Progress in implementing CCAFS at AfricaRice

Governance

The CCAFS research Program consists of four themes:

1. Theme 1, Adaptation to Progressive Climate Change
2. Theme 2, Adaptation Pathways for Current Climate Risk
3. Theme 3, Pro-Poor Climate Change Mitigation
4. Theme 4, Integration for Decision Making

AfricaRice participates in three out of four themes: 1, 2 and 4, fore mostly through four bilateral projects: RISOCAS, ESCAPE, MICCORDEA and PARASITE.

The RISOCAS project finished formally in February 2011. A follow-up activity is currently being undertaken with CCAFS contribution, which is updating the RIDEV model. The aim of this activity is to have an updated model that serves to optimize the planting window for rice under a changing climate. The updated RIDEV will play a crucial role in developing Target Populations of Environments (TPE) to guide breeders (Theme 1.2) as well as a role in the ESCAPE project, where it will be used in climate insurance tools that will be developed in this project (Theme 2.3). Since ESCAPE focuses on irrigated rice only, complementary funds from CCAFS will be used to include climate-insurance modules for rainfed rice systems. The same holds for the MICCORDEA and the PARASITE project, where complementary funds from CCAFS will be used to include other pests and diseases into the model.

Bilateral Projects

The RISOCAS project (Developing rice and sorghum crop adaptation strategies for climate change in vulnerable environments in Africa) is funded through GIZ/BMZ. It is executed in collaboration with the University of Hohenheim (Germany) as lead institute, CIRAD (France), IER (Mali) and FOFIFA (Madagascar). The project focuses on development of crop adaptation strategies for irrigated rice, rainfed sorghum, and rainfed upland rice to cope with climate change. A broad range of varietal types of rice and sorghum will be cultivated along longitudinal and altitudinal gradients in West Africa and Madagascar. Relevant meteorological data, soil characteristics and water balances, and parameters of growth and yield will be monitored. These data will be used to identify valuable traits for varietal improvement and to adapt, calibrate and field-validate crop models for predictive applications in the context of climate change scenarios.

The ESCAPE project (Environmental and Social Changes in Africa, Past, present and future) is funded through the French donor ANR. The project is part of a bigger project led by IRD. The AfricaRice subproject is executed in collaboration with CIRAD (France), ISRA and SAED (Senegal) and IER and ON (Mali). ESCAPE aims to assess the vulnerability of rural societies in sub-Saharan Africa to climate and environmental changes and to explore adaptation pathways to reduce this vulnerability. This will be

achieved by fostering inter-disciplinary research, through both retrospective and prospective studies, on the evolution of different agricultural, ecological, and social systems interacting together under the global environmental changes.

The MICCORDEA project (Mitigating the Impact of Climate Change On Rice Disease resistance in East Africa) is funded through GIZ/BMZ. The project is led by AfricaRice and executed in collaboration with George August University of Gottingen, IRRI, MARTI (Tanzania), RAB (Rwanda) and NARO (Uganda). The expression of plant resistance to blast and BLB is known to be climate-dependent. According to the IPCC East Africa is among the more vulnerable regions in Africa to climate change. The trend is towards increasing temperature and declining rainfall, factors that may intensify disease occurrence and severity. Disease occurrence may deter farmers from investing in intensification measures because of risks related to yield loss. The development of rice varieties that resist these diseases under current and future climates is, therefore, of great importance. This will require the evaluation of current pathogen population structures and the likely impact of climate change on the evolution of host-pathogen relationships.

The PARASITE project (Preparing African Rice Farmers Against Parasitic Weeds in a Changing Environment) is funded through the Dutch science foundation (WOTRO). The project is led by Wageningen University and executed in a collaborative effort with AfricaRice, CNRA (Cote d'Ivoire), INRAB (Benin) and MARI (Tanzania). The aim of the project is to prepare the rice sector in threatened areas of Sub-Saharan Africa against projected increases in infestation levels of parasitic weeds (*Striga* spp. and *Rhamphicarpa fistulosa*). Vulnerable locations will be investigated, with emphasis on the effects of climate variability and extremes on parasitic-weed survival, reproduction and virulence, direct and indirect economic impacts, and sustainable management strategies for resource-poor farmers. In addition, national crop protection systems will be investigated in how they function and innovate, taking parasitic weeds in rice-based cropping systems as a case study. Such analyses are aimed to develop policy guidelines geared to improve overall preparedness for new or increasing biotic constraints, as well as communication between different stakeholders in the sector.

Research Activities in 2011

Theme 1.2 Breeding strategies for future climatic conditions: Updating RIDEV

The RIDEV model is a simple simulator of rice phenology and thermal sterility risk that takes into account microclimate (shoot apex T that depends on the meristem position, either in the floodwater or above it after booting or under upland conditions). The panicle may yet have another T because of its exposure above the canopy and its own transpiration rate. This tool, in its original version of the 90s, became a very practical tool for (1) on-farm decision support, (2) regional risk scenario mapping and (3) study of genotypic differences. It is foreseen to replace the old (DOS/GW-Basic) version with a new one that has improved algorithms applicable to a broader range of environments (arid to humid, cold to hot), and disposes of an efficient parameter optimization tool. Within the rice manager, it will provide the temporal matrix for timing of whatever cultural recommendations are simulated (plus the sterility

risk information). Other applications concern phenotyping because we want a version with automatic parameter optimization that can be applied to hundreds of genotypic field datasets.

The present RIDEV mini project concerns the development of crucial logarithms of water, canopy and panicle temperature for this new version of RIDEV. The calibration and validation of the model will use multi-site data various sources. The validated model will be then built into the upcoming Rice Nutrient Manager software. The project purpose will be achieved using data from The Philippines (dry season 2009 form IRRI, Senegal cold season and hot season 2010 from AfricaRice, France temperate summer 2009 from CIRAD and data for validation step (provided by AfricaRice and CIRAD/FOFIFA in Madagascar).

A statistical model of daily minimum and maximum water temperature was built using data from four different sites and seasons. The database on phenology, indicators of canopy architecture, met and micro-met data as well as the panicle temperature data for the four sites and seasons has been built. The multiple correlation analysis and the extraction of the best explicative models for canopy and panicle temperature is being processed. The time of day of anthesis (TOA) is an important variable to take into account in the temperature induced sterility studies. A predictive statistical model of the TOA has been built using the field observations and weather data from the four sites and seasons. The most important weather parameters to predict the TOA are the air minimum air temperature (average of the seven previous days) and the average VPD (average of the seven previous days).

The new RIDEV code has been developed and is awaiting incorporation of the newly developed equations to predict water, canopy and panicle T. The automatic parameter optimization routine is has been established and is undergoing tests.

Theme 1.3 Species and genetic diversity for climate change:

The goal of the PARASITE project is to contribute to understanding host-parasite interactions for parasitic weed species and rain-fed rice as affected by present and future environmental conditions. Three PhD students have been selected and finished their course work. Socio-economic, ecological and agronomical baseline studies have started. The baseline date will increase our understanding of climate effect on the rice-parasite interaction. CCAFS funding is used to complement the climate change research component of the project.

Theme 2.3 Prediction of climate impacts, and enhanced climate services

A Postdoctoral Fellow has been employed for the ESCAPE project on 1 December 2011. He has started data mining of regional literature focusing on weather data and crop yields. The database will act as a reference system for meteorological effect on crop and crop yields. The anticipated purchase of meteorological equipment has been postponed due to late arrival of the funds.

Before the arrival of the PDF an inventory was made by an MSc student on available literature and data of bird damage on rice. The rationale to conduct this study is to have a database that can be used to separate the effect of bird damage from meteorological damage and to analyze if adverse

meteorological conditions can aggravate bird damage. On other word, if drought increases the chance of attack by birds.

Theme 4.2 Data and tools for analysis and planning

The main activity for this theme will be mapping the actual and potential rice areas in Africa and modeling the effect of climate change on future production. The activity is undertaken in collaboration with IRRI. A side activity is the collaboration with Global Yield Gap Atlas project (GYGA). Two AfricaRice scientists attended the GYGA Kick-off workshop in Wageningen. The GYGA will provide the first easily accessible, transparent, reproducible, and agronomically accurate web-based platform to estimate exploitable gaps in yield and water productivity for the world's major food crops including rice, enabling governments, policy makers, agricultural research and extension institutions, funders of agricultural research, foundations, private sector organizations and others to identify regions with the greatest potential to sustainably increase global food supply with improved management practices. ICRISAT, AfricaRice, and IRRI are expected to provide information, although AfricaRice has no budget from GYGA, except for travelling cost for workshops and training course. Data should come from AfricaRice survey data as well as on-farm trials.

Finances

AfricaRice received US$ 640,000 for CCAFS activities from CIAT. Due to late arrival of the funds only US$347,816 has been used leaving a balance of US$437,164. For 2012, a budget of US$400,000 will be used, while a provision will be made for the remaining US$224,229 to be spent in the second half of 2012.

CCAFS Workshops

- CCAFS CG Contact Point Meeting & Science Workshop was attended at Bonn, from 9-11 June 2011 at Bonn, Germany. The meeting was extremely useful to clarify the how bilateral projects on climate change could fit within CCAFS and how to report on it.

2011 Events related to CCAFS

- Global Science Conference of Climate Smart Agriculture was attended from 24-26 October 2011 at Ede, the Netherlands. The AfricaRice CCAFS contact point was invited as follow up to his attendance to the Science Forum in June 2009. The conference brought the core of CSA together and serviced as a board to ventilate the Wageningen Declaration to put agriculture firmly on the climate change agenda during the COP17 to be held in Durban in December

CGIAR Research Program:
Climate Change, Agriculture and Food Security
2011 Technical Report
January-December 2011

Contract code: CRP7 130.11
Grant code: CI-C70xx1

Bioversity International
Via dei Tre Denari 472/a, 00057 Rome, Italy

Cover photograph: Farmer's children in the fields of Ejere Ethiopia. Taken during a field visit for the Seeds for Needs Project. This project focuses on women farmers in Ethiopia, and their ability to adapt their subsistence farms to climate change, which will have an immense impact on the health and well-being of children in those communities. Credit: Tsega Wolday, Bioversity

Table of Contents

1.3 Activity Summary

Objective 1.3 – Species and genetic diversity for climate change adaptation

Output 1.3.1 – New knowledge, guidelines and access to germplasm are provided for using genetic and species diversity to enhance adaptation, productivity and resilience to changing climate

Projects implemented in multiple countries, on a number of crops, developed approaches for selecting and distributing germplasm that meets farmers' needs and is likely to be adapted to future climates. In Ethiopia and Papua New Guinea (PNG) innovative climate modeling and geographic information system (GIS) tools were used to select, from genebank collections and farmers, germplasm of durum wheat and barley, taro and sweet potato. Multi-location trials took place in Ethiopia for 100 varieties each of barley and durum wheat selected from 12,500 screened. Crop suitability maps were also developed. One project evaluated 200 samples of buckwheat and oat in ten different regions of China. In Bolivia and Malaysia, complementary research consisted in farmers screening and selecting germplasm of potato and rice (respectively), subsequently distributed for planting and evaluation.

Additional studies carried out in Ethiopia, PNG, Malaysia and Bolivia focused on analyzing seed flows for various crops to understand better how traditional seed systems could be enhanced to facilitate distribution of seeds. Cultural factors influenced the way different kinds of seeds were shared in different locations.

Initiatives for adapting banana cultivation to climate change started with a workshop to define parameters for modeling the impacts of climate change, and focused on a range of pests and diseases and three cultivar groups to develop models of how pests and diseases are likely to affect banana cultivation under climate change. Finally, an international group received training on methods, approaches and tools to evaluate how biodiversity-rich practices, notably the integration of neglected and underutilized crops in agricultural systems, facilitate adaptation to climate change.

Output 1.3.2 – New information, knowledge, guidelines and germplasm are made available to farmers, breeders, local communities and scientists and promoted through knowledge sharing, peer-reviewed articles, information systems and media

A workshop among experts prioritized Indonesia as an area for collecting endangered banana genotypes. Information was integrated into databases to permit gap analysis on *Musa* species held in collections. Field evaluations of local cultivars revealed that some varieties are more resistant than others to high winds.

Socioeconomic surveys in Ethiopia and PNG probed farmers' knowledge of climate change and its impacts, as well as seed systems and barriers to accessing seed. In Malaysia and Bolivia, information was collected on local practices for seed selection and production management of rice and potatoes that could be used for climate change adaptation. An international training course was offered in Nepal to train trainers in tools for agrobiodiversity assessment and monitoring.

Geographic coordinates associated with genebank collections have been improved in databases, to facilitate selection of climate-adapted germplasm. In addition, the Climate change, Agriculture and Food Security (CCAFS) Agtrials site has been linked to the Generation Challenge Programme (GCP) Crop Ontology database so that trial data can be linked to germplasm in genebanks.

Output 1.3.3 – Policies to enable access to and use of genetic resources for climate change adaptation and diffusion of adapted germplasm

Activities under this output were articulated around three objectives: 1) understanding which policies impact on Plant Genetic Resources for Food and Agriculture (PGRFA) users' ability to access and use genetic resources for climate change adaptation; 2) supporting the adoption of policies and legal frameworks that facilitate the exchange of germplasm potentially useful for climate change adaptation, in particular the multilateral system (MLS) of access and benefit-sharing under the International Treaty on Plant Genetic Resources for Food and Agriculture; and 3) documenting and publishing experiences and lessons learnt from activities under 1 and 2, and from previous relevant Bioversity projects in the same area, ensuring that this information was made available to relevant international policy making bodies.

Under objective 1, research focused on gathering information about how germplasm flows between the Consultative Group for International Agricultural Research (CGIAR) Centres and their partners and then to end-users, and factors facilitating or hindering this process. Data on CGIAR Centres' transfers and acquisitions of plant germplasm were collected and analyzed, based on interviews of 64 scientists in seven CGIAR Centres, and conducting literature reviews about how policies and laws may affect access to and use of technologies and germplasm for climate change adaptation by different types of germplasm users (breeders and scientists in public and private organizations, seed industry and farmers). Preliminary results have been documented in a CCAFS research paper which will be submitted for publication in early February 2012.

Activities under Objective 2 took place as part of Bioversity's project: *Genetic Resources Policy Initiative 2: Implementing the International Treaty on Plant Genetic Resources for Food and Agriculture*. Participant countries were selected and full proposals from these countries received for their participation in the project. The creation of a "University Platform", in collaboration with three partner universities, aimed at providing research support to advance quality research on topics related to the implementation of the Treaty's MLS on access and benefit-sharing, and access to information and technologies related to germplasm use, including the use of the Climate Analogues tool to identify potentially adapted germplasm in each of the eight project countries.

Several publications, including a multi-authored peer reviewed book, and an article in a scientific journal, have been completed under Objective 3. Bioversity submitted reports and research papers to the FAO Commission on Genetic Resources for Food and Agriculture and the Governing Body of the International Treaty, and organized several side events during the bi-annual regular sessions of these international bodies. The written submissions and side events introduced the CCAFS programme and highlighted the importance of ensuring the flow of genetic material necessary for climate change adaptation.

Output 1.3.4 – *Identification and evaluation of the differential roles of women and men, and other social groups, in strategies for conservation and use of species and genetic diversity; and the impact of those strategies on those different groups, are integrated into knowledge sharing and other activities to achieve outcomes*

A number of projects have focused on women, notably "Seeds for Needs" projects in Ethiopia and PNG. Surveys have focused on women farmers' understanding of the impact of climate change and how they are coping with it. Women were empowered to participate in decision making regarding selection of varieties to be planted, and were also involved in evaluating varieties of barley and wheat for traits that they considered important. The seeds they preferred will be distributed to other women farmers to be evaluated in the next phase.

1.4 Activity Reporting

2011 Activity Plan for CCAFS Centre General Funds:
Activities, Deliverables & Partners

CG Centre:	**BIOVERSITY**

Table A. Main contacts persons in the Centre

Contacts	**Name**	**Email**
Climate Change Contact Point	Laura K Snook	l.snook@cgiar.org
Admin. Issues	Gerry O'Donoghue	g.odonoghue@cgiar.org
Support	Allison Poulos	a.poulos@cgiar.org
Communications	Jeremy Cherfas	j.cherfas@cgiar.org

Table B. Main bilateral funded projects under CCAFS 2011 (>US$250.000)

ID#	**Name of project**	**Total budget under CCAFS (2011)**	**Donor**	**Principal investigator**
1	Strengthening national capacities to implement the International Treaty of PGRFA: Genetic Resources Policy Initiative (GRPI) Phase II	$250,000	The Netherlands	Michael Halewood
2	Reinforcing resilience of poor rural communities against food insecurity, poverty and climate change through on-farm conservation of local agrobiodiversity	$325,000	International Funds for Agricultural Development (IFAD)	Stefano Padulosi
	Total	$575,000		

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
1.3 Species and genetic diversity for climate change adaptation					
Output 1.3.1 New knowledge, guidelines and access to germplasm are provided for using genetic and species diversity to enhance adaptation, productivity and resilience to changing climate;					
1.3.1.1	Identification of genetic material conserved in genebanks with potential adaptive traits for climate change adaptation for barley, wheat, sweet potato, taro and rice	List of accessions; crop suitability maps; Publication of methodology	Institute of Biodiversity Conservation (IBC), Ethiopia; National Agricultural Research Institute, PNG; Indian Council Agricultural Research, India; Semongok Agriculture Research Centre (ARC), Sarawak Malaysia; Foundation for the Promotion and Research of Andean Products (PROINPA), Bolivia	Carlo Fadda	Through Focus Group discussions and surveys in Malaysia and Bolivia we defined with the farmers requirements and climatic issues faced. We screened and selected for desirable traits rice seed and potato varieties held and stored by the farmers. Thereafter we screened material in the national genebank and identified varieties with adaptive traits, based on GIS and other data. These were distributed to the communities for planting and evaluation. Traits sought were: **Rice:** capacity to grow on all types of soil, to resist drought, pest, disease, lodging, shattering and flowers capable of withstanding rain; providing two harvests/season; **Potato:** varieties with good cooking qualities for market and producing acceptable yields even under pressure of pests and diseases.
	Crop suitability maps for 5 crops in East Africa, Indo Gangetic Plains, South America and South East Asia		IBC, Ethiopia; National Agricultural Research Institute, PNG; Indian Council Agricultural Research, India; Semongok Agriculture Research Centre (ARC), Sarawak Malaysia; PROINPA, Bolivia	Carlo Fadda	A crop suitability map has been prepared for barley and durum wheat in Ethiopia based on climatic conditions and the characterization information gathered from the Gene bank. The work is ongoing in Papua New Guinea, where the ideal climatic profile for taro and sweet potato has been identified and documented but need to be matched with climate change scenarios. In 2012 data will also be collected by Semongok Agriculture Research Centre (ARC), Sarawak Malaysia and PROINPA, Bolivia.
1.3.1.2	General strategic framework of	Proceedings of an international	International Union for Conservation of Nature	Stefano Padulosi	An international workshop addressing ”On farm conservation of neglected and underutilized species: status, trends and novel

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	participatory approaches and methods to assess where and when biodiveristy rich practices facilitate adaptation to climate change developed through international expert consultation	workshop held in Germany on 14-16 June 2011	(IUCN), Switzerland; PROINPA, Bolivia; Local Initiative for Biodiversity, Research and Development (LI-BIRD), Nepal; MS Swaminathan Research Foundation, India; German experts (incl. Prof. K. Hammer); FAO, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), Italy; University of Perugia, Italy; University of Suaceva, Romania; NGO Peliti, Greece; NGO ProSpecieRara, Switzerland; R. Zougmore- CCAFS, Niger; University Goettingen, Germany; GIZ, Germany; LUGV, Branderburg, Germany; FAO, Italy; OriGIn, Switzerland; Slow Food, Germany; International Institute of Tropical Agriculture (IITA), Nigeria		approaches to cope with climate change" took place in Frankfurt on 14-16 June, 2011. The workshop, attended by ca 30 participants from 10 countries, covered methods, approaches and tools regarding participatory monitoring of agrobiodiversity on farm, including a novel method for Red Listing of cultivated species. Proceedings of the workshop are in press.

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	(2011) 2. Tailoring general methodological framework for testing out in national contexts carried out through multi-stakeholder workshops held in Bolivia, India and Nepal	1) Proceedings of three national workshops held in Nepal, India and Bolivia on fine tuning of participatory approaches to national contexts. 2) novel approach method for red listing of cultivated species conceptualized and disseminated to IFAD Project partners for testing	PROINPA, Bolivia; Ministry of Agriculture, Bolivia,; Ministry of Environment, Bolivia; LI-BIRD, Nepal; Ministry of Agriculture, Nepal; MS Swaminathan Research Foundation, India; ICAR, India; The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), Italy; FAO, Italy; OriGIn, Switzerland)	Stefano Padulosi	1) National workshops organized as per following schedule: 1-2 September in Kathmandu, Nepal; 5-6 September in Chennai, India; 21-22 September in La Paz, Bolivia. Their proceedings are in press. 2) Novel approach for Red Listing developed and disseminated to project partners for testing (attach 1); 3) Discussion among experts on participatory monitoring carried out during Oct-Nov 2011 through the WB-supported email forum "Solution Exchange". Proceedings of discussion available (attach 2). 4) Poster on Red Listing for Cultivated Species for IUCN Congress in Sept 2012 in Korea approved.
1.3.1.4	Multi-location trials of over 300 local varieties of five priority crops carried out in at least 3 different climatic zones in East Africa and Indogangetic	First year evaluation report for Ethiopia and India	IBC, Ethiopia; Indian Council Agricultural Research, India; National Agricultural Research Institute, PNG	Carlo Fadda	A first set of multi-location trials took place in Ethiopia (for barley and durum wheat) and China (for buckwheat and oat) and are ongoing in PNG, where different varieties of taro and sweet potato have been multiplied to ensure sufficient planting material for the trials. Two hundred accessions of buckwheat and oat were evaluated in 10 locations in north, northwest and southwest China and data on major agronomic traits are being compiled and analyzed. The most suitable varieties for different locations will be identified for local farmers. In Ethiopia 100 accessions of barley and

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	Plains and in PNG, with participation of local farmers				100 accessions of durum wheat were selected among 12,500 varieties screened for multi-location trials and the best performing 25, according to women farmers, were selected for a second year of evaluation. In PNG 30 varieties of taro and 36 varieties of sweet potato were selected for bulking in order to ensure sufficient planting material for the trials for each of the varieties, to take place in 2012.
	Initiation of community-based participatory documentation/ monitoring of target species/NUS and their deployment to cope with climate change in project sites across India, Nepal and Bolivia	Initial mapping of the distribution of target NUS, their status of conservation and use in target areas along with data on genetic and cultural erosion	PROINPA, Bolivia; Ministry of Agriculture, Bolivia,; Ministry of Environment, Bolivia; LI-BIRD, Nepal; Ministry of Agriculture, Nepal; MS Swaminathan Research Foundation, India; ICAR, India; and possibly: International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), Italy; FAO, Italy	Stefano Padulosi	1) Standardized survey questionnaires were developed jointly with partners to include the role of gender in conserving genetic diversity and indigenous knowledge and its value within climate change copying strategies (attach 3). 2) Surveys for the development of initial maps on target crops will be applied starting in January-February 2012.
1.3.1.5.	Knowledge on distribution of local seed material (seed systems) gathered and its	Information on local seed systems compiled from surveys	IBC, Ethiopia; National Agricultural Research Institute, PNG; Indian Council Agricultural Research, India; Semongok Agriculture	Carlo Fadda	Seed flow amongst the farmers, the seed producers and the extension workers was defined and analyzed. **Rice:** In Malaysia, due to cultural taboos, seeds move through the system via family links and not sale over the counter; therefore, distribution of selected seed varieties from the communities, need to be managed carefully and creatively. Heirloom varieties that are

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	effectiveness in climate change adaptation strategies documented		Research Centre (ARC), Sarawak Malaysia; PROINPA, Bolivia		not exchanged and may contain important traits for improved breeding of local varieties are being investigated. **Potato:** In Bolivia local systems need to be strengthened by introducing high quality seed and re-establishing links between seed and potato producers. **Sweet potato:** In PNG planting materials are freely exchanged within but not outside of the local community. Relatives and spouses from other clans/communities/regions form an important seed sharing network from whom materials in short supply (germplasm for novel, old, lost cultivars) can be freely obtained, although payment for planting materials is growing as selling crops for profit becomes more common. **Taro:** Planting materials are freely shared even with non-relatives and those outside the village, with expectations of reciprocity. The local seed systems are dynamic and generally resilient to shocks with farmers accessing a wide range of varieties from different eco-regions and frequently try novel ones. **Barley and durum wheat:** In Ethiopia seed sourcing for both crops is multi-faceted and dynamic, despite some bottlenecks and potential access barriers for the more marginalized farmers, particularly for barley, due to the limited seed supply off-farm. It might therefore be difficult to access adapted seeds as climate change progresses. For wheat there is a dynamic informal seed system for landraces strongly rooted in the presence of community genebanks. More formal systems ensure distribution of modern varieties, although sometimes seeds are not available when they are most needed by farmers. Technical report elaborated. See 1.3.2.2 for further details regarding the surveys.

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
1.3.1.7.	Musa AAB x climate change modeled in Latin America using modified ECOCROP and climate change scenarios; maps of banana production areas in Asia and Africa based on participatory banana editor; options for modeling Musa pest and disease response to climate change reviewed; parameters synthesized for 3 pests and diseases for modeling effect of climate on incidence	The parameters for modeling effects of climate on major banana groups and important pests and diseases are identified	MUSALAC, BARNESA, BAPNET (including participating countries by region: LAC -Costa Rica, Brazil, Colombia, Panama; ESA - Uganda, Rwanda, Kenya; WCA Ghana, Nigeria, Cote d'Ivoire, Cameroon; APO - India, China, Taiwan, Australia, Indonesia); CIRAD; International Centre for Tropical Agriculture (IITA), Nigeria; International Centre for Tropical Agriculture (CIAT), Colombia; University of Western Australia; Queensland Department of Primary Industries, Australia; CacaoNet, The International Coconut Genetic Resources Network (COGENT) (including participating countries by region: LAC - Costa Rica, Brazil, Trinidad, Mexico; SSA -	Charles Staver	Via a one-day workshop on climate change and banana growth and pests and diseases, 40 banana scientists generated a state of the art on parameters for moving forward with climate change projections on banana growth for three cultivar groups, considering *Fusarium* wilt, black leaf streak and weevils/nematodes. The participatory banana mapping editor is being reprogrammed for more speed and with links to CCAFS functions. Terms of reference for the modeler have been prepared, hiring is in progress and data collection in the field is ongoing with partners.

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
			Cote d'Ivoire, Ghana, Nigeria, Cameroon, Tanzania; APO - India, Sri Lanka, Indonesia, Philippines, Malaysia), Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), France; IITA, Nigeria; CIAT, Colombia; Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Costa Rica; South Pacific Commission (SPC), Fiji; United States Department of Agriculture (USDA), USA; University of Queensland, Australia; Reading University, United Kingdom (UK); World Cocoa Foundation; Asian and Pacific Coconut Community (APCC)		

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
Output 1.3.2 New information, knowledge, guidelines and germplasm are made available to farmers, breeders, local communities and scientists and promoted through knowledge sharing, peer reviewed articles, information systems and media					
1.3.2.1	Identifying areas for future collecting missions, assessing drought tolerance and incorporating evaluation data in the Musa Germplasm Information System (MGIS)	Areas of interest (dry, cold, wet areas) for future collecting missions identified; Data on B genome contribution to drought tolerance available; MGIS structure upgraded to incorporate evaluation data	International Centre for Tropical Agriculture (CIAT), Colombia; IBC, Ethiopia; National Agricultural Research Institute, Papua new Guinea (PNG); Institut d'Economie Rurale, Mali; Indian Council Agricultural Research, India; Millenium Seed Bank, UK; Botanic Garden Conservation International (BGCI), UK; members of the *Musa* Taxonomy Advisory Group; University of Philippines Los Banos (UPLB), Philippines; KULeuven, Belgium; CIALCA partners	Nicolas Roux	During the MusaNet consultation workshop held at Montpellier in March 2011, priority areas for collecting endangered genotypes were defined; Indonesia was the first priority. In addition, an inventory of all known *Musa ex situ* collections was started and will be available on the MusaNet website, which will allow finalising the gap analysis for *Musa* spp. Collecting missions' data are being mapped and will be linked to major collections such as the FHIA collection, in Honduras through the *Musa* Germplasm Information (MGIS) Database. In the Philippines, an on-going field trial is evaluating several IMTP varieties and local cultivars for their tolerance/susceptibility to biotic stress (drought and typhoons). Two strong typhoons hit the experimental fields, revealing that some varieties (e.g., Saba, FHIA 25, and FHIA 17) are more resistant than others to blow down. In collaboration with KULeuven, Belgium, the physiological evaluation of drought in *vitro* has been done via the development of a sorbitol test where priming and growth has been evaluated. Transpiration and photosynthesis capacity are being validated in a new autorophic model. IMTP data from phase I to II is accessible at the accession level from MGIS website and uploaded on AgTrials; negotiations are ongoing with partners about uploading evaluation data from other trials.
1.3.2.2.	Socio economic survey of local farmers undertaken in at	Socio economic reports; database on indigenous knowledge	IBC, Ethiopia; National Agricultural Research Institute, PNG; Indian Council Agricultural	Adam Drucker	Mixed-mode socio-economic surveys were carried out in Ethiopia and PNG. Preliminary data analysis was carried out, a technical report elaborated and additional data collection is on-going. Surveys probed local farmers' knowledge of climate change and its impacts,

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	least three countries to document indigenous knowledge on crop diversity and adaptation to climate change		Research, India; Semongok Agriculture Research Centre (ARC), Sarawak Malaysia; PROINPA, Bolivia		sought to gain understanding regarding farmers' seed systems and any extant access barriers to seed, as well as to capture farmers' crop variety preferences. Basic information on households in Malaysia and Bolivia has been collected as follows: **Rice:** experience in rice culture, the average age of farmers involved in padi rice growing and data on gender with regards to the selection of seed. **Potato:** information on the management of diversity and adaptation of production systems under current climatic conditions and market pressure. To date information on local practices that can be adapted to climate change is being collected and evaluated with farmers.
1.3.2.3	Training of scientists and community members on tools and methods for research on underutilized species	At least 25 researchers trained; 200 community members trained	Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), Uganda; International Foundation for Science (IFS), Sweden; African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE), Kenya; Institut de Recherché et de Développment sur la Biodiversité des Plantes Cultivées, Aromatiques et Médicinales (IRDCAM),	Per Rudebjer	International Training Course organized by IFAD NUS3 Project in Pokhara, Nepal on 25-28 November 2011. Project Staff trained on agrobiodiversity assessment on farm, establishment of community biodiversity registers/CBR, Four Cell Analysis and novel Red Listing method for cultivated species. Trained personnel (ca 15) have subsequently transferred acquired knowledge to their peers back in their home countries (some 30 as a whole). Community members are expected to be trained on CBR and other best practices during the first quarter of 2012. EU-ACP project on training scientists on underutilized species research delayed; approval of Year2 POW pending. Additional Deliverable: Book published in 2011: "Teaching agrobiodiversity: a curriculum guide for higher education".

