodiversity of wild relatives of CGIAR-mandated crops and the redistribution of vector-borne crop and livestock diseases in response to climate change. In developing a suite of regional adaptation strategies, the CP-CC will work closely with the CP-Genomics in determining the extent and mechanisms of thermal damage in selected crops and other species whilst identifying adaptation pathways. The CP-CC will also take advantage of, and build upon, existing databases of genetic and environmental responses to identify the best genetic and agronomic interventions to maintain productivity in the face of climate change.

Adaptation to climate change at the household level is the underlying driver of the CP-CC. A key activity will be to integrate the bio-physical and socio-economic aspects of farming systems through innovative and interdisciplinary approaches. Scientists, farmers/fishers and policy-makers will work together to increase awareness of climate change issues in the community to identify options that will increase the resilience of their agro-ecosystems. Education is a key component within the CP-CC. CGIAR scientists will work closely with national and regional policy makers to ensure congruency with impact and adaptive research outputs. The CP-CC will also develop and promote adaptive production systems and policies that will mitigate further climate change. The principal means will be to increase carbon stocks and nutrient use efficiency in high potential tropical and sub-tropical agro-ecosystems and to slow tropical deforestation.

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Preamble

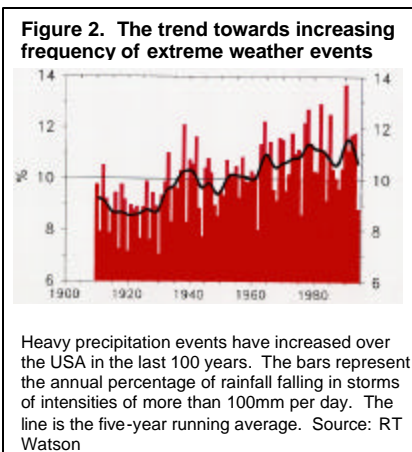
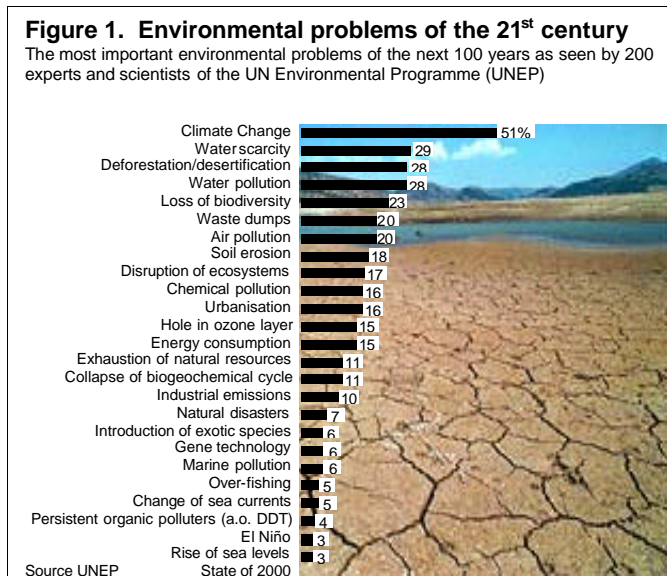
During recent decades, the national and international research community – and in particular the CGIAR - has successfully developed and implemented the genetic and environmental foundations to overcome poverty and food insecurity in the developing world. Climate change will impose additional stresses to already delicately balanced agro-ecosystems. It threatens to reverse the gains made by the Consultative Group of International Agricultural Research (CGIAR) and its partners in achieving food security, poverty reduction and environmental sustainability, and to limit future gains the CGIAR system could achieve.

If the CGIAR does not develop and lead a coordinated global program of collaborative research to address the problem of climate change on the rural poor in the developing world, **can it fulfil its mission** to contribute to food security and eradicate poverty in developing countries in the 21st century? Can the spirit of the Challenge Program concept be fully realized without **elevating the vision** of the CGIAR System to **provide leadership** in addressing the environmental threat that is arguably the greatest threat to securing sustainable food and fibre production for mankind in the next 100 years?

1. The Science

Rationale and Objectives

The global scientific community views climate change as the **most significant environmental threat of the 21st century** - endangering the sustainability of the world's environment, its agriculture and consequently the health and well being of its people (Figure 1). The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR) for the first time states that scientific evidence of human-induced global warming is unequivocal and that latest predictions are worse than previous estimates (IPCC 2001). The past 100 years have been the warmest on record. Warming during the last 50 years has a clear human signature and by 2100 global temperatures are expected to increase by 1.4-5.8° C. Sea levels are rising and are expected to increase by 14 to 88 cm by 2100—flooding low-lying areas and displacing hundreds of millions of people. Rainfall patterns are also changing, and El Niño events are increasing in frequency and intensity.

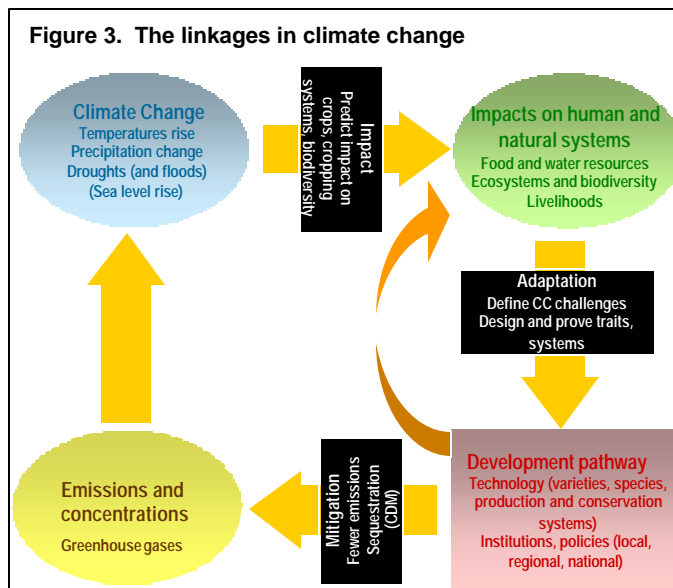


Severe droughts are likely in Southern Africa, South-East Asia, the Mediterranean and Central Asia. Wetter climates and more floods are predicted for parts of East Africa and Latin America as well as more smoke and haze problems in South-East Asia and Central America. In the face of growing population demands, crop yields are predicted to decrease by up to 20% in large parts of Africa, Asia and Latin America (Rosenzweig and Iglesias 2001). The geographical boundaries of agro-ecosystems, as well as species composition and performance will change markedly. Marine ecosystems are a primary source of protein for millions of the poor in coastal communities and small island states and migratory patterns of fish stocks are changing. Coral reefs have, and will continue to experience major bleaching and mortality events in response to rising temperatures. Although a global phenomenon, the impacts of climate change will be unevenly distributed—with the developing world potentially suffering the most¹.

¹ *Climate Change 2001: Synthesis Report* 3.33, p. 77

In addition to these longer-term, more permanent shifts in seasonal climatic patterns are near-term increases in frequency and intensity of weather extremes (Figure 2). These are already disrupting agriculture, fisheries and the natural resource base. Poorer countries with predominantly rural economies and low levels of agricultural diversification will be at most risk. They have little flexibility to buffer potentially large shifts in their production bases. Higher worldwide food prices are likely to result²—compounding bio-physical constraints on production and negatively affecting both rural and urban poor. Resilient production systems and policy options must be developed that ensure high-levels of food production in the face of an increasing incidence and magnitude of extreme weather events.

This proposed Challenge Program on Climate Change (CP-CC) will create an innovative global community of CGIAR, Advanced Research Institutes (ARI), National Agricultural Research Systems (NARS) and their associated Institutes (NARIs) and Non-Governmental Organizations (NGO) partners that will develop the new methods, knowledge and tools necessary for addressing threats to agriculture. It will assess and manipulate the Genotype x Environment x Management (GxExM) paradigm and support the CGIAR's global effort in Integrated Natural Resource Management (INRM) in overcoming poverty and providing food security in the developing world in the face of very significant environmental and climatic stresses.



Goal. The goal of the program is to develop the knowledge base to guide adaptation of agricultural systems that reduce the vulnerability of the developing world to the adverse effects of climate variability, improve rural livelihoods, and mitigate further climate change.

Research Objectives. There are three objectives, as follows (Figure 3):

1. **Determine the specific impacts** of climate change on key food production systems and identify the rural populations most at risk, emphasizing high-population and marginal systems in Southern and South-East Asia, Sub-Saharan and North Africa, Latin America and the Pacific small island states.
2. **Develop and implement farm-level adaptation strategies** in response to climate change that maximize food production and security and minimise natural resource degradation.
3. **Identify and demonstrate** viable greenhouse gas **mitigation options** that promote sustainable development in high-potential irrigated cropping, agro-forestry, forestry and pasture systems.

Box 1. Definitions from TAR Synthesis Report Annex B.

Adaptation
Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Mitigation
An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.

Vulnerability
The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability, and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

² *Climate Change 2001: Impacts, Adaptation and Vulnerability*, 5.3.6, p.269.

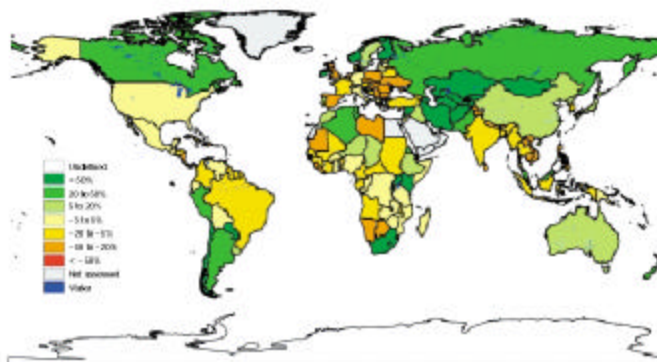
Science Issues. Three critical science issues have emerged during the development of this research program:

1. The importance of systems science in predicting impacts of climate change on key agricultural systems

Not all individuals and societies are equally at risk to climate change and global environmental change. For example, the amount and variability of rainfall will affect rain-fed cropping systems differently than humid forested systems (Figure 4). Climate change itself could have little or no effect on some ecosystems goods and services and major effects on others. The magnitude of these effects may be expressed at a variety of scales, from sub-regions to broader based impacts.

Regardless of the magnitude of bio-physical impacts, they will be coupled with and modified by socio-economic elements, resulting in differing vulnerabilities in production systems across the globe. Systems analysis, incorporating ecological, social and economic perspectives has the potential to ensure that systems diversity and complex interactions are investigated in a comprehensive assessment of the impacts of climate change on the world's poor. These assessments will form the basis for global planning.

Figure 4. Country level impacts of climate change on rain-fed cereal production in 2080



Max-Planck Institute of Meteorology model ECHAM4 for 2080: Impacts on currently cultivated land. Source: Fischer et al. 2002.

2. The need to develop and tailor adaptation strategies to specific food production systems and regions.

The CGIAR has historically been at the forefront of research with national partners to improve the capacity of the rural poor to build sustainable production systems that are resilient to bio-physical and socio-economic stresses. Just as system vulnerability will also vary in magnitude, the ability of local populations to adapt their production systems to cope with climate change will vary across the developing world. They are both controlled by the flexibility with which food provision (i.e. the supply, availability and access to food and related essential resources) is mediated by government institutions and policy.

Large increases in grain sterility of cereal and legume crops caused by climate change raises an alarming food-security issue³ (Han Yong Kim et al. 1996, Horie 1993, Matsui et al. 1997, Satake and Yoshida 1978, Vara Prasad et al. 2001). It will make the task to feed 3 billion more people within 30 years a daunting challenge. Sterility and yield loss also threatens root and tuber crops⁴, pasture and tree species (Pigott and Huntley 1981), but its extent is unknown. If rates of rice yield decrease due to thermal stress are broadly validated, and assuming the range in temperature increases in the latest IPCC data (0.14 – 0.58°C per decade), yield of tropical grain crops could decrease by 5 – 11 % by the year 2020 and by 11 - 46 % by 2050.

The IPCC TAR has emphasized changes in climate variability and extremes. The CP-CC will cover the important issue of longer-term climate change, focussing during the first 5 years on nearer-term issues of adaptation. This is important for food production needs over the next 20 years, and sets a solid platform for coping with longer-term impacts.

Changes in production systems will have significant impacts on both socio-economic well-being and the environment. Detailed assessments of production systems performance and adaptation under different climates will determine the outcomes. Similar methodologies to those employed in vulnerability and impact assessments ensure consistency in this program.

Bio-physical and socio-economic adaptation strategies will need to be regional, and in most cases, systems- and possibly site- (micro-climatic) specific. The flexibility of the GxExM model will be applied through the participatory research networks, which currently exist throughout the regions. A strong linkage is planned with

³ *Climate Change 2001: Synthesis Report* 4.19 p.85

⁴ *Ibid.*

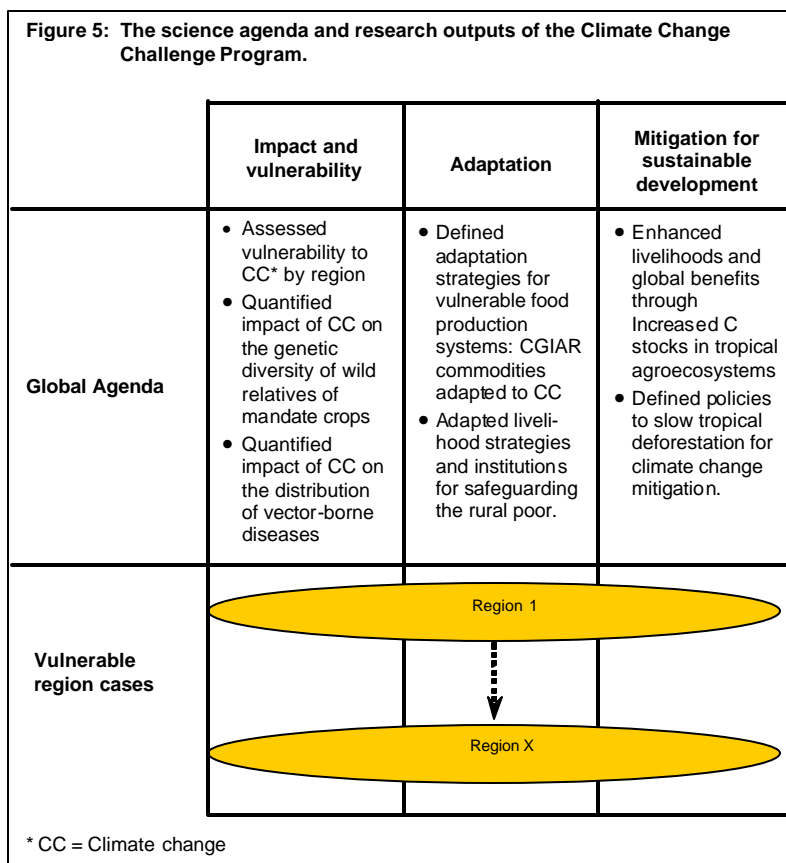
both the Genomics and Water Management CPs, the former having a defined project on drought tolerance and the latter manipulating a key environmental commodity.

3. The need to develop innovative food production systems that can help mitigate the environmental consequences of greenhouse gases.

Increased food supply can be achieved at farm and regional levels through one or a combination of three strategies - **extensification** (clearance and cultivation of *new land*); **intensification** (change in production practices on a given area to either *increase intensity* of production or *increase the yield* of a particular crop or tree or crop/tree combination); and **trade** - to acquire food.

Recent decades have seen a linear decline in the area harvested per capita compensated for by increased intensification within production systems. But this was often associated with significant concomitant increases in climate change “forcing” factors, such as greenhouse gas emissions, and changes in dust generation and albedo. Intensification processes can act as both sources and sinks of several greenhouse gases, with the relative size of these varying widely depending on the practices and the environment in which these occur.

There is a serious deficiency of detailed emissions data and full-cost greenhouse gas accounting under most crop production systems in the developing world. Apart from the former “Methane from Rice” UNEP-CGIAR network in South and East Asia and the Alternatives to Slash and Burn (ASB) Program, quality data are limited. But there is great potential for collaborative projects between the CGIAR and ARIs to refine regional and global greenhouse gas (GHG) budgets. A systems accounting approach has recently been employed across the Indo-Gangetic Plain (Grace et al. 2002), utilising long-term benchmark sites for soil carbon change and evaluating the potential for reducing greenhouse emissions across whole farming systems. It is significant that the higher yielding intensified production systems only emitted moderate levels of greenhouse gases with relatively low emissions per production unit. It is these type of sites that provide the essential background data needed to develop aligned productivity and mitigation strategies.

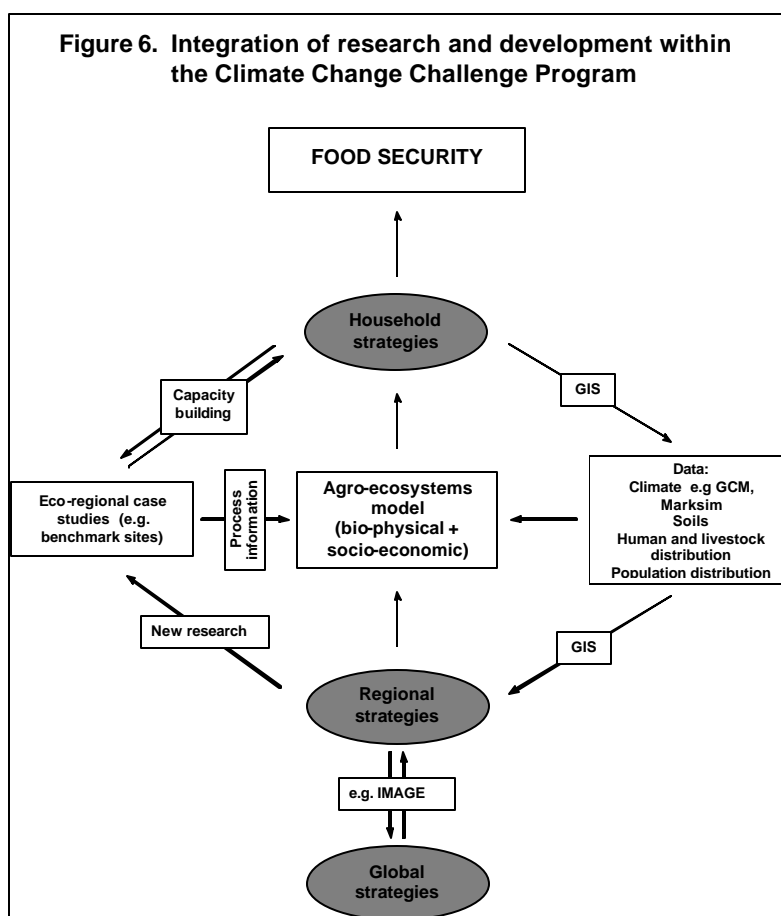


The tight synergy between carbon and nitrogen use efficiency for sustainable systems development and greenhouse gas reduction is now being recognised as a dual adaptation-mitigation strategy. The Clean Development Mechanism (CDM) is a mechanism financed by industrialized countries investing in carbon sequestration projects in developing countries. This option combines the goals of sustainable development, food security, and desertification control in developing countries with creditable low- and medium-cost greenhouse gas mitigation projects. In addition, increased productivity and sustainability in agriculture could reduce the demand for clearing forests and savannas to meet local agricultural and economic needs.