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
			Benin; Plant Genetic PROINPA, Bolivia; Ministry of Agriculture, Bolivia; Ministry of Environment, Bolivia; LI-BIRD, Nepal; Ministry of Agriculture, Nepal; MS Swaminathan Research Foundation, India; ICAR, India; Oxfam-Novib, The Netherlands		
1.3.2.5	Quality checking of the georeferences in GENESYS, SINGER, EURISCO that contribute to crop suitability Atlas and diversity analysis	Increase in % of georeferenced Passport data and use of data in crop suitability evaluations , EURISCO data of interest for the CRP7 priority countries are identified and mapped in atlas	AfricaRice, The World Vegetable Center (AVRDC), University California Berkeley	Elizabeth Arnaud	AVRDC Passport data have been updated and geographic coordinates of 58,312 samples in Bioversity's database were improved using BioGeomancer and GEOlocate. Of these 14,541 are linked with accessions in SINGER, GRIN and EURISCO and included in GENESYS. Among the 41,209 accessions in EURISCO originating from the CRP7 target regions (West Africa, East Africa and Indo Gangetic Plain) Bioversity increased the number of georeferenced accessions from 2705 to 6417. This is still too low to produce meaningful maps. The information will be shared with EURISCO national focal points so they can contribute to increasing the data quality (note: maps of georefenced accessions are available).
	Develop tools and linkages to AgTrials website for GENESYS, and	Strategy to link GENESYS and improved crop traits with	GCP- Integrated Breeding Platform (IBP);CIAT; Information and communications	Elizabeth Arnaud	AgTrials and the GCP Crop Ontology are dynamically linked so the metadata of the evaluation site records includes the ontology terms and additional trait information in the ontology can be dynamically accessed from AgTrials. New trait names recorded on AgTrials are

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	improved crop ontology (metadata, trait names, etc) and define collaboration with ICT-KM for the use of the ESRI & CIAT resources on the cloud for GENESYS	AgTrials, to upload metadata and increase use of ESRI resources	technology and knowledge management (ICT-KM)		submitted to the Crop Ontology. A test of web harvesting the CGIAR Passport data was done to evaluate the feasibility of linking the AgTrials' varieties to the genebank data. The GENESYS phase II proposal being developed will include the necessary links and services for AgTrials to access the genebank data. The first case study to test the ESRI services is the current upgrade of the collected sample database into a geospatial database. The future of ICT-KM is not yet clearly defined within the CGIAR change so no collaboration was defined.
	Establish strategic partnerships to access data for diversity analyses of CWR and NUS with GBIF and Sud Experts Plantes; test and application of GBIf tools to genebank data, extension of DarwinCore	MoU and two-year MOC with GBIF signed; proposal submitted for collaboration with Sud Expert Plantes partners in Africa and Asia; first data sets on Crop wild relatives and priority crops selected in GBIF portal– GBIF includes updated data from	GBIF, SEP, BGCI	Elizabeth Arnaud	The Memorandum of Understanding between Bioversity and GBIF was signed. A seminar held with Sud Expert Plantes (SEP) led to the submission of a first concept note to the French GEF. However, the finalization of a proposal with SEP and the GBIF Memorandum of Collaboration are pending because (i) French donors changed the SEP project submission timeline; (ii) more clarity is required on Bioversity's role within GENESYS phase II; (iii) submission of the CRP1.1. Agrobiodiversity component is in progress. A web service developed in R was installed on the Crop Wild Relatives Portal to automatically download the species list from GBIF.

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
		international and European genebanks			
Output 1.3.3 Policies to enable access to and use of genetic resources for climate change adaptation and diffusion of adapted germplasm					
1.3.3.1	Collection and analysis of information on CGIAR centres' and their partners' acquisitions, uses and distribution of germplasm in the context of climate change	Paper presenting the information collected and a preliminary analysis of factors affecting adapted germplasm exchange; Peer reviewed article on use and distribution of germplasm in India 1999-2009 and implications on policy	CGIAR Centres; IBC, Ethiopia; National Agricultural Research Institute, PNG; Indian Council Agricultural Research, India; University of Chicago, USA; University of Reading, UK; Catholic University of Louvain, Belgium	Michael Halewood	Data on CGIAR centres' transfers and acquisitions of plant germplasm were collected for genebanks and breeding programmes. Different methodologies to analyze and represent germplasm flows were considered and tested out: geographical maps, social network maps, graphs. A number of maps and graphs have been generated and included in a CCAFS Working Paper which will be submitted for publication in February 2012.
1.3.3.2	Survey of centres' practices in germplasm acquisitions and distributions and how policies affect them. Literature review	Paper presenting the information collected and a preliminary analysis of factors affecting adapted germplasm	CGIAR Centres; University of Illinois in Chicago, USA; University of Turin, Italy.	Michael Halewood	Visits and interviews were organized in CIAT, CIMMYT, CIP, ICARDA, ICRISAT, IITA and IRRI. A total of 64 scientists (including genebank managers, breeders, pre-breeding scientists, diffusion and impact experts, climate change experts and directors of ecological and geographical target regions) were interviewed about their experiences in the acquisition, use and distribution of germplasm in the context of climate change and the policy factors that affect the access to and use of germplasm by different germplasm users.

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	on Centres' diffusion strategies for improved germplasm and the conditions for success or failure	exchange and the diffusion of CGIAR improved germplasm			Literature reviews on the following topics were conducted: the impact of access and benefit-sharing regulations on availability of genetic resources; effects of intellectual property protection on agricultural research organizations' ability to access and use germplasm and technologies potentially useful for climate change mitigation and adaptation; and the factors involved in the dissemination of improved germplasm from the CGIAR centres to final users. Information collected through the interviews and the literature reviews has been analyzed and synthesized in a CCAFS Working Paper to be submitted for publication in February 2012.
1.3.3.3	Selection of country partners that will be involved in Treaty implementation work. Inception visits and initial workshops. Preparation of template/s for partners to conduct stock-taking studies on PGRFA and the implementation of the Treaty's MLS.	Inception workshops and proceedings from these workshops	EMBRAPA, Brazil; Kenyan Agricultural Research Institute (KARI), Kenya; University of Malaya, Malaysia; Instituto Nacional de Investigaciones Agricola (INIA), Peru; MS Swaminathan Research Foundation, India; Local Initiative for Biodiversity, Research and Development (LI-BIRD), Nepal; PROINPA, Bolivia; IBC, Ethiopia; Indian Council Agricultural Research, India; University of Illinois in	Michael Halewood	A call for expressions of interest for support from the project for research and capacity building concerning the implementation of the Treaty's multilateral system on access and benefit-sharing was circulated in July 2011. Proposals from Nepal, Bhutan, Uganda, Rwanda, Burkina Faso, Ghana, Cote D'Ivoire, Costa Rica and Guatemala were selected among the 27 expressions of interest were received. Full proposals from these countries were submitted in December 2011. In parallel, a "University Platform" has been set up with collaborators from the Universities of Reading, Louvain and Illinois. This platform will provide research support to advance quality research on topics related to the implementation of the Treaty's multilateral system and the access to information and technologies related to germplasm, including the use of the Climate Analogues tool for the identification of potentially adapted germplasm in each of the project countries. A planning, kick-off meeting will be held in Rome in 6-10 February 2012. Representatives from each partner country, the University Platform, the Treaty Secretariat, Bioversity and CIAT will participate.

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	Preparation of guidelines on the use of adapted germplasm from genebanks (Project : Seeds for Needs)		Chicago, USA; CIRAD, France; Catholic University of Louvain, Belgium. University of Reading, UK		The project is also supporting an Indian national workshop on Treaty implementation, scheduled for late January 2012, coordinated by ICAR and IBPGR. Seeds for Needs activities in Ethiopia will start in 2012 and will expand the work already undertaken to cover different ecosystems.
1.3.3.4	Providing technical inputs to relevant international processes enabling access to and use of germplasm for climate change adaptation	Multi-authored and peer reviewed book entitled Crop genetic resources as global commons?; five papers and oral statements submitted to, and two side events organized in, the Governing Body of the Treaty on Plant Genetic Resources for Food and Agriculture and the FAO Commission on	CGIAR Centres; Representatives of regional groups attending intergovernmental fora, Secretariats of relevant international agreements	Michael Halewood	The full manuscript – including 19 peer reviewed Chapters by 41 authors -- of a book entitled *Crop Genetic Resources as Global Commons: Challenges in International Law and Governance*, was sent to Earthscan, for publication in 2012. Four national case studies on incentives and challenges for countries to implement the Treaty's multilateral system of access and benefit-sharing were compiled and will be published and distributed in 2012 as a Bioversity publication. A report entitled "Experiences of international institutions with the implementation of the agreements with the Governing Body under Article 15 of the Treaty, with particular reference to the use of the Standard Material Transfer Agreement for Annex I and non-Annex I crops" was submitted to the 4th Session of the Governing Body of the International Treaty (Bali, March 2011). It includes detailed break downs of data on the Centres' genebanks' and breeding programmes' acquisitions and distributions of PGRFA, Centre-by-Centre, over an 18-month period, from August 2008 to January 2010. Centres' experiences were presented in a side event entitled "The CGIAR Centres' experiences implementing their Article 15

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
		Genetic Resources for Food and Agriculture			agreements with the Governing Body of the International Treaty", held during the Fourth Session of the Governing Body of the International Treaty. An overview of activities undertaken under the System-wide Genetic Resources Programme (SGRP) in relation to genetic resources from 2009 through 2010 was submitted to the Fifth Session of the FAO Intergovernmental Technical Working Group on Plant Genetic Resources for Food and Agriculture (Rome, April 2011) and the Thirteenth Session of the FAO Commission on Genetic Resources for Food and Agriculture (Rome, July 2011). A research paper concerning the impact of climate change on microbial genetic resources used in food and agriculture was submitted to the same session of the Commission and published as Background Study Paper No. 57: Beed, F., Benedetti, A., Cardinali, G., Chakraborty, S., Dubois, T., Garrett, K., & Halewood, M. (2011). *Climate Change and Micro-Organism Genetic Resources for Food and Agriculture: State of Knowledge, Risks and Opportunities*. A closely related paper concerning policy options for governing an international microbial genetic resources commons was published in the proceedings of the National Academies of Science. Halewood, M. (2011). *Options for governing the microbial commons* in National Research Council. Designing the Microbial Research Commons: Proceedings of an International Workshop. Washington, DC: The National Academies Press. During the Commission meeting, a CCAFS side event entitled

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
					"Agrobiodiversity to address climate change, agriculture and food security" was organized. CCAFS programme was presented and representatives from CGIAR Centres and national partner organizations introduced samples of research activities investigating the role of agrobiodiversity in adapting agricultural production systems to climate change. *References and links for all publications and events mentioned above have been listed below under 1.5 Publications.*
Output 1.3.4: Identification and evaluation of the differential roles of women and men, and other social groups, in strategies for conservation and use of species and genetic diversity; and the impact of those strategies on those different groups, are integrated into knowledge sharing and other activities to achieve outcomes.					
1.3.4.4	Survey of women's understanding on impact of climate change and how they are coping with it (Seeds for Needs Project)	Technical report	IBC (Ethiopia) NARI (PNG)	Adam Drucker	See 1.3.2.2. Technical report elaborated.

Milestone #	Activity in 2011	Deliverables in 2011	Partners	Contact persons	2011 Reporting
	Women farmers evaluation of locally adapted varieties from gene banks in Ethiopia (Seeds for Needs Project)	Evaluation data	IBC (Ethiopia)	Carlo Fadda	Women were empowered in order to participate in decision making and in the identification and use of local crop varieties with suitable and beneficial adaptive traits. Women farmers evaluated 100 varieties together with extension workers and local genebank managers. Women farmers' evaluation was considered of great importance in the selection of varieties for the following planting season due to their preference for some traits that are not important to other stakeholders. Seeds of their preferred varieties were distributed to other women farmers within the communities to be sown during the next cropping season. Overall, more than 100 women were directly involved in the pilot phase of the project in Ethiopia. An ongoing study will assess how many more women benefited from the on farm trials by linking to the women directly involved in the project.

1.5 Publications

Blogs

1. Cherfas, J. 4 December 2011. Who knows what about climate change? *Available online:* http://www.agriculturedaily.org/blog/2011/12/who-knows-what-about-climate-change/
2. Cherfas, J. 9 December 2011. Could climate-smart agriculture help save our forests? *Available online:* http://blog.cifor.org/6185/could-climate-smart-agriculture-save-our-forests/
3. Cherfas, J. 18 July 2011. Climate Change at the Commission on Genetic Resources for Food and Agriculture. *Available online:* http://ccafs.cgiar.org/blog/climate-change-commission-genetic-resources-food-and-agriculture

Books

1. Halewood, M., Louafi, S and Lopez-Noriega, I. Editors. Crop Genetic Resources as a Global Commons: Challenges in International Law and Governance. London: Earthscan. [peer reviewed]. *Manuscript sent in 2011 to Earthscan, for publication in 2012. Available for order on Earthscan website at: http://www.earthscan.co.uk/?tabid=102815*
2. Rudebjer P, van Schagen B, Chakeredza S, Njoroge K, Kamau H, Baena M. 2011. Teaching agrobiodiversity: a curriculum guide for higher education. [peer reviewed] *Available on CD-ROM.*

Book Chapters

1. Padulosi S., V. Heywood, D. Hunter and A. Jarvis (2011). Underutilized Species and Climate Change: Current Status and Outlook. In Shyam S. Yadav, Robert J. Redden and Jerry L. Hatfield Eds. Crop Adaptation to Climate Change, First Edition. Hermann Lotze-Campen and Anthony E. Hall. John Wiley & Sons, Ltd. Published 2011 by Blackwell Publishing Ltd.507-521 pp. [peer reviewed] *Available on CD-ROM.*
2. Ramirez, J., Jarvis, A., Van den Bergh, I., Staver, C. and Turner, D. (2010). Chapter 20: Changing climates: Effects on growing conditions for banana and plantain (*Musa* spp.) and possible responses. In Shyam S. Yadav, Robert J. Redden and Jerry L. Hatfield Eds. Crop Adaptation to Climate Change, First Edition. Hermann Lotze-Campen and Anthony E. Hall. John Wiley & Sons, Ltd. Published 2011 by Blackwell Publishing Ltd. 426-438 pp. [peer reviewed] *Available upon request.*
3. Snook, L., Dulloo, M.E., Jarvis, A., Scheldeman, X., Kneller, M. (2011). Crop Germplasm Diversity - the Role of Gene Bank Collections in Facilitating Adaptation to Climate Change. In Shyam S. Yadav, Robert J. Redden and Jerry L. Hatfield Eds. Crop Adaptation to Climate Change, First Edition. Hermann Lotze-Campen and Anthony E. Hall. John Wiley & Sons, Ltd. Published 2011 by Blackwell Publishing Ltd.495-506 pp. [peer reviewed] *Available on CD-ROM.*

Discussions

1. Discussion among experts on participatory monitoring; Solutions Exchange e-mails, October – November 2011. *Available on CD-ROM.*

2. Fadda, C. 1 September 2011. Seeds for needs approach was proposed as one option to mitigate drought-induced food crisis.
3. Fadda, C. 5-9 October 2011. Seeds for needs approach as an example on how science can help policy to adapt to climate change. Pre-Meeting for the IPBES second multi-stakeholder meeting. Nairobi, Kenya.

Events

1. Agrobiodiversity to address climate change, agriculture and food security. 19 July 2011. Thirteenth Regular Session of the Commission on Genetic Resources for Food and Agriculture. Food and Agriculture Organization of the United Nations, *Available on CD-ROM and online:* http://ccafs.cgiar.org/events/19/jul/2011/agrobiodiversity-address-climate-change-agriculture-and-food-security
2. The CGIAR Centres' experiences implementing their Article 15 agreements with the Governing Body of the International Treaty. 14 March, 2011. Fourth Session of the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture. Bali, Indonesia. *Available online:* http://www.sgrp.cgiar.org/sites/default/files/CGIAR_Experiences_SideEvent140311_flyer.pdf

Journal Articles

1. Bellon, M.R., D. Hodson and J. Hellin. 2011. Assessing the vulnerability of traditional maize seed systems in Mexico to climate change. *Proceedings of the National Academy of Sciences USA*. 108 (33): 13432-13437. [peer reviewed] *Available on CD-ROM and online:* www.pnas.org/cgi/doi/10.1073/pnas.1103373108
2. Bonham, C.A. and Dulloo, E. and Mathur, P. and Brahmi, P. and Tyagi, V. and Tyagi, R.K. and Upadhyaya, H.D. (2010) *Plant genetic resources and germplasm use in India.* Asian Biotechnology and Development Review, 12 (3). pp. 17-34. [peer reviewed] *Available on CD-ROM.*
3. Ford-Lloyd BV, Schmidt M, Armstrong SJ, Barazani O, Engels J, Hadas R, Hammer K, Kell SP, Kang D, Khoshbakht K, Li Y, Long C, Lu B-R, Ma K, Nguyen VT, Qiu L, Ge S, Wei W, Zhang Z, Maxted N. Crop Wild Relatives—Undervalued, Underutilized and under Threat? BioScience 2011, 61(7): 559-565. [peer reviewed] Available online: http://www.jstor.org/pss/10.1525/bio.2011.61.7.10
4. Halewood, M. 2011. Options for governing the microbial commons. In P. F. Uhlir (Ed.), *Designing the Microbial Research Commons: Proceedings of an International Workshop*. (pp. 191-200). Washington: National Academy of Science. [peer reviewed] *Available online:* http://www.nap.edu/openbook.php?record_id=13245&page=191
5. Pascual, U., Narloch, U., Nordhagen, S. and Drucker, A. G. 2011. The economics of agrobiodiversity conservation for food security under climate change. *Economía Agraria y Recursos Naturales*. Vol. 11 (1): pp. 191-220. [peer reviewed] *Available online:* http://aeea.webs.upv.es/aeea/ficheros/Revistas/EARN_11_1/11_1_09_Pascual.pdf
6. Ramírez, R., A. Jarvis, I. Van den Bergh, C. Staver and D. Turner. Climate change in the subtropics: The impacts of projected averages and variability on banana productivity. ProMusa symposium – "Cultivation of bananas and other tropical fruits under sub-tropical conditions – Special problems and innovative solutions" Acta Horticulturae. *In press.*

Maps

1. Arnaud, E. and team. 2011. Maps of georeferenced accessions. *Available on CD-ROM.*
2. Platform for Agrobiodiversity Research. Mapping of agrobiodiversity as an adaptation strategy on the AMKN website. *Available online:* http://amkn.org/#/bm=1/ctr=4628280.715140242;968867.446404513/lvl=1/pts=biodiv_cases

Meeting Proceedings

1. On farm conservation of neglected and underutilized species: status, trends and novel approaches to cope with climate change; Frankfurt, Germany, 14 – 16 June 2011. *In press.*
2. Proceedings of three national workshops on fine tuning of participatory approaches to national contexts; Kathmandu, Nepal, 1-2 September, Chennai, India, 5-6 September, La Paz, Bolivia, 21-22 September. *In press.*
3. Staver, C. 14 October 2011. Proceedings of Workshop ProMusa 2011 Pests and diseases in bananas – projecting the effects of climate change; Salvador de Bahia, Brazil. *Available on CD-ROM.*

Presentations

1. Bonham, C. 9 May 2011. Climate Change and Policy: Access and use of agrobiodiversity in India. CRP7 Seminar. Bioversity International, Rome, Italy. *Available online:* http://player.vimeo.com/video/23631561
2. Cadima, X. Foundation for the Promotion and Investigation of Andean Products (PROINPA), Bolivia, presented on the role of agrobiodiversity in coping with climate change and the experience of rural communities and indigenous peoples. Available on CD-ROM and online: http://www.fao.org/fileadmin/templates/nr/documents/CGRFA/Local_Perspective_Cadima.pdf
3. Dulloo, M.E., Van Zonnevald, M., Thormann, I., Drucker, A., Marandu, W., and Gaisberger, H. 13 May 2011. Seeds for Needs: Adaptation to climate change; Progress to date in Ethiopia. CRP7 Seminar. Bioversity International, Rome, Italy. Available on CD-ROM and online: http://www.slideshare.net/slideshow/embed_code/8336241
4. Lopez Noriega, I., 13 May 2011. CRP7 and Policy Research and Support Unit. . CRP7 Seminar. Bioversity International, Rome, Italy. Available on CD-ROM and online: http://www.slideshare.net/slideshow/embed_code/8335107
5. Rudebjer, P. 17 June 2011. Capacity enhancement in CCAFS - Bioversity's contribution. CRP7 Seminar. Bioversity International, Rome, Italy. *Available online:* http://www.slideshare.net/slideshow/embed_code/8376437
6. Staver, C. y J. Ramirez. 22 – 24 June 2011. Bananeros frente al cambio climatico: Adaptacion al incertidumbre, variabilidad y eventos extremos. International Congress - Cambio Climático en el Sector Platanero y Bananero, Piura, Perú. *Available upon request.*
7. Perez Vicente, L. 22 – 24 June 2011. Expectativas y desafíos para el manejo sostenible de plagas en musáceas frente a la variabilidad climática. 1st International Latin American Congress on Banana and Plantain - Cambio Climático en el Sector Platanero y Bananero. *Available upon request.*

8. Jarvis, A. and J. Ramirez. 22 – 24 June 2011. Impactos e implicaciones del cambio climático para la banana en Latinoamérica y el Caribe. 1st International Latin American Congress on Banana and Plantain - Cambio Climático en el Sector Platanero y Bananero. *Available upon request.*

Public Awareness Materials

1. Farmers and genebanks: creating alliances to help rural communities cope with climate change. Platform for Agrobiodiversity Research. Rome, Italy. 2011. *Available on CD-ROM and online:* http://agrobiodiversityplatform.org/climatechange/files/2011/08/Prova6-corretto6-LOWRES.pdf

Statements

1. Platform for Agrobiodiversity Research – Statement made at the 13th Regular Session of the Commission on Genetic Resources for Food and Agriculture (CGRFA): Agenda Item 2.2 Climate change and genetic resources for food and agriculture. *Available on CD-ROM and online:* http://agrobiodiversityplatform.org/climatechange/files/2011/07/PAR_Statement.pdf

Surveys

1. Standardized survey questionnaire developed jointly with partners to include also role of gender in conserving genetic diversity and indigenous knowledge and their value within climate change copying strategies. *Available on CD-ROM.*

Technical Reports & Background Papers

1. Experiences of international institutions with the implementation of the agreements with the Governing Body under Article 15 of the Treaty, with particular reference to the use of the Standard Material Transfer Agreement for Annex I and non-Annex I crops. Fourth Session of the Governing Body of the International Treaty, Bali, Indonesia, 14-18 March 2011. *Available on CD-ROM and online:* http://www.planttreaty.org/sites/default/files/gb4i05e.pdf
2. Report of the Thirteenth Regular Session of the Commission on Genetic Resources for Food and Agriculture. Food and Agriculture Organization of the United Nations, Rome. July 2011. *Available on CD-ROM and online:* http://www.fao.org/nr/cgrfa/cgrfa-meetings/cgrfa-comm/thirteenth-reg/en/
3. Report from the international agriculture research centres of the consultative group on international agricultural research to the intergovernmental technical working group on plant genetic resources for food and agriculture. Food and Agriculture Organization of the United Nations, Rome. April 2011. *Available on CD-ROM and online:* http://typo3.fao.org/fileadmin/templates/agphome/documents/PGR/ITWG/ITWG5/ITWG5_INF8ReportfromCGIARFINALUpton_01.pdf
4. Beed, F, Halewood M. et al. May 2011 Climate Change and Micro-Organism Genetic Resources for Food and Agriculture: State of Knowledge, Risks and Opportunities. Background Study Paper No. 57. CGRFA, Food and Agriculture Organization of the United Nations, Rome. *Available on CD-ROM and online:* http://www.fao.org/docrep/meeting/022/mb392e.pdf

5. Fujisaka, S., Williams, D and Halewood, M. (Eds). April 2011. Background Paper No. 48: The impact of climate change on countries' interdependence on genetic resources for food and agriculture. Food and Agriculture Organization of the United Nations, Rome. April 2011. *Available on CD-ROM and online:* ftp://ftp.fao.org/docrep/fao/meeting/017/ak532e.pdf
6. Ling, Li. 2011. Climatic stresses at pea collection sites in China; final technical report for the Vavilov Frankel Fellowship. Liaoning Academy of Agricultural Science, Liaoning, China. *Full text available upon request.*

Videos

1. Cherfas, J. 18 July 2011. Climate Change at the Commission on Genetic Resources for Food and Agriculture. Jeremy Cherfas. *Available online:* http://ccafs.cgiar.org/blog/climate-change-commission-genetic-resources-food-and-agriculture
2. Seeds for needs project update – helping women farmers in Ethiopia adapt to climate change. August 2011. *Available online:* http://www.youtube.com/watch?v=Ye8yUUNXnxE&list=UUGIRaI1_FpiN271fRnaFimA&index=8&feature=plcp
3. Seeds for Needs, Papua New Guinea Mid-term Report. November 2011. *Available online:* http://www.youtube.com/watch?v=LsyaDyYlwpo&feature=player_embedded

Websites

1. http://agrobiodiversityplatform.org/climatechange/
2. http://www.bioversityinternational.org/
3. http://www.bioversityinternational.org/announcements/seeds_for_needs.html
4. http://www.bioversityinternational.org/research/sustainable_agriculture/neglected_underutilized_species
5. http://www.bioversityinternational.org/training/agrobiodiversity_education.html
6. http://www.cropontology.org/
7. http://eurisco.ecpgr.org/
8. http://www.genesys-pgr.org/
9. http://www.planttreaty.org
10. http://singer.cgiar.org/

1.6 Case Studies

Case type: (a) innovative activities and results related to social differentiation and gender

Brief description of the activity

The research projects called "Seeds for Needs" builds on the idea that options for adaptation to climate change already exist in genebanks and farmers' fields. The projects test innovative methodologies and tools to model future climates, using GIS and climate information from collecting sites, to identify germplasm with the desired adaptive traits that are likely to perform well under projected future climatic conditions. Seeds for Needs projects have been used to select varieties to help women farmers adapt to climate change in Papua New Guinea (PNG) and Ethiopia. The target crops in PNG (taro and sweet potatoes) and Ethiopia (barley and durum wheat) are commonly managed by men, who traditionally decide which varieties to sow. The involvement of women in the planting and evaluation of the adapted varieties represents an important step towards the selection of varieties that specifically meet women's needs.

Photo: A farmer and her daughter participate in the Seeds for Needs inception workshop held 19-20 April 2010, IBC, Addis Ababa, Ethiopia. Credit: Tsega Wolday, Bioversity

Result of activity

Empowerment of women to participate in decision making and the identification and adoption of local crop varieties with suitable and beneficial adaptive traits resulted in both in project countries. In Ethiopia specifically, more than 12,500 accessions of durum wheat and barley were screened using the GIS tool and the most promising 100 varieties of each crop were tested on-farm with the involvement of more than 100 women farmers. In the pilot phase the varieties were sown and monitored in three sites selected as climate analogues and evaluated by women farmers, extension workers and local genebank managers. The women farmers selected seeds of varieties with traits that were not prioritized by other stakeholders. Seeds of their preferred varieties were distributed to other women farmers within the communities to be sown in the next cropping season.

Partners involved and their role

The project is jointly implemented by Bioversity, the Institute for Biodiversity Conservation (IBC, Ethiopia) and the National Agricultural Research Institute (NARI), PNG. In Ethiopia, women farmers linked to the community genebanks are also involved in project implementation, while in PNG a group of interested women farmers will be formed during project implementation. A (female) PhD student from Cambridge University is carrying out socioeconomic research.

Web address for further information

http://www.bioversityinternational.org/announcements/seeds_for_needs.html

Case type: (b) innovative results from capacity strengthening activities

Brief description of the activity

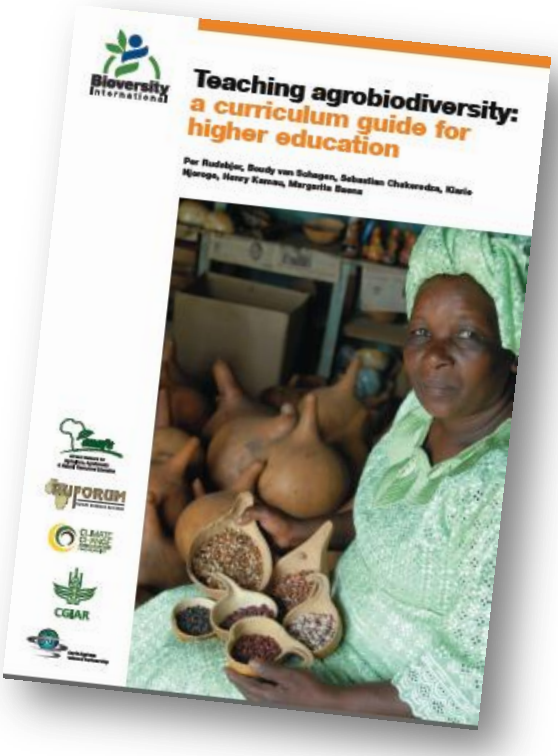
In recent years, research has yielded a rapidly growing knowledge base on how agricultural biodiversity is linked to threats from, adaptation to and mitigation of climate change. It is now urgent to inform higher agricultural education systems and policy makers accordingly, with a view to integrating such knowledge into curricula. Since 2008 Bioversity has worked closely with university partners to analyze how agrobiodiversity is taught (or not, as is mostly the case) so as to develop tools to improve the uptake of this area of study at university level. Regional capacity building consultations were held in 2009 (Sub-Saharan Africa and Asia-Pacific) and 2010 (Meso-America), helping to identify climate change-related gaps in curricula, such as: crop suitability models, risks of genetic erosion in landraces and crop wild relatives, the virulence and distribution of pests and diseases, and adapting cropping systems to climate change. In 2011, Bioversity built further on this work and its findings, and included 'Impact of climate change on agrobiodiversity' as one of 14 suggested topics in a newly published book: *Rudebjer P, van Schagen B, Chakeredza S, Njoroge K, Kamau H, Baena M. 2011. Teaching agrobiodiversity: a curriculum guide for higher education*, to be distributed among agricultural universities globally and disseminated via the internet.

Result of activity

Increased awareness of the role of agrobiodiversity in adaptation to climate change among universities in Sub-Saharan Africa, Asia-Pacific and Meso-America. Climate change aspects have been included in regional programmes on agrobiodiversity. In 2011 a book has also been published (see description of activity above). In 2012 Bioversity will build further on this by working with key partners (educational networks and the Platform for Agricultural Biodiversity Research), to promote the book and raise awareness, with a view to achieving revised curricula at the university level and positively influencing graduates' capacity to manage agrobiodiversity under climate change.

Partners involved and their role

Thirty-one universities in 23 countries were involved in these activities. University networks include: African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE) and the Regional Forum for Capacity Building in Agriculture (RUFORUM); International organizations involved include: the Technical Centre for Agricultural and Rural Cooperation (CTA), and the Tropical Agriculture Research and Higher Education Centre (CATIE)



Research on which the activity is based

A broad range of research of relevance to agrobiodiversity and climate change, particularly: (a) Jarvis A, Jane A, Hijmans RJ. 2008. The effect of climate change on crop wild relatives. Agriculture, Ecosystems and Environment 126(1-2):13–23; (b) Lane A, Jarvis A. 2007. Changes in climate will modify the geography of crop suitability: agricultural biodiversity can help with adaptation. Journal of Semi-Arid Tropical Agricultural Research 4(1).

Web address for further information

http://www.bioversityinternational.org/training/agrobiodiversity_education.html

Case type: (c) innovative and successful communications activities

Brief description of the activity: Bioversity's CCAFS funding has supported Bioversity research yielding a better understanding of the advantages of Neglected and Underutilized Species (NUS) such as nutrition and cultural diversity, as compared to staple crops in enhancing adaptation and resilience in agricultural production systems. Communicating the message about the role and importance of NUS, and effective promotion of their wider adoption will require a variety of approaches, methods and tools. To meet this communications challenge, Bioversity will build on its previous experience, including the deployment of innovative communications methods that were created and adopted within a global project, funded by the International Fund for Agricultural Development (IFAD), which was successfully concluded in 2010.

Activity 1: Raising public awareness: NUS promotional campaigns were carried out in collaboration with a renowned Restaurant Chain (Alexander Coffee) in Bolivia, to promote appetizing, tasty, high quality dishes and snacks based on NUS; **Result:** contribute to changing people's erroneous perception that NUS are 'foods for the poor', boosting demand and thus the production of NUS grains by smallholder farmers and the local economy; **Partners:** Bioversity, Alexander Coffee, PROINPA and La Paz on Foot, Bolivia; **Source of research:** IFAD NUS Project (phase II).

Activity 2: Communicating beyond national borders: A web page was created specifically for Santiago de Okola village (Lake Titicaca, Bolivia) and an introductory note on Agrotourism activities focusing on NUS was published in the Lonely Planet Tourist Guide for Bolivia; **Result:** An increase in tourists from Bolivia, Latin America and overseas boosted the very poor economy of the village (figures for 2009 recorded approx. 125 tourists, generating an income of USD 7,000 for the local community). This increase continues to be sustained in 2011. **Partners:** Bioversity, Foundation for the Promotion and Research of Andean Products (PROINPA) and La Paz on Foot, Bolivia; **Source of research:** IFAD NUS Project (phase II).

Activity 3: Email-based platform discussion held Oct-Nov 2011 through "Solution Exchange for the Climate Change Community" platform; **Result:** contributions from the discussion will be used in the implementation of 2011-2012 work under CCAFS; Inputs from experts have been compiled and shared among CCAFS partners. These and other products resulting from Bioversity's CCAFS research will also be posted on the web page for NUS and climate change, which is under construction by Bioversity. **Partners:** Bioversity, Solution Exchange Community members; **Source of research:** IFAD/World Bank.

Web address for further information

http://www.bioversityinternational.org/research/sustainable_agriculture/neglected_underutilized_species

http://www.santiagodeokola.com/

Photo: Participants in the International Expert Conference held in June 2011 in Frankfurt, Germany. The Conference reviewed methods, approaches and tools relevant to participatory monitoring of agrobiodiversity and provided recommendations for their adoption in the context of the CCAFS/IFAD NUS3 Project, which has just been launched in Nepal, India and Bolivia. Image source: Bioversity

Case type: (d) innovative non-research partnerships

Brief description of the activity
The Joint Capacity Building Programme for Developing Countries on the Implementation of the Treaty and its Multilateral System of Access and Benefit Sharing is a non-research partnership between the Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the Food and Agriculture Organization of the United Nations (FAO) and Bioversity International which supports the implementation of the ITPGRFA, specifically the development of new institutional, legal and administrative mechanisms to implement its Multilateral System of Access and Benefit Sharing (MLS). The MLS aims to create a globally accessible pool of diverse plant genetic resources for food and agriculture (PGRFA) which can be used for plant breeding to adapt to climate change-related biotic and abiotic stresses. The Joint Programme offers capacity building to countries and regions through workshops and expert advice about integrating their PGRFA into the MLS.

Result of activity
During Phase 1, draft laws, policies and administrative guidelines (or draft amendments to existing policies) to implement the MLS were developed in partnership in Kenya, Malaysia, Madagascar, Peru and the Philippines. PGRFA collections in Kenya, Madagascar, Peru and Sudan were identified for inclusion in the MLS. An Agreement to allow the Secretariat of the Pacific Community (SPC) to act as regional agent for handling requests for materials under the MLS was endorsed by Ministers of Agriculture and Forestry of South Pacific Island States, setting a precedent that other regions can consider for collective implementation of the MLS. Phase 2 commenced in 2011, with a call for expressions of interest for support from the Joint Programme. Bioversity received 27 such expressions from 22 countries, of which eight were selected for work that will proceed during 2012-2014. In 2011, a University Research Platform was created to foster involvement of professors, post-docs and Ph.D students in Joint Programme activities.

Partners involved and their role
The Secretariat of the ITPGRFA, FAO and Bioversity International co-execute the Joint Programme. The lead agency from partner countries is usually the National Treaty Focal Point, supported by a committee which includes representatives from other relevant government departments, agricultural research, civil society, and farmers' organizations. The Universities of Louvain (Belgium), Reading (UK) and Illinois (USA) have been involved in project planning and identifying areas of mutual interest for capacity building and policy development of the University Research Platform,

Web address for further information: http://www.planttreaty.org

National Partners and CGIAR Centres' cooperate to implement the multilateral system of access and benefit-sharing of the International Treaty on Plant Genetic Resources for Food and Agriculture. From left to right: Ahmed Amri (ICARDA), Daniele Manzella (Treaty PGRFA), David Williams (CGIAR SGRP), Michael Halewood (Bioversity) and Isabel Lapeña (SPDA, Peru.)
Image source: Bioversity

Acknowledgement

Special thanks to Bioversity's CRP7 Team:

Karen Amaya, Elizabeth Arnaud, Fred Atieno, Margarita Baena, Mauricio Bellon, Nadia Bergamini, Paul Bordoni, David Brown, Audrey Chaunac, Jeremy Cherfas, Evelyn Clancy, Sónia Dias, Miguel Dita, Adam Drucker, Pablo Eyzaguirre, Carlo Fadda, Hannes Gaisberger, Gea Galluzzi, Elizabeth Goldberg, Elisabetta Gotor, Michael Halewood, Vincent Johnson, Henry Kamau, Eldad Karamura, Isabel Lopez Noriega, Michael Mackay, Doreen Masegosa, Luca Matteis, Gus Molina, Yurie Naito, Stefano Padulosi, Allison Poulos, Prem Mathur Marleni Ramirez, Nicolas Roux, Max Ruas, Per Rudebjer, Milko Skofic, Laura Snook, Olga Spellman, Charles Staver, Imke Thormann, Inge Van den Bergh, Jacob Van Etten, Jacob, Maarten Van Zonneveld, Stephan Weise, Tsega Wolday, and Zongwen Zhang.

Annexes

Annex I – CD-ROM of Publications

Enclosed

Annex II – Annual Reports for Bilateral Funding

Title	Donor	Annual Report
Matching seeds for needs: Innovative research using germplasm variation for adapting to climate change and improving the livelihoods of poor farmers in Papua New Guinea (PNG): Phase 1	Anonymous	*2011 report has not been finalized*[i]
Mejoramiento de la calidad de vida de comunidades rurales en cuatro paises de America Latina y el Caribe, a traves de innovaciones tecnologicas en la produccion, procesamiento agroindustrial y mercadeo del platano	FONTAGRO	*Attached in Zip file.*
Enhancement and implementation of the Crop Ontology for data integration and data interoperability	Generation Challenge Programme	*Attached in Zip file.*
Development of a Global Strategy for the *Ex Situ* Conservation of pearl millet and finger millet and their Wild Relatives	Global Crop Diversity Trust	*2011 report has not been finalized*
Reinforcing resilience of poor rural communities against food insecurity, poverty and climate change through on-farm conservation of local agrobiodiversity	International Funds for Agricultural Development	*2011 semi-annual report attached in Zip file.*
Strengthening national capacities to implement the International Treaty of PGRFA: Genetic Resources Policy Initiative (GRPI) Phase II	The Netherlands	*2011 report has not been finalized*
Adaptation to climate change: Innovative tools to match seeds to the needs of women farmers	World Bank	*2011 semi-annual reports attached in Zip file.*

[i] 2011 reports that have not been finalized will be sent by 30 April 2012

Annex III – Acronyms

ANAFE	Agroforestry and Natural Resources Education
APCC	Asian and Pacific Coconut Community
APO	Asia, Pacific and Oceania
ARC	Agriculture Research Centre
AVRDC	The World Vegetable Center
BAPNET	Banana Asia and Pacific Network
BARNESA	The Banana Research Network for Eastern and Southern Africa
BGCI	Botanic Garden Conservation International
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CCAFS	Climate Change, Agriculture and Food Security
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
COGENT	The International Coconut Genetic Resources Network
CRP	CGIAR Research Program
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation)
ESRI	Environmental Systems Research Institute, Inc.
EURISCO	European Plant Genetic. Resources Search Catalogue
FAO	Food and Agriculture Organization of the United Nations
GBIF	Global Biodiversity Information Facility
GCP	Generation Challenge Programme
GIS	Geographic Information System
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
IARC	International Agricultural Research Centres
IBC	Institute of Biodiversity Conservation
IBP	Integrated Breeding Platform
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICRISAT	The International Crops Research Institute for the Semi-Arid Tropics
ICT-KM	Information and communications technology and knowledge management
IFAD	International Fund for Agricultural Development
IFS	International Foundation for Science
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
INRAN	Institut National de Recherche Agronomique du Niger

IPK	Leibniz Institute of Plant Genetics and Crop Plant Research (IPK)
IRDCAM	Institut de Recherché et de Développment sur la Biodiversité des Plantes Cultivées, Aromatiques et Médicinales
IRRI	The International Rice Research Institute
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	International Union for Conservation of Nature
LAC	Latin America and Caribbean
LI-BIRD	Local Initiative for Biodiversity, Research and Development
MGIS	Musa Germplasm Information System
MLS	Multilateral system of access and benefit-sharing
MUSALAC	Plantain and Banana Research and Development Network for Latin America and the Caribbean
NARI	National Agricultural Research Institute
NARS	National Agricultural Research Systems
NBPGR	National Bureau of Plant Genetic Resources (India)
NGO	Non-governmental organization
NUS	Neglected and Underutilized Species
PNG	Papua New Guinea
PROINPA	Foundation for the Promotion and Research of Andean Products (Fundación para la Investigación y la Promoción de Productos Andinos)
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SEP	Sud Expert Plantes
SINGER	System-wide Information Network for Genetic Resources
SPC	South Pacific Commission
UPLB	University of Philippines Los Banos
USA	United States of America
USDA	United States Department of Agriculture

CIAT 2011 ANNUAL TECHNICAL REPORT TO CCAFS

1. OUTCOME

Title: Major crop wild relative collecting and pre-breeding programme to adapt to climate change established in response to CIAT research on threats to crop wild relatives

What is the outcome of the research:

During 2011 the Norwegian Government funded the Global Crop Diversity Trust and the Millenium Seed Bank to establish a 10-year and US$50m programme focused on crop wild relative collection and pre-breeding for climate change adaptation. Research led by CIAT scientists over the previous 5-6 years and regular discussions with the Global Crop Diversity Trust were fundamental in the prioritizing and design of the programme.

What outputs produced in the 3 preceding years resulted in that outcome:

Maxted, N.; Dulloo, E; Ford-Lloyd, B.V.; Iriondo, J.M.; Jarvis, A. 2008. Gap analysis: a tool for complementary genetic conservation assessment. **Diversity and Distributions** p. 1-13.

Hijmans, R.J.; Jarvis, A.; Guarino, L. 2008. Climate envelope modeling: Inferring the ranges of species to facilitate biological exploration, conservation planning, and threat analysis . p. 244-254 In Problem-solving in conservation biology and wildlife management (2nd edition). Blackwell (UK)

Jarvis, A.; Lane, A.; Hijmans, R.J. 2008. The effect of climate change on crop wild relatives. **Agriculture, Ecosystem & Environment** 126:13-23.

Van Zonneveld, M.; Jarvis, A.; Dvorak, W.; Lema, G.; Leibing, C. 2009. Climate change Impact predictions on Pinus patula and pinus tecunumanii populations in Mexico and Central America, **Forest Ecology and Management**, 257(7): 1566-1576.

Jarvis, A.; Upadhyaya, H.; Gowda, CLL.; Aggarwal, PK.; Fujisaka, S.; Anderson, B. 2010. Climate Change and its effect on conservation and use of plant Genetic Resources for Food and Agriculture and associated biodiversity for food security. In FAO Thematic Background study. 27 p.

Maxted N., Shelagh Kell, Álvaro Toledo, Ehsan Dulloo, Vernon Heywood, Toby Hodgkin, Danny Hunter, Luigi Guarino, Andy Jarvis & Brian Ford-Lloyd. 2010. A global approach to crop wild relative conservation: securing the gene pool for food and agriculture. **KEW BULLETIN** VOL. 65: 561–576.

Ramirez, J.; Khoury, C.; Jarvis, A.; Debouck, D.G.; Guarino, L., 2010. A Gap analysis methodology for collecting crop genepools: a case study with Phaseolus beans. **PLOS one**, 5(10), e13497,doi10.137/journal.phone.0013497.

What partners helped in producing the outcome:

Global Crop Diversity Trust, University of Birmingham, Bioversity International

Who used the output?

- Global Crop Diversity Trust
- Norwegian Government
- FAO Commission on Plant Genetic Resources for Food and Agriculture

How was the output used?

The research demonstrating the threats that crop wild relatives were under from climate change and habitat conversion, and the analyses showing the very poor conservation status of these genepools made crop wild relative collecting a high priority for fundraising for the Global Crop Diversity Trust. Parallel to this, papers by Nigel Maxted (with CIAT co-authors) demonstrated a shift in the patterns of use for crop wild relatives, showing clear potential in these genepools for providing the traits required to adapt crops to future climate stresses. These results were presented in the FAO Commission on Plant Genetic Resources, and also distributed as background papers top the State of the World on Plant Genetic Resources published by the FAO in 2010. The Global Crop Diversity Trust made this their highest priority for a new programme initiative, and secured a US$50m grant from the Norwegian Government to implement an ambitious 10 year program in collaboration with the Millenium Seed Bank to ensure collection and conservation of threatened genepools, and to fund pre-breeding programmes for traits deemed crucial to adapt crops to climate change. The project commenced in 2011, and CIAT is currently providing research support to the project in defining priorities for collecting.

What is the evidence for this outcome:

- The website of the programme available here: http://www.cwrdiversity.org/home/
- Reports from two Bellagio workshops organized by the Global Crop Diversity Trust in which CIAT participated where many of the ideas were discussed and developed (available upon request)
- FAO Commission documents available online: http://www.bioversityinternational.org/fileadmin/bioversityDocs/Policy/Access_and_Benefit_Sharing/CGIAR%202009%20FAO%20Commission_Impact%20Climate%20Change_ak532e.pdf, and associated commentaries provided by FAO staff here http://climate-l.iisd.org/guest-articles/the-work-of-the-commission-on-genetic-resources-for-food-and-agriculture/

Summary CIAT activities according to outputs 2011

1.1.4 Testing of participatory methods that are sensitive to gender, livelihoods categories and other social differentiators, to apply globally

Participatory methods were used to jointly with Oxfam GB and local NGO's systematically addressed the challenges of climate change on farmers' livelihoods, gender and supply chains in 3 contrasting supply chains. The products of the case studies delivered were a (i) framework with concrete response pathways for collective, supply chain inclusive adaptation, a (ii) set of methodologies and tools that will enable Oxfam and partners to scale out the approach across projects globally and (iii) specific results for three supply chains. Three publications have been submitted in late 2011.

1.2.3 Differential impact on different social groups of strategies for addressing abiotic and biotic stresses induced by future climate change, variability and extremes are identified, evaluated and disseminated.

Drought selected lines were evaluated with farmers in Kenya and Malawi, with gender differentiated data obtained. Men favoured traits associated with marketability, while women included traits associated with consumption, including consumption of leaves. The model EcoCrop was used to predict impacts of climate change on four crops (banana, potato, cassava and dry bean) and was further enhanced to allow the analysis of the benefits of improving four major traits on each of the crops: drought, waterlogging, heat and cold tolerance. Broad breeding priorities were developed and tested via the modeling technique (EcoCrop). Four book chapters and one paper were published.

1.3.1 New knowledge, guidelines and access to germplasm are provided for using genetic and species diversity to enhance adaptation, productivity and resilience to changing climate

Lines have been selected in several African countries that correspond to those that have been selected in Colombia and that present a mechanism of drought resistance of sustaining photosynthate remobilization to grain under stress.
Phenotypic evaluation of Brachiaria forage grass genotypes for their tolerance to waterlogging conditions in pots resulted in identification of a set of 30 germplasm accessions and hybrids. A total of 27 germplasm accessions of herbaceous forage legumes (Canavalia, Stylosanthes and Arachis) were evaluated for their tolerance to waterlogging stress conditions.

3.1.1 Analysis of agricultural development pathways and the trade-offs among mitigation, poverty alleviation, food security and environmental health

CIAT developed Terra-i that detects land-cover changes resulting from human activities in near real-time, producing updates every 16 days. It currently runs for the whole of Latin America and is being expanded over the next year to cover the entire tropics. Additionally an online tool – based on digital map server technology – for evaluating biomass and carbon in the context of deforestation, land use, population and natural resources was developed for the Amazon region.

3.3.1 Analysis of mitigation biophysical and socioeconomic feasibility for different agricultural practices and regions, and impacts on emissions, livelihoods and food security

A set of 42 hybrids of Brachiaria humidicola were evaluated under field conditions for their ability to inhibit nitrification in soil and 5 hybrids were found with greater level of biological nitrification inhibition. A manuscript was submitted for publication on resource use and GHG emissions of eight tropical fruit species cultivated in Colombia. In-vitro dry matter digestibility estimates of the studied 147 Brachiaria progenies (BR09) ranged from 59.7 to 76.0 % with 5 weeks of regrowth, and from that 38 entries were above 67.2%. All the 39 Canavalia accessions assessed had an IVDMD above 71.9 % with 16 weeks of growth. Thus these legumes and the superior grass hybrids are potential candidates to effectively reduce GHG emissions per unit livestock product.

4.2.1 Integrated assessment framework, toolkits and databases to assess climate change impacts on agricultural systems and their supporting natural resources

Data for 24 Global climate models were produced at the global level and very high resolution using two downscaling methods. Economic analysis of low carbon policies for agricultural sector (WB) and Assessment of Investment & Financial Flows for Adaptation and Mitigation in the Agriculture Sector in Colombia (PNUD) were conducted in Colombia. Climate change impacts on several crops, yields, production and economic cost were assessed for Thailand. Detailed calibration procedures were developed for the EcoCrop model and the model was used for predicting the impact of climate change on five crops: banana (tropical and sub-tropical), potato, dry beans, cassava and sorghum. Six papers were produced from this work.

2011 Activity Plan for CCAFS Centre General Funds: Activities, Deliverables & Partners

CG Centre:	CIAT

Table C. Activity tables by Themes/Objectives

Note:

(1) Activities should be approximately US$250.000 in value, inclusive of all costs, i.e. including personnel, overhead etc. The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that Regional Program Leaders can plan synthesis and coordination activities. They will not be used for any later reporting.

(2) Milestone numbers will be provided by Theme Leaders.

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (2)	**Activity in 2011**	**Deliverables in 2011**	**Status of activity / deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.1.4.1	Development of gender-sensitivity participatory methods for grounding climate change model results to community level decision making processes that address food security issues	-Method developed and applied in three communities in three countries in Central and South America	The case studies implemented jointly with Oxfam GB and local NGO's systematically addressed the challenges of climate change on farmers' livelihoods in 3 contrasting supply chains (SC): the Guatemala frozen vegetables chain supplying a global wholesaler, the Bogotá (Colombia) small-scale farmers supply chain assuring food security of the metropolitan area and the Jamaican smallholder fresh vegetable chain supplying the hotel industry. The products of the case studies delivered are a (i) framework with concrete response pathways for collective, supply chain inclusive adaptation, a (ii) set of methodologies and tools that will enable Oxfam and partners to scale out the approach across projects globally and (iii) specific results for three supply chains. Three publications have been submitted in late 2011. http://dapa.ciat.cgiar.org/impacts-of-climate-change-on-supply-chains-in-guatemala-bogota-and-jamaica/	Oxfam; CRS; Learning Alliance; Sustainable Food Lab

1.2 Breeding strategies for future climatic conditions				
1.2.3.1	PVS/PPB; Testing field selection and data collection. Differentiating among female and male bean variety preferences in a range of dynamic scenarios (low/high stress; market-driven/subsistence)	-Report: Set of guidelines and potential new varieties adapted to low/high stress -New adapted cultivars – beans- -A systematic review of gender-differentiated varietal preference work to-date (from literature, field reports).	Drought selected lines were evaluated with farmers in Kenya and Malawi, with gender differentiated data obtained. Men favored traits associated with marketability, while women included traits associated with consumption, including consumption of leaves. Earliness, cooking time and marketability were the most commonly cited farmer-preferred traits. A desk study was executed to compile results of past surveys with farmers on most preferred traits.	Pan African Bean Research Alliance (PABRA) Kenya, Rwanda, Burundi and Malawi and PRGA.
1.2.3.1	Development of detailed priorities and strategies for breeding of at least 4 crops	-Policy briefs and research papers outlining a methodology for developing breeding strategies under climate change, and plans and strategies for at least 4 crops globally	This activity is partly related to activity 4.1.6. The model EcoCrop was used to predict impacts of climate change on four crops (banana, potato, cassava and dry bean) and was further enhanced to allow the analysis of the benefits of improving four major traits on each of the crops: drought, waterlogging, heat and cold tolerance. Broad breeding priorities were developed and tested via the modeling technique (EcoCrop). Four book chapters were published and one journal article (Trop. Plant Biol.) was submitted and accepted for publication. Next steps on this process involve: (a) the development of a more robust process-based cassava model based on existing models (GLAM, Challinor et al. 2004, and the model of Cock et al. 1979), (b) the usage of GLAM and CROPGRO-BEAN for modeling dry bean, (c) the usage of ORYZA for rice, and (d) the usage of SOLANUM for potato.	CIP; Bioversity International; NARs; regional breeding bodies; GIPB
1.3 Species and genetic diversity for climate change				
1.3.1.3	Evaluation of drought-selected bean genotypes in contrasting environments in Africa,	-Mechanisms of drought resistance effective in specific environments determined. Drought resistant lines enter varietal release process in at least 2 countries in Africa.	Lines that have been selected in several African countries correspond to those that have been selected in Colombia and that present a mechanism of drought resistance of sustaining photosynthate remobilization to grain under stress. The pattern that is emerging suggests that this is a mechanism with wide utility across environments. Lines selected for drought tolerance were registered for formal release process in Kenya and Zimbabwe, while the release process was completed in Malawi.	Ethiopian Institute of Agricultural Research (EIAR); Kenyan Agricultural Research Institute (KARI); Department of Agricultural Research and Technology of Malawi (DART); Agricultural Research In Tanzania (ART); Dept. of Research and Special Services DR&SS, Zimbabwe

1.3.1.3	Evaluation of *Brachiaria* forage grass hybrids for their tolerance to water logging.	-Five *Brachiaria* hybrids identified with greater level of water logging tolerance than the parents	Phenotypic evaluation of Brachiaria forage grass genotypes for their tolerance to waterlogging conditions in pots resulted in identification of a set of 30 germplasm accessions and hybrids. Field evaluation (including participation of farmers) of this 30 *Brachiaria* genotypes including *Brachiaria humidicola* germplasm accessions, interspecific hybrids and checks in Panama, Nicaragua and Colombia resulted in identification of five hybrids (BR06/0387; BR06/0850; BR06/1454; BR02/1794; BR04/2069) with higher level of tolerance to waterlogging than their parents. A seed company (Papalotla) is further evaluating these hybrids at multilocations for potential seed multiplication and commercialization.	CORPOICA-Colombia; INTA-Nicaragua; IDIAP-Panamá
1.3.1.3	Evaluation of herbaceous forage legumes for their tolerance to water logging	-Two herbaceous forage legumes identified with greater tolerance to water logging than commercial cultivars	A total of 27 germplasm accessions of herbaceous forage legumes (Canavalia, Stylosanthes and Arachis) were evaluated for their tolerance to waterlogging stress conditions. One accession of *Canavalia brasiliensis* (CIAT 905), three accessions of *Stylosanthes guianensis* (CIAT11995, 178, 146) and three accessions of *Arachis pintoi* (CIAT 22268, 22342, 22233) were identified as tolerant to waterlogging conditions.	Embrapa
Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (2)	**Activity in 2011**	**Deliverables in 2011**	**Status of activity / deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				

Theme 3, Pro-Poor Climate Change Mitigation				
Mile-stone # (2)	**Activity in 2011**	**Deliverables in 2011**	**Status of activity / deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
Milest one	Development of deforestation monitoring tools for policy targeting	Functioning habitat conversion monitoring tool	Terra-i detects land-cover changes resulting from human activities in near real-time, producing updates every 16 days. It	The Nature Conservancy (TNC); King's College

3.1.1.5	and REDD+ implementation	for Latin America online and available to policy makers	currently runs for the whole of Latin America and is being expanded over the next year to cover the entire tropics. Running on a set of computers this analysis can be refreshed with new imagery every 16 days and for every 250m square of land. A portal to the Terra-i habitat change monitoring system has been implemented (www.terra-i.org) where the latest detections can be downloaded in GIS formats (for free for noncommercial use) or viewed with our web mapping tool (http://maps.ciat.cgiar.org/Terra-I/Index.html). Terra-I has been used to develop baselines for REDD+ national strategies in Colombia, Peru and Ecuador, and has also been used to identify primary fronts of agricultural frontier expansion in Paraguay, Brazil and Colombia. The system is currently being combined with aboveground carbon measurements to quantify emissions arising from habitat change.	London; HEIG-VD (Switzerland)
Milest one 3.1.1.5	Development of an Amazon-wide policy targeting tool for ecosystem services	Online spatial policy targeting tool comprising data on carbon distribution and potential for ecosystem service payments under REDD+ and other carbon-based market incentives	An online tool – based on digital map server technology – for evaluating biomass and carbon in the context of deforestation, land use, population and natural resources was developed for the Amazon region. The tool includes a deforestation calculator for assessing past change and future change based on land use models. The application also allows users to calculate the opportunity costs of avoided deforestation based on agricultural statistics. Both these calculations can be made for administrative units or user-defined areas digitized directly within the application. The resource can be accessed at http://gismap.ciat.cgiar.org/mapaz/.	Amazon Initiative; ICRAF; CIFOR; World Bank; Amazon-based INIAs; EMBRAPA
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				
Milest one 3.3.1.1	Evaluation of *Brachiaria* forage grass hybrids for their ability to inhibit nitrification in soil and to reduce nitrous oxide emission to the atmosphere.	-Two *Brachiaria* hybrids identified with greater level of biological nitrification inhibition (BNI) than the parents.	A set of 42 hybrids of Brachiaria humidicola were evaluated under field conditions for their ability to inhibit nitrification in soil and found 5 hybrids with greater level of biological nitrification inhibition.	JIRCAS-Japan
	Life Cycle Analysis of at least two tropical fruit production systems	-Determination of major factors contributing to unfavourable energy balances in two fruit production systems	Field data generated, and secondary data compiled for 8 tropical fruit species to quantify the life cycle emissions and sequestration in fruit-based production systems. The manuscript was submitted for publication (Graefe,S. Tapasco J., González A. 2011. - Resource use and GHG emissions of eight tropical fruit species cultivated in Colombia. Submitted (IJCCSM-Oct-2011 0034), International Journal of Climate Change Strategies and	Colombian NARs, ASOHOFRUCOL (Colombia)

			Management). Further work on ground quantification/verification of inputs used on fruit farms, and production strategies that contribute to energy footprint started late 2011.	
Milestone 3.3.1.1	Evaluation of ruminal gas production potential of Brachiaria hybrids and Canavalia accessions	Brachiaria and Canavalia forages with high *in-vitro* digestibility and low methane production potential identified.	In-vitro dry matter digestibility estimates of the studied 147 Brachiaria progenies (BR09) ranged from 59.7 to 76.0 % with 5 weeks of regrowth, and from that 38 entries were above 67.2% . All the 39 Canavalia accessions assessed had an IVDMD above 71.9 % with 16 weeks of growth. Thus these legumes and the superior grass hybrids are potential candidates to effectively reduce GHG emissions per unit livestock product.	Embrapa

Theme 4, Pro-Poor Climate Change Mitigation				
Mile-stone # (2)	**Activity in 2011**	**Deliverables in 2011**	**Status of activity / deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.2.1.3	Downscaling of GCM data based on the DELTA-Station method for multiple years and SRES emissions scenarios	Online data repository of downscaled 1km present and future climate projections	Data for 24 Global climate models were produced at the global level with high spatial resolution using two downscaling methods, and made available through www.ccafs-climate.org. Initial analyses of the PRECIS RCM for Latin America were made, indicating moderate confidence in results. Detailed evaluation of the MRI RCM was also made and found to significantly over estimate precipitation. Significant upgrades of processing capacity and disk space were made during 2011 (to be continued in 2012). Data from the new IPCC experiments (CMIP5) were gathered and are being processed as part of 2012 activities.	Tyndell Center; Stanford University
4.2.1.9	Development of detailed agricultural impact analysis under climate change for 3 countries in Latin America and Asia	Adaptation road maps for agricultural sectors in three countries outlined in policy briefs, project reports and research papers	A case study was conducted for Colombia evaluating rice and livestock methane emissions and climate change adaptation strategies. Economic analysis of low carbon policies for agricultural sector (WB) and Assessment of Investment & Financial Flows for Adaptation and Mitigation in the Agriculture Sector in Colombia (PNUD) were conducted. Another study was carried out for Thailand, where suitability impacts were assessed for several crops using the EcoCrop	GTZ; Departamento de Planeacion Nacional (Colombia); Ministries of Environment and Agriculture; CORPOICA (Colombia)

			model. Potential impacts on yields and production were estimated as well as economic cost. Data from local partners were collected for the model calibration and the estimations of yields and prices under progressive climate change. Detailed impact analyses were also finalized using niche-based approaches for the Andean region, including Peru, Bolivia, Ecuador and Colombia, and the results incorporated in planning exercises in the Andean Community (CAN). Two policy briefs were published for Colombian agriculture, and for Mesoamerican coffee.	
4.2.1.6	Development of niche-based models (also known as agro-ecological zonification) for evaluating impacts of climate change on agricultural production	Enhanced niche-based approaches developed and published for analysis of climate change impacts on major AND minor crops	Detailed calibration procedures were developed for the model EcoCrop (see Ramirez-Villegas et al. 2011; http://dx.doi.org/10.1016/j.agrformet.2011.09.005) and the model was used for predicting the impact of climate change on five crops: banana (tropical and sub-tropical), potato, dry beans, cassava and sorghum. Six papers were produced out from this work: • Beebe et al. 2011. http://www.wiley.com/WileyCDA/WileyTitle/productCd-0813820162.html • Ceballos et al. 2011 http://www.wiley.com/WileyCDA/WileyTitle/productCd-0813820162.html • Schafleitner et al. 2011 http://www.wiley.com/WileyCDA/WileyTitle/productCd-0813820162.html • Ramirez et al. 2011 http://www.wiley.com/WileyCDA/WileyTitle/productCd-0813820162.html • Ramirez-Villegas et al. 2011 http://dx.doi.org/10.1016/j.agrformet.2011.09.005 • Jarvis et al. *Accepted for publication.* Trop. Plant Biol. Is Cassava the answer for African Climate Change Adaptation? There is still ongoing work for other crops in Africa and South Asia, and collaboration was established with the Global Crop Diversity Trust (GCDT) to produce vulnerability analyses for about 20 more crops. The work is currently being carried out at CIAT.	University of Leeds; World Bank

4.3 Refining frameworks for policy analysis				
4.3.1.1				

CASE STUDY

Title: *Improving common bean productivity: An analysis of socio-economic factors in Ethiopia and Eastern Kenya*

Case type: Social differentiation, Gender and climate change

Brief description of the activity: Climate change is already having a very negative impact on the lives of over 325 million people every year. Small communities are often the most severely affected, yet the least equipped to cope with the impacts of climate change. Dry areas of eastern Africa already experience endemic drought, and are examples of what other regions will experience in the future under climate change scenarios. Extensive farmer surveys were carried out in dryland Kenya and Ethiopia to understand the vulnerability to climate change of different social groups of households, and the limitations on increasing common bean productivity through technological innovation within these fragile agro-ecosystems.