Research Approach and Methodology

The number of different regions and agricultural systems, the uncertainty of the magnitude of climatic change in both short- and long-term, and the lack of emissions data in the developing world (and potential problems with data collection) have provided the major influences on how the research approach within CP-CC has been formulated (Figure 5). A systems approach clearly provides the best mechanism for data collection, integration and both up and down-stream dissemination for a wide client base. This will ensure greatest flexibility, whilst maximising the use of current and future data stores, and ensures consistency across both the developing and developed world systems in facilitating a research agenda.

At the core of the research and development effort within the CP-CC will be the development of a suite of linked agro-ecosystem models and aligned data structures to provide a systems framework for basic and applied research, data collection, predictive outputs, decision making, policy formulation and participatory activities across the CGIAR and its partners (Figure 6). In constructing this systems framework, the CP-CC will take full advantage of current efforts in ARIs and NARS to develop compatible systems tools, by building upon existing relationships and developing new ones. The aim will be to maximise our ability to produce and disseminate high quality strategic information on adapting agricultural systems to climate change from national to farm level in a timely fashion.



A number of underlying themes will promote internal linkages within the CP-CC and potential external links to other CPs:

- *Reducing abiotic and biotic stress* provides the linkage between impacts and adaptation research. One of the key issues facing producers is reducing yield loss and improving yield reliability in the face of changing stresses. This is especially critical against the background of potential changes in the incidence of extreme events when socio-economic stress might well also be greatest.
- *Improving resource use efficiency* provides the linkage between adaptation and mitigation research within the CP-CC. Improving resource use efficiency will promote natural resource conservation, improve profit and reduce climate “forcing” and other aspects of environmental degradation. Improving water-use efficiency will help buffer the impacts of climate extremes by developing production systems less dependent on water in times of drought. This will provide both agronomic benefit as well as limiting greenhouse gas production and other aspects of environmental degradation.
- *Managing carbon* provides additional links between adaptation and mitigation research within the CP-CC. The principal means to mitigate climate “forcing” and at the same time to promote sustainable development are to limit further emissions of greenhouse gases to the atmosphere and to actively sequester carbon in biomass and soils. The magnitude of carbon sequestration in developing countries depends to a major extent on rainfall regimes. The carbon sequestration potential could be identified at a similar scale of resolution using systems methodologies and models that are employed in the impact and adaptation modules within this Challenge Program.

**Box 2. Climate Change and the Rice Wheat System in the Indo-Gangetic Plain:
An example case study for the CP-CC**

The rice-wheat rotational cropping system typical of the Indo-Gangetic Plain (IGP) is a vital food system on which millions of people depend. It is however highly sensitive to climate change (especially change in variability), particularly given the other demands on water in the region. Researchers in the Rice-Wheat Consortium for the IGP¹ (RWC) have identified several key questions relating to climate change and system productivity:

- How are yields in the rice-wheat cropping system apportioned between variations in seasonal weather, planting date and/or other management aspects?
- How can potential yield losses across the region due to increased climate variability and consequent changes in planting date and other management aspects be quantified and mapped?
- What strategies can improve the system productivity and sustainability, thereby improving food security, and how would these strategies need to be adjusted in response to changing climate variability?
- What are the environmental tradeoffs associated with developing alternative strategies to improve production in the face of climate variability?

These questions form a strong basis for developing a Regional Case Study for the CP-CC. They have clear links to Impacts, Adaptation and Mitigation aspects highly relevant to key, locally-perceived issues. They also bring together research addressing production problems relating to current conditions, near-term changes in climate variability and long-term changes in climate.

CP-CC research would bring together many well-established research strengths of the CGIAR:

- Abiotic stresses (e.g. drought and salinity), biotic stresses (e.g. pests) and the interactions that lead to yield reductions.
- Germplasm development (link to CP-Genomics), management of GxExM data management and GIS.
- Water resources (link to CP-Water) and evaluation of environmental tradeoffs.
- Carbon management and GHG emissions.
- Policy needs and responses.

Effective links to complementary skills in the international Global Change research community worldwide will be made through collaboration with GECAFS²: Work would also build on systems analysis tools being developed by groups coordinated by GCTE³ and ICASA⁴. Several detailed analyses of the global warming potential of the rice-wheat system have been completed, which can serve as a foundation for further studies on environmental tradeoffs.

Research in the region is already well supported by NARS and the CGIAR system and the RWC is already in place to help link research in the region. There is significant policy and donor interest in the system, particularly by DFID and other major bi-lateral agencies. Further, a case study would build on “Climate Variability and Rice-Wheat Productivity in the Indo-Gangetic Plains”, a grant recently awarded to the RWC by the Asia Pacific Network (a non-traditional donor to the CGIAR system) and by other, CGIAR initiatives.

The study would provide an excellent example of how a regional-important issue can bring together CGIAR, NARS and ARI research communities and their respective donors to address jointly a common focus.

¹ The Rice-Wheat Consortium for Indo-Gangetic Plains (<http://www.rwc-prism.cgiar.org>) is a regional collaboration between agricultural research organisations from Bangladesh, India, Nepal and Pakistan and CIMMYT and IRRI.

² Global Environmental Change and Food Systems (<http://gecafs.org>) is a joint project of IGBP, IHDP and WCRP with the objective “to determine strategies to cope with the impacts of Global Environmental Change on food provision systems and to analyse the environmental and socio-economic consequences of adaptation”.

³ Global Change and Terrestrial Ecosystems (<http://www.nmw.ac.uk/GCTEFocus3/>) is a Core Project of IGBP.

⁴ The International Consortium for Agricultural Systems Applications (<http://www.icasanet.org>)

- *Understanding processes of adaptation:* If changes are required to existing production systems to meet the challenges posed by climate change and climate variability, ultimately rural inhabitants are the people that will be making them. It is, therefore, important that any proposed interventions make sense for farmers to adopt them, i.e. that their livelihoods are enhanced as a result. This requires a good understanding of the bio-physical, social and economic dynamics of individual households, and the way in which these interact. This could be aided by bio-socio-economic modeling using approaches emerging from the field of complex adaptive systems

The systems approach and research employed in the CP-CC will be made operational through selected eco-regional case studies (See Box 2). This will ensure that in addressing the climate change agenda, we are directly exploiting the GxExM paradigm in a target region and providing a broad base for linkage with other Challenge

Programs. The demand-driven regional agendas will focus on the most critical climate-change-related science and development issues, providing flexibility in adapting food production systems and livelihoods to both near-term changes in climate variability and longer-term shifts in climate.

Regional cases will lend themselves to an integrated natural resource management approach, and encompass many of the key issues raised in the proposed research agenda. Other examples could be crop-livestock systems of Southern and Western Africa and Central Asia; recuperation of degraded pastures in the Amazon Basin; maize-bean systems of Latin America; agro-forestry systems in East Africa; and coral reef and pelagic fishing systems in the Pacific.

Each of the case studies will be underpinned by a set of operational elements. These are designed to provide clear linkages between research, policies and capacity building, thus ensuring maximum relevance of our research and development efforts to the ultimate end-users, our NARS stakeholders, national and international policy-makers. All these elements must be included in an eco-regional case study:

- Assessment of vulnerability, adaptation, policy and institutional needs
- Assessment of costs and benefits in social, economic and ecological terms
- Data collation and management as a means to advance science
- Simulation model development and integration
- Capacity building (scientists and policymakers)

A critical constraint to effective adaptation to and mitigation of climate change in the developing world has been a lack of opportunity to participate effectively in international research and policy debate. Due to its vision of broad linkages, the Challenge Program concept provides the opportunity for expanded national and international capacity building in both of these areas. In addition to capacity building through collaborative research and training, the Challenge Program will promote dialogue between researchers and key decision makers in government, donor agencies and international entities such as the SBSTA⁵ of the UNFCCC⁶.

Research Outputs

The core output will be a greatly enhanced capacity for NARS to develop systems-based impact, adaptation and mitigation assessments and strategies to respond to the continuing threat of global climate change. This output will be facilitated through the development of bio-physical and socio-economic systems analysis tools. The systems tools are an assemblage of the operational elements outlined in the research approach, which integrate best knowledge of organism response to the environment and management (from this and other CPs). They will form the standard platform for iterative analysis of case studies across the globe, and will be suitable for use and integration of both the developing and developed spheres of climate change research and development.

Initial research projects (0-5 years) have been developed to close immediate gaps in meeting objectives, and provide a research and development platform for future research (5-10 years).

The initial suite of research projects and specific outputs are:

Objective 1 - Determine impacts of climate change on key agricultural & fisheries systems and identify most rural populations most at risk.

The following research activities will be conducted to achieve objective 1. Research outputs follow each activity description.

Impacts Project 1. Assess regional vulnerability in agricultural and fisheries production systems in response to climate change.

The IPCC has offered broad and low resolution regional predictions of likely impacts of Global Circulation Model (GCM) scenarios on production of key commodities. Climate patterns vary at spatial scales far lower than standard GCM outputs. Higher resolution global impact efforts, such as IMAGE 2 (which include interactions and feedbacks of the society-biosphere-climate system) provide more relevant systems-orientated climate impact assessments. They are limited by lack of precise data from developing world systems which form a large part of any global systems analysis and response. Current global impact assessments are therefore inadequate for benchmarking and predicting impacts on production at either household or farming systems level, the basic unit of impact and assessment of the CGIAR.