Result of activity: The data set elucidates a range of constraints limiting common bean production in Kenya and Ethiopia. Drought has a probability of occurrence estimated at 38% in Ethiopia and 60% in Eastern Kenya. Bean yield loss due to drought is substantial among almost all varieties when drought occurs, implying low levels of resistance among the cultivars grown by the farmers at the time of this baseline. Farmers on average expect to lose about 22% of their harvest in Ethiopia and 43% in Eastern Kenya. Liquid financial assets are rare and most decision makers have low levels of education. High population density leads to continuous cultivation of land with few soil amendments and inadequate water conversation techniques. Over dependency on annual crops and family labor create problems of seasonal peaks in labor demand. Production vulnerability is neutral to wealth and production scale, but female headed households are more susceptible to yield loss than their male headed counterparts. Adoption of recently released improved cultivars in Ethiopia reduced vulnerability by 20%.

Partners involved and their role: KARI-Kenya and EIAR-Ethiopia. Partners supplied knowledge about the general context within which to plan and execute the study, and participated in surveys.

Research on which the activity is based: Bean programs in both Kenya and Ethiopia are active in genetic improvement and have released cultivars adapted to dryland conditions.

Web address for further information: s.beebe@cgiar.org; r.buruchara@cgiar.org; e.katungi@cgiar.org

CASE STUDY

Title: *Generation, assessment and distribution of ready-to-use future climate data for climate change impact assessment*

Case type: communications and inter-centre collaboration

Brief description of the activity: There has been significant scientific discord over what the best resolution for forecasting the impacts of climate change on agriculture is. Several researchers (particularly climate researchers) state that original GCM (General Circulation Model) resolution should be kept in order to manage, understand and not bias or alter uncertainties produced by GCMs themselves; however, a coarse resolution of 100 or 200km (or even more) is simply not practical for assessing agricultural landscapes. Moreover, changes in topography and climate variables are not the only factors accounting for variability in agriculture; soils and socioeconomic drivers, also often differ over small distances, influencing agro-ecosystems, increasing uncertainties, and making prediction and assessment models more inaccurate and complicated to calibrate. As such, we provide the most current and comprehensive set of climate change ready-to-use datasets, available online at http://www.ccafs-climate.org.

Result of activity: Datasets from other CGIAR institutions (i.e. ILRI, IFPRI) and/or global programs (i.e. HarvestChoice, IPM CRSP) were incorporated into CIAT's database. The climate database (with a total of 441 different scenarios –the sum of 24, 20 and 19 GCMs, times 7 time-slices and 3 emissions scenarios each) complements other existing databases that also use downscaling but are only available either for a limited set of GCMs, time-slices, regions, or for variables or at coarser resolution. We used the so-called Delta Method and another method (i.e. "disaggregation"), and created a set of 441 different future climate scenarios at four spatial resolutions (including 30 arc-second [~1km]). The datasets are up-to-date and freely available. Data is provided for the whole globe and is used continuously by researchers around the world for crop modeling, species distributions modeling and other subjects. During 2011 the website was severely updated, passing from a fairly basic interface with poor graphic design to an improved and good-looking interface with the possibility of queries available for testing at http://test.ccafs-climate.org, that will replace the current version at http://www.ccafs-climate.org. The website is accessed 150 times per day, and during 2011 received 16,300 unique visitors.

Partners involved and their role: ILRI (International Livestock Research Institute), IFPRI (International Food Policy Research Institute), PIK (Postdam Institute for Climate Impact Research), HarvestChoice, IPM CRSP (Integrated Pest Management Collaborative Research Support Program). All of them provided their own datasets that were added to our website and database.

Research on which the activity is based: Activity under T4.2 on downscaling climate information.

Web address for further information: http://www.ccafs-climate.org; j.r.villegas@cgiar.org; c.e.navarro@cgiar.org

CASE STUDY

Title: *Supporting CCAFS coordinating unit and taking a CGIAR-wide lead in climate change communications*

Case type: communications

Brief description of the activity: CIAT provided crucial support in communicating climate change issues through a range of press releases, videos and photo-journals throughout the year which highlighted both CIAT research outputs and those coming from the CCAFS program as a whole.

Result of activity: Outputs included, but are not exclusive to:

Support in the release of the vulnerability hotspots report and the Crop Adaptation to Climate Change book. The press releases were disseminated to Spanish language outlets, and Andy Jarvis provided phone interviews to Time Magazine, BBC Mundo, and Radio France International amongst others.

Major press attention on coffee, cocoa and tea impact studies. CIAT released stories in conjunction with CCAFS on impact studies of climate change on coffee, tea and cocoa in Central America and Africa. These studies carried the CCAFS logo, were posted on the CCAFS website, and were picked-up by hundreds of major news outlets, including BBC, LA Times, The Guardian, Forbes etc.

Photo pieces for Agriculture and Rural Development Day. A photo series on farmer's visions for a climate-smart future were developed based on field visits to Kenya. These were replicated into postcards, printed as large posters for ARDD, and reproduced in The Guardian in the run-up to COP17.

Publication of climatesmart agriculture case studies in the run-up to COP17. Three climate-smart agriculture case studies were reported on in the run up to COP17, from both Kenya and India. The story in Kenya about "Maurice the Madman" resulted in significant visits to the CCAFS website. From India, Reuters Alertnet also ran Cashing In On Climate Change – with Apples, and Climate Conversations: Tackling Punjab's Burning Desire.

Support during COP17. Neil Palmer provided photos of ARDD, Forest Day and other events held around COP17, and also provided a video screened during ARDD showcasing climate-smart agricultural case studies.

Partners involved and their role: CCAFS coordinating unit, Burness Communications and the partners involved in ARDD organization were all closely involved in the development of these results. The cocoa press release was developed in conjunction with the Gates Foundation, who invited CIAT to contribute to their *Impatient Optimists* blog when the study was released.

Research on which the activity is based: Multiple research activities from CIAT under Themes 1 and 3, and cross-cutting activities managed centrally by the Coordinating Unit.

Web address for further information: Links provided above.

CASE STUDY

Title: *Impact of progressive climate change on 3 supply chains, farmer's livelihoods and gender in Latin America*

Case type: Social differentiation and gender, novel partnerships

Brief description of the activity:
The case studies implemented jointly with Oxfam GB and local NGO's systematically addressed the challenges of climate change on farmers' livelihoods in 3 contrasting supply chains (SC): the Guatemala frozen vegetables value chain supplying a global wholesaler, the Bogotá (Colombia) small-scale farmers supply chain assuring food security of the metropolitan area and the Jamaican smallholder fresh vegetable chain supplying the hotel industry. The products of the case studies were a (i) framework with concrete response pathways for collective, supply chain inclusive adaptation, a (ii) set of methodologies and tools that will enable Oxfam and partners to scale out the approach across projects globally and (iii) specific results for three supply chains.

Result of activity: The data set elucidates that in the Guatemala SC over the next 40 years the suitability for the production of sweet pea will likely decrease drastically whereas broccoli will likely suffer much less. Farmers engaged in a more inclusive and transparent SC model are likely to suffer much less than farmers depending on their own. The inclusive model is offering active roles for women in the SC. Overall female households have poorer resource bases than men lead households. The public and private sector are using the results from Guatemala for the implementation of SC enhancing projects.
The suitability within the current food production areas for Bogotá are likely to change quite seriously by 2050 for staple crops such as maize, cassava and plantain and for fruits such as mango, papaya and blackberry. Most sensitive farmer groups are those selling their produce to and depending directly on intermediaries, farmers selling their produce to both sources, the farmers market (mercado campesino*)* and to the intermediaries are less vulnerable. As a consequence of shifting farming systems into higher altitudes, ecosystems that provide essential environmental services to downstream populations (paramos), will become threatened in the near future. The implication for Bogotá's food security, the ecological landscape around the capital and farmers' livelihoods is likely to be large if proper adaptation strategies are not implemented. Women's crops are more exposed to climate change than men's crops. Oxfam GB uses the results from Bogotá for political awareness building and campaigning. In Jamaica the vulnerability level of small farmers is high because of their high sensitivity and low adaptive capacity in three of five livelihood assets (human, social and financial capital), the largest threat at the moment is the risk for damage from extreme weather events like hurricanes. In Jamaica male households of the studies SC have less access to organizations on average and they also report less access to education, training and assistance. The three case studies contributed to the development of a framework for supply chain adaptation, which continues to be developed in collaboration with private-sector partners as well as development NGOs.

Partners involved and their role: Oxfam GB, The Sustainable Food Lab (SFL), SUMAR, ADAM, ILSA, University of West Indies (UWI), Soils and More, cropster.org.

Research on which the activity is based: Activity in Theme 1 related to supply chain adaptation frameworks, under objective 1.1 with links to milestones in Objective 1.3.

Web address for further information:
p.laderach@cgiar.org , a.eitzinger@cgiar.org ,
http://dapa.ciat.cgiar.org/impacts-of-climate-change-on-supply-chains-in-guatemala-bogota-and-jamaica/

CCAFS CIAT PUBLICAITONS 2011

PEER-REVIEWED PAPERS

Butare, L., I. M**. Rao,** P. Lepoivre, J. Polania, C. Cajiao, J. B. Cuasquer and S. **Beebe.** 2011. New sources of resistance in *Phaseolus* species to individual and combined aluminium toxicity and progressive soil drying stresses. Euphytica 181: 385-404.

Blair, M. W., C. H. Galeano, E. Tovar, M. C. Muñoz Torres, A. Velasco, **S. Beebe and I. M. Rao**. 2011. Development of a Mesoamerican intra-genepool genetic map for QTL detection in a drought tolerant x susceptible common bean (*Phaseolus vulgaris* L.) cross. Molecular Breeding (published online).

Graefe, S; Dufour, D; Giraldo, A; Muñoz, L.A; Mora, P; Solís, H; Garcés, H; Gonzalez, A. 2011. Energy and carbon footprints of ethanol production using banana and cooking banana discard: A case study from Costa Rica and Ecuador. Biomass and Bioenergy. DOI: 10.1016/j.biombioe.2011.02.051 [Artículo aprobado]

Herrera-Campo, B.; **Hyman, G**.; Bellotti, A.; 2011. Threats to cassava production: known and potential geographic distribution of four key biotic constraints, *Food Sec.*DOI 10.1007/s12571-011-0141-4

Jarvis, A., **Ramirez-Villegas, J**., Herrera Campo, B.V., Navarro-Racines, C.E. 2011. Is Cassava the Answer to African Climate Change Adaptation. *Tropical Plant Biology*, accepted for publication.

Jarvis, A.; **Lau, C**.; **Cook, S.E**.; Wollenberg, E.; Hansen, J.; **Bonilla, O**.; Challinor, A. 2011. An integrated adaptation and mitigation framework for developing agricultural reserch: synergies and trade-offs. *Experimental Agriculture* 47:185-203. [Artículo aprobado]

Maxted, N.; Kell, S.; Toledo, Á.; Dullo, E.; Heywood, V.; Hodgkin, T.; Hunter, D.; Guarino, L.; **Jarvis, A**. & Ford-Lloyd, B. 2011. A global approach to crop wild relative conservation: securing the gene pool for food and agriculture. *KEW BULLETIN* VOL. 65: 561–576 .

McClean, P, J. Burridge, **S. Beebe, I. Rao** and T. Porch. 2011. Crop improvement in the era of climate change: An integrated multi-disciplinary approach for common bean (*Phaseolus vulgaris* L.). Functional Plant Biology 38: 927-933

Mulligan, M.; **Fisher, M**.; Sharma, B.; Xu, Z.X.; Ringler, C.; Mahé, G.; **Jarvis, A**.; **Ramírez, J**.; Clanet, J.C.; Ogilvie, A.; Ahmad, M. 2011. The nature and impact of climate change in the challenge program on water and food (CPWF) basins. *Water International* 36 (1): 96-124.

Ramirez-Villegas, J., Jarvis, A., Laderach, P. In press. Empirical approaches to assess the impacts of climate change on agriculture: The EcoCrop model and a case study with grain sorghum. *Agricultural and Forest Meteorology*. http://dx.doi.org/10.1016/j.agrformet.2011.09.005

Ramirez-Villegas, J., Salazar-Villegas, M, Jarvis, A. and Navarro-Racines, C.E. 2011. A way forward on adaptation to climate change in Colombian agriculture: Perspectives towards 2050. *Climatic Change*, accepted for publication.

Vermeulen S.J.; Aggarwal,P.K.; Ainslie,A.; Angelone, C.; Campbell, B.M.; Challinor A.J.; Hansen, J.W.; Ingram, J.S**.; Jarvis, A**.; Kristjanson, P.; **Lau, C**.; Nelson, G.C.; Thornton P.K.; Wollenber, E. 2011. Options for support to agriculture and food security under climate change. *Environmental Science and policy*.

BOOK CHAPTER

Leal Filho W.; **Laderach, P**.; **Lundy, M**.; **Jarvis, A**.; **Ramírez J**. 2011. The Economic, Social and Political Elements of Climate *Change.Change*: 703–723-723.
Available:http://www.springerlink.com/index/10.1007/978-3-642-14776-0.

Beebe,S.; **Ramirez,J**.; **Jarvis, A**.; Idupulapati , M. R.; Mosquera, G.; Bueno, J.M.; and Blair, M. 2011. Genetic Improvement of Common Beans and the Challenges of Climate Change Chapter 16. In Crop Adaptation to Climate Change, ISBN: 978-0-8138-2016-3, 632 p.

Ceballos,H.; **Ramirez,J**.; Bellotti,A.; **Jarvis, A**.; and Alvarez, E.; 2011. Adaptation of Cassava to Changing Climates. Chapter 19. In Crop Adaptation to Climate Change, ISBN: 978-0-8138-2016-3, 632 p.

Jarvis, A.; **Ramirez, J**.; **Bonilla-Findji, O**, and Zapata, E. 2011. Impacts of Climate Change on Crop Production in Latin America, Chapter 3.1. In Crop Adaptation to Climate Change, ISBN: 978-0-8138-2016-3, 632 p.

Padulosi, S.; Heywood,V.; Hunter, D.; and **Jarvis, A**. 2011. Underutilized Species and Climate Change: Current Status and Outlook, Chapter 26. In Crop Adaptation to Climate Change, ISBN: 978-0-8138-2016-3, 632 p.

Ramirez,J.; **Jarvis, A**.; Van den Bergh, I.; Staver, Ch.; and Turner, D. 2011. Changing Climates: Effects on Crowing Conditions for Banana and Plantain(Musa spp.) and Possible Responses. Chapter 20. In Crop Adaptation to Climate Change, ISBN: 978-0-8138-2016-3, 632 p.

Snook , L.K.; Dulloo M.E.; **Jarvis, A**.; Scheldeman, X. and Kneller, M. 2011. Crop Germplasm Diversity: The Role of Gene Bank Collections in Facilitating Adaptation to Climate Change, Chapter 25. In Crop Adaptation to Climate Change, ISBN: 978-0-8138-2016-3, 632 p.

Schafleitner, R**.; Ramirez, J**.; **Jarvis, A**.; Evers, D.; Gutierrez, R.; and Scurrah, M. 2011. Adaptation of the potato crop to climate change. Chapter 11 in Crop Adaptation to Climate Change, ISBN: 978-0-8138-2016-3, 632 p.

CONFERENCE PROCEEDINGS

Subbarao, G. V., T. Ishikawa, K. Nakahara, M. Ishitani and I. M. Rao. 2011. BNI (Biological Nitrification Inhibition) function in tropical *Brachiaria* pastures. Plenary paper presented at the III International Symposium on Forage Breeding held at Bonito, MS, Brazil, 7 to 11 November 2011. Published as CDROM (pp. 401-414).

Rao, I., J. Miles, P. Wenzl, A. Louw-Gaume, J. A. Cardoso, J. Ricaurte, J. Polania, J. Rincon, V. Hoyos, E. Frossard,

T. Wagatsuma and W. Horst. 2011. Mechanisms of adaptation of brachiariagrasses to abiotic stress factors in the tropics. Plenary paper presented at the III International Symposium on Forage Breeding held at Bonito, MS, Brazil, 7 to 11 November 2011. Published as CDROM (pp. 361-383).

Van den Bergh, I., **Ramirez-Villegas, J**., Staver, C., Turner, D., Jarvis, A., and Brown, D. 2011. Climate Change in the Subtropics: Impacts of Projected Averages and Variability on Banana Productivity. *Acta Horticulturae, in press.*

CIMMYT CCAFS Report (2011)

1.1 OUTCOMES (MAX 1 PAGE)

a. What is the outcome of the research: (use of research results by non-research partners)
A research review titled "Maize production in a changing climate: Impacts, adaptation and mitigation strategies" (Jill E Cairns et al.) published online in Advances in Agronomy, Vol. 114 (2012); reprint requests received from some policy makers and media institutions.

b. What outputs produced in the three preceding years resulted in that outcome:
CIMMYT has been intensively involved in understanding the physiological bases and developing elite germplasm with adaptation to important abiotic and biotic stresses in the developing world through special projects such as DTMA, BMZ-Phenotyping, BMZ-Asia, CSISA, etc. The publication mentioned above is a result of this accumulated knowledge.

c. What partners helped in producing the outcome:
Although the authors were from the CIMMYT (Global Maize Program, Socio-economics Program & Global Conservation Agriculture Program), the datasets used for the climate change predictions relied heavily on (a) the worldClim 1.4 dataset (Hijmans et al., 2005); (b) downscaled outputs from 19 SRES (Special Reports on Emissions Scenarios) models and the A2 emissions scenario with data provided by CIAT (Ramirez and Jarvis, 2008), and (c) collaboration with various national partners in generating phenotypic datasets on maize especially in Africa and Asia.

d. Who used the output?
This is more likely to be used by various stakeholders in the near future, although CIMMYT Corporate Communications will use this very soon to enhance awareness regarding climate change vulnerability in maize-based systems.

e. How was the output used? In priority setting as well as designing strategies for developing and deploying stress resilient maize.

f. What is the evidence for this outcome: Specifically, what kind of study was conducted to show the connection between the research and the outcome? Who conducted it? (Please provide a reference or source)

1.2. Impact study: not applicable yet

1.3. Activity summary (max 1 page for CIMMYT):

Outcome 2.1: Systematic technical and policy support by development agencies for farm-to community-level agricultural risk management strategies and actions that buffer against climate shocks and enhance livelihood resilience in at least 20 countries.
Activity summary – CIMMYT has an extensive network of trial sites across EA and IGP for germplasm evaluation. A framework for maize germplasm meta-database was developed and benchmark cultivars identified to allow curation of long term trial data in both regions and to provide the

starting point for future modelling exercises to be conducted under CCAFS. Curation of data is underway in EA and IGP using this framework.

Outcome 2.2: Better climate-informed management by key international, regional and national agencies of food crisis response, post-crisis recovery, and food trade and delivery in at least 12 countries.

Activity summary – For the development of management responses and for crop model calibration and validation, benchmark cultivars for different maize mega-environments have been identified. These cultivars will serve as the baseline for future modelling strategies. Screening of elite germplasm including inbred lines and hybrids have been undertaken in both Africa and Asia under heat, combined heat and drought, and biotic stresses, leading to identification of key donors and traits; this will aid in accelerating development of climate change resilient maize for the target regions.

Outcome 2.3: Enhanced uptake and use of improved climate information products and services, and of information about agricultural production and biological threats, by resource-poor farmers, particularly vulnerable groups and women, in at least 12 countries.

Activity summary – To identify vulnerable regions, climate change scenarios for EA were projected using the outputs of 19 global climate models at the maize production (mega-environment) level. This information combined with threshold values by mega-environment and the probability of drought stress allowed the identification of vulnerable regions to guide future targeting strategies.

1.4. Activity reporting

A separate word file attached.

1.5. Publications

CCAFS Publications

1. Anneke, P. , Mukubi, J., Pellny, T., Verrier, P., Beyenne, G., Lopes, M., Emami, K., Treumann, A., Lelarge-Trouverie, C., Noctor, G., Kunert, K., Christine Foyer. 2011. The responses of maize leaves to elevated CO2: acclimation and signalling. *Plant Cell and Environment* 34, 314-331
2. Dendooven, L., Gutiérrez-Oliva, V.F., Patiño-Zúñiga, L., Ramirez-Villanueva, D.A., Verhulst N., Luna-Guido M., Marsch, R., Montes-Molina, J., Gutierrez-Miceli, F.A., Vásquez-Murrieta, S., Govaerts, B., 2012. The net global warming potential of conservation agriculture compared to the traditional cultivation of maize in the central highlands of Mexico. *Soil Biology and Biochemistry*, *Submitted*.
3. Dendooven, L., Patiño-Zúñiga, L., Verhulst N., Luna-Guido M., Marsch, R., Govaerts, B., 2012. Global warming potential of agricultural systems with contrasting tillage and residue management in the central highlands of Mexico. *Agriculture, Ecosystems and Environment*, *Accepted*.
4. Dendooven, L., Patiño-Zúñiga, L., Verhulst, N., Boden, K., García-Gaytán, A., Luna-Guido, M., Govaerts, B., 2012. Greenhouse Gas Emissions from No-tilled Permanent Raised and Conventional Tilled Beds in the Central Highlands of Mexico. In: Kang, M.S. (Ed.), Preparing Agriculture for Climate Change, In press.
5. Erenstein, O., Kassie, G.T., Mwangi, W., 2011. Comparative analysis of maize based livelihoods in drought prone regions of eastern Africa: Adaptation lessons for climate

change. Paper presented at the conference: *Increasing Agricultural Productivity & Enhancing Food Security in Africa: New Challenges and Opportunities*, 1-3 November 2011, Africa Hall, UNECA , Addis Ababa, Ethiopia

6. Hailemariam, T., M. Kassie and B. Shiferaw (2011) On the Joint Estimation of Multiple Adoption Decisions: The Case of Sustainable Agricultural Technologies and Practices in Ethiopia. Paper submitted to IAAE's 28th Triennial Conference (August 18-24, 2012), Brazil.
7. Jat ML, Jat R K, Gupta Raj and Gopal Ravi. 2011. Conservation agriculture in cereal systems of South Asia: effect on crop productivity and carbon-based sustainability index. In: *Resilient food systems for a changing world*, Proceedings of the 5th World Congress of Conservation Agriculture Incorporating 3rd Farming Systems Design Conference, Brisbane Australia, 26-29 September, 2011, p 26-27.
8. Jat RK, Gopal R, Jat ML, Gupta, R, Singh, Y and Kumar, M. 2011. Productivity and carbon based sustainability index of maize under contrasting tillage practices for rice-maize production systems of eastern Indo-Gangatic plains. In: *Addressing Climate Change effects and Meeting Maize Demand for Asia, Book of extended summaries for the eleventh Asian Maize Conference* (Eds Zaidi et al), Nanning, China, November 7-11, 2011, p 386-387, CIMMYT, Mexico, D.F.
9. Jat SL, Parihar CM, Singh AK, Jat ML and Jat RK. 2011. Carbon sustainability and productivity of maize based cropping system under conservation agriculture practices in Indo- Gangetic plains. In: *Resilient food systems for a changing world*, Proceedings of the 5th World Congress of Conservation Agriculture Incorporating 3rd Farming Systems Design Conference, Brisbane Australia, 26-29 September, 2011, p 110-111.
10. JE Cairns, J Hellin, K Sonder, BM Prasanna, JL Araus (2012). Maize production in a warming climate: Impacts, challenges and adaptation through the development and deployment of climate-adapted germplasm. Submitted to *Global Change Biology.*
11. JE Cairns, K Sonder, PH Zaidi, N Verhulst, G Mahuku, R Babu, SK Nair, B Das, B Govaerts, MT Vinayan, Z Rashid, JJ Noor, P Devi, F San Vicente, BM Prasanna (2012). Maize production in a changing climate: impacts, adaptation and mitigation strategies. In D Sparks (Ed). *Advances in Agronomy* 114: 1-58.
12. Kassie, M., S. Wagura and B. Shiferaw (2011) Gender and Food Security: Empirical Evidence from Kenya. Paper submitted to IAAE's 28th Triennial Conference (August 18-24, 2012), Brazil.
13. Lobell, D., A. Sibley, and I. Ortiz-Monasterio. 2012. Extreme heat effects on wheat senescence in India. *Nature Climate Change* doi:10.1038/nclimate1356.
14. Lopes M and Foyer C. (2011) The impact of high CO2 on plant abiotic stress tolerance. In: *Crop Stress Management and Global Climate Change*, CABI, JL Araus and G Slafer (Eds.)
15. Muricho, G., M. Kassie, M. Odendos, and J. Ouma. 2011. Characterization of maize-legume farming systems in Kenya: analysis of technology choice, resource use, gender, risk management, food security and poverty profiles. CIMMYT Socioeconomics Program Working Paper (draft)
16. Mittal, Surabhi. 2011. Modern ICT for agricultural development and risk management in smallholder agriculture in India. CIMMYT Socioeconomics Program Working Paper (draft)
17. Oliver, K., M. Kassie, F. Mmbando.2011. Characterization of maize-legume farming systems in Tanzania: analysis of technology choice, resource use, gender, risk management, food security and poverty profiles. CIMMYT Socioeconomics Program Working Paper (draft)
18. Saharawat YS, Ladha JK, Pathak H, Gathala M, Chaudhary N and Jat ML. 2011. Simulation of resource-conserving technologies on productivity, income and greenhouse gas emission in rice-wheat system. *Journal of Soil Science and Environmental Management*, Vol. 3 (12), December, 2011, Available online at http://www.academicjournals.org/JSSEM.
19. Shiferaw, B., Hellin, J., Cairns, J., Reynolds, M., Ortiz-Monasterio, I., Banziger, M., Bayou, D. and La Rovere, R. Climate change and food security in the developing regions: vulnerabilities and potential of maize and wheat research to expand options for adaptation and mitigation. Submitted to *Journal of Development and Agricultural Economics*

20. Verhulst, N., Govaerts, B., Sayre, K.D., Sonder, K., Romero-Perezgrovas, R., Mezzalama, M., Dendooven, L., 2012. Conservation agriculture as a means to mitigate and adapt to climate change, a case study from Mexico. In: Wollenberg, E., Nihart, A., Tapio-Biström, M.-L., Grieg-Gran, M. (Eds.), *Climate Change Mitigation and Agriculture*. Earthscan, Oxon, ISBN: 9781849713924, pp. 287-300.
21. Verhulst, N., Sayre, K.D., Vargas, M., Crossa, J., Deckers, J., Raes, D., Govaerts, B., 2011. Wheat yield and tillage-straw management system × year interaction explained by climatic co-variables for an irrigated bed planting system in northwestern Mexico. *Field Crops Research,* 124, 347–356, DOI 10.1016/j.fcr.2011.07.002

CRP MAIZE & WHEAT activities supporting CCAFS

1. Aranjuelo, I., Molero, G., Erice, G., Avice, J. C., & Nogués, S. 2011. Plant physiology and proteomics reveals the leaf response to drought in alfalfa (Medicago sativa L.). *Journal of Experimental Botany*, 62(1), 111-23.
2. Cossani C. M, Slafer G.A., Savin R., 2011. Do barley and wheat (bread and durum) differ in grain weight stability through seasons and water–nitrogen treatments in a Mediterranean location? *Field Crops Researc*h 121 (2011) 240–247
3. Erenstein, O., Kassie, G.T., Langyintuo, A., Mwangi, W., 2011. Characterization of Maize Producing Households in Drought Prone Regions of Eastern Africa. Socio-economics Working Paper 1. CIMMYT, Mexico, DF.
4. Jaleta, M., M. Kassie and .Shiferaw (2011)Tradeoffs in Crop Residue Utilization in Mixed Crop-Livestock Systems and Implications for Conservation Agriculture and Sustainable Land Management. Paper submitted to IAAE's 28th Triennial Conference (August 18-24, 2012), Brazil.
5. Jat ML, Saharawat YS, Majumdar K and Gupta R. 2011. Precision-conservation agriculture practices for smallholder maize farming systems of South Asia. In: *Addressing Climate Change effects and Meeting Maize Demand for Asia, Book of extended summaries for the eleventh Asian Maize Conference* (Eds Zaidi et al), Nanning, China, November 7-11, 2011, p 370-372, CIMMYT, Mexico, D.F.
6. Kassie, M., M. Jaleta, B. Shiferaw, F. Mmbando and M. Mekuria (2011) Interdependence in Farmer Technology Adoption Decisions in Smallholder Systems: Joint Estimation of Investments in Sustainable Agricultural Practices in Rural Tanzania. Paper submitted to IAAE's 28th Triennial Conference (August 18-24, 2012), Brazil.
7. Kumar A, Gupta RK, Jat ML, Malik RK, Sidhu HS, Gopal R. 2011. Inclusive research for agriculture development: farmers' participation and innovation. In: *Resilient food systems for a changing world*, Proceedings of the 5th World Congress of Conservation Agriculture Incorporating 3rd Farming Systems Design Conference, Brisbane Australia, 26-29 September, 2011, p 282-283.
8. Lopes M and Foyer C. (2011) The impact of high CO2 on plant abiotic stress tolerance. In: Crop Stress Management and Global Climate Change, CABI, JL Araus and G Slafer (Eds)
9. Lopes M and Reynolds MP, 2011. Drought Adaptive Traits and Wide Adaptation in Elite Lines Derived from Resynthesized Hexaploid Wheat. *Crop Science*, 51(4), 1617.
10. Lopes MS (2011) Physiology as a tool to improve drought and heat tolerance. 1st Regional Winter Wheat Symposium. Tabriz, Iran.
11. Lopes MS (2011) Drought adaptive traits in spring wheat advanced lines and re-synthesized hexaploid wheat. International Workshop on Dryland Science for food security and natural resource management under changing climate 7-9 December, Konya Turkey.
12. Majumdar K, Jat ML and Shahi VB. 2011. Soil nutrient availability for zero till and conventional tilled maize in eastern India. In: *Addressing Climate Change effects and Meeting Maize Demand for Asia, Book of extended summaries for the eleventh Asian Maize*

Conference (Eds Zaidi et al), Nanning, China, November 7-11, 2011, p 388-389, CIMMYT, Mexico, D.F.