⁵ Subsidiary Body for Scientific and Technical Advice

⁶ United Nations Framework Convention on Climate Change

A pilot methodology (MarkSim) has been developed and tested by ILRI and CIAT scientists that allows outputs from a GCM to be downscaled and applied to field scale systems simulation models on a daily basis (Jones and Thornton 2002, see Sidebar). Using GCM scenarios of climate change, land-use change scenarios, and crop and livestock production models, it is possible to model and map the impacts of climate change on agricultural systems. These will serve as benchmarks in developing adaptation and mitigation strategies. This high resolution predictive approach needs solid understanding of developing world agricultural systems and local climate and soils. It also needs data regarding poverty status, market access and other key factors determining social and economic risk. These data will be collected through close collaboration with our national partners.

Fisheries impacts will be investigated by ICLARM which has developed partnerships with National Oceanic and Atmospheric Administration (NOAA), the Australian Institute of Marine Science, major NGOs and other agencies to create a system which predicts areas at high risk to coral bleaching, and to quantify actual patterns of bleaching and mortality. This work would be enhanced and extended to include socio-economic sensitivity to bleaching events caused by reduced fisheries productivity.

Outputs:

- Sub-regional spatial and temporal quantification (on the 5-50 year time horizon) for changes in production of major irrigated and rainfed crops under the CGIAR mandate.
- Risk/vulnerability maps for coastal communities reliant on coral reef and pelagic fisheries.
- Semi-quantitative frameworks for assessing vulnerability to climate change at the regional level, from an integrated social-ecological and economic perspective.

Impacts Project 2. Assess potential shifts in genetic diversity of wild relatives of mandate crops

Plant breeders use broad-based collections of plants and their wild relatives to produce improved varieties for improved global food security and to alleviate poverty. Protected areas conserve plant genetic resources under current environmental conditions, but little thought is generally given to future trends in species' distributions under the threat of climate change.

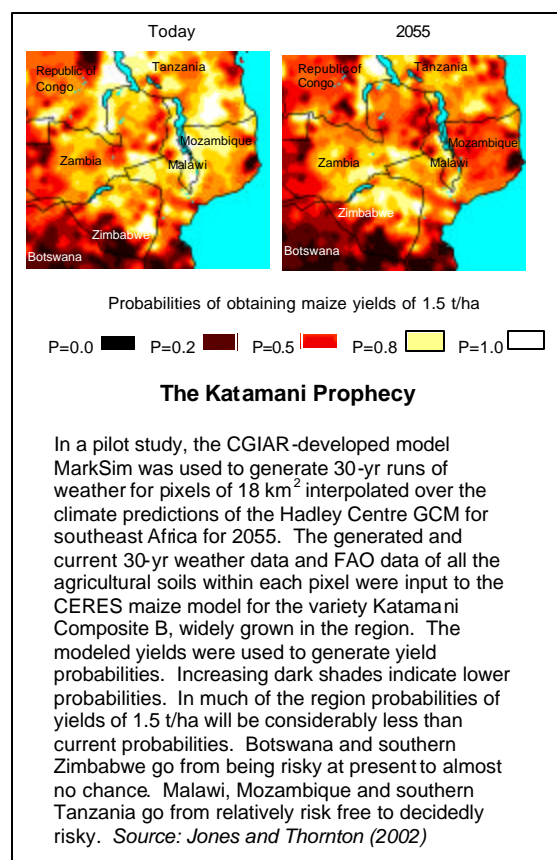
The FloraMap pilot study with wild relatives of the common field peanut will be extended to wild relatives of other CGIAR-mandated crop species to assess objectively the adequacy of the *in situ* (protected areas) and *ex situ* (gene banks) conservation strategies for these key gene pools. Conservation gaps and regions of eco-geographic importance for germplasm collection and for *in situ* conservation will be identified. They will incorporate future scenarios of shifts in distribution of these key species as a result of climate change and identify potential refuges using site-similarity assessments for *ex situ* conservation. These activities will be carried out in close collaboration with national programs in the management of plant genetic resources.

Outputs:

- Digital atlas of the wild relatives of the major global food crops and re-distributions in response to climate change over the next 50 years.
- Identified conservation domains to preserve primary genetic material that may be highly susceptible to extinction through climate change.

Impacts Project 3. Assess distribution of vector-borne diseases

The direct effect of global climate change on the dynamics of insect pest populations in the tropics depends on the relative lengths of the wet and the dry seasons, and temperature. Cropping patterns will also change in response to changing climate. For example, there are already more planting opportunities for cassava in North-



Eastern Brazil than previously. As a result, white fly populations that build up on early-planted crops now cause increased damage by migrating to later-planted crops. Changes in cropping systems will lead to different suites of pest insects and will require new understanding of host plant behaviour, pest dynamics and the dynamics of beneficial predators.

Vector distribution data sets will be integrated and environmental data sets will be compiled under the overall data collection projects of the CP-CC. Multi-variate models will be developed to predict distributions of crop and livestock diseases transmitted by these vectors. These models will be applied to environmental data modified to reflect climate change scenarios. They will be used to predict change in distribution of disease risk over the next three to five decades

Output:

- Digital atlas of spatial and temporal re-distribution of vector borne crop and livestock diseases that most affect poor farmers and livestock keepers in the tropical regions of Africa and Latin America.

Objective 2 - Develop farm-level adaptation strategies in response to climate change that maximize food production and security and minimise natural resource degradation

Adaptation Project 1. Determine potential thermal damage to cereals and legume crops (and selected pasture and tree species) and identify mechanisms for adaptation to climate change.

A large increase in grain sterility of cereal and legume crops in response to thermal stress raises a major food security issue. The extent of thermal damage to root and tuber crops, pasture and tree species is largely unknown. Validation of these responses is urgently required to ensure suitable mechanisms are identified to make new germplasm available that is adapted to new climatic situations.

Outputs:

- Specific mechanisms by which thermal damage occurs at flowering of primary CGIAR crops and those that confer tolerance to high temperatures determined (in collaboration with the Challenge Program on Genomics).
- Germplasm to accommodate heat stress by changing the time of day at which the crop flowers.
- Responses of selected pasture and tree species to heat damage determined.

Adaptation Project 2. Identify adaptation strategies for changing climates

CGIAR centers and NARS partners together have conducted extensive multi-location testing over more than 30 years on various CGIAR mandate crops. The agronomic and crop performance data collected from these trials served to identify robust, stable genotypes that can be grown in a particular environment or across environments. The full potential of this wealth of data available in the CGIAR Centers have not been fully exploited to understand better the interactions between genotype, environment and management (GxExM). Databases exist within the CGIAR (e.g. International Crop Information System and Sustainable Farming Systems Database) which can be further developed for extrapolation in climate change research. Careful analysis of these interactions, coupled with generated weather described in Objective 1 will define which currently available germplasm and systems of crop management will be able to provide solutions to the changed climates in any particular region in the future.

Outputs:

- Comprehensive database on GxExM information for CGIAR commodities that is readily accessible for querying and data mining.
- Defined short (fertiliser and organic inputs) and long-term (rotation driven) management options which maintain crop production, organic carbon and nutrient stores in the irrigated and rainfed tropics and sub-tropics.
- Mixed-farming (crop-livestock) and agro-forestry strategies for sustained household incomes in the tropics.
- Site-similarity maps for determining best management practices under changed climatic conditions for optimal productivity across tropical and sub-tropical agro-ecosystems (linked to the latter two outputs).

Adaptation Project 3. Identify new livelihood strategies and institutions

This topic will focus on education, through increasing awareness and articulating “best-bet” responses to climate change from a rural household perspective. It represents the most significant contribution the CP-CC will make to householder response to climate change in both the near- and long-term. At the farm scale climate change will impact agricultural incomes and expose farmers and fishers to increased production risk, with consequences

on the level and incidence of poverty. Households and communities will attempt to adapt their livelihood strategies in order to manage food security as climate change alters the mean and variance of food yield. In order to explore promising risk management strategies, research will need to integrate the bio-physical and socio-economic aspects of farming system dynamics. This will require the development of innovative and interdisciplinary approaches where scientists, farmers/fishers and policy-makers work together to increase awareness of climate change issues in the community and the identification of options that will increase the resilience of their valuable agro-ecosystems.

It is important to develop and implement livelihood options that provide farmers with diversified systems and increase their access to markets. An associated challenge will be to develop farmers own capacity to adapt to change. This includes a substantial training and education component, in which national and community-based scientists will work closely with the CGIAR in developing innovative techniques for increasing awareness of and capacity to adapt to climate change.

The design and implementation of flexible and adaptive institutions and policies, based on lessons from past experiences and from continual self-monitoring will be addressed in this topic. Again, education is a key component, with CGIAR scientists working closely with national and regional policy makers to ensure congruency with impact and adaptive research outputs.

In addition to its household level thrust, this topic will place increased emphasis on marginal lands, e.g., sub-tropical and tropical drylands and drought-prone farmlands such as the desert margins and the dry savannah of West and South-East Africa. These are areas of “double jeopardy” in which climate change impacts are projected to be most severe, bringing additional hardships to some of the poorest populations in the world.

In the fisheries sector, vulnerability maps for coral reef and pelagic fishing with near-real time predictions of stock movements will provide local communities with advice on which fisheries are most likely to be productive in any given year.

Outputs:

- Identified and implemented of bio-physical and socio-economic livelihood strategy options in the tropics, rainfed and irrigated sub-tropics and coastal communities that optimise and sustain production in response to a changing climate change.
- Improved analytical and community-based methods and protocols developed to cope with climate change, including methods for early responses to long-range climate forecasts.
- Enhanced adaptive management capacity of farmers, fishers and policy-makers.
- Identified mechanisms of flexible governance at the local, community and national level that promote the resilience of production systems and the adoption of sustainable livelihood strategies.

Objective 3 - Identify and implement viable greenhouse gas mitigation options that promote sustainable development in high-potential irrigated cropping, agro-forestry, forestry and pasture systems

Mitigation Project 1. Develop and implement strategies to increase carbon stocks and nutrient use efficiency in tropical and sub-tropical agro-ecosystems for enhanced livelihoods and global benefits

Innovative farming practices that increase carbon stocks and reduce emissions of other GHGs constitute a win-win situation because they also increase nutrient use efficiency, which directly increases food production and farmers' livelihoods. Currently there are few estimates of how much C is lost, or sequestered, in agricultural production systems in the developing world. This project, which aims to assess above-ground and soil carbon in smallholder agro-ecosystems, will require development of innovative field methods. Total Global Warming Potential will require data on nitrous oxide and methane emissions and uptake as well. This information will also close major gaps in global estimates and allow more accurate formulation of national communications under Article 12 of the UNFCCC.

The work will demonstrate how more environmentally sustainable practices can also result in better livelihoods for the rural poor. An additional objective will be to devise transfer schemes that directly benefit small-scale farmers in developing countries through equitable cost-sharing mechanisms between the North and the South. More practical, cost-effective methods will be developed to determine carbon baselines, provide attractive benefits to communities, and enhance the policy and institutional environments underlying project success. Participatory policy and institutional research will be undertaken to support these transfer mechanisms. The outputs will be deployed to pro-actively influence the development of international agreements on carbon

marketing that advance the interests of the poor. Complementarities between this and the Rainforest Challenge Program will be exploited through site linkages.

Outputs:

- Cost-effective and practicable methods to assess and to increase soil and above-ground carbon and decrease ancillary greenhouse gas emissions in agro-forestry, cropping and mixed farming systems of the tropics and subtropics.
- Working models demonstrating how smallholder communities can participate successfully in emerging carbon markets while increasing the sustainability of their farming systems.
- Policy and institutional mechanisms that promote carbon sequestration and nutrient use efficiency by smallholders.

Mitigation Project 2. Develop policies that slow tropical deforestation for climate change mitigation

Of all the activities related to land use, land use change, and forestry (LULUCF), changes in forest cover make by far the largest contribution to GHG fluxes in the developing world. Deforestation and forest harvest are sources of carbon, while afforestation and reforestation are sinks for it. Estimates put the net loss of forest cover in the tropics at 14.6 million ha per year during the 1990s⁷.

For many local people, the most profitable option of land use results in clearing or degradation of the forest. LULUCF activities are heavily influenced by policy. At present these activities are largely independent of the CDM or carbon trading. To change current trends of forest destruction and degradation will require policy interventions, such as environmental service payments, including not only carbon but other ecological services such as quantity and quality of water and conservation of biodiversity.

Livelihoods analyses and adaptive modeling (Objective 2) will provide tools by which the role for service payments as a means of increasing household incomes can be investigated. Four specific topics have been identified where additional knowledge can lay the foundation for effective policy decisions to increase carbon sequestration and reduce emissions in forested lands in the developing world.

Outputs:

- *Debt.* Policy briefs presented to the major lending institutions (World Bank and International Monetary Fund) and to bilateral lending institutions that use external debt write-off as a means to reduce carbon emissions in Africa.
- *Roads and transportation.* Specific recommendations that national transportation development plans should be altered to reduce carbon losses through deforestation (Brazil, Cameroon, Indonesia)
- *Livestock.* Policy briefs that propose ways that policymakers can apply regulatory levers to lessen livestock pressure on forests in Amazonia.
- *Enhanced adaptive management capacity.* Identified institutional arrangements at the local level, and articulation of national and international policy instruments that will ensure that the poor receive environmental service payments in order to reduce carbon emissions.

Competence and Comparative Advantages of the CGIAR Centers and their Partners

Climate change will not present the world with a collection of new climates, but climate patterns will shift within specific regions. In pursuit of its mission of poverty alleviation and increased food security, the CGIAR and its partners have for the past 30 years prepared the scientific and socio-economic foundations necessary for developing the right production system for the right climate. For example, CIMMYT and IRRI have provided core materials for increasing crop production using traditional breeding techniques to develop germplasm that covers climatic conditions across the globe. Diversification into other agro-ecosystem production units has been successfully provided through like programs in CIAT, CIFOR, ICARDA, ICLARM, ICRAF, ICRISAT, ILRI and IPGRI. Understanding how climate interacts with nutritional and biotic stresses and how it influences socio-economic development at global and regional levels has been recognised as crucially important when searching for successful adaptation strategies.

There has been increasing recognition of the importance of eco-regional management, for example through the success of IITA in integrated pest management (IPM). In particular, the embracing of INRM as a key strategy by the CGIAR ensures the three essential ingredients of GxExM are now recognised as critical in holistic approaches to food production and climatic change across a wide range of spatial and temporal scales.

⁷<http://www.iucn.org/news/mbforests.pdf> accessed 29 August 2002.

In the developing world, climate change will be an added stress to already delicately balanced ecosystems. The foundations to overcome poverty and food insecurity have been successfully determined by the CGIAR in the past, and have now been fortified by the selection of Genomics and Water Management as fast-tracked Challenge Programs. The world's climate directly influences all aspects of the CGIAR's research and development agenda, and a CP-CC, providing careful assessment and manipulation of the GxExM paradigm, will provide the back-bone of the CGIAR's global effort in overcoming poverty in the developing world.

In constructing the necessary systems framework, the CP-CC will take full advantage of the current efforts of the ARIs participating in the program, so that together we will develop systems tools. We will build upon existing relationships, and develop new ones, to maximise our ability to produce and disseminate high quality strategic information on adapting agricultural systems to climate change from national to farm level in a timely fashion. The agro-ecosystem climate downscaling methodology already builds on the strong linkages between the CGIAR and the crop simulation communities in ARIs in the US, Europe and Australia, exemplified by the International Consortium for Agricultural Systems Applications (ICASA).

Significant capacity also exists within the CGIAR and aligned ARIs for detailed spatial and temporal analyses at a variety of scales. For example, the GASSIA initiative - Geospatial Applications to Support Sustainable International Agriculture, in collaboration with the US Geological Survey (USGS), ensures that a high quality information network is available to the CGIAR for data acquisition, storage and delivery. This provides the basis to support down-stream research and development projects in desertification, carbon sequestration, poverty mapping and biodiversity protection. These networks are currently under-utilised within the CGIAR and the wider global change community in impact assessment. However they provide the ideal platform for fully integrating the developing world into climate change assessments and decision making at all levels.

Expert groups from Europe and North America (e.g. US-Consortium for Agricultural Soils Mitigation of Greenhouse Gases) have strongly recommended soil carbon sequestration as a climate policy measure to benefit farmers in terms of sustainable systems development. The CGIAR is in a unique position to provide global leadership in this area, due to the strength of its research and development in the tropics where mitigation potential is high, and its strong linkages with key ARIs in this area.

2. Relevance to CGIAR Goals and Impact

Potential to Contribute to CGIAR Goals of Food Security, Poverty Alleviation, and Environmental Sustainability

The mission of the CGIAR is "To contribute to food security and poverty eradication in developing countries through research, partnerships, capacity building, and policy support, promoting sustainable agricultural development based on the environmentally sound management of natural resources" (*CGIAR Annual Report 2000*). The CP-CC will contribute to that goal by developing strategies and technologies to help farmers adapt to both the near and longer-term impacts of climate change and to mitigate further environmental degradation.

Assessing vulnerability will be a priority in the initial stages of the CP-CC as it forms the basis for adaptation and mitigation strategies. The systems and regional case study approach employed in the CP-CC will continue to be developed within the NARS to create a global network for on-going research and development available to all.

Mechanisms for Delivery and Dissemination of Outputs

Information only becomes knowledge when it is used to influence decisions, whether by policymakers, farmers, researchers or the community at large. The role of the CP-CC will be to turn data into knowledge that results in better livelihoods within sustainable systems of natural resource management in the developing world. The overall objectives in delivering information will be to:

- Reduce the time lags between discovery and adoption.
- Widely disseminate results and impact.
- Enhance the relevance of research.
- Encourage feedback on research priorities.

The CP-CC will include a specialist Communications and Education unit responsible for information dissemination and efficient delivery. This unit will also include specialists in participatory methods from within the CGIAR and NARS. For delivery and development of participatory adaptation and mitigation strategies with farmers, the main thrust will be through existing NARS networks, the International Centers and NGO's. Innovative participatory techniques will continue to be developed to ensure rapid dissemination of core

information and capacity building within NARS in both systems analysis and participatory research methodologies.

The CIMMYT Risk Management Project in Southern Africa, with the assistance of ARIs, has linked high-level systems analysis with on-farm participatory methods. This has resulted in near real-time climatic assessments of whole-farm management strategies in extremely vulnerable rainfed systems. It has provided a better understanding of the actual decision making process as farmers adapt through diversification of their production system.

NARS and NGO partners have already been involved in the identification of problems, priorities and delivery mechanisms at the Nairobi workshop (see below). They will continue to be involved at all stages of the development of the proposal and its execution, from setting research agenda to governance, which will ensure rapid and effective feed of information to partners and their governments. Output of significant policy relevant information will be facilitated through the governance board and NARS representatives.

International Public Goods Produced

The IPCC and the global scientific community will also benefit from the outputs of the CP-CC by providing more accurate assessments of the impacts, adaptation and mitigation mechanisms in the developing world. It will guide a more informed global debate and ensure greater global coordination through the framework convention on climate change.