13. Shiferaw, B., Negassa, A., Koo, J., Wood, J., Sonder, K., Braun, J-A., and Payne, T., 2011. Future of Wheat Production in Sub-Saharan Africa: Analyses of the Expanding Gap between Supply and Demand and Economic Profitability of Domestic Production. Paper presented at *Increasing Agricultural Productivity & Enhancing Food Security in Africa: New Challenges and Opportunities* 1-3 November 2011, Africa Hall, UNECA, Addis Ababa, Ethiopia
14. Verhulst, N., Nelissen, V., Jespers, N., Haven, H., Sayre, K.D., Raes, D., Deckers, J., Govaerts, B., 2011. Soil water content, maize yield and its stability as affected by tillage and crop residue management in rainfed semi-arid highlands. *Plant and Soil* 344: 73-85, DOI 10.1007/s11104-011-0728-8.

1.4 ACTIVITY REPORTING

Each Program Participant will receive their activity plan with one additional column. A small remark against each activity/deliverable should be prepared to **indicate the status of the activity (2-4 sentences required per activity).**

Theme 1, Adaptation to Progressive Climate Change						
Mile-stone # (3)	**Prog.**	**Activity in 2011**	**Deliverables in 2011**	**Partners**	**Contact persons (If different from in Table B)**	**Status of the activity**
1.1 Adapted Farming systems to changing climate conditions						
1.1.1	SEP	Characterization of institutional arrangements and policies that enhance the adaptive capacity of the resource-poor to adopt new maize and wheat farming practices, strategies and behaviors to reduce their vulnerability • Scoping study for characterization of climate-adaptation options in maize and wheat production systems in target regions • Identify coping and adaptation strategies of farmers and the poor to	Synthesis of institutional arrangements, policies and mechanisms for improving the adaptive capacity of agricultural sector actors; what is working where, how and why (Research paper) Enhanced knowledge on differential capacity of the smallholder farmers in wheat and maize systems to cope with and manage long term climate risks (Policy brief)	SIMLESA Project (Africa); CSISA project (IGP-Asia), MasAgro (INIFAP, SAGARPA; IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway	Jonathan Hellin and Bekele Shiferaw	A scoping study completed and comprehensive paper on coping strategies and adaptation options submitted to *Journal of Development and Agricultural Economics* Shiferaw, B., Hellin, J., Cairns, J., Reynolds, M., Ortiz-Monasterio, I., Banziger, M., Bayou, D. and La Rovere, R. **Climate change and food security in the developing regions: vulnerabilities and potential of maize and wheat research to expand options for adaptation and mitigation**. See Section 1.5.

		manage future climate outcomes				
1.1.2	GCAP	Validation trials of best-bet conservation agriculture (CA) systems in the IGP On farm research to identify system components for CA systems in the IGP Collation of data of CA trials in the IGP Trials to evaluate the effects of crop rotations under CA conditions in the IGP	Data on the yield and other benefits (e.g. labor, fuel/animal use) of CA options compared to conventional tilled agriculture. Data on the productivity effects of components for increasing the productivity, diversification and intensification of CA systems. Data available for use with crop models on the effects of CA on system productivity Data on the effects of crop rotations on system productivity and production risks	Indian Council for Agricultural Research (ICAR); Bangladesh Agricultural Research Institute (BARI); Nepal Agricultural Research Council; IRRI; Cereal Systems Initiative for South Asia (CSISA) et al.	ML Jat	Validation trials on best management practices (CA based) *vis-à-vis* conventional practices have been established with KVKs and farmer cooperatives across IGP. Farmers' participatory trials on fine tuning of component technologies for CA (cultivar choices, nutrient, residue, water, weed management etc.) have been undertaken across cropping systems and IGP region. Data has been compiled.
1.1.3	SEP	Ex-ante analysis of likely future impacts of improved technology options for maize and wheat in terms of expected economic and environmental benefits	Better understanding of the likely future impacts of progressive climate change on livelihoods in maize and wheat systems (leading to research paper)		Sika G. and Kindie Tesfaye	An ex-ante analysis of wheat production in sub-Saharan Africa (Shiferaw et al.,) was completed based on geospatial crop modeling and bio-economic modeling of wheat production possibilities in 12 SS Africa countries. This was presented at the IFPRI **Agricultural Productivity-Africa Conference 1-3 November 2011, Africa Hall, UNECA, Addis Ababa, Ethiopia.** Two working papers documenting the 'promising wheat technologies' and 'promising maize technologies' completed and ex-ante analysis of future impacts of maize and wheat technologies using the IMPACT model has been initiated
1.1.4	GCAP	Validation trials of best-bet conservation agriculture (CA) systems in EA	Data on the productivity effects of components for increasing the productivity, diversification and	Ethiopian Institute of Agricultural Research (EIAR);	Frederic Baudron and Fred	CA trials have been set up in 4 stations in Ethiopia and 4 stations in Kenya. 60 on-farm trials have been set up in Ethiopia and 48 in Kenya.

		On farm research to identify system components for CA systems in EA Collation of data of CA trials in EA Trials to evaluate the effects of crop rotations under CA conditions in EA	intensification of CA systems. Data on the effects of crop rotations on system productivity and production risks	Kenyan Agricultural Research Institute (KARI); Sustainable Intensification on Maize-Legume Systems in Eastern and Southern Africa (SIMLESA) project.	Kanampiu	Additional (on-station) component trials were put in place to assess the minimum quantity of mulch necessary for CA and to test different intercropping options (planting dates and density). Data collation is in progress. A treatment on maize-legume rotation has been included in each on-station and on-farm trial.
1.2 Breeding strategies for future climatic conditions						
1.2.1	SEP/GIS	Analysis of the effects of climate change on growth and yield of maize & wheat	Wheat areas/ countries vulnerable to increased climate variability and climate change mapped Maize areas/ countries highly vulnerable to increased frequency of extreme climate events and ecosystem disturbance mapped		Kai Sonder and Dave Hodson	Mapped changes for future maize production in 4 countries in Central America within joint project with CIAT and CRS. Utilized downscaled climate change data for 2020s and 2050s produced by CIAT to run DSSAT on HPC in Nairobi supported by Global futures staff. In combination with farmer interviews and socioeconomic data hot spots will be identified and adaptation strategies elaborated. Changes in heat stress and temperatures for maize mega environments for the 2050s in Africa mapped and calculated for all maize producing countries and in collaboration with physiologists. Published in J. E. Cairns, K. Sonder, P. H. Zaidi, N. Verhulst, G. Mahuku, R. Babu, S. K. Nair, B. Das, B. Govaerts, M. T. Vinayan, Z. Rashid, J. J. Noor, P. Devi, F. San Vicente, and B. M. Prasanna, Maize Production in a Changing Climate: Impacts, Adaptation, and Mitigation Strategies. In Donald Sparks, editor: Advances in Agronomy, Vol. 114, Burlington: Academic Press, 2012, pp. 1-58. Calculated changes between current conditions and 2050s for temperatures and rainfall regimes for all CIMMYT

						nursery trial sites for Africa. Identified homologue areas for the nursery sites. For 2012 new analogue tool would be utilized to identify areas that currently already experience similar agro climatic conditions that nursery sites are predicted to experience under future climate conditions. Identified drought risk areas in maize producing countries in SSA based on 60 years historical monthly climate data. This was combined with mapping and calculation of maize production areas and poor populations within these in currently arid, semi arid and dry sub humid environments to estimate potential impact of drought tolerant material and to identify areas already under risk of drought or dry spell impact. Mapped area changes in the 6 maize mega environments as defined in Bellon et al. 2005 for Africa between current long term climate data and 2050s. Results to be published in 2012 Mapped wheat mega environment changes of two dominant MEs for India for 2050s based on 19 downscaled GCM outputs and emission scenario A2 as detailed repetition of earlier study (can Wheat take the heat). Results still inconclusive due to large variability between GCM models.
1.2.2	GWP	Suitable international wheat trial data identified and collated and relevant climate / environment data of these trials reconstructed or accessed	Framework for international wheat trial meta database developed; initiation of data curation	Stanford University	Lopez; Crossa; Manes; Payne	Data preparation of 5 set of international trials comprising hundreds of international locations and CIMMYT wheat lines Individual location analyses for each site in each trial in order to estimate, genetic and residual variance for grain yield, maturity, phenology, etc. heritability of the trials were estimated lines within certain range of maturity days were included in the final set.

						Collection of environmental data from a large number of locations from SAWYT and ESWYT series of historical trials. Statistical analyses assessing the effect of environmental variables as a possible cause of phenotype x environment interaction analyses are being studying to identify the locations more affected by heat
1.2.3	GMP	Understanding the distribution, prevalence and epidemiology of maize insect-pests and diseases and develop tools to forecast changes in range and severity of climate-induced biotic stresses	Knowledge of the dynamics of maize pests/pathogens generated in partnership with selected NARES, especially in tropical/sub-tropical regions Forecasting tools suitable under different climatic situations/models developed based on data collected from target countries/ regions	CIMMYT, ARIs (USDA-ARS, NARES in SSA (Ethiopia, Kenya, Zimbabwe), Asia (India, Nepal, Bangladesh, Pakistan, southern China), & LAC (Mexico)	D Jeffers; G. Mahuku; PH Zaidi; S Mugo; T Tefera; J Cairns; Prasanna BM	Review of the effects of climate change on maize production including insect-pests and diseases published in *Advances in Agronomy* (114: 1-58, 2012). See section 1.5 for more details. Collation of historical datasets with grain yield, disease scores and weather data underway to increase our understanding of the dynamics of important maize diseases
1.3 Species and genetic diversity for climate change						
1.3.1	GWP	Analysis of the effects of climate change on growth and yield of wheat; initiation of heat tolerance screening (IGP)	Knowledge of the effects of high CO_2 and heat stress on wheat crop phenology, plant functions and yields Characterization of heat stress tolerance mechanism(s) in wheat and identification of morpho-physiological traits suitable as selection criteria in breeding for heat stress tolerance		Lopez; Crossa; Manes Gomez; Reynolds	Determination and analysis of yield correlations for selectable physiological traits in a population of advanced spring wheat lines grown in warm and drought environments Analysis of the effect of heat stress on crop phenology and its impact on grain yield Evaluation of advanced wheat lines under heat stress conditions Part of the work related to Physiological traits, stress tolerance mechanisms, plant function and effects of High CO_2 is published in: Lopes M and Foyer C. (2011); Lopes M and Reynolds MP 2011; and Reynolds MP and Rebetzke G,

						2011. See section 1.5 for details of these publications.
1.3.2	GMP	Analysis of the effects of climate change on growth and yields of maize	Knowledge of the effects of high CO_2 and heat stress on maize crop phenology, plant functions and yields Characterization of heat stress tolerance mechanism(s) in maize and identification of morpho-physiological traits suitable as selection criteria in breeding for heat stress tolerance Development of datasets for climate modeling to identify potential yield gains of climate-resilient germplasm and hotspots for product dissemination	CIMMYT, ARIs (USDA-ARS, NARES in SSA (Ethiopia, Kenya, Zimbabwe), Asia (India, Nepal, Bangladesh, Pakistan, southern China), and LAC (Mexico)	**IGP:** D Jeffers; PH Zaidi; **EA**: J Cairns; G Taye; **LA:** S Trachsel	A panel of 300 testcrosses screened under heat and combined heat and drought stress in Asia, Africa and Mexico. Yield stability was found to be associated with reduced pollen sterility, increased flowering synchrony and delayed senescence. Association mapping is now underway. Early generation (S_3) test-crosses of the BC1F3 lines derived from the population developed by crossing drought x water-logging tolerant lines were evaluated under managed water-logging, and the same are under evaluation under drought stress in current season A framework for long term maize trial datasets from Africa, Asia and Latin America for different mega-environments developed in collaboration with CCAFS-Global Futures team. Datasets from East African trials (2008-2010) curated for the following groups: 1. Late maturing hybrids 2. Late maturing OPV varieties 3. Early maturing OPV varieties. These datasets will be used for modeling activities planned for 2012

Theme 2, Adaptation Pathways for Current Climate Risk						
Mile-stone # (3)	Prog.	**Activity in 2011**	**Deliverables in 2011**	**Partners**	**Contact persons (If different from in**	**Status of the activity**

					Table B)	
2.1 Managing climate risk and building resilient livelihoods						
2.1.1	GCAP	On-farm trials on options for system diversification and intensification in CA systems in the IGP	Evaluation of the effects of options for system intensification and diversification on climatic risks	Indian Council for Agricultural Research (ICAR); Bangladesh Agricultural Research Institute (BARI); Nepal Agricultural Research Council; IRRI; Cereal Systems Initiative for South Asia (CSISA) et al.	ML Jat	Farmers' participatory field trials for exploring options for diversification through intensification have been undertaken using innovative management options (CA, raised beds, intercrops, relay crops etc). Sugarcane intercropped with wheat, garlic, onion, chickpea etc. increased farm income by US$ 400-1000 ha^{-1} in North-west IGP. Whereas in eastern IGP, maize intercropped with legumes using raised beds have been found much remunerative. Relay planting of wheat in cotton in western IGP has resulted in significant gain (US$ 350 ha^{-1}) in farm profitability
2.1.2	SEP	Mapping and characterization of climate-related risk and survey of current formal and informal risk management strategies employed by the rural poor in the IGP	Farm survey data and maps on risk management strategies employed by the poor at farm or community level in cereal based systems in the IGP (linked to CSISA) and Central America	CSISA project (IGP-Asia), IITA, CIAT, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway MasAgro, Tortillas on the Roaster,	Surabhi Mittal	Farm household survey conducted in IGP in five states of India- Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal across 20 districts covering 120 villages (N= 1200 households). This survey captures the information on the various information sources and networks of the farmers and the information needs of the farmers and identifies the information gap amongst the farmers on climate risk management and agricultural production. The data is collected, computed and cleaned. The data analysis is completed and the report is in writing stage.
2.1.3	SEP	Document and evaluate existing institutional approaches (including ICT-based and other information delivery models) to manage climate-related food crises and price volatility for wheat and maize as major food staples in target	1. Preliminary report on role of ICT and existing institutional arrangements to manage climate- risk for smallholder farmers	CSISA project (IGP-Asia), IITA, CIAT, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway	Surabhi Mittal and Olaf Erenstein (and Million	Three major ICT based institutions- Iffco Kissan Sanchar Limited (IKSL), Reuters market light (RML) and Kissan Sanchar prominently working in IGP are being studied. The details will soon be documented in a research paper. First round of primary farm household data collected, entered and initial analysis to assess climate-risk

		regions		DTMA, SIMLESA Project	Tadesse)	management by smallholder farmers in southern Ethiopia and willingness to pay for crop insurance.
2.1.4	GCAP	On-farm trials on options for system diversification and intensification in CA systems in EA	1. Evaluation of the effects of options for system intensification and diversification on climatic risks	Ethiopian Institute of Agricultural Research (EIAR); Kenyan Agricultural Research Institute (KARI); Sustainable Intensification on Maize-Legume Systems in Eastern and Southern Africa (SIMLESA) project.	Frederic Baudron and Fred Kanampiu	Intercropping, relay-cropping and "double-intercropping" (i.e. intercropping followed by relay cropping) to maximize resource use efficiency (mainly water) are being tested on-station (4 in Ethiopia and 4 in Kenya) and on-farm (60 in Ethiopia and 48 in Kenya)
2.1.5	SEP	Mapping and characterization of climate-related risk and survey of current formal and informal risk management strategies employed by the rural poor in EA	1. Farm survey data and maps on risk management strategies employed by the poor at farm or community level in cereal based systems in EA	DTMA, SIMLESA Project	Kai Sonder and Dave Hodson	Synthesis report for Eastern Africa documenting maize farmers' risk management in drought prone areas (Erenstein, O., Kassie, G.T., Langyintuo, A., Mwangi, W., 2011. Characterization of Maize Producing Households in Drought Prone Regions of Eastern Africa). See section 1.5 for more details Conference paper on adaptation lessons from maize producers in Eastern Africa (Erenstein, O., Kassie, G.T., Mwangi, W., 2011. Comparative analysis of maize based livelihoods in drought prone regions of eastern Africa: Adaptation lessons for climate change). See Section 1.5 for more details.
2.1.6	GCAP	On-farm research trials on the management of agricultural systems that enhance the natural resource base (EA and IGP)	1. Data on the effects of agricultural systems on the natural resource base and on system resilience to climate-related agricultural risk	Indian Council for Agricultural Research (ICAR); Bangladesh Agricultural Research	ML Jat, Frederic Baudron and Fred Kanampiu	IGP: Large number of farmers participatory field trails has been undertaken on CA based crop management technologies in cereal systems and in collaboration with NARES that showed significant savings in water, fuel and lowers global warming potential EA: Soil physical and chemical parameters have been monitored

				Institute (BARI); Nepal Agricultural Research Council; IRRI; Cereal Systems Initiative for South Asia (CSISA) et al. EA: Ethiopian Institute of Agricultural Research (EIAR); Kenyan Agricultural Research Institute (KARI); Sustainable Intensification on Maize-Legume Systems in Eastern and Southern Africa (SIMLESA) project.		in over 120 on-station and on-farm trials where different CA options are being tested. Crop growth models (APSIM) have been calibrated and validated for 2 sites in Ethiopia and 2 sites in Kenya. The model will be used as a decision-support tool, through the exploration of different scenarios.
2.3.1	GMP	Identification of multiple biotic and abiotic stress tolerant maize germplasm that could be adopted by resource-poor farmers in areas vulnerable to climate change	1. Disease screening sites and protocols for maize established in targeted countries with high current climate risk	CIMMYT, ARIs (USDA-ARS, NARES in SSA (Ethiopia, Kenya, Zimbabwe), Asia (India, Nepal, Bangladesh, Pakistan, southern China),	BM Prasanna, D Jeffers, G Mahuku, J Cairns, PH Zaidi	As an important step towards harmonization of stress screening protocols, key phenotyping sites for prioritized biotic and abiotic stresses in Asia (e.g., Mandya, Udaipur, Sabor, Ludhiana, Hyderabad in India; Gazipur in Bangladesh; Rampur in Nepal; Sahiwal in Pakistan) and Africa (e.g., in Kenya, Ethiopia, Tanzania, Zimbabwe & Nigeria) have been identified; Nearly 40 Davis weather stations have been procured for installation in the first quarter of 2012 at these sites for obtaining reliable weather data from these important stress phenotyping

				& LAC (Mexico)		sites.
2.3.2	GMP	Identification of multiple biotic and abiotic stress tolerant maize germplasm that could be adopted by resource-poor farmers in areas vulnerable to climate change	2. Maize germplasm (inbreds / hybrids / OPVs) with resistance to combinations of major biotic (diseases and insect-pests) and abiotic stresses (drought, heat and waterlogging) identified and/or developed for selected climate change-vulnerable regions	CIMMYT, ARIs (USDA-ARS, NARES in SSA (Ethiopia, Kenya, Zimbabwe), Asia (India, Nepal, Bangladesh, Pakistan, southern China), and LAC (Mexico)	BM Prasanna, D Jeffers, G Mahuku, J Cairns, PH Zaidi	In both Asia and Africa, elite hybrids and inbred lines have been evaluated under managed stress screening for important stresses (*Africa:* heat; drought + heat in Africa; heat; *Asia:* heat + drought; waterlogging; key diseases like downy mildews, PFSR and BLSB) leading to identification of donors and component traits. The identified stress resilient germplasm will be further tested in 2012 and shall be used in recombination experiments to develop multi-stress resilient products for Asia and Africa

Theme 3, Pro-Poor Climate Change Mitigation						
Mile-stone # (3)	Prog.	**Activity in 2011**	**Deliverables in 2011**	**Partners**	**Contact persons (If different from in Table B)**	**Status of the activity**
3.1 Low-carbon agricultural development pathways						
3.1.1	SEP	Collecting baseline data on adoption of zero and minimum tillage and the potential of conservation agriculture for reducing carbon emissions or soil carbon sequestration in wheat-rice systems in the Indo-Gangetic plains	1. Enhanced availability of data and information for national, regional and global players interested in reducing the carbon foot prints of cereal based intensive agriculture	IFPRI (Global Futures Project), SIMLESA Project (Africa) CSISA project (IGP-Asia), IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA,	Vijesh Krishna and Surabhi Mittal	Baseline farm household data collection on adoption of zero and minimum tillage in the IGP was completed (n = 2592 households) as part of the CSISA project in South Asia, and is being analyzed. These data sets provide complete information on adoption history of zero tillage and reduced tillage in the hubs of India, Nepal and Bangladesh.

				UMB-Norway		
3.2 Institutional arrangements and incentives for mitigation						
3.2.1	SEP	Analysis of the economic and environmental benefits from the adoption of conservation agriculture technologies in maize and wheat systems	1. Enhanced knowledge on the economic, environmental and social benefits from scaling up/out climate responsive innovations for smallholder maize and wheat farmers and implications for policy 2. New understanding about the direct and indirect economic and environmental costs and benefits from agricultural mitigation	IFPRI (Global Futures Project), SIMLESA Project (Africa) CSISA project (IGP-Asia), IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway	Menale Kassie, Moti Jaleta and Vijesh Krishna	Case-studies on economic and environmental effects of zero tillage is conducted among 340 households of West Bengal and Haryana as part of CSISA and other projects. Plot- and household- level data on conservation agriculture practices and technologies collected in East African countries (Ethiopia, Kenya, and Tanzania) and in India in Eastern and Western Indo-Gangetic plain(IGP) in collaboration with partners in the respective country. Several papers have been developed based on analysis of economic, social (gender) and environmental benefits of conservation agriculture and presented at the **World Conservation Agriculture Congress in Brisbane** (26-29 Sept, 2011) and submitted to the **IAAE's 28th Triennial Conference** (August 18-24, 2012), Brazil. See publications list: **Kassie et al (2011); Moti et al. (2011); Hailemariam et al. (2011).**
3.3 Test and identify desirable on-farm practices and their landscape-level implications						
3.3.1	GCAP	On-farm trials on strategies to increase system productivity, soil quality and carbon sequestration in EA and IGP	1. Data available on the effects of CA systems on system productivity. Evaluation of C sequestration will require continuation of the trials for several years.	EA: Ethiopian Institute of Agricultural Research (EIAR); Kenyan Agricultural Research Institute (KARI); Sustainable Intensification on Maize-Legume Systems in Eastern and	ML Jat, Frederic Baudron, Fred Kanampiu and Medha Devare	IGP:Long-term trails on CA in predominant cereal systems (Rice-wheat, rice-maize, maize-wheat) has been established in the IGP in collaboration with ICAR institutions and State Agricultural Universities. The crop and water productivity, energy, soil properties, carbon sustainability index etc are being monitored. Pl see publications in Section 1.5l EA: Productivity indicators and total soil carbon are being monitored annually in over 120 on-station and on-farm trials where different CA options are being tested

				Southern Africa (SIMLESA) project. IGP: Indian Council for Agricultural Research (ICAR); Bangladesh Agricultural Research Institute (BARI); Nepal Agricultural Research Council; IRRI; Cereal Systems Initiative for South Asia (CSISA) et al.		
3.3.2	GCAP	Studies on management effects on GHG emissions, especially nitrous oxide, in CA systems in the IGP and Mexico.	1. Data on GHG emissions from different crop management practices, especially with reference to N management in CA systems.	Indian Council for Agricultural Research (ICAR); Bangladesh Agricultural Research Institute (BARI); Nepal Agricultural Research Council; IRRI; Cereal Systems Initiative for South Asia (CSISA); Instituto	ML Jat, Bram Govaerts and Ivan Ortiz Monasterio	A study on GHG emission under in contrasting tillage, residue and nutrient management practices in rice-wheat rotation of Indo-Gangetic plains (Haryana, India) has been undertaken wherein CH_4, NO_2 and CO_2 are being monitored. A PhD scholar from CCS Haryana Agricultural University has been engaged in the same study.

				Nacional de Investigación Forestal, Agrícol y Pecuaria (INIFAP), Mexico		

Theme 4, Integration for Decision Making						
Mile-stone # (3)	Prog.	**Activity in 2011**	**Deliverables in 2011**	**Partners**	**Contact persons (If different from in Table B)**	**Status of the activity**
4.2 Assemble data and tools for analysis and planning						
4.2.1	SEP	Assess vulnerabilities of households and communities to climate shocks and develop regional quantitative and qualitative scenario storylines/ analyses for maize and wheat systems	1. Vulnerability maps with up-to-date datasets from a food security and sustainability perspective in maize and wheat production systems (policy brief) 2. Prototype regional scenarios produced (main regional uncertainties identified; initial regional storylines developed; reports, and initial scoping for model analysis)	IFPRI (Global Futures Project), SIMLESA Project (ES-Africa); CSISA project (IGP-Asia), DIVA (ES-Africa); DTMA (Africa); IITA, ICARDA, ICAR, EIAR, KARI, UMB-USA, UMB-Norway	Kai Sonder and Dave Hodson	Mapped changes for future maize production in 4 countries in Central America within joint project with CIAT and CRS on maize bean systems. Utilized downscaled climate change data for 2020s and 2050s produced by CIAT to run DSSAT on HPC in Nairobi supported by Global futures staff. In combination with farmer interviews and socioeconomic data hot spots will be identified and adaptation strategies elaborated. Final report after project end in April 2012. Feasibility and profitability of wheat production in SSA study conducted with IFPRI. Combined biophysical and socioeconomic modeling utilizing DSSAT on cell basis as well as a GIS based transport cost model and economic sensitivity analysis identified areas within 11 SSA countries where wheat production could be profitable under different prize and input cost situations. Study included 2050s outlook with 4 downscaled GCM models under A2 emission scenario and CO_2 fertilization effects to determine whether investment in wheat production is sustainable for long

						term perspective. Study to be published in 2012 after post review model run calculations and mapping are redone. Produced drought risk maps for India and Bangladesh based on 60 years of historical (1950-2009) monthly rainfall data. This was combined with water logging soil areas in maize production zones to identify areas where maize may be exposed to drought and flooding conditions within the same cropping season to identify areas where dual stress tolerant varieties currently being developed can be deployed. Mapped changes of temperature and rainfall regimes in Mexico and CA between current long term averages and 2050s predicted averages for 19 GCM models and A2 emission scenario. Shared with CA experts and breeders for planning purposes. Published in book chapter: Verhulst, N., Govaerts, B., Sayre, K.D., Sonder, K., Romero-Perezgrovas, R., Mezzalama, M., Dendooven, L., 2011. Conservation agriculture as a means to mitigate and adapt to climate change, a case study from Mexico. In: Wollenberg, E., Nihart, A., Tapio-Biström, M.-L., Grieg-Gran, M. (Eds.), Climate Change Mitigation and Agriculture. Earthscan, Oxon, ISBN: 9781849713924, pp. 287-300.
4.3Refine frameworks for policy analysis						
4.3.1	SEP	Start integrated biophysical and economic approaches for estimating future impacts of climate change	1. Model calibrated for global and regional assessments of climate change impacts on maize and wheat production systems and food security	Idem.	Sika G and Kindie Tesfaye	DSSAT Model developed for global crop simulations (using several wheat cultivars adapted to major wheat growing environments) is being validated The Global Economic Model (IMPACT) linked to DSSAT and Economic Surplus model (DREAM) is also being validated for Wheat and work on Maize will continue during 2012

Case Study 1: Gender and Food Security: Empirical Evidence from Kenya

Case type: Social differentiation and gender

Description of the activity: Using recent household survey data from maize-legume systems in rural Kenya, we test if female-headed households (FFHs) are more likely to be food insecure compared to male-headed households (MHHs). We use the perception of the respondents about their own food security status rather than consumption (converted into calories) or expenditure data. Based on all food sources (own production+ food purchase + safety nets and welfare programs + 'hidden harvest' from communal resources), the respondents assessed the food security status and livelihood vulnerability of their households to climatic and other shocks. This data was captured for the most recent past twelve months and the responses were grouped into the following four categories: severe (chronic) food shortage, occasional (transitory) food shortage, no food shortage but no surplus (break-even), and food surplus.

Results of the activity: The probit model (binary food security) results show that FHHs are 13% less likely to be food secure than MHHs. Similar results were obtained using the order probit model where FHHs suffer more form chronic (3%) and transitory (12%) food insecurity. For the break-even and food surplus category, the MHHs have about 5% and 9% higher probability of food security than the FHHs. However, using covariate matching methods the food security gap between FHHs and MHHs declines to 1.3- 2.8%, indicating that the remaining food security gap (the part that cannot be explained by observed characteristics) may be attributed to less observable factors, such as discrimination and other non-observable factors including ability and motivation.

Partners involved and their role: Researchers from the Kenya Agricultural Research Institutes (Kakamega and Embu regional centers) and ICRISAT participated in the data collection process.

Research on which the activity is based: Data for this analysis was collected using SIMLESA project that supports the CCAFS project effort in east Africa. The SIMLESA project aims to develop climate-smart interventions that will improve productivity and reduce downside risks and enhance food security for resource poor maize and legume farmers in five countries in Eastern and Southern Africa. More details in Kassie et al. 2011 Gender and Food Security: Empirical Evidence from Kenya. IAAE's 28th Triennial Conference paper.

Web address: http://iaae.confex.com/iaae/portal.cgi?e=m.kassie@cgiar.org&p=672227&r=norole)

http://simlesa.cimmyt.org/

Case Study 2: Conservation agriculture as a means to mitigate and adapt to climate change, a case study from Mexico

Case type: Communications

Description of the activity: Developing climate change prediction models for Mexico, summarize different prediction models, summarize the potential of CA as a means to mitigate and adapt to climate change for two contrasting agro-ecological environments in Mexico and the economic potential of CA for climate change mitigation and adaption

Result of activity: published book chapter (Verhulst, N., Govaerts, B., Sayre, K.D., Sonder, K., Romero-Perezgrovas, R., Mezzalama, M., Dendooven, L., 2012. Conservation agriculture as a means to mitigate and adapt to climate change, a case study from Mexico. In: Wollenberg, E., Nihart, A., Tapio-Biström, M.-L., Grieg-Gran, M. (Eds.), Climate Change Mitigation and Agriculture. Earthscan, Oxon, ISBN: 9781849713924, pp. 287-300); the text of this book chapter has been shared on various occasion with journalists, visiting scientists and students to sensitize them to the climate change problem and give a summary of the work done in Mexico.