As well as responding to the IPCC-TAR, the CP-CC responds directly to several Articles of the UNFCCC, ratified or acceded to by 187 members of the UN community. These articles require that the Parties:

- Give full consideration to those developing country Parties that would have to bear disproportionately the burden of the adverse effects of climate change. (*Article 3.2*)
- Take precautionary measures to anticipate, prevent, or minimize the causes of climate change and mitigate its adverse effects, taking into account different socio-economic contexts. (*Article 3.3*)
- Address the adaptation to adverse effects of climate change, and decisions made at the COPs of the UNFCCC, emphasizing capacity building. (*Articles 4.1, 4.4, and 4.8*)
- Meet the specific needs of developing country Parties arising from the adverse effects of climate change, and/or implement response measures, especially in countries with areas prone to natural disasters and drought. (*Article 4.8*)
- Support and further develop, as appropriate, international programs or organizations aimed at conducting research, data collection, and systematic observation. (*Article 5*)

3. CGIAR Partnerships and Stakeholder Involvement

Stakeholders' Involvement in Problem Identification, Research Planning, and Implementation

Stakeholders will continue to be involved in problem identification, priority setting and program implementation linked in a "bottom-up" mechanism. Over sixty participated in the *Climate Change and Rural Prosperity* workshop convened by the Inter Center Working Group on Climate Change (ICWG-CC) in Nairobi, Kenya, on 23-26 April 2002. Delegates from Asia, Africa and Latin America representing NARS, NGOs, policy makers and regional fora were sponsored to attend, using a grant from IDRC. Representatives of ARIs from the North and members of the ICWG-CC who attended were sponsored by their own institutions.

The purpose of the workshop was to enable NARS, NGO and other developing country practitioners and researchers to identify priority research themes with CGIAR scientists and contribute to a suitable modular framework on climate change research and on-going participatory activities.

The following principles have guided and will continue to guide development of the CP-CC and its implementation to promote national support:

- Issues and topics requiring research were identified and ranked through consultations with stakeholders, researchers, research institutions, policymakers and investors during the Nairobi workshop. Further extensive consultations will be undertaken during the development of the full program proposal.
- NARS from the South have been and will continue to be involved at all levels—from the setting research agenda to governance, including writing the Pre-Proposal.
- Capacity building will be achieved through research partnerships and the placing of young research scientists within the programs and projects of the climate change global partnership.

- Because partners in developing countries have been and will continue to be involved at all levels in this Challenge Program, research results can be implemented rapidly within national research, development and policy bodies. Additionally, research partnerships within the global climate change research community will develop a stronger research base and provide new collaborative framework.
- Research findings will be quickly disseminated through the NARS and CGIAR utilising both traditional and advanced (web-based) education and communication networks and published in peer-reviewed journals to ensure availability to the national and international communities.

A key element for the success of this Challenge Program is the emphasis to build the link between science and environmental policy. The United Nations Environmental Program (UNEP) will serve as the key partner in the policy arena to create this link—particularly through regional ministerial processes such as the African Ministerial Conference on the Environment (AMCEN) and through the consultation processes that led up to and will follow-up the World Summit on Sustainable Development.

Further innovative ways will be sought to obtain maximum delivery. The current collaboration between UNEP and the CGIAR ICWG-CC is an example of such an initiative including joint workshops with governments and scientists as well as development of a pilot project. The collaboration offers synergies and mutual benefits for both the CGIAR Centers and their partners and UNEP.

Examples in the UNEP/CGIAR collaboration that are being explored during the pilot phase are:

- Agro-forestry to bring smallholder farmers into the CDM.
- The impact of alternatives to slash and burn agriculture on climate change and poverty alleviation.
- A pilot study in the potential effect of climate change on crop yields in South-Eastern Africa (see section on Impacts above).
- New methods for assessment of land degradation.
- Development of a CDM project in Western Kenya on carbon sequestration.

Appropriate policy messages and data sources, which will be used to:

- Link mainstream agricultural science into environmental policy processes.
- Provide information service to governments.
- Include feedback of political priorities into the scientific agenda.

In addition, the process of developing partnerships for this Challenge Program began through a series of presentations and dialog with the scientific and policy communities. It will continue during Phase 3 through the consultation process that will inform and drive the development of the full proposal.

The envisaged research partnerships with institutions worldwide will bring development budgets together with science budgets, which are often funded at national level. The CGIAR Centers and their NARS partners have existing networks of well categorized research benchmark areas that extend across the globe. Those partnerships will be vital in evolving potential interventions to mitigate the effects of global climate change, and adapt them to local conditions.

Key stakeholders in the development of this proposal have been the IPCC, with several IPCC delegates attending the Nairobi workshop and the continued support and guidance of the past IPCC chair in the development of this proposal.

Collaborative Arrangements among Centers and with NARS, NGOs, ARIs, Farmers, the Private Sector and Development Institutions

The Challenge Program on Climate Change proposal has been developed with no dominance by a single institution. It reflects the active participation of the 15 CGIAR Centres working in close collaboration with the broader international global change research community, notably GECAFS (building on a Memorandum of Understanding between the ICWG-CC and GECAFS) and GCTE. GCTE Focus 3 provides an international framework for planning, conducting and synthesising the impacts of global change on agro-ecology and production systems.

In addition to these worldwide research networks, several individual research groups have also indicated their commitment to help develop the full Challenge Program proposal and to collaborate in its research agenda: EMBRAPA (Brazil), the 18 national partners of the Alternatives to Slash and Burn program, the University of Florida and Wageningen University and Research Centre and USGS. Additional partners, as appropriate, will be identified and cultivated during the full development of the CP-CC Proposal. Box 1 gives an example of how the RWC, GECAFS, GCTE and the ICWG-CC can come together to develop and implement a specific project addressing specific farmer and policy needs. A fuller list of potential partners from the research and development communities is given in Appendix A.

Coordination to Produce Synergies and Cost-Effectiveness

A governance structure for the program was agreed upon and approved at the Nairobi stakeholders' workshop (Figure 7). It draws inspiration and elements from the innovative model used by Australian Cooperative Research Centers (CRC's). The governance processes will ensure efficiency, financial integrity and accountability to partners and investors, and world-class, innovative research in climate change as it affects people at risk (Table 1).

Under the oversight of the Board, the Program Director will convene the Program Development/Steering Committee (PD/SC), which will consult with stakeholders to develop the research agenda and the business plan. A Program Advisory Committee will be appointed of eminent scientists and development practitioners to advise the Board and the Program Director on the quality, relevance and implementation of the science. An Interim Steering Committee was created and endorsed at the stakeholders' workshop to develop the Pre-Proposal and includes membership from NARS, ARIs and ICWG-CC members.

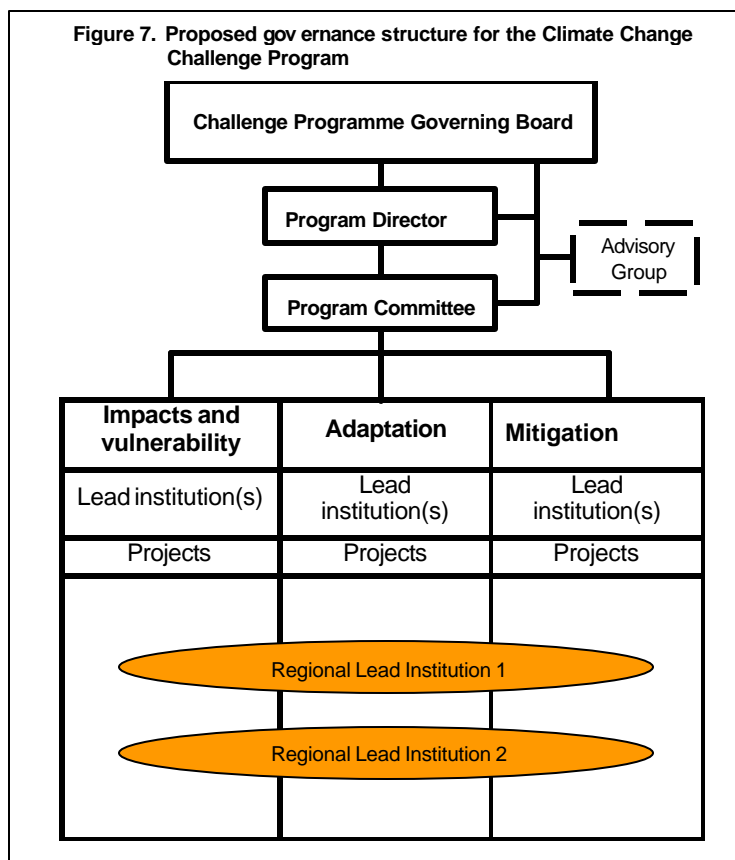


Table 1. Proposed roles for the components of the governing structure.

Governance component	Role	Qualifications	Activities
Board	High-level representation	Donors, Policymakers, Private sector, Other stakeholders	Strategic direction, Fund-raising
Director	Coordinator	Manager and Scientist with CGIAR experience	Leadership and Administration
Program Development/ Steering Committee	Guide scientific direction and ensure quality	Representation from CGIAR Centers, NARS, and ARIs, Wide disciplinary selection is vital	Scientific guidance And assessment

Potential to Enhance the Capacity of NARS partners

NARS (with some notable exceptions like Indonesia and Kenya) have been largely uninvolved in the links between food security and climate change. Expanding our existing partnerships with NARS, universities in the South and NGOs on this issue will broaden their research and training agenda. New national institutions, in addition to those dealing with research in agriculture, forestry and fisheries will need to be involved, particularly those dealing with environment, natural resources and policy.

Policy makers and civil society in the developing countries generally have a limited understanding of where and how climate change will affect agriculture and forest production systems. They are not fully aware of the huge opportunities for mitigation and the potential benefits of adaptation strategies. Government representatives of developing countries to the UNFCCC and its subsidiary bodies have expressed the need for knowledge and expertise in the links between food security and climate change, several of them expressing their wishes to become “climate change-literate”. CGIAR centres are uniquely equipped to facilitate such training in partnership with the World Bank Institute and others.