Partners involved and their role: numerous partners national (Mexican) and international have been involved in the research network that was developed around the long-term research trials where the research was conducted. In summarizing the research for the book chapter, CINVESTAV Mexico and KU Leuven Belgium researchers were involved.

Research on which the activity is based: The majority of the research was conducted in long-term trials of CIMMYT in Mexico. This research was reported in: Dendooven et al. (2012) accepted for publication in Agr Ecosyst Env; Govaerts et al. (2007a) Soil Till Res 94, 209-219; Govaerts et al. (2008) Appl Soil Ecol

38, 197-210; Govaerts et al. (2006b) Appl Soil Ecol 32, 305-315; Govaerts et al. (2007b) Appl Soil Ecol 37, 18-30; Govaerts et al. (2005) Field Crop Res 94, 33–42; Govaerts et al. (2006a) Soil Till Res 87, 163-174; Govaerts et al. (2006c) Plant Soil 280, 143–155; Govaerts et al. (2009) Soil Till Res 103, 222-230; Ortiz-Monasterio et al. (2010) in: M.P. Reynolds (ed) Climate Change and Crop Production, ISBN: 9781845936334; Sayre et al. (2009) in: J. Dixon, H.-J. Braun, and P. Kosina (eds) Wheat Facts and Future, CIMMYT, Mexico D.F.; Sayre et al. (2005) in: C. H. Roth, R. A. Fischer and C. A. Meisner (eds) Evaluation and Performance of Permanent Raised Bed Cropping Systems in Asia, Australia and Mexico, Proceedings of a workshop held in Griffith, Australia. ACIAR Proceedings 121, ACIAR, Griffith, Australia; Verhulst et al. (2011b) Plant Soil 340, 453-466; Verhulst et al. (2011a) Plant Soil 344, 73-85.

Web address: http://conservacion.cimmyt.org

Case Study 3: Maize Production in the Changing Climate in Africa

Case type: Communications

Brief description of the activity: Given the time lag between the development of improved germplasm and adoption in farmers' fields, the development of improved breeding pipelines needs to be a priority. An analysis was done on the potential impacts of changes in temperature and precipitation at the maize mega-environment level, to identify hot spots of climate variability for priority setting, product development and deployment.

Results of the activity*:* This study addressed the potential impacts of climate change on maize production, with particular focus on sub-Saharan Africa. Previous climate projections have tended to focus at the country level; in this review, temperature changes by 2050 were presented at the maize mega-environment level. The achievements so far in stress tolerance breeding and physiology, and potential new tools to enhance resilience of maize to abiotic and biotic stresses were presented. Sustainable agronomic and resource management practices that can effectively contribute to climate change mitigation were highlighted.

Partners involved and their role: The publication involved an inter-disciplinary team of nine CIMMYT scientists, including physiology, GIS, pathology, molecular and conventional breeding, and conservation agriculture. The multi-disciplinary interaction allowed a more thorough analysis of the potential impacts of climate change across the maize-based systems in sub-Saharan Africa, rather than focusing a specific discipline or area. Although the authors were from the CIMMYT (Global Maize Program, Socio-economics Program & Global Conservation Agriculture Program), the datasets used for the climate change predictions relied heavily on (a) the worldClim 1.4 dataset (Hijmans et al., 2005); (b) downscaled outputs from 19 SRES (Special Reports on Emissions Scenarios) models and the A2 emissions scenario with data provided by CIAT (Ramirez and Jarvis, 2008), and (c) collaboration with various national partners in generating phenotypic datasets on maize especially in Africa and Asia.

Research on which the activity is based: Climate projections were based on downscaled outputs from 19 SRES models. Past achievements in stress breeding and physiology, and new tools for accelerate breeding gains and dissect stress adaptation were based on the accumulated knowledge from several projects led by CIMMYT, especially DTMA (Drought Tolerant Maize for Africa) Project, besides published literature. More information Cairns et al. 2012. *Advances in Agronomy* 114: 1-58.

Web address for further information:

http://www.sciencedirect.com/science/bookseries/00652113

Case Study 4: Mobile phones based information providers to mitigate weather and market related risks in India

Case type: Improving flow of information relating to weather and market information through text messages on mobile phones of farmers.

Brief description of the activity: The Reuters Market Light (RML) provides daily four small text messages (SMS) to registered farmers on universally used handsets for two preferred crops, as indicated by the subscriber, in local languages. These messages are about crop prices in nearby markets, input prices, advisory to improve yields and weather forecast. The information is provided to the farmer throughout the crop cycle.

Result of activity: RML services had a major impact on farmers through its commodity price updates and weather forecasts which helps farmers to mitigate production risks related to uncertain weather conditions and market risks due to market prices uncertainties. In an evaluation survey of around 500 farmers across India by RML, farmers (60%) reported that they make profits by using the price information which helps them to analyze the trends in prices and market arrivals and make alternative decisions on selling, storage and target markets. More than 90 per cent of the farmers found that the information delivery by RML through text messages is useful and relevant for their farming activities and help them to cope with changing market scenarios and rainfall patterns. The information on likelihood of rainfall helps farmers to plan their use of inputs - pesticides, fertilizers, herbicides and also make decisions on timings of sowing and harvesting.

Partners involved and their role: RML has partnerships with various handset manufacturers, telecom operators, banks and agricultural input companies to improve their reach to the farmers. RML also partners with leading agricultural institutes and universities for sourcing and developing agriculture advisory content, Indian Meteorological Department and various other private sector weather information companies to provide local weather information. RML also

works closely with various central and state-level government departments and public sector bodies to benefit the maximum number of farming communities in the country.

Research on which the activity is based: ICT for small-scale agricultural development and risk management in India. More information in Mittal, S. 2011. ICT for small-scale agricultural development and risk management in India, CIMMYT Socioeconomic Program Working Paper.

Web address for further information: http://www.reutersmarketlight.com/

2011 Activity Plan for CCAFS Centre General Funds: Activities, Deliverables, & Partners

CG Centre:	CIP

Table A. Main contacts persons in the Centre

Contacts	Name(s) (specify roles if more than one)	Email
Climate Change Contact Point	Roberto A. Quiroz	r.quiroz@cgiar.org
Admin. Issues	David Theriault	d.theriault@cgiar.org
Communications	Valerie Gwinner	v.gwinner@cgiar.org
Others (if needed, specify role)	Paolo Donini, DDG-Research	p.donini@cgiar.org

Table B. Bilateral funded projects under CCAFS (2011)

ID#	Name of project	Approximate budget under CCAFS (2011) (1)	Donor	Principal investigator (also list any key contacts in EA, WA, or IGP, if applicable)
1	Participatory development and testing of strategies to reduce climate vulnerability of poor farm households in East Africa through innovation in potato and sweet potato technologies and enabling policies	206,078	Government of Germany - BMZ & GTZ	Lieven Claessens (CIP-SSA)
2	Predicting climate change induced vulnerability of African agricultural systems to major insects pests through advanced	584,339	Government of	Jürgen Kroschel

	insects phenology modeling and decisions aid development for adaptation planning		Germany - BMZ & GTZ	
3	Achieving Sustainable Rural Development in the Peru-Bolivia Altiplano through the Improvement of Andean Agriculture.	212,882	CIDA-Canada	Roberto Quiroz
4	Breeding of potato cultivars tolerant to high temperature and adapted to long days with improved quality traits for variety selection in East Asia against global climate change	5,000	Korea, Republic of (Government of The Republic of Korea -RDA)	Merideth Bonierbale
5	Mejora en los sistemas productivos de papa y trigo a través de variedades con tolerancia a la sequia.	8,000	Government of Peru	Stef de Haan
6	Broadening the genetic base of potato for the tropics, in preparation for climate change	2,000	Global Crop Diversity Trust (GCDT)	Merideth Bonierbale

Notes: If a bilateral project is contributing to more than one CRP, this is only the CCAFS activities.

Table C. Activity Tables by Themes/Objectives

Note:

(1) Activities should be approximately US $250,000 in value, inclusive of all costs (i.e., including personnel, overhead, etc.).
(2) The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that regional program leaders can plan synthesis and coordination activities. They will not be used for any later reporting.
(3) Milestone numbers will be provided by theme leaders.

Theme 1: Adaptation to Progressive Climate Change				
Milestone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**

1.1 Adapted Farming systems to changing climate conditions				
1.1.1.1	Compilation of existing databases on potato performance related to climate from multiple sources	Global database and tools for collection, storage, analysis and consultation of potato trial data.	A global database has been built upon the open source software 'biomart' (www.biomart.org). CIP has made available some data for the general public. In another installation, the database scheme allows for capturing much more details on field experiments. Currently, the most typical trials (for yield and late blight resistance in one or more environments) are provisioned for. More data types can be accommodated as needs arise. Biomart can be consulted both by web page and from within the free statistical software R. Using the CIP developed R library 'agricolae,' this allows analysts to directly retrieve data from the shared online repository and analyze them in R. For ease of use of non-R users, a graphical point-and-click interface is being developed to facilitate the use of routine analyses. This same interface—called tentatively 'DataCollector'—also serves to check the conformance to formats while importing data from Excel. A first version of DataCollector is under usability testing; a training workshop is scheduled for breeders for mid-March 2012.	CIP regional offices and key NARI partners
		Potato yield data sets documented and available	Formats to document comprehensively the trial data in accordance with current best practices in data documentation have been developed based on CIPs International Cooperators Guide for potato trials and will be further reviewed and consolidated during the February workshop.	
		Potato abiotic stress tolerance data sets documented and available (heat, drought, salinity)	Drought tolerance database from 10 genotypes–locality San Ramon 2011. These will be available in February 2012. Heat tolerance database is going to be improved. Available in December 2012. Efficient methods for selection models will be transferred to breeding programs.	
		Potato evaluation site descriptors documented and available	**Physiological parameters:** Adaptation drought stress–Parameter measurement: canopy cover, normalized difference vegetation index-NDVI, specific leaf area-SLA. Tolerance dehydration–Parameter measurement: stomatal conductance, water use efficiency, cell membrane thermostability.	

			Avoidance dehydration Parameter measurement: osmotic potential, adjustment osmotic, relative water content. These will be available in May 2012.	
1.2 Breeding strategies for future climatic conditions				
1.2.1.3	User-friendly geospatial potato & sweetpotato models	Software containing CIP-developed routines for daily climate generators (temperature & rainfall), and for correcting daily rainfall estimated by TRMM downloadable from the MP7 web-site (an advanced beta version)	The software (beta version) was developed in Matlab and reprogrammed in C++ for end users. It contains several modules, each of the module duly tested and either published, submitted to a peer-reviewed journal or near submission. A Wavelet Transform (WT)-based Multi-Resolution Analysis (MRA) was implemented to combine remotely sensed data with the distinctive feature of local rainfall variability extracted from gauged measurements (Quiroz et al. 2011). The MRA allows the decomposition of a signal into various resolution levels which retain the main features of the original signal. Three applications of the MRA methodology to rainfall signals for a specific geographical position are summarized: (1) rainfall data gap infilling based on an improved version of the procedure described by Carbajal et al. 2010; (2) daily rainfall estimation from Normalized Difference Vegetation Index (NDVI), based on Quiroz et al. 2011; and (3) TRMM correction, based on Heidinger et al. 2011. It was shown that the methodology produced good results in contrasting areas of the world (e.g., Ethiopian highlands, the Indo-Gangetic plains, Sao Paulo, Brazil, and the Andean Plateau). The feasibility of generating long-term daily rainfall data was also demonstrated. Daily rainfall generated with remotely sensed information was quite good, as judged by several metrics (e.g., probability density functions, bias, R2, entropy difference). When spatial climate is required, most users revert to interpolation techniques. Anusplin is one of the widespread techniques used for climate interpolation. This interpolation technique was used in the Altiplano. When a large number (n = 19) of weather stations were used for daily rainfall, Anusplin provided good interpolations, as tested by cross-validations. However, if the number of weather stations used in the interpolation process was below 10, the interpolation values were meaningless. In geospatial reconstruction of daily rainfall, using the WT-based MRA described by Quiroz et al. 2011, the quality of the generated	SENAMHI – National meteorology & Hydrology services Peru & Bolivia EMBRAPA. Brazilian Agricultural Research Corporation CAAS MP3-RTB

			data was similar to those generated by Anusplin using 19 weather stations. On average, R2 were ~0.4 and > 0.6; MSE ~10 and ~3; and Bias <1 (both methods) for Anusplin and NDVI-reconstructions, respectively. The big difference was that for the tested area, only one weather station was required for the NDVI-based reconstruction. For data-scarce environments, the common denominator in CCAFS areas, these are encouraging results. A WT-MRA weather generator was also developed and tested against standard Markov–chain-based weather generators (paper in preparation). A detailed report recently submitted to Theme 4 leader contains more details. SENAMHI, the National Meteorology Service in Peru and a close collaborator in this activity, is already testing some of the tools to implement the ones suited to their needs. The data completion tool, together with the data reconstructions, are the ones being further validated in other sites of Peru. We have contacted other national meteorology offices in South and Central America. A joint test with data from Ethiopia was conducted with IRI and with ACIAR for India. Delayed funding also held up the acquisition of a high performance computer. With the HPC CIP will be able to run applications in other CCAFS sites. **Publications:** Carbajal, M., Yarlequé, C., Posadas, A., Silvestre, E., Mejía, J., and Quiroz, R. 2010. Reconstrucción de datos faltantes de precipitación pluvial diaria mediante la Transformada Wavelet. *Revista Peruana Geo-Atmosférica (RPGA)* 2: 76–88. Quiroz, R., Yarlequé, C., Posadas, A., Mares, V., and Immerzeel, W.W. 2011. Improving daily rainfall estimation from NDVI using wavelet transform. *Environmental Modelling & Software* 26(2): 201–209. Heidinger, H., Yarlequé, C., Posadas, A., and Quiroz, R. 2012. TRMM rainfall correction over the Andean Plateau using wavelet multi-resolution analysis. *International Journal of Remote Sensing* (in press).	
1.2.1.3		Preliminary suitability maps for	The methodology used for mapping suitability included (1) a consultative process to define the rules for determining the suitability of different	NARIS in Target countries

		selected potato and sweetpotato varieties and cultivars	genotypes. The preliminary version contained rules for photoperiod and temperature—both for plant growth and development and tuberization needs; (2) generation of global data input for the suitability mapping process at different spatial resolutions; (3) developing geospatial algorithms in the computer; (4) feedback from crop experts; (5) use of crop models with specific parameters for target regions and genetic material; and (6) inclusion of present and future climate scenarios for a comparative assessment. At a global level, the process was completed for both potato and sweetpotato crops. Parameters for sweetpotato materials adapted to East Africa (cultivars: Naveto, Tanzania, Jewel, and Zapallo) were run and maps are available. In the case of potato, the crop modeling process was conducted for the Andes and part of Asia (*S. tuberosum*, *S. andigena*, and hybrids). Paper is in preparation.	MP3-RTB
1.2 Breeding strategies for future climatic conditions				
	Development of efficient screening methods for heat-tolerant potato	In-vitro screening protocol for tuberization available	Results demonstrated that the in-vitro screening method was highly effective in identifying families with a high potential for adaptation to stress conditions—in this case, ability to tuberize at elevated temperatures (Tº used 18º 27º 30º C). This offers the possibility of reducing the number of families to be assessed under field conditions to evaluate only a small group of families with a high rate of effectiveness of selection and identification of superior parental combinations for breeding. Three locations in Peru have been selected for validation of the in-vitro techniques under field conditions, San Ramon–Chanchamayo (January–April/high RH > 50%, day and night high temperature); La Molina–Lima (January–April/low RH <50% day and night high temperature); and Majes–Arequipa (January–April/low RH <50% day high temperature and night low temperature). The latter location serves as a control site. **Identification of Heat-Tolerant Potato Clones for Asian Countries** The strategic use of parental materials and new selection sites and more stressful seasons in Peru has resulted in a new generation of potential varieties with more reliable marketable yield and higher selection scores	Rural Development Authority of Korea

			than previously available. Twenty-two selected genotypes will be introduced to in-vitro culture to be transferred to Korea for evaluation in East Asian environmental conditions. In Korea as well as Peru, these genotypes will be further assessed under high-temperature field conditions to confirm the predictive ability of the heat tolerance screening system for variety development targeting similar eco-geographic areas of the world.	
1.3 Species and genetic diversity for climate change				
1.3.1.1	Testing of drought- and heat-tolerant potato germplasm	3 candidate potato varieties with drought tolerance identified	370120, 370121, 395193.1, 396311.1	
		3 candidate potato varieties with heat tolerance identified	Families 303529 (c40.027 S. Munive—Early screening method) 303491(6.099 E. Mihovilovich—heterosis) 303408 (c54.098 S. Munive—early screening method) 302205 (K39.017 S. Munive—in-vitro screening method)	
		Tuber seed of 4 heat-tolerant candidate varieties available for validation trials	Early screening method. Families recommended (3031149, 303156, 303018, 303098, 303139, 303405, 303609, 303408, 303023); susceptible families (303082 303143 303191)	
	Development of efficient screening methods for heat-tolerant potato	In-vitro screening protocol for tuberization available	Families selected by In-vitro screening method (302478, 304107, 302496, 303408, 303136).	
Theme 2, Adaptation Pathways for Current Climate Risk				
Milestone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				

2.1.1.4	Characterize climate related risk of key potato- and sweet potato-based systems, including the local perspective	Synthesis report, including lessons learnt in different continents	Field studies to assess the awareness of local populations and their vulnerability in the face of climate change have been conducted in several regions in Peru and Africa. One study focused on El Niño phase of ENSO and concluded that rural communities in Peru tend to recall El Niño events according to the magnitude of negative impacts they have caused and that the ability to cope with climatic hazards is dependent on assets and diversification of income sources. Another study conducted in the Peruvian Altiplano assessed the smallholders´ climate vulnerability with respect to food security based on similarities of household attributes. The analysis focused on the most important dimensions of vulnerability: land and livestock resources, agricultural management, education, traditional knowledge, and purchasing power. A cluster analysis revealed similarities among the livelihood systems resulting in a set of five typical vulnerability patterns. The resulting vulnerability patterns further allowed differentiating the social group of smallholders recognizing that the livelihood systems show clearly distinct characteristics, including their ability to absorb climate shocks. The differential household attributes are thereby related to differential vulnerability outcomes in agricultural production and food purchase that are used to verify the vulnerability patterns. By ranking the vulnerability patterns according to the severity of vulnerability, we propose thematic and spatial entry points for vulnerability reduction. In East Africa, the tradeoff analysis (TOA) was used to assess the climate vulnerability of the livelihood systems and the viability of adaptation options using quantitative impact assessment tools. The assessment engaged farmers, policy makers and researchers in modeling adaptation to climate variability and change and captured their perceptions of climate vulnerability and adaptation options. The results showed differences between agro-ecologies and stakeholder groups, and generated relevant information for ensuring that the TOA approach involves relevant stakeholders from the onset. **Publications:** Sietz, D., Mamani Choque, S.E., and Ludeke, M.K.B. 2011. Typical patterns of smallholder vulnerability to weather extremes with regard to food security in the Peruvian Altiplano. *Regional Environmental Change*	NARIS in target countries

			Online First. Sietz, D., Thiele, G., and Claessens, L. 2011. Adapting African agriculture to climate change - Engaging stakeholders in reducing climate vulnerability. Working Paper 2011-7.	
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				
2.3.3.3	Modeling climate-sensitive pest and diseases for potato- and sweetpotato-based systems	Preliminary versions of the models	- The Insect Life Cycle Modeling (ILCYM) Software for analyzing a wide range of insect pests and natural enemies was updated and improved. - Life table data collections for 16 pest species and 7 related natural enemies are ongoing. The project has recruited 17 students based in 5 countries: 1 (Benin), 3 (Cameroon), 7 (Kenya), 3 (Uganda), and 3 (Peru). - Training workshops aimed at introducing the students involved in the project, their supervisors, and scientists on the use and application of ILCYM were successfully conducted between May and June 2011, in Kenya, Cameroon, and Uganda, respectively. - Two websites (CIP-HQ and *icipe*-HQ) were used for hosting ILCYM software. - ILCYM was used for predicting climate-change–caused changes in global temperature on potato tuber moth *Phthorimaea operculella* (Zeller) distribution and abundance. The manuscript is under review on *Agricultural and Forest Meteorology*.	CRP3-RTB IITA, ICIPE, Kephis, (Kenya), Makerere University, and NaCCRI (Uganda)

Theme 3, Pro-Poor Climate Change Mitigation				
Milestone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				
Milestone *3.3.1.1*	Measure GHG fluxes in potato- and sweetpotato-based systems and develop MRV	Validated equipment for field assessments of soil carbon stocks and recalcitrance Synthesis of preliminary results	The measurement of soil carbon stocks and their recalcitrance is a key task to understand and model GHG fluxes in agricultural systems. State-of- the-art equipment for bench and field assessment was tested and compared in collaboration with the Instrumentation Center of the Brazilian Agricultural Research Corporation (EMBRAPA). The partnership has assessed soil CS and C stability in different agro-ecosystems in the Southern Peruvian Andes, Kenya, and Brazil, using state-of-the-art non-destructive analytical methods. Spectroscopic techniques, with high potential for field application, were used to analyze whole soil samples without sample preparation. Carbon stocks as well as aliphatic and aromatic recalcitrance of soil carbons were assessed. Positive results have been obtained using Laser Induced Breakdown Spectroscopy (LIBS), Laser Induced Fluorescence (LIFS), and Near Infrared Spectroscopy (NIRS). Methodologies using LIBS and NIRS are being developed for soil C quantification and a LIFS equipment was developed by EMBRAPA to evaluate C stability in soil. Several papers were published (or in press) and the synthesis of the comparative analysis has been published as a chapter of a joint CCAFS-FAO book in which we added to our own work on emergent techniques a review of the recent literature on the subject. CCAFS also published the extended version of the comparative assessment as an institutional working paper. Relevant results from some emerging techniques based on NIRS, LIBS, and LIFS, which	EMBRAPA-Agricultural Instrumentation Rutgers University University of Manitoba MP5

			measure carbon quantity and stability were presented. Each methodology has specific capabilities and their combined use along with other analytical tools will improve SOM research. Opportunities are provided by the development and application of portable equipment systems, based on spectroscopic methods, for in-situ measurements of SOM content, in different ecosystems. These apparatus could provide faster and lower cost field analysis to improve the data bases on carbon content in soils and their compartments. These increased data are essential for carbon balance models and for reducing extrapolation risks from a reduced number of carbon analyses. **Publications:** Milori, D.M.P.B., Segnini, A., da Silva, W.T.L., Posadas, A., Mares, V., Quiroz, R., and Martin-Neto, L. 2012. Emerging techniques for soil carbon measurements. In: Wollenberg, E., Nihart, A., Tapio-Bistrom, M.-L., Grieg-Gran, M. (Eds.), *Climate Change Mitigation and Agriculture*. London: Earthscan, pp. 252–262. Milori, D.M.P.B., Segnini, A., da Silva, W.T.L., Posadas, A., Mares, V., Quiroz, R., and Martin-Neto, L. (Eds.). 2011. Emerging techniques for soil carbon measurements. CCAFS Working Paper no. 2. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark. Segnini, A., Posadas, A., Quiroz, R., Milori, D.M.B.P., Saab, S.C., Martin Neto, L., and Vaz, C.M.P. 2010. Spectroscopic assessment of soil organic matter in Wetlands from the high Andes. *Soil Science Society of America Journal* 74: 2246–2253. Segnini, A., Posadas, A., Quiroz, R., Milori, D.M.B.P., Vaz, C.M.P., and Martin-Neto, L. 2011. Soil carbon stocks and stability across an altitudinal gradient in southern Peru. *Journal of Soil and Water Conservation* 66: 213–220. Segnini, A., Posadas, A., Quiroz, R., Milori, D.M.B.P., Vaz, C.M.P., and	

			Martin-Neto, L. 2012. Characterization of Peatland Soils from the High Andes by 13C NMR Spectroscopy. *Organic Geochemistry* (in press).	
Theme 4, Integration for Decision Making				
Milestone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.2.1.2	Develop a climate downscaling methodology based on wavelets, multifractals and neural networks	Proof of concept plus a paper Covered under Milestone 4.2.1.2	Climate downscaling is a difficult task in data-scarce environments, a condition found in most areas where the CGIAR and CCAFS work. Therefore, the completion of daily rainfall time series at different spatial resolutions—to be used for estimating downscaling parameters and to build a daily weather generator—were the focus of the initial stages of our work, as reported above. A downscaling algorithm based on the multiplicative random cascade disaggregation method was developed. The principal objectives were to (1) generate a multiscaling random cascade disaggregation model that represents the precipitation as a Lognormal distribution, using a multifractal technique; (2) use the Mandelbrot-Kahane-Peyriere function to characterize the process; and (3) apply the model to simulate rainfall distribution in an Andean area (Peru-Bolivia) with high topographical and rainfall heterogeneities. This algorithm was tested and calibrated using TRMM precipitation data to generate the downscaling parameters. Daily TRMM 3B42 v6 data for the period 1998–2007 were obtained from TRMM Online Visualization and Analysis. Monthly rainfall snapshots were created by accumulating daily estimates. February, April, and August 2003 were used to represent the wettest, an intermediate, and the driest month in the high plateau and surroundings, respectively. A square area of 16 x 16 TRMM pixels (~ 430 x 430 km)—spanning an altitude gradient from around	University of California at Santa Barbara

			2,000–6,500 masl and a rainfall gradient from ~ 400–3,000 mm y^{-1} was selected. A rainfall ensemble over the entire square was downscaled—using the random cascade disaggregation model—to the individual pixels. Cascading down the rainfall events below the ~ 28 km resolution (TRMM pixel size) requires for geospatial measurements of the events at the lowest desirable spatial resolution. For this proof of concept the probabilistic generator was parameterized using ~ 1 km layers generated through interpolation and NDVI-derived data, as shown above. Anusplin interpolation has the limitation that a large number of weather stations are demanded to have good quality interpolated data. NDVI-derived data are suitable in areas with rainfall below 1,200 mm per rainy season. Another limitation for using NDVI-derived data is the presence of clouds which could potentially introduce bias in the process. Downscaled values (~ 1 km) are contained within the 95 % confidence interval of interpolated surfaces (more details were submitted in a report to CCAFS Theme 4 leader). The beta version of the algorithm is ready. CCAFS has just approved the acquisition of the high-performance computer where the software will be programmed and run. We invite CCAFS colleagues to contact us to test the suitability of the model in other target regions of the Program. **Publications:** In preparation	
4.2.1.9	Vulnerability assessment of potato and sweet potato based systems in target countries	Vulnerability (drought and heat stress) georeferenced maps and data sets using climate change scenarios and models defined in Theme 1.	Climate change scenarios were used to map heat–stress-prone areas at present and in 2050. CIP has developed varieties that can tuberize at higher temperature (> 18^{o}C). Preliminary runs for these materials were conducted using generic coefficients. Field experiments are planned to fine-tune model parameters to improve the assessment. Based on the temperature thresholds for different phenological states, global data were preprocessed and used as input for the geospatial algorithm developed to assess heat stress, particularly during the tuberization phase. To assess whether the warming trends had a significant effect on potato productivity, we simulated the behavior of several varieties using the model described by (Condori et al. 2010), with gauge temperature data. In a higher spatial resolution analysis for the vulnerability of potato in the Andes, the response to temperature changes during the last 50 years was assessed for the	NARIS in target countries

			following varieties at different altitudes: Luki (*Solanum juzepczukii*, a bitter variety), Gendarme (*Solanum tuberosum* ssp. Andigena), and Sajama (a hybrid containing *Solanum tuberosum* ssp. Tuberosum –dominant-, *Solanum tuberosum* ssp. Andigena, *Solanum phureja*, and *Solanum acaule*). In an inter-Andean valley at 3,200 masl, all three varieties showed high potential productivity; a productivity that declined with time. The second site was located near Lake Titicaca at 3,920 masl. In this site, the potential productivity was maintained throughout the simulation period. The thermal regulation provided by the large water mass of the lake seems to buffer the effect of rising temperature seen elsewhere. The third site was a location at 4,250 masl. In this site not even the frost-tolerant Luki variety was able to produce in the 1960s. Nonetheless, in recent years, temperatures seem to be reaching the levels where bitter potatoes can be produced. Simulation findings are consistent with the warming trends in the center of origin of potato. Likewise, the results support the hypothesis of an upward migration of potato-based agriculture. This migration will produce an encroachment upon grasslands and peatlands. The upward movement of potato agriculture is supported from the productivity point of view. Notwithstanding, changes in productivity should not be the only indicator for assessing the impact of climate change on the agriculture of the region. The feedback to the environment, for instance in CO_2 emissions, must be factored into the equation. Wet grasslands and peatlands in the Andes are very rich in soil carbon contents and the carbon molecules stored in those soils are highly labile (Segnini et al. 2010). On the other hand, the carbon stocks in cropped land are substantially lower (Segnini et al. 2011). Plowing carbon-rich soils to convert them to crop land, just because the climate is appropriate to produce more food, might be deleterious to the environment. If pasturelands in the Andes are incorporated into crops, the soil carbon pool can be reduced from more than 225 Mg/ha to around 55 Mg/ha (top 30 cm of soil). Preliminary results combining models fed with IPCC scenarios to map suitable areas for potato production by 2050, and imagery mapping of actual land use indicate that potential loss of C stocks is in the order of 14 Tg (14 x 1012 g). The complete analysis was described by Quiroz et al. 2012 With the late disbursement, the hiring of staff to finalize the drought stress scenarios was delayed. This work will be shortly implemented and	

			reported soon. **Publications:** Condori, B., Hijmans, R.J., Quiroz, R., and Ledent, J.-F. 2010. Quantifying the expression of potato genetic diversity in the high Andes through growth analysis and modeling. *Field Crops Research* 119: 135–144. Quiroz, R., Posadas, A., Yarlequé, C., Heidinger, H., Barreda, C., Raymundo, R., Gavilán, C., Carbajal, M., Mares, V., Tonnang, H.E.Z., Kroschel, J., Forbes, G.A., and De Haan, S. 2012. Challenges to sustainable potato production in a changing climate: A research perspective. Invited paper, Potato Research – Under editorial revision Other publications cited above	
4.3 Refining frameworks for policy analysis				
4.3.1.1	Assessment of potato and sweetpotato crop/system productivity potential and identification of promising technologies for modeling	Report on promising technologies (potential book chapter)	The simulation of productivity impacts of climate change with alternative crop varieties has been conducted within the Global Future Project, involving the use of the DSSAT crop modeling system for spatial global simulations. An essential first step was the calibration of modern varieties for DSSAT. Efforts have been made to collect and collate yield trial data available at CIP and to use this data for the calibration of the SUBSTOR potato module of DSSAT. The fact that yield trials are an integral part of the work of plant breeders at CIP (and elsewhere) offers the opportunity to obtain experimental data for crop model calibration. Breeders are interested in applications of crop growth models to explore the performance of a particular clone or variety in different environments and to assess the performance of so called "virtual cultivars." The efforts to calibrate the DSSAT model have shown that a good calibration requires a sound understanding of the model. This refers to the understanding of the processes simulated as well as to the interpretation of the genetic coefficients. The latter are often difficult to reconcile with the concepts breeders are used to work with. Nonetheless, the calibration work benefitted greatly from the support provided by CIP's Crop Management and Production Systems Division, which develops and maintains the	IFPRI and CG Centers in Global Futures Project (CIAT, CIFOR, CIMMYT, ICRAF, ICRISAT and IRRI)

			SOLANUM potato model. Given the constraints encountered, it was only possible to calibrate 3 cultivars instead of the 10 initially envisaged. The quality of the results for the 3 cultivars, which have been calibrated, can be considered to represent the best obtainable. As they are based on the available field data and evaluated against the knowledge of CIP experts, the calibrated coefficients certainly represent good approximations to the "real" coefficient values.	