4. Magnitude and Evidence of Financial and Resource Support

The CP-CC requires significant levels of up-front funding to achieve its objectives. Total funding requirements are anticipated to be US \$5 million during the first year, expanding to US \$16 million per year by the fifth year of implementation. One-quarter of this amount is envisaged to come from funds allocated by the World Bank and other CGIAR donors. Three-quarters of the funding is envisaged to come from new non-traditional sources. New sources include the pool of global research funds earmarked for climate change research through the Global Environment Facility (GEF), the BioCarbon Fund, and the Climate Change Convention. These include investments by developed countries, often managed through their ministries of environment, and science and technology. A significant amount in this category is also expected to come from corporate sources.

We expect that a considerable amount of new funds will be generated through restricted grant proposals that are submitted by the program, or by partner consortia whose work will be linked with and included in the program. In addition, many participating institutions or consortia will increase their ability to source funds through independent efforts that are allied with the CP-CC. This applies particularly to investment sources at the national level in developed and developing countries that are only accessible to institutions based within their own country. The Program Steering Committee will process, endorse and submit proposals that meet its criteria on behalf of the respective consortia. There are large potential returns envisaged to the unrestricted investment in the program as it leverages much greater investment through these non-traditional sources.

The CP's financial resources will be allocated for three types of activities:

- Core activities to coordinate and manage the program, and to cover the staff and facilities dedicated specifically to the program.
- Research contracted from participating institutional consortia that include CGIAR Centers, ARIs, and NARS.
- Competitive grants to participating consortia.

It is estimated that 10% of the funds would be allocated to the core activities, 40% to contracted research, and remaining half allocated through competitive grants to research consortia.

Evidence of Donor Interest and Commitment

There is clear evidence that donors are willing to commit significant up-front funding. The U.S. Agency for International Development (USAID) has funded the activities of the ICWG-CC since its inception and has promised funds to help cover current activities. The Canadian International Development Research Council (IDRC) committed support for the Consultation Workshop in April. The ICWG-CC has submitted a PDF-B proposal to the GEF. The ICWG-CC Chair and Lead Scientist, supported by former IPCC Chair and World Bank Chief Scientist Dr R.T. Watson, were invited to make presentations to the Scientific and Technical Advisory Panel of the GEF. Although the granting of a PDF-B grant does not imply automatic approval of a full proposal, it augurs well for proposal approval. The United Nations Environment Programme has been actively collaborating with the ICWG-CC in developing a new proposal to support work to link science and policy in the adaptation of agricultural systems to climate change.

Prospects/potential for Attracting New Funds

Currently, there is a substantial investment already in research related to climate change by developed countries. These funds are allocated from sources that often have not traditionally been accessible to the CGIAR Centres and their developing country partners. The CP-CC and colleagues from the IPCC and GECAFS are confident that a CGIAR CP-CC would open up major new avenues of financial support.

An indication of the magnitude of new funding that is emerging was contained in the statement by a group of UNFCCC Annex I Parties following the conclusion of sixth Conference of the Parties (COP-6) in Bonn (July 2001). It included a commitment of a funding window of US\$435 million annually by 2005. This pool of funds is

expected to support work on all three of the programs key components: Impacts and Vulnerability, Adaptation, and Mitigation.

There also are definite prospects of uniquely promising avenues for support for each of the program components. Work on impacts and vulnerability is particularly suited to funding through global and national sources as the Centers link their efforts with strong international scientific projects and groups that are engaged in global change research. These include the GECAFS and other advanced national and international groups based in the developed countries.

New support for adaptation research is likely to be forthcoming from donors that are concerned with the linkage between climate change and livelihood security in the developing world. Many donors are becoming sensitive to the global warming effects that the North is causing by its fossil fuel consumption, and that they will have greatest adverse effects upon the poor of the South. One indication of this change is that the GEF is shifting from an initial emphasis on mitigation to give strong attention to adaptation issues.

The mitigation research component will attract new funding from large new investment sources that are being developed to try to enhance smallholder participation in carbon projects. The BioCarbon Fund, and the Community Carbon Fund, are two efforts being launched in 2002 by the World Bank. The Bank is seeking to subscribe \$200 million for trial investments in this area. The head of the new BioCarbon Fund participated in our global workshop and has been collaborating in the development of this proposal. CGIAR scientist-members of the ICWG-CC have been appointed as members of the advisory committee of the World Bank's BioCarbon Fund. The Fund is already drawing upon the ICWG-CC for scientific support in developing and implementing the Funds. Many other entities are now initiating carbon projects that will need solid science to underpin successful implementation. Other promising funding sources possibilities are the ODA investment windows for the environment of many donor countries. These include the national government environmental agencies in the US and EU, which have not traditionally funded CGIAR activities.

The ICWG-CC was launched in 1998, prior to the concept of Challenge Programs. The members have been vigorously developing and implementing joint projects on climate change issues since that time. The expertise necessary to address climate change issues is now widely distributed among them.

Conclusion

The CGIAR can only effectively meet its overall goals in the 21st century by developing and leading a coordinated global program of collaborative research to address the problem of climate change on the rural poor in the developing world. The spirit of the Challenge Program concept will be fully realized by elevating the vision of the CGIAR System to provide leadership in addressing this environmental threat.

The Future Harvest Centers, in partnership with the global scientific community on climate change, are fully prepared to take on this mantle of global leadership. We have the support and the encouragement to do so. The challenge program will provide the framework and resources to fulfill that expectation.

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Abbreviations and Acronyms

AMCEN	African Ministerial Conference on the Environment
ARI	Advanced Research Institute
CDM	Clean Development Mechanism (of the Kyoto Protocol of the UNFCCC)
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIFOR	Center for International Forestry Research
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
COP	Conference of the Parties (of the UNFCCC)
CP	Challenge Program (of the CGIAR)
CP-CC	Challenge Program on Climate Change
CRC	Cooperative Research Centers (Australia)
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria (Brazil)
FAO	Food and Agriculture Organization (of the United Nations)
GASSIA	Geospatial Applications to Support Sustainable International Agriculture
GCM	Global Circulation Model
GCTE	Global Change and Terrestrial Ecosystems (a Core Project of the IGBP)
GECAFS	Global Environmental Change and Food Systems
GEF	Global Environment Facility
GHG	Greenhouse gas
GxExM	Genotype x Environment x Management
ICARDA	International Center for Agricultural Research in the Dry Areas
ICASA	International Consortium for Agricultural Systems Applications
ICLARM	International Center for Living Aquatic Resources Management
ICRAF	International Centre for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICWG-CC	Inter-Center Working Group on Climate Change
IFPRI	International Food Policy Research Institute
IGBP	International Geosphere-Biosphere Programme
IGP	Indo-Gangetic Plain
IHDP	International Human Dimension Programme
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
INRM	Integrated Natural Resource Management
IPCC	Intergovernmental Panel on Climate Change
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated pest management
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
LULUCF	Land-use, land use change, and forestry
NARS	National Agricultural Research System
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration (USA)
PD/SC	Program Development/Steering Committee
PDF-B	Project Development Facility, Block B (of the GEF)
RWC	Rice-Wheat Consortium
TAR	Third Assessment Report (of the IPCC)
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	U.S. Agency for International Development
WARDA	West Africa Rice Development Association
WCRP	World Climate Research Programme
WMO	World Meteorological Organization (of the United Nations)

Appendix

Potential partners in the Challenge Program on Climate Change (30 August 2002)

1. Proponents

World Bank, ESSD and Biocarbon Fund
United Nations Environment Programme

2. Other 'advanced research institutions' and international organizations and consortia

Centre de Cooperation Internationale en Recherche Agronomique pour le Développement (CIRAD) France
Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia
USGS EROS Data Center, USA
Earth Institute, Columbia University, USA
International Research Institute (IRI), Columbia University, USA
International Institute for Sustainable Development (IISD), Canada
Centre for Ecology and Hydrology, UK
Tropical Soil Biology and Fertility Programme Institute (TSBFI), Kenya
University of California, Center for Sustainable Resource Development, Berkeley, USA
University of California, Department of Land, Air, and Water Resources, Davis, USA
University of Reading, Department of Agriculture, UK
World Conservation Union (IUCN), Kenya
International Centre for Insect Physiology and Ecology (ICIPE), Kenya
Wageningen University, Business Unit Agrosystems Research, The Netherlands
Hamburg Institute for International Economics, Germany
International Fertiliser Development Corporation (IFDC)
Forschungszentrum Karlsruhe, IMK-IFU, Germany
Cranfield University, Silsoe, UK.

3. National agricultural research systems (NARS)

EMBRAPA/Agrobiology, Brasil
EMBRAPA/East Amazon, Brasil
CORPOICA, Colombia
Kenya Forestry Research Institute
Kenya Agricultural Research Institute (KARI)
National Agriculture Research Organisation (NARO), Uganda
Division of Environmental Sciences, Indian Agricultural Research Institute, India

4. Local and National NGOs

Consortio de Desarrollo de Ucayali (CODESU), Perú
Recursos Nacionales Tropicales S.A., Costa Rica
CARE Kenya – TASK Project

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5. Other National Agencies and Universities in Developing Countries

University of Zimbabwe, Department of Soil Science & Agricultural Engineering
The Office of the Vice-Presidency, Colombia
Ramganhhaeng University, Department of Biology
Forest Research Institute Malaysia (FRIM), Malaysia
The State Ministry of Environment of Indonesia
National Environmental Secretariat, Kenya
Parliament of Uganda
Ministry of Agriculture and Rural Development, Forest Science Institute of Vietnam

6. International Consortia

Alternatives to Slash-and-Burn Systemwide Programme (ASB) hosted by ICRAF

Amazon Initiative led by Embrapa and CIAT

Association for Strengthening Agricultural Research in Eastern and Central Africa (ASERECA), Uganda
Global Environmental Change and Food Systems (GECAFS)
Global Change and Terrestrial Ecosystem (GCTE)
Consortium for Agricultural Soils Mitigation of Greenhouse Gases (CASMGs)
International Consortium for Agricultural Systems Applications (ICASA)

7 Future Harvest Centers

Centro Internacional de Agricultura Tropical (CIAT)

Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)
Centro Internacional de la Papa (CIP)
Center for International Forestry Research (CIFOR)

International Centre for Agricultural Research in Dry Areas (ICARDA)
International Centre for Living Aquatic Resources Management (ICLARM)
International Centre for Research in Agroforestry (ICRAF)
International Crops Institute for the Semi-Arid Tropics (ICRISAT)
International Food Policy Research Institute (IFPRI)
International Institute of Tropical Agriculture (IITA)
International Livestock Research Institute (ILRI)
International Plant Genetic Resources Institute (IPGRI)

International Rice Research Institute (IRRI)
International Water Management Institute (IWMI)
West Africa Rice Development Association (WARDA)

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**Consultative Group on International Agricultural Research
Inter Center Working Group on Climate Change**

Challenge Program Proposal

The Challenge of Climate Change

**Research to Overcome its Impact on Food Security,
Poverty,
and Natural Resource Degradation
in the Developing World**

Plan for Full Proposal Development, with Request for Support

1. THE PLAN

The development of the full proposal will build on the outcomes of a series of meetings of the Inter-Center Working Group on Climate Change and the global workshop convened in Nairobi in April, 2002, in which both the content and structure of the Challenge Program were established. The consortium will plan collaborative research projects of global significance to both assess and ameliorate the interactions between climate change and agriculture, forestry and aquatic production systems in the developing world to:

- Identify most vulnerable countries, regions, systems and sections of society to the adverse effects of climate change
- Determine adaptation strategies to cope with climate change
- Develop mitigation strategies to limit further climate forcing
- Communicate research results to key stakeholders in the scientific and policy communities

The steps to be followed in the proposal design and implementation will be:

- Identify knowledge gaps from the point of view of all stakeholders (who needs to know what)
- Identify which researchers and research institutions are best able to carry out the research to resolve them (who can do it)
- Develop a ranked science agenda to address stakeholder needs
- Develop a strategic plan for two-way communication with the policy making community in the south
- Develop a business plan including a list of potential investors and funding programs to implement the agenda within a viable and credible system of governance.

The first priority is to make sure that the research agenda is relevant to and reflects the current, and what are likely to be future, concerns of stakeholders—poor people in developing countries that will be affected by climate change. The second requirement is to identify how this agenda can be executed to have impact using scientific rigor and creativity. The third step is to develop a business plan to implement the research agenda including a defined system of governance.

2. ACTIVITIES

Activity 1. Appoint an Expert Advisory Panel (EAP) of eminent scientists and administrators from developing and developed countries, chosen from amongst the global change community, stakeholders and agricultural, forestry and aquatic science communities.

The EAP will be appointed by the ICWG-CC with the advice of the interim Steering Committee appointed at the Nairobi workshop. The task of the EAP will be to: (1) oversee activities of the Proposal Development Committee (PDC) and (2) review the science agenda and business plan on behalf of the ICWG-CC. The EAP will be made up of five scientific experts in the field of climate change and its effects on agricultural and other managed production systems from key developing and developed country partners. The EAP will

provide advice to the ICWG-CC as to the identity of the categories of institutions that should be included in the stakeholders' (defined as users, researchers and research institutions and policymakers and investors) meetings, such as Regional Fora, NARS institutions, NGOs, and ARIs. The EAP will also recommend the criteria that should be used to set priorities amongst the proposed themes that comprise the science agenda. The EAP will also recommend a suitable framework by which peer review of the components of the modular structure would be carried out and also a mechanism by which some form of competitive grants could be undertaken.

Activity 2. Implement a stakeholder process with the international policy community, through collaboration with UNEP to solicit input of the policy community in the south.

This process will be facilitated primarily through the regional ministerial processes that UNEP currently organizes. Recent initiatives to strengthen linkages between UNEP and the CGIAR have led to new opportunities strengthen science–policy linkages. UNEP and the CGIAR will bring scientists, policy makers and other stakeholders together to implement this process. The process will begin by taking advantage of contacts made at the World Summit on Sustainable Development (WSSD), at the South Asia expert workshop that the ICWG-CC jointly sponsored during the lead up to COP-8 of the UNFCCC, and subsequent meetings of the Subsidiary Body for Scientific and Technical Advice of the UNFCCC.

Activity 3. Convene the Proposal Development Committee (PDC) to consult with stakeholders and develop the research agenda.

The ICWG-CC will appoint a PDC of 18 scientists and scientific administrators, comprising nine CGIAR representatives, and nine non-CGIAR representatives taken from nominees chosen by the EAP from the global change science, agriculture, forestry and aquatic science communities. The task of the PDC will be to convene regional stakeholders' workshops in Asia, Africa and Latin America of users, researchers and research institutions, policymakers, investors and CGIAR scientists to refine the science agenda. These workshops will seek to refine the overarching framework agreed in Nairobi. The concern will be to draw out the perceptions of developing country partners. Under the guidance of the EAP, the PDC will invite ARI partners in developing and developed countries to collaborate in further elaborating the themes already identified and ranked by stakeholders at the April, 2002 meeting. The EAP will review the proposed research themes elaborated by the PDC for scientific excellence and help to identify key potential partners from the wider scientific research community.

Activity 4. Develop a business plan

The PDC will consult with stakeholders, researchers and research institutions, policymakers and investors and set the science agenda and its priorities. The resulting partnerships would be incorporated in the business plan, together with budgets, work plans, milestones, projected outputs and uptake pathways. The process will be external to the CGIAR Centers and manifestly transparent.

Activity 5. Prepare a full program proposal document for the challenge program

Under the oversight of the EAP, the PDC will complete the formulation of the science agenda and the business plan. The PDC, in consultation with the EAP, will prepare the full proposal document. The document will be circulated to all participants above to ensure that it is in conformity with their recommendations and in line with the Science Council criteria and requirements. The EAP will review the document prior to submission to the Science Council to ensure that the science is world class and that the business plan is soundly based.

Activity 6. Prepare project documents for other investors and funding programmes

The ICW-CC in consultation with the PDC will tailor the full proposal for other potential investors, and submit funding proposals to them.

3. OUTPUTS

The primary output of the next stage of the proposed Challenge Program is a full challenge program proposal that will describe:

- A detailed proposal and funding strategy including a global Science Plan for the Challenge Program formulated jointly with NARS and ARIs
- The process for independently selecting, awarding and peer-reviewing the research themes and researchers and ensuring integrity of the selection process
- A business plan that will detail how governance of the Challenge Program will be implemented including non-CGIAR input, the specific management structure, the transparent allocation of funds and ensure accountability
- Modalities and strategies for the Challenge Program's implementation, including rigorous external peer review
- Prioritized research themes within a modular structure addressing the three IPCC topics of *impact, adaptation* and *mitigation*;
- The contribution of the proposed research themes and researchers to the global Science Agenda of the Challenge Program
- A clear research strategy to involve a range of appropriate Centers and other research institutions
- A clear strategy to link the scientific outputs with policy makers' consultative fora.

4. DRAFT WORKPLAN AND TIMETABLE

Activities	2002/3											
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
1. Appoint EAP												
2. Conduct seminars and consult regional and global policymakers												
3. Convene PDC												
4. Develop business plan												
5. Prepare full project document for the CGIAR CP												
6. Prepare project documents for other donors												

5. AMOUNT REQUESTED FROM THE CGIAR

US \$200,000

6. ITEMS TO BE FINANCED BY THE CHALLENGE PROGRAM PHASE 3

Table 1 outlines the support requested from the CGIAR and promised by other donors, and the allocation of resources to the activities outlined above, followed by a general statement of how the resources will be used.

Table 1. Framework Budget by Activity

Activities	CGIAR	CO-FINANCING
		USAID
1. Appoint an Expert Advisory Panel (EAP)	\$15,000	\$25,000
2. Conduct seminars and consult regional and partners	\$85,000	
3. Convene PDC	\$25,000	\$25,000
4. Develop business plan	\$50,000	\$50,000
5. Prepare project document for Phase 3.	\$25,000	
6. Prepare project documents for other investors		\$50,000
TOTAL COSTS	\$200,000	\$150,000

The budget for the entire set of activities is US \$350,000. This proposal for funding is to support this package of activities (Activities 1-5) during the period of November, 2002 to October 2003 during which time the specific activities leading to the development of a Challenge Program proposal for the CGIAR together with Activity 6, proposals to the GEF, the World Bank and other donors will take place. Funding for project development activities has been indicated by USAID and IDRC.

7. LIST OF ACRONYMS

ARI	Advanced Research Institute
CFP	Call for proposals
CGIAR	Consultative Group on International Agricultural Research
EAP	Expert Advisory Panel
EMBRAPA	Empresa Brasileira de Pesquisa Agricultura
GECAFS	Global Environmental Change and Food Security
GEF	Global Environment Facility
ICWG-CC	Inter Center Working Group on Climate Change
IDRC	International Development Research Centre
IGBP	International Geosphere-Biosphere Programme
IHDP	International Human Dimensions Programme
NGO	Non Governmental Organization
NSF	National Science Foundation
PDC	Proposal Development Committee
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WCRP	World Climate Research Programme