CIP Case Study

Title: developing the bases for a CCAFS-IAI capacity strengthening alliance in the Americas

- Case type: innovative non-research partnerships

- Brief description of the activity – One of the aims of CCAFS is to ensure effective engagement with institutional and policy stakeholders and to provide, through a demand-driven process, downscaled analyses and tools for future climates. CIP initiated the conversations with the Inter American Institute for Global Change Research (IAI), to take advantage of their network of contacts with institutions and policy makers in the region and their information on institutional demands that could contribute to achieving CCAFS goal in the Americas. IAI considers one of its main priorities to be the support of training and education activities, such as granting fellowships and research opportunities to students and professionals from many countries of the Americas. IAI has also access to high-level decision-makers in most institutions in the Americas dealing with climate and its impact on the society. Marcella Ohira, IAI's Assistant Director for Capacity Building, was invited to CIP to explore options for developing CCAFS-IAI synergies in the continent. CIP and CIAT tested one of the options by jointly sponsoring a Colombian student with IAI to be trained at INPE/CPTEC (Brazil) on seasonal forecasting at different spatial scales and to assess climate impact on beans and potato productivity in the Andes.

- Result of activity – The test-case training was highly successful, as rated by the four institutions involved. In addition, CIP contacted IAI and CCAFS directors and theme leaders to discuss a formal agreement to not only sponsor young scientists but to jointly reach decision-makers in the Americas.

- Partners involved and their role – CIP and IAI initiated the conversations, both virtually and face-to-face; CIP-CIAT-IAI co-invested in the training of the young Colombian scientist. INPE/CPTEC (Instituto Nacional de Pesquisas Espaciais/Centro de Previsao de Tempo e Estudos Climaticos) provided training on ETA (Regional model) and seasonal forecasting. CCAFS director and Theme leaders were contacted to assess the feasibility of a formal inter-institutional MOU CCAFS-IAI, but answer is still pending.

- Research on which the activity is based – For the time being the research activities where the partnerships has been based on were climate downscaling and crop modelling, but the potential is for using this vehicle to channel all the knowledge generated in CCAFS and partner institutions and reach scientists and policy-makers in the Americas as well as to elicit demands from the governments in the region on climate-food systems research.

- Web address for further information (if available)

CIP Case Study

Title: Improving regional capacity for climate related vulnerability analysis

- Case type: innovative results from capacity strengthening activities

- Brief description of the activity – One of the aims of CCAFS is to ensure effective capacity strengthening of national partner institutions. CIP has conceived that this activity should not be initiated from scratch but rather be built upon previous experiences, which provide the opportunity for enhanced impacts. During the second half of the past decade, CIP worked actively with agricultural national institutions in Mexico, Costa Rica, Ecuador and Panama, in order to develop their in-house capacities for vulnerability analysis in the face of climate change and increased frequency of extreme weather events affecting agriculture. Several joint studies such as the determination of spatial-temporal variability of precipitation, soil erosion risks associated to land use systems and the application of the SWAT model for the assessment of the effect of soil management on watersheds conditions have been conducted in collaboration with new vulnerability analysis units that CIP helped to establish or strengthen at national research institutions in the above mentioned countries. Within CCAFS, CIP has continued the interaction with these units, fostering the maintenance and strengthening of a regional institutional network. The expansion of this interaction is proceeding beyond the initial group of national agricultural research institutions (NARIs) and is including the meteorological organizations such as SENAMHI in Peru and in other countries.

- Result of activity – This is an ongoing activity (due to delayed funding) that will provide a platform for climate related vulnerability analysis in the region and also for further training activities.

- Partners involved and their role – Initial partners in former activities have been INIFAP (Mexico), INTA (Costa Rica), INIAP (Ecuador) and IDIAP (Panama). Lately, we have initiated an active collaboration with EMBRAPA and the meteorological organizations of the respective countries. SENAMHI- Peru and SENAMHI-Bolivia already started testing our data gap filling and reconstruction products and the Costa Rican meteorology service is in the process of joining. This collaboration will allow more effective regional data availability and the joint development of methods and tools for vulnerability analysis.

- Research on which the activity is based – Several lines of research, particularly vulnerability analysis, remote sensing, climate downscaling and crop modelling are contributing to this activity. It is also based on the assessment of complex interactions between climate variability, productive resources and agricultural management that affects farmer's capacity to adapt to climate change. This approach evaluates smallholder's vulnerability with respect to food security based on typical patterns of household characteristics and livelihood capitals.

- Web address for further information (if available)

CIP Case Study

Title: Insect Life Cycle Modeling (ILCYM) software training events in 2011

- Case type: innovative results from capacity strengthening activities

- Brief description of the activity – CIP's Agroecologyl/IPM program organized three-day training workshops on the use and application of ILCYM software at CIP-HQ Lima, Peru from 13 to 15 April 2011; at icipe, Nairobi, Kenya from 18 to 20 May 2011; at IITA, Yaounde, Cameroon from 1 to 3 June 2011 and at NaCCRI, Uganda from 27 to 29 June 2011. Overall, the training courses involved 56 participants from Peru (15), Kenya (13), Cameroon (13) and Uganda (15), who were students and scientists participating in the collaborative BMZ-funded project entitled "Predicting climate change induced vulnerability of African agricultural systems to major insects pests through advanced insects phenology modeling and decisions aid development for adaptation planning". Participants developed temperature dependent phenology models based on life tables for the potato tuber moth *Phthorimaea operculella* (pest cohort life table) and its parasitoid *Copidosoma koehleri* (parasitoid cohort life table with variable rate) as well as *Trialeurodes vaporarorium* (pest full life table). The developed models were later used for deterministic, stochastic, and spatial simulation for estimating the species potential population distribution and field abundance. Further, different temperatures scenarios were applied for the analysis of the impacts of future climate change scenarios on different insect species. Other ILCYM trainings were conducted at the Joint ICTP-TWAS Workshop on Regional Climate Change and Impacts Modeling for Critical Assessment and Adaptation Strategies in Agriculture and Water Sectors over the Horn of Africa, 20-24 June 2011, Nairobi Kenya, as well as at the Summer School on Climate Impacts Modelling for Developing Countries: Water, Agriculture and Health Trieste, Italy, 5-16 September 2011.

- Result of activity – The training was highly successful, as rated by the institutions involved.

- Partners involved and their role – Partners in this training activity were the International Center for Insect Physiology and Ecology (*icipe*), Nairobi, Kenya, as well as the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. The partners hosted the training activities and are actively collaborating in project activities to investigate the impact of climate change on insect pests and their natural enemies.

- Research on which the activity is based – ILCYM software is an innovative open-source computer package developed by the Agroecology/IPM program of the International Potato Center (CIP), Lima, Peru (available at http://www.cipotato.org/ilcym/), which facilitates the development of generic pest phenology models based on temperature. Modeling outputs lead to a better understanding of pests' biology and ecology and support decision making in pest management. The program determines best-fit non-linear functions for temperature-driven processes in insect species, i.e. development, mortality and reproduction, and compiles them into an overall pest phenology model. A rate summation and cohort up-dating approach is used for simulating multidimensional age and stage structured populations. ILCYM links developed models to a

geographic information system (GIS) environment, in which three generic risk indices (Establishment, Generation, and Activity index) can be visualized in worldwide or regional maps. Life-table parameters can be forecasted over time for single locations. ILCYM is also an ideal tool for assessing the effects of global warming on insect pest populations.

- Web address for further information (if available): http://cipotato.org/research/crop-management-production-systems/global-control-principles-and-strategies-for-potato-and-sweetpotato-pests-and-diseases/insect-phenology-modeling-and-climate-change

CIP-CC Publications (2011 and Forthcoming)

Adimo, A.O.; Njoroge, J.B.; Claessens, L. (CIP); Wamocho, L.S. 2011. Land use and climate change adaptation strategies in Kenya. Mitigation and Adaptation Strategies for Global Change. (Netherlands). 17(2):153-171. ISSN 1381-2386, http://dx.doi.org/10.1007/s11027-011-9318-6.

Blandon-Diaz, J. U., Forbes, G. A., Andrade-Piedra, J. L., & Yuen, J. E. (2011). Assessing the Adequacy of the Simulation Model LATEBLIGHT Under Nicaraguan Conditions. Plant Disease, 95(7):839-846. http://dx.doi.org/10.1094/PDIS-10-10-0702

Buytaert, W.; Cuesta-Camacho, F. (CIP); Tobon, C. 2011. Potential impacts of climate change on the environmental services of humid tropical alpine regions. Global Ecology and Biogeography. (UK), 20(1):19-33. ISSN 1466-822X. http://dx.doi.org/10.1111/j.1466-8238.2010.00585.x.

Garrett, K.A.; Forbes, G.A. (CIP); Savary, S.; Skelsey, P.; Sparks, A.H.; Valdivia, C.; Bruggen, A.H.C. van.; Willocquet, L.; Djurle, A.; Duveiller, E.; Eckersten, H.; Pande, S.; Vera Cruz, C.; Yuen, J. 2011. Complexity in climate-change impacts: an analytical framework for effects mediated by plant disease. Plant Pathology. (UK), 60(1):15-30. ISSN 0032-0862. http://dx.doi.org/10.1111/j.1365-3059.2010.02409.x.

Kadian, M,S,; Bonierbale, M.; Singh, S.V.; Luthra, S.K.; Sharma, N.; Patel, N.H.; Kumar, V. 2011. Early maturing potato for sustainable intensification in cereal based systems in India. In: EAPR 2011 Abstracts, The 18th Triennial Conference of the European Association for Potato Research held at Oulu, Finland during July 24-29, 2011. p. 111.

Kromann, P. (CIP); (2011). Use of the Environmental Impact Quotient to Estimate Health and Environmental Impacts of Pesticide Usage in Peruvian and Ecuadorian Potato Production. Journal of Environmental Protection, 02(05):581-591. DOI: 10.4236/jep.2011.25067

Legay, S.; Lefevre, I.; Lamoureux, D.; Barreda, C. (CIP); Tincopa Luz, R. (CIP); Gutierrez, R. (CIP); Quiroz, R. (CIP); Hoffman, L.; Hausman, J.F.; Bonierbale, M. (CIP).; Evers, D.;

Schafleitner, R. (CIP). 2011. Carbohydrate metabolism and cell protection mechanisms differentiate drought tolerance and sensitivity in advanced potato clones (Solanum tuberosum L.). Functional and Integrative Genomics. (USA), 11(2):275-291. ISSN 1438-793X. http://dx.doi.org/10.1007/s10142-010-0206-z.

Quiroz, R., Yarlequé, C., Posadas, A., Mares, V., Immerzeel, W.W. 2011. Improving daily rainfall estimation from NDVI using wavelet transform. Environmental Modelling & Software, 26(2):201-209. DOI: 10.1016/j.envsoft.2010.07.006.

Rana, R.K.; Sharma, N.; Kadian, M,S,; Girish, B.H.; Arya, S,; Campilan, D.; Pandey, S.K.; Carli, C.; Patel, N.H.; Singh, B.P. 2011. Perception of Gujarat farmers on heat-tolerant potato varieties. *Potato Journal,* 38(2):121-29. http://www.indianjournals.com/ijor.aspx?target=ijor:pj&volume=38&issue=2&article=004&type=pdf

Savary, S.; Nelson, A.; Sparks, A.H.; Willocquet, L.; Duveiller, E.; Mahuku, G.; Forbes, G. (CIP); Garrett, K.A.; Hodson, D.; Padgham, J.; Pande, S.; Sharma, M.; Yuen, J.; Djurle, A. 2011. International agricultural research tackling the effects of global and climate changes on plant diseases in the developing world. Plant Disease. (USA), 95(10):1204-1216. ISSN 0191-2917. http://dx.doi.org/10.1094/PDIS-04-11-0316.

Schafleitner, R. (CIP); Ramirez, J.; Jarvis, A.; Evers, D.; Gutierrez, R. (CIP); Scurrah, M. (CIP). 2011. Adaptation of the potato crop to changing climates. In: Yadav, S.S.; Redden, R.J.; Hatfield, J.L.; Lotze-Campen, H.; Hall, A.E. (eds). Crop adaptation to climate change. Oxford (UK). John Wiley & Sons. pp. 287-297. ISBN 978-0-8138-2016-3. http://dx.doi.org/10.1002/9780470960929.ch20.

Segnini, A.; Posadas, A. (CIP); Quiroz, R. (CIP); Milori, D.M.B.P.; Vaz, C.M.P.; Neto, L.M. 2011. Soil carbon stocks and stability across an altitudinal gradient in southern Peru. Journal of Soil and Water Conservation, (USA), 66(4):213-220. ISSN 0022-4561. http://dx.doi.org/10.2489/jswc.66.4.213.

Sharma, N.; Kumar, P.; Kadian, M.S.; Pandey, S.K.; Singh, S.V.; Luthra, S.K. 2011. Performance of potato (*Solanum tuberosum*) clones under water stress. *The Indian Journal of Agricultural Sciences*. 81(9):39-43.

Sietz, D. (CIP); Mamani Choque, S.E.; Ludeke, M.K.B. 2011. Typical patterns of smallholder vulnerability to weather extremes with regard to food security in the Peruvian Altiplano. Regional Environmental Change. (Germany). ISSN 1436-3798. Published online 15 Nov 2011:17 p. http://dx.doi.org/10.1007/s10113-011-0246-5.

Simon, R. (CIP); Fuentes, A.F.; Spooner, D.M. 2011. Biogeographic implications of the striking discovery of a 4,000 kilometer disjunct population of the wild potato *Solanum morelliforme* in South America. Systematic Botany. (USA), 36(4):1062-1067. ISSN 0363-6445. http://dx.doi.org/10.1600/036364411X605065.

Sparks, A.H.; Forbes, G.A. (CIP); Hijmans, R.J.; Garrett, K.A. 2011. A metamodeling framework for extending the application domain of process-based ecological models. Ecosphere. (USA). ISSN 2150-8925. 2(8):14 p. http://dx.doi.org/10.1890/ES11-00128.1.

Forthcoming 2012

Heidinger, H., Yarlequé, C., Posadas, A., Quiroz, R., 2012. TRMM rainfall correction over the Andean Plateau using wavelet multi-resolution analysis. International Journal of Remote Sensing, 33(14):4583–4602. DOI: 10.1080/01431161.2011.652315.

Kroschel, J., M. Sporleder, H.E.Z. Tonnang, H. Juarez, P. Carhuapoma, J.C. Gonzales & R. Simon (2012): Predicting climate change caused changes in global temperature on potato tuber moth *Phthorimaea operculella* (Zeller) distribution and abundance using phenology modeling and GIS mapping. Journal of Agricultural and Forest Meteorology (Special Issue on Climate Change) (awaiting editor final approval).

Milori, D.M.P.B., Segnini, A., da Silva, W.T.L., Posadas, A., Mares, V., Quiroz, R., Martin-Neto, L., 2012. Emerging techniques for soil carbon measurements, In: Wollenberg, E., Nihart, A., Tapio-Bistrom, M.-L., Grieg-Gran, M. (Eds.), Climate Change Mitigation and Agriculture. Earthscan, London, UK, pp. 252-262

Quiroz, R., Posadas, A., Yarlequé, C., Heidinger, H., Barreda, C., Raymundo, R., Gavilán, C., Carbajal, M., Mares, V., Tonnang, H.E.Z., Kroschel, J., Forbes, G.A., De Haan, S., 2012. Challenges to sustainable potato production in a changing climate: A research perspective. Invited paper, Potato Research – Under final editorial revision

Sporleder, M., H.E.Z. Tonnang, P. Carhuapoma, J. C. Gonzales, H. Juarez & J. Kroschel (2012): Insect Life Cycle Modeling (ILCYM) software – a new tool for Regional and Global Insect Pest Risk Assessments under Current and Future Climate Change Scenarios. CABI Book publication (in press).

ICARDA CCAFS 2011 Report – Activity summary

1.1 Adapted Farming systems to changing climate conditions

1.1.1.1. Compilation and analyses of existing databases to collate and geo-reference multi-site trial data on cereals and food legume crops. Data from South Asia sites of ICARDA's international nursery testing program collated and published (Indo-Gangetic Plain and neighboring zones).

1.1.1.3 Development and testing of zero tillage and conservation agriculture technologies in cereal and legume-based cropping systems. Assessment of potential for dissemination on conservation agriculture practices for climate change adaptation.

1.1.2.1 Using production environment descriptors as predictors for adaptive traits of small ruminants. Methodology for similarity mapping developed and tested in four pilot countries. This pilot study in four selected countries developed a GIS based approach to determine and combine production environment descriptors for indigenous sheep and goat breeds.

1.1.3.1. Identify and promote strategies and methods of drought mitigation and preparedness for progressive climate change conditions. Reactive (crisis) measures of coping with drought used in WANA were described and pro-active options (risk management) of drought management were identified.

1.2 Breeding strategies for future climatic conditions

1.2.1.4 Community-based identification and evaluation of rangeland and forage species for tolerance to drought, cold and salinity, as potential sources of climate change adapted germplasm. Identification of range and forage plant materials with potential for adaptation to the adverse effects of climate change.

1.2.1.3 Develop modelling approaches to evaluate the impacts of climate change and the effects of adaptation technologies on water availability for crops and their productivity under decadal futures from 2020 to 2050. Simulation of impact of a (regionally downscaled) changing climate on wheat growth and yield under rainfed, Mediterranean conditions.

1.2.3.1 Assessment of the impact of climate change on cropping patterns, rural income and food security in in dry areas with priority given to most vulnerable countries. Using estimates of climate change impacts on agricultural crops based on crop simulation models with crop experimental data and production costs obtained by household surveys, we developed stochastic mean-variance model calibrated to main AEZs in each of four Central Asian countries.

1.3.1.1 Analyzing functional genomic markers related to the tolerance of indigenous sheep to heat stress under arid conditions. Developed stress tolerance indices based on physiological and blood parameters to identify tolerant and susceptible individuals in Barki desert sheep and goats.

1.3.1.7. Monitoring of population changes and adaptation of insect pests and diseases of cereals and food legumes. The status of insect pests and diseases were monitored in East Africa and CWANA regions during the 2010-2011 cropping seasons.

1.3.1.1. Development of the Focused Identification of Germplasm Strategy (FIGS) to select best bets for adaptation to climate change. Development of algorithms for the identification of best bet sets of genetic resources for drought, heat and salinity tolerance with FIGS.

1.3.3.1 Organize targeted collection for sampling landraces and wild relatives in dry and hot areas. One collecting mission was organized to Cyprus focusing on dryland and salt affected areas using gap analysis and targeted collecting mission approach.

1.3.3.1 Develop strategies for fast track testing and release of varieties and rapid multiplication and dissemination of adapted varieties to climate change. A document on 'best practices in variety release protocols' to expedite a process under emergency situations (Ug99).

2.1 Managing climate risk and building resilient livelihoods

2.1.1.4 Monitor and model the effects of extreme rainfall events on land, water and vegetation resources and develop adaptation strategies. The impact of soil and water conservation practices on reducing erosion and capturing sediments was assessed.

3.3 On-farm mitigation practices and landscape implications

3.3.1.1 Measuring carbon sequestration in rangelands. ICARDA scientists studied the soil organic carbon (SOC) sequestration potentials of rangelands in Central Asia. Native and current SOC content of the rangelands of Central Asia were estimated.

2011 Activity Plan for CCAFS Centre General Funds:
Activities, Deliverables & Partners

CG Centre:	ICARDA

Table A. Main contacts persons in the Centre

Contacts	Name(s) (specify roles if more than one)	Email
Climate Change Contact Point	Rachid Serraj ; Maarten van Ginkel (DDG-R)	R.Serraj@cgiar.org; M.vanGinkel@cgiar.org
Admin. Issues	Tareq Bremer (projects), Erwin Lopez (Finance)	T.Bremer@cgiar.org
Communications	Michael Devlin (CODIS)	M.Devlin@cgiar.org
Others (if needed, specify role)		

Table B. Bilateral funded projects under CCAFS (2011)

ID#	Name of project	Approximate budget under CCAFS (2011) (1)	Donor	Principal investigator (also list any key contacts in EA, WA or IGP, if applicable)
1	Salinity Management in Iraq	84,000	ACIAR	Manzoor Qadir, Fadi Karam, Theib Oweis
2	Water benchmarks of WANA (options ...)	69,000	AFESD	Mohammed Karrou, Theib Oweis

3	Mountains water management	82,000	IFAD	Mohamed Karrou, Feras Ziadat, Fadi Karam
4	Water for Livelihoods (WLI)	98,000	USAID	Fadi Karam, Theib Oweis
5	Water management in Libya	196,000	Libya	Theib Oweis, Feras Ziadat, M. Karrou
6	Focused Identification of Germplasm Strategy	130,000	GRDC	Kenneth Street, Abdallah Bari

Notes:

(1) If a bilateral project is contributing to more than one CRP, this is only the CCAFS activities.

Table C. Activity tables by Themes/Objectives

Note:

(1) Activities should be approximately US$250.000 in value, inclusive of all costs, i.e. including personnel, overhead etc.
(2) The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that Regional Program Leaders can plan synthesis and coordination activities. They will not be used for any later reporting.
(3) Milestone numbers will be provided by Theme Leaders.

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.1.1.1	Compilation and analyses of existing databases to collate and geo-reference multi-site trial data on cereals and food legume crops-and make them available as international public good on the Internet.	Data from South Asia sites of ICARDA's international nursery testing program collated and published (Indo-Gangetic Plain and neighbouring zones).	During 2011, the following activities have been carried out: The correct coordinates of all 52 research sites of the international nursery testing program of ICARDA in South Asia that have reported experiment results between 2005 and 2010 have been determined (1 in Bangladesh, 28 in India, 8 in Nepal, 15 in Pakistan). Data from a total of 350 experiments grown at the 52 sites between 2004/05 and 2010/11 have been verified and collated (71 on bread wheat, 3 on durum wheat, 64 on barley, 86 on chickpea, 116 on lentil, 2 on fababean, 8 on grass pea). Uploading of the collated data to the AgTrials website has been initiated but is delayed due to technical problems. It will be completed as soon as possible. (W. Goebel and M. Imtiaz)	NARS in countries of the Indo-Gangetic Plain region (Pakistan, India, Nepal, Bangladesh, Bhutan); other CGIAR institutes.
1.1.1.3	Development and testing of zero tillage and conservation agriculture technologies in cereal and legume-based cropping systems	Assessment of potential for dissemination on conservation agriculture practices for climate change adaptation.	Conservation agriculture (CA), and in particular zero-tillage (ZT) adoption in West Asia, has increased from 0 ha in 2005/6 to over 20,000 ha in 2010/11 (AusAid/ACIAR funded Project in Iraq). As the adoption of CA spreads throughout West Asia a need exists to re-evaluate current plant breeding programs which use	ICARDA with NARS partners

			conventional tillage (CT) practices in their selection process and determine the suitability of lines developed under CT for use under ZT conditions. Trials conducted at ICARDA in 2010/2011 evaluated 100 lines each of Barley and Lentil under ZT and conventional tillage (CT) systems. Tillage system did not affect the overall ranking of lentil and barley lines as both crops reacted similarly to ZT and CT systems. (David Feindel et al.)	
1.1.2.1	Using production environment descriptors as predictors for adaptive traits of small ruminants	Methodology for similarity mapping developed and tested in four pilot countries	This pilot study in four selected countries developed a GIS based approach to determine and combine production environment descriptors (PEDs) for indigenous sheep and goat breeds. NARS collaborators mapped the current breed distributions and provided addditional information on special breed characteristics and adaptive traits. The breed distributions were used to determine the natural environments to which the breeds are adapted to. Similarity mapping technique was then used for assessing the likeness between one location and another. In this study four thematic similarity maps (temperature, precipitation, landforms and soil patterns) were integrated into a single environmental similarity map using the 'most limiting factor' approach. The main advantage is that by using an index approach the relationship between two locations is evaluated on a continuous scale and thus, avoids classification traps. The key breed environmental characteristics were evaluated through their own similarity index approaches, depending on whether they are continuous variables (e.g. temperature, precipitation), discrete variables (e.g. landform classes) or complex variables (e.g. soil patterns). Distribution and similarity maps were produced for 61 sheep and 24 goat breeds. The results are being used by FAO to develop a PEDs module in FAO's Global Domestic Animal Diversity Information System (DAD-IS). (E. de Pauw and B. Rischkowsky).	FAO, NARS in Egypt, Iran, Morocco, and Turkey
1.1.3.1	Identify and promote strategies and methods of drought mitigation and preparedness for progressive climate	Guidelines, assessments and methods	Reactive (crisis) measures of coping with drought used in WANA were described and pro-active potential options (risk management) of drought management were identified; Trials on the response of different crops to different supplemental irrigation	NARS, ARI, Development organizations,Policy makers, Other CG

	change conditions		levels were conducted in Morocco (wheat, maize, red pepper) and in Syria (wheat, faba bean, chickpea, lentils)and agronomic and soil moisture data were collected; Trials on the response of different genotypes of durum wheat and barley (10 from each) were conducted in Syria and agronomic and soil moisture data were collected. The effects of different techniques of water harvesting (contour ridges, cisterns, check dams) were evaluated in Jordan. (Mohammed Karrou, IWLMP)	Centers
1.2 Breeding strategies for future climatic conditions				
1.2.1.4	Community-based identification and evaluation of rangeland and forage species for tolerance to drought, cold and salinity, as potential sources of climate change adapted germplasm	Range and forage plant materials with high potential for adaptation to the adverse effects of climate change	Several promising shrub and grass species have been identified and seeded at ICARDA's during fall 2011. The seedlings will be transplanted in March 2012 to a community based rangeland site in Syria. The sites are located in a dry environment (arid) near a salt lake characterized by high degree of salinity. The seedlings will be transplanted along a gradient of salinity from high EC to mid to low. Soil samples has been randomly taken from each site and analyzed at ICARDA's soil lab for EC, OM, pH, soil texture. Over 60 accessions of *Opuntia ficus indica* (Cactus inermis) have been imported from various locations (North Africa, Italy, Argentina, Brazil, etc.). The cactus pads have been planted in three different environments (greenhouse, shaded area, open field) to minimize the risk of losing the plant materials due to extreme weather conditions. The pads are being monitored closely to evaluate the impact of low temperature especially at night. During the spring of 2012 we plan to transplant another set of pads to the field. Such set up will assist us in evaluating the date of plantation of *Opuntia* species on the establishment (vigor and growth) and assess the impact of low temperature. (Mounir Louhaichi et al.)	NARs, ARIs, Other CG Centers
1.2.1.3	Develop modelling approaches to evaluate the impacts of climate change and the effects of adaptation technologies such as supplemental irrigation and water harvesting on	A validated crop model , assessements of CC impacts and recommendations for adaptation stratigies	Focus of activity 1.2.1.3 in 2011 was the simulation of the impact of a (regionally downscaled) changing climate on wheat growth and yield under rainfed, Mediterranean conditions using the CropSyst cropping systems simulation model. Therefore, the	NARS, ARI, Meteo. Organizations, Other CG Centers

	water availability for crops and their productivity under decadal futures from 2020 to 2050	development	model was successfully calibrated to multi-year crop growth biophysical data sets from ICARDA headquarter, Tel Hadya, located in the north of Syria. Subsequently, we analyzed the impact of climate change considering the future periods 2011-2030, 2046-65 and 2080-99, and quantified possibilities of mitigating the negative impact of climate change by means of application of supplemental irrigation. Simulation results indicated that compared to historic (1980-2010) conditions under climate change scenario SRES A1B wheat yield (variety *Cham-1*) will change by on average (of 14 GCMs) +2 % (0.04 Mg/ha), -7 % (-0.13 Mg/ha) and -23 % (-0.44 Mg/ha) considering the periods 2011-2030, 2046-65 and 2080-99, respectively. Thus, after a negligible increase in yields in the immediate future, yields in the mid- and long-term future will be negatively affected by climate change. Year-to-year variability of agricultural production will also increase. Simulations revealed that the percentage of years with yields below 0.78 Mg/ha will increase from 10 % percent historically to 16, 22 and 34 % in the three considered futures. This means in one out of three years yields will be heavily affected by climate change in the long-term future. Not surprisingly, given the fact that water is the most growth-limiting factor, supplemental irrigation could mitigate these negative impacts, in part by allowing for earlier planting of wheat and thus avoidance of (terminal) heat stress during grain filling period. However, more irrigation water would be required in the future – on average 181 mm per season in 2080-99 as opposed to only 134 mm historically – to satisfy crop water requirements. As irrigation water resources are limited, policies on where to allocate water and how much, will have to be adapted in a climate change future. Growing summer crops under full irrigation might be a less viable option. (Rolf Sommer)	
1.2.3.1	Assessment of the impact of climate change on cropping patterns, rural income and food security in in dry areas with priority given to most	Policy recommendations on measures for the adaptation of agricultural systems to climate change	Using estimates of climate change impacts on agricultural crops based on crop simulation models CropSyst (wheat) and DSSAT (cotton, potato) calibrated to each of the AEZs with crop experimental data from Central Asia (CA) countries, and production costs obtained by household surveys, we developed	ICARDA, IFPRI, NARS

	vulnerable countries		stochastic mean-variance model calibrated to main AEZs in each of four Central Asian countries (Kazakhstan, Uzbekistan, Tajikistan and Kyrgyzstan). The approach measures the utility of the households according to the expected income and variance of income. Results show that climate change as uneven effect on farm income across CA and the effects are more location specific. The model results demonstrate up to 60% of income increase in Northern regions of Kazakhstan, but in contrast Southern regions with arid climate may have 20 % of decline of their income in the future. Similarly, farmers in semiarid regions of Tajikistan may expect 60-70% of income increase, but farmers located in arid region on Tajikistan might have income loss of 30%. Less variation in expected farm income is obtained for Kyrgyzstan where only 10-20% of positive change of income may be expected. However, this level of increase may not increase the farmers' utility since additional growth of income expectation may be offset by increasing weather induced risk in Kyrgyzstan. Similarly, farmers in Uzbekistan also may obtain slight increase of their revenues in the near future (2010-2040) but decline of revenues will happen in the late future (2070-2100) especially when irrigation water availability will be reduced. The main policy recommendation is to improve access to inputs and adaptation technologies for the most vulnerable areas (Aden Aw-Hassan et al., 2012)	
1.3.1.1	Analyzing functional genomic markers related to the tolerance of indigenous sheep to heat stress under arid conditions	· Functional molecular information and markers that can be utilized for early detection of tolerant animals ·Understanding of the signaling system controlling tolerance to oxidative stress as a preliminary basics for other stresses such as diseases and parasites	In 2011 the project completed the development of stress tolerance indices based on physiological and blood parameters to identify tolerant and susceptible individuals in Barki desert sheep and goats in Egypt. The results from the on-station experiment in 2010 showed that the physical exercise stress trial ,which simulated grazing on poor pasture under heat stress by walking the animals for about 3 hours under direct solar radiation, proved to be a better indicator for tolerance to abiotic stresses than heat stress alone (exposure to solar radiation). Thus, this exercise was repeated with a larger number of animals (100 Barki sheep and 50 Barki goats) to validate the stress tolerance indices calculated in 2010 and test the repeatability of the individual variation in	APRI-Egypt

			biological parameters in response to stress. For both the indigenous Barki sheep and goats clear individual variations in their response to abiotic stress were detected. The experiments also showed that no single physiological parameter was reliable enough to assess individual tolerance to abiotic stress under hot-dry conditions. Thus, the index combined a number of physiological reactions, such as rectal temperature, respiration and metabolic rate. The animals assigned to the two extreme groups, classified as tolerant and intolerant according to their stress tolerance scoring in both 2010 and 2011, are now being compared by genomic analysis. The genomic analysis will include quantitative gene expression assays and should determine functional molecular markers that can be utilized for early detection of tolerant animals.(Barbara Rischkowsky and Aynalem Haile)	
1.3.1.7	Monitoring of population changes and adaptation of insect pests and diseases of cereals and food legumes	Major changes in population structures of insect pests and diseases monitored	The status of insect pests and diseases were monitored in East Africa and CWANA regions during the 2010-2011 cropping seasons. Salient points are summarized below: There was an outbreak of Barley stem gall midge (Mayetiola hordei) a minor pest throughout the barley growing areas of Syria due to warmer winters that favour pest development. Rust surveillance using biological trap nurseries showed that the new yellow rust Yr27 virulent race was wide spread on major wheat cultivars in East Africa. Moreover, Ug99 and its derivatives (races TTKSK and TTKST) were reconfirmed in East Africa. The appearance of this devastating race was due to adaptations to warmer weather conditions. Survey for faba bean viruses in Sudan showed that Bean yellow mosaic virus, Broad bean stain virus and Broad bean mottle virus and their aphids or beetles were the most prevalent ones. Survey for faba bean viruses in Bekaa valley, Lebanon showed that Bean leafroll virus was the most common followed by Bean yellow mosaic virus and Chickpea chlorotic stunt virus. The most	NARS

			important cereal virus was Barley yellow dwarf virus-PAV (BYDV-PAV) During the survey period, high aphids populations were observed in most fields. The incidence of the viruses was increased due to warmer weather conditions suitable for high incidence of insect vectors during the season.(Safaa Kumari). Disease monitoring on conservation agriculture in Syria showed that the minor disease (downy mildew) was a major problem on early planted lentil. The tested lentil genotypes showed varying levels of reactions that could be utilized for anticipatory plant breeding. This disease will become an important threat in the adoption of lentil in Conservation agriculture as an adaptation/mitigation strategy in climate change and variability (Seid Kemal, Mustapha El-Bouhssini et al.)	
1.3.1.1	Developement of the Focused Identification of Germplasm Strategy (FIGS) to select best bets for adaptation to climate change	Subsets of genetic resources with higher frequency of drought and heat tolerant germplasm made available to collaborators. Methodology for selecting adapted germplasm	We worked on development of proper algorithms for the identification of best bet sets of genetic resources for drought, heat and salinity tolerance with FIGS approach. A total of 16 subsets were developed for wheat and barley using FIGS, among which six are developed for heat, drought and salinity tolerance to collaborators for wheat with CIMMYT (SeeD project) and barley (ICARDA-breeders). This has concerned more than 3200 accessions now under-evaluation for sought traits. The other subsets are for diseases and insect resistance and tolerance to boron toxicity (Abdallah Bari, Kenneth Street and Ahmed Amri).	Breeders, crop physiologists collaborators inside and outside ICARDA
1.3.3.1	Organize targeted collection for sampling landraces and wild relatives in dry and hot areas	Genetic resources with potential genes for adaptation to the adverse effects of climate change	One collecting mission was organized to Cyprus focusing on dryland and salt affected areas using gap analysis and targeted collecting mission approach. A total of 445 accessions were collected including around few accessions of *Aegilops bicornis* and forage species growing under high saline areas on the Mediterranean cost. (Ali Shehadeh, Josephine Piggin, Ahmed Amri)	NARS
1.3.3.1	Develop strategies for fast track testing and release of varieties and rapid multiplication and dissemination of adapted varieties to	Farmers access to adapted varieties ensured	The emergence and fast spread of stem rust race Ug99 created alarm as the world's wheat varieties are susceptible. Fast tracking testing and release and accelerated seed multiplication is critical to counter the threat of stem rust of wheat (Ug99) in selected at risk	Public and local private seed sector

	climate change		countries in collaboration with NARS, public/private seed companies, national extension services and farmers. Within this context ICARDA launched a comparative study on variety release in selected countries to draw lessons and prepare a document on 'best practices in variety release protocols' to expedite a process particularly under emergency situations. (Zewdie Bishaw et al.)	

Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.1.1.4	Monitor and model the effects of extreme rainfall events on land, water and vegetation resources and develop adaptation strategies	A validated model Already covered by Milestone 2.1.1.x	The significance of few heavy rainfall events on producing high proportion of the total annual sediment loss from agricultural fields was assessed. The impact of soil and water conservation practices on reducing erosion and capturing sediments was assessed. Watershed- and community-based plans to adapt to heavy rainfall events were suggested and implemented. Setup and run a model to understand the impact at watershed level. (Ziadat Feras)	NARS, ARI, Other CG Centers
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				

Theme 3, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				
3.3.1.1	Measuring carbon sequestration in rangelands	Methodology and tools for assessing carbon sequestration in rangelands developed	ICARDA scientists studied the soil organic carbon (SOC) sequestration potentials of rangelands in Central Asia. Using published data on soil organic carbon contents, the FAO-UNESCO Soil Map of the Word and a Land Use/ Land Cover Change map of Central Asia (comparing year 1982 and 2000), the native as well as current SOC content of the rangelands of Central Asia were estimated. Losses in response to land use change and degradation of rangelands (observed on 4.9 Mha) were estimated to 50 Tg. During the same considered period, however recuperation of rangelands was observed and the estimated sequestration of SOC (20.7 Tg) would offset around 42 % of the aforementioned losses, altogether pinpointing Central Asia rangelands to contribute only very little to the estimated	ARIs, NARS, CG centers, universities

			SOC losses in response to land use. (Mounir Louhaichi and Rolf Sommer)	

Theme 4, Integration for Decision Making				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.3 Refining frameworks for policy analysis				

ICARDA CCAFS 2011 Report - Case Studies

1. Impacts of climate change on the income rick of farmers in different farming systems in four Central Asian counties.

Case type: Social differentiation

The analysis uses crop simulation models, data from farm surveys and economic risk programming modelling. The research was funded by the Asian Development Bank.

The study finds varying climate change impacts in different agro-ecosystems in four Central Asian Countries. The computed climate change impacts ranged from large positive effects (60-70% in Tajikistan semiarid regions) to large negative effects (30% in Tajikistan arid regions). However, the effects also varied among rural households of with different social characteristics in different ways. The study finds that in Kazakhstan, small scale farmers with large proportion of female headed households and with less access to extension services appear to have experienced the greater negative impact of climate change, while the larger farm operators mainly run by male farmers and with relatively better extension services have experienced rather positive effect. In Kyrgyzstan, small sale farmers in semiarid areas, although the data shows that they had better access to extension, have, depending on the scenario assumed, the greatest negative impacts or lower positive impact, while in the sub-humid areas, where the effect was largely positive, have much larger farm holding (double the size). Similarly in Tajikistan the arid areas with relatively larger holding plots had negative impact of climate change, while the humid areas with smaller plots had experienced a larger positive impact.

It should be noted that organically the study was designed to assess the climate change effects from the agro-ecological view point. However, looking at the data it was possible to use limited socioeconomic indicators to see how these are related to climate change effects. However, the socioeconomic differences used in this analysis are only indicative but they are not definitively identified as factors of climate impact differences. There has been no attempt in this study to make quantitative analysis of the effects of the socioeconomic differences and services in climate change effects among different socio-economic strata of rural communities. Such analysis should be given a priority in the future. The conclusion of such research will strengthen efforts to empower farmers with capacities and better services to adapt to climate change and reduce the vulnerability to its effects.

The partners involves in the research include:

1. National agricultural research systems of Uzbekistan, Kazakhstan, Tajikistan and Kyrgyzstan. The roles of these organizations were mainly data collection & interpretation, received capacity development in data analysis.

2. IFPRI was a full partner and participated in survey design, training NARS, crop simulation modelling, and economic analysis.

3. ICARDA managed the project, designed the research, implemented et surveys, crop simulation modelling and economic analysis.

This activity is based in ADB co-funded project titled Adaptation to Climate Change in Central Asia and People's Republic of China which continued 2009-2012.

Web address for further information (if available): The project ends in March 2012 and information has not yet been placed on the web (more information can be obtained from Tareq Bremer, (T.Bremer@cgiar.org) or Aden Aw-Hassan (a.aw-hasaan@cgiar.org) (ICARDA).

2. FIGS : Example of innovative and successful communication

FIGS is a new and innovative trait-based and user-driven approach conceived to rapidly identify plant genetic resources of crop landraces and their wild relatives that can be used in breeding new crop varieties and in the rehabilitation of degraded ecosystems. It searches for specific sought-after traits, using as a surrogate the environment, based on the hypothesis that the germplasm is likely to reflect the selection pressures of the environment to which the germplasm has been adapted and where it has continuously evolved.

Quantitative relationships between traits and climate parameters have been established and suggested as basis for selecting FIGS subsets as well as for modeling the impact of climate changes. The frequency and the intensity of drought, heat and salinity are expected to increase with climate change. To develop drought and heat tolerance subsets of wheat (durum and bread wheat), FIGS approach used both trait and climate data to first develop a priori information based on the quantification of the trait-environment relationship. The a priori information is then used to define subsets of accessions with a high probability of containing the sought after traits.

For both crops (bread and durum wheat) FIGS subsets selected have been planted to assess drought and heat related traits and develop the material for use in crop improvement. The FIGS algorithms developed within the climate change context will be further fine tuned to be deployed. All along new and more detailed climate variables and GIS derived layers are also under development to improve the predictive power of these algorithms.

FIGS approach has been developed by ICARDA researchers in partnership with researchers from the NI Vavilov Reseach Institute of Plant Sciences (Russia), the Australian Winter Cereals Collection, and Nordic Genebank.

FIGS has been recognized by several fora. Several institutions and researchers have expressed interest to collaborate in further development of FIGS and its use. An international consultation

has been recently launched as a framework to further enrich this new approach and develop it along with its allied tools. FIGS is envisaged as a new strategic research approach for researchers and crop plant breeders worldwide, who are searching for climate related traits and looking to improve crop yields and combat the negative effects of climate change. As a platform a wiki for FIGS (FIGS wiki) is planned to be launched soon.

Web links: http://icardablog.wordpress.com/category/media-releases/ ; http://atlas-conferences.com/cgi-bin/abstract/cbcr-78 or http://at.yorku.ca/c/b/c/r/78.dir/cbcr-78.pdf http://www.springerlink.com/content/m7140x68v2065113/; http://www.fao.org/docrep/014/i2215e/i2215e.pdf ; ICARDA (new web site)

3. Conservation Agriculture for climate change adaptation in cereal-based Dryland productions systems in West Asia.

Innovative non-research partnerships

The ACIAR-AusAID conservation agriculture (CA) project is focused on promoting CA in Northern Iraq. It is currently implemented in Iraq by an Iraqi NARES team in close partnership with ICARDA. To make this possible, ICARDA has set up a parallel program in Syria to support the project and extend CA within Syria, from where the initial field research program for Iraq was planned and implemented, along with the design and development of the first locally-produced zero tillage (ZT) seeders. Modified seeders were also developed by Iraqi farmers and local manufacturers to make the technology more affordable to poor farmers. In Syria, the project has since expanded to eight different workshops across the country, providing a template for a simple design and an affordable cost to the average small-scale farmer. Based on a participatory approach, extension activities were developed to transfer the concept of CA to farmers' fields.

These innovative activities utilized working groups consisting of stakeholders from all facets of the industry including Research, Extension, NGOs, Agribusiness, Manufacturing, and Farmers. Each Working Group covered a specific geographical area, mainly at the district level. They were provided with a ZT seeder unit and were managed by an enthusiastic and reliable partner in the area. Innovative farmers from the area were selected to evaluate the ZT seeder in a side by side comparison with his management practice, which normally involved several tillage operations prior to seeding. The farmer used his own tractor in the trial. The seeder unit was then passed on to the next farmer. This allowed many farmers in the region the ability to evaluate ZT technology. The participatory approach has encouraged farmers to purchase ZT seeders from local manufacturers and has helped increase the number of farmers using ZT from a few on 50 ha in 2007 to over 1,000 farmers using ZT seeders on over 30,000 ha in 2011.

Project website: http://www.icarda.org/ACIAR/Index.htm .

Activity summary report

7.1 Theme 1: Adaptation to Progressive Climate Change

7.1.1.2 Building of regional and national capacities to produce and communicate appropriate adaptation and mitigation strategies for progressive climate change at the national level (e.g. through NAPAs)

Several independent activities fall under this output: 1) support for smallholder farmers in Southeast Asia with candidate adaptation practices; 2) interactive, web-based digital vegetation maps as decision support tool for present and future climates based on ecological suitability and potential application of useful tree species; 3) farmers' preferences for tree functions and species in regions of low, intermediate and higher rainfall in the Sahel; and 4) a method to evaluate climate responses, in particular water-use efficiency, of trees from long-term datasets. These activities have resulted in at least 4 journal papers as well as a guidebook and a web-based digital map.

7.1.1.3 New knowledge-synthesizing institutional arrangements, policies and mechanisms for improving the adaptive capacity of agricultural sector actors and those involved in managing the food system

Two independent activities, in China and Kenya, have been analysing climate vulnerabilities, how farmers have responded to climate change shocks, such as floods and droughts, and how local institutions contribute to coping by raising adaptive capacities. These activities have resulted in at least three papers.

7.1.2.1 Understanding and evaluating the response of different varieties/crops to climate change in time and space, and generating comprehensive strategies for crop improvement through a combination of modelling, expert consultation and stakeholder dialogue

The activities relate to climate impacts projected for trees, agroforestry systems and other ecosystems and include journal papers on projections of climate change impacts on winter chill for temperate fruit trees and plants in the US and Tibet as well as impacts of climate change on parkland agroforestry systems in the Sahel and biome shifts in West Africa, resulting in five journal papers.

7.2 Theme 2: Adaptation through Managing Climate Risk

7.2.1.2 Analytical framework and tools to target and evaluate risk management innovations for resilient rural livelihoods and improved food security

A framework was developed on how people and trees can co-adapt to climate change by reducing vulnerability through multifunctional landscapes. Dendrochronology through tree-ring analysis is introduced as a tool to assess past climatic responses and impacts as a basis to enhance adaptation and ecosystem resilience in Africa. These activities let to the publication of one multi-chapter book and two papers.

7.2.3.1 Improved climate information tools and products to support management of agricultural and food security risk

A paper on tree histories as basis for understanding the challenges current climate variability poses to agriculture and food systems.

7.3 Theme 3. Pro-Poor Climate Change Mitigation

7.3.1.1 Analysis of agricultural development pathways and the trade-offs among mitigation, poverty alleviation, food security and environmental health

The activities refer to an economic analysis of potential mitigation effects from tree planting within the WKIEMP project in W. Kenya and an assessment of bioenergy feedstock potentials from perspectives of livelihood, food security and environmental sustainability. The activities have resulted in a working paper and report to the World Bank.

7.3.2.1 Evidence, analysis and trials to support institutional designs, policy and finance that will deliver benefits to poor farmers and women, and reduce GHG emissions

This output includes a variety of activities relating to: 1) a social impact assessment of barriers to and factors affecting participation in biocarbon projects for different social groups, including women; 2) an institutional analysis of the range of existing and emerging institutional arrangements and incentives for better inclusion and benefits for smallholders; 3) a methodology and PDD for a grassland carbon project in China; 4) contracts with at least 1000 smallholders to participate in a smallholder biocarbon project following development of pilot institutional arrangements, incentive mechanisms and MRV protocols for carbon trade; and 5) a comparative analysis of choice experiment in the design of carbon payments.

7.3.2.2 Improved capacity to increase the uptake and improve the design of incentives mechanisms and institutional arrangements to deliver benefits to poor farmers and women

Several workshops and capacity building initiatives to increase the uptake and improve the design of incentives mechanisms and institutional arrangements were carried out: In January 2011, a taskforce meeting was held to identify capacity needs for negotiators at the UNFCCC. Following this, two workshops were held in Africa and Asia in May 2011 where negotiators and land managers were trained and discussed on REDD concepts involving monitoring, reporting and verification as well as safeguards. A land-use planning for low-emissions development strategies was developed that will reduced. Several opportunity cost training workshops were also held in Africa, Asia and Latin America. Two research papers were produced as outcomes from the meeting discussions.

7.3.3.2 Methods developed and validated for GHG monitoring and accounting at farm and landscape level to contribute to compliance and voluntary market standards

A methodology was developed for measurement of GHGs (N_2O, CH_4, CO_2) in tropical developing countries. In addition a Land Health Surveillance Framework and measurement protocol were developed that together allow to estimate soil carbon stocks up to 100cm depth at landscape scale ($10x10km^2$). Repeated measurements, particularly of soil carbon, can be used for monitoring in compliance and voluntary markets. The need for high temporal and spatial resolution of the gas fluxes requires that further work be carried out that will ultimately allow to model GHG fluxes in tropical agricultural systems better. Several publications have been released so far.

7.4 Theme 4. Integration for Decision Making

7.4.1.1 For each region, coherent and plausible futures scenarios to 2030 and looking out to 2050 that examine potential development outcomes under a changing climate and assumptions of differing pathways of economic development; developed for the first time in a participative manner with a diverse team of regional stakeholders

Stakeholder workshops were held in the districts of Machakos (Kenya), Mbarali (Tanzania) and Bugesera (Rwanda) to gather the information and communication needs of the different stakeholder categories. Participants included ministry of agriculture officials, national scientists, NGOs, farmer representatives and media. A communication strategy has been developed to guide development of KISPS. A web page has been created within ICRAF websites under the banner evergreen agriculture but due to the rising interest in the farming practice a separate website for evergreen agriculture has been developed and is set for uploading and populating.

7.4.1.3 Evidence on, testing and communication of, successful strategies, approaches, policies, and investments contributing to improved science-informed CC-ag development-food security policies and decision making

Learning events at SBSTA34 in Bonn as well as Forest Day 5, Agriculture and Rural Development

Day 3 and COP17 in Durban on climate-smart agriculture, landscape approaches (the place of agroforestry, afforestation and reforestation in REDD; evergreen agriculture and MRV of terrestrial biocarbon were carried out with a number of partners. Several policy briefs have been published.

7.4.2.1 Integrated assessment framework, toolkits and databases to assess climate change impacts on agricultural systems and their supporting natural resources

An integrated assessment framework and toolkit for analysing likely effects of specific adaptation and mitigation options in target regions was prepared and made available to partners. The report identifies a number of perspectives for clarifying the range of tools and methods employed and provides detailed descriptions of a range of tools and methods developed by ICRAF and ASB for REDD+ and AFOLU. A website for the tools and methods is forthcoming.

7.4.3.1 Tools developed and climate change impacts assessed at global and regional levels on agricultural systems (producers, consumers, natural resources), national/regional economies, and international transactions

Several papers were prepared on payments for ecosystem services including carbon, water and biodiversity derived from the RUPES and PRESA projects together with academic and local partners. A number of papers and policy briefs were also published that: a) consider the implications of climate agreements and legislation on national plans and policies for sustainable development in the tropical forest margins; b) summarize experience with avoided deforestation and REDD pilot studies for key policy processes; and c) describes the rangeland management impacts on soil organic matter in China.

2011 Activity Plan for CCAFS Centre General Funds:
Activities, Deliverables & Partners

CG Centre:	ICRAF

Table A. Main contacts persons in the Centre

Contacts	Name(s) (specify roles if more than one)	Email
Climate Change Contact Point	Henry Neufeldt	h.neufeldt@cgiar.org
Admin. Issues	Josephine Njoroge	j.njoroge@cgiar.org
Communications	Paul Stapleton	p.stapleton@cgiar.org
Others (if needed, specify role)		

Table B. Bilateral funded projects under CCAFS (2011)

ID#	ID#	Name of project	Approximate budget under CCAFS (2011)	Donor	Principal investigator
1	BELG-796	Increasing small-scale farmer benefits from agroforestry tree products in West and Central Africa- AFTP4A	0.028	Belgium	Anne Degrande
2	BELG-NEW1	CATS	0.017	Belgium	
3	BOTH-	Land Use Planning to Promote Sustainable Biofuel Production in West	0.000	BOTH	

	NEW1	Kalimantan, Indonesia			
4	BRIG-NEW1	Quick biodiversity survey of Bridgestone Sumatra Rubber Estate, North Sumatra	0.044	BridgeStone Corporation Japan	
5	CIAT-816	Globally Integrated Africa Soil Information Service (AfSIS)	0.023	CIAT	Keith Shepherd
6	CIAT-NEW1	Amazon Initiative Eco-Regional Programme	0.004	CIAT	Roberto Porro
7	CPWF-NEW1	Challenge Programme on Water and Food	0.001	Challenge Programme on Water and Food	
8	CLUA-NEW1	Enabling Strategy, Legal and Policy Environment for Low-Carbon Development Planning and the promotion of profitable diverse agroforestry	0.003	CLUA	
9	COWZ-NEW1	Eastern Africa Programme	0.018	Concern Worldwide	Jeremias Mowo
10	CAWT-NEW1	Eastern Africa Programme	0.005	Conservation Agriculture with Trees	Jeremias Mowo
11	CFCZ-846	Promoting Development of Economically Viable Rubber Smallholdings in West Africa	0.051	Cooperation of Common Fund for Commodities	Asaah
12	FLDZ-872	Domestication of Jatropha curcas for oil production on smallholder farms in the Sudano-Sahelian region with focus on Mali, 2009-2013	0.002	Danish Centre for Forest, Landscape and Planning	Antoine Kalinganire
13	DFID-778	Protracted Relief Programme Phase 2 (PRP 2)	0.002	DFID	
14	GTZG-719	Trees in Multi-Use Landscapes in Southeast Asia(TUL-SEA)	0.004	GIZ	Meine van Noordwijk

15	EELZ-821	Rwanda Master Plan For Irrigation	0.001	Ebony Enterprises Ltd	Malesu Maimbo
16	EURU-NEW3	Impacts of Reducing Emissions from Deforestation and Forest Degradation and enhancing carbon stocks	0.013	European Union	
17	EURU-810	ALL-REDDI SEA	0.003	European Union	Meine van Noordwijk
18	FAOZ-NEW1	SouthEast Asia Programme	0.023	FAO	Ujjwal Pradhan
19	FOMS-NEW1	Agroforestry for Improving Food Security and Simultaneous Leverage on Climate Change Adaptation and Mitigation	0.028	Formas	
20	GAUG-824	Adaptation of Land use to Climate Change in Sub-Saharan Africa (ALUCCSA)	0.006	Georg-August-Universitat Gottingen	Antoine Kalinganire
21	HFER-749	East Africa Dairy Development (EADD)	0.001	Heifer International	Steve Franzel
22	HKLZ-820	Sustainable Livelihood Options and Carbon Rights as a basis for efficient and fair emission reduction in the central Kalimantan Ex-Mega Rice Project	0.005	HK Logistics LTD. Global Solutions	
23	ICAR-851	Enabling Small Holders to Improve their Livelihoods and Benefit from Carbon Finance under the National Agricultural Innovation Project (NAIP)	0.265	India Council for Agricultural Research	Pal Singh
24	ICAR-NEW	South Asia Programme	0.023	India Council for Agricultural Research	Pal Singh

25	IPOC-841	Research on the Study Accounting for Greenhouse gas Emissions	0.039	Indonesian Palm Oil Commission	
26	IDRC-819	Going to Scale: Enhancing the Adaptive Management Capacities for Sustainable Land Management in the Highlands of Eastern Africa	0.001	IDRC	Jeremias Mowo
27	IFPR-NEW1	Global Futures Project	0.004	IFPRI	Frank Place
28	IFAD-NEW3	Parkland Trees and Livelihoods: Adapting to Climate Change in West African Sahel	0.029	IFAD	John Weber
29	IFAD-NEW2	Scaling-Up Conservation Agriculture With Trees For Improved Livelihoods And Environmental Resilience in Eastern and Southern Africa	0.026	IFAD	Jeremias Mowo
30	IFAD-808	Promoting Rural Innovations through Participatory Tree Domestication in West and Central Africa	0.022	IFAD	Zac Tchoundjeu
31	IFAD-NEW1	Enabling rural transformation and grassroots institutional building for sustainable land management and increased incomes and food security	0.005	IFAD	
32	IFAD-781	Programme to Support Smallholder Conservation Agriculture Promotion in Western and Central Africa	0.003	IFAD	
33	IFAD-788	Rewards for, Use of and Shared Investment in Pro-poor Environmental Services Phase II(RUPES-II)	0.003	IFAD	Beria Leimona
34	IISD-NEW1	Alternative to Slash-and-burn programme	0.093	IISD	Peter Minang
35	IISD-855	Building REDD Capacity Workshops	0.008	IISD	Peter Minang
36	ILRI-NEW2	South East Asia Programme - Vietnam	0.005	ILRI	

37	CRAD-699	CAFNET: Connecting, enhancing and sustaining environmental services and market values of coffee agroforestry in Central America, East Africa and India	0.007	CIRAD	
38	IRLD-720	Malawi Agroforestry food Security Programme	0.107	Ireland	
39	IRLD-868	Evergreen Agriculture for Sustainable Food Production in Malawi	0.012	Ireland	
40	JPAN-753	Bioenergy Provision within Agroforestry Systems in East Africa	0.003	Japan	
41	ZALF-783	Climate Change Impact Assessment and Adaption Options in Vulnerable Agro-landscapes in East Africa	0.076	ZALF	
42	ZALF-854	Strategies To Use Biofuel Value Chain Potential in Sub-Saharan Africa to Respond to Global Change	0.014	ZALF	
43	MLRI-857	Reducing Emissions from Deforestation and Degradation through Alternative Land uses in Rainforests of the Tropics (REDD-ALERT)	0.077	Macaulay Land Use Research Institute	
44	MLRI-826	Development and Application of Methodologies For Reduced Emissions From Deforestation and Forest Degradation (DEFRA REDD)	0.033	Macaulay Land Use Research Institute	
45	MARS-NEW1	Vision for Change	0.038	Mars Inc	
46	MULT-899	SEA Regional Office Operations	0.008	Multidonor	
47	MULT-897	Latin America Operations	0.006	Multidonor	Roberto Porro
48	NSFZ-NEW1	Greenhouse gas emissions from soils in Kenya	0.051	NSF	Henry Neufeldt
49	NETH-	Improved Capacity in Rainwater Management for Sustainable Development	0.002	Netherlands	Malesu Maimbo

	792				
50	NORD-886	Architecture of REALU: Reducing Emissions for All Land Use (Phase II)	0.486	NORAD	Peter Minang
51	PERU-323	Estudio Integral de los factores claves para el desarrollo de la Agroforesteria en Ucayali	0.007	Peru	Roberto Porro
52	MOFA-873	Scientific and Technical Cooperation in Research, Development and Training in Agro-forestry in the Maldives	0.004	Republic of Maldives	
53	RADA-865	Sustainable Land Management Project (Rwanda)	0.000	Rwanda Agricultural Development Authority	
54	CFOR-716	Improving Economic Outcomes for Smallholder Growing Tea In Indonesia	0.004	CIFOR	
55	CFOR-784	ICRAF/CIFOR Activities and Projects in Vietnam	0.002	CIFOR	Minh Ha Hoang
56	UNLV-616	To advance domestication of Allanblackia spp. In selected countries in Africa III	0.004	Unilever	Ramni Jamnadass
57	UNOP-880	Sustainable Catchment Management and Sediment Control in the Lake Tanganyika Catchment Basin	0.002	UNOPS	Fergus Sinclair
58	VRUN-NEW1	Eastern Africa Programme	0.007	Vrije Universiteit	Jeremias Mowo
59	WABU-890	Towards projecting Land Use Impacts on Carbon Stocks and Soil Health in Kenya using Standardized Field Measurement Protocols and Satellite Image Analysis	0.010	Wajibu MS Ltd	Keith Shepherd
60	WWFZ-836	Carbon Benefits Project: Modeling, Measurement and Monitoring	0.094	WWF	Henry Neufeldt

Notes:

(1) If a bilateral project is contributing to more than one CRP, this is only the CCAFS activities.

Table C. Activity tables by Themes/Objectives

Note:

(1) Activities should be approximately US$250.000 in value, inclusive of all costs, i.e. including personnel, overhead etc
(2) The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that Regional Program Leaders can plan synthesis and coordination activities. They will not be used for any later reporting.
(3) Milestone numbers will be provided by Theme Leaders.

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.1.3.1	Understanding of institutional arrangements, policies and mechanisms that enhance the adaptive capacity of resource-poor households to adopt new farming practices, strategies and behaviours that reduce their	Papers	Thorlakson T and Neufeldt H: Reducing Subsistence Farmers' Vulnerability to Climate Change: Evaluating the potential contributions of agroforestry in western Kenya. Submitted to Agriculture, Ecosystems and Environment. Thorlakson T. 2011: Reducing subsistence farmers' vulnerability to climate change: The potential contributions of agroforestry in western Kenya. ICRAF Occasional Paper 14. Nairobi	Harvard, CCAFS, KARI; COMART

	vulnerability to CC		From field research conducted in western Kenya, this study investigates how recent climate-related shocks and stresses have affected subsistence-farming communities. It concludes that farmers are not coping with floods, droughts and rainfall variability in a sustainable way. To cope with extreme weather events and variations, they are usually forced to sell farm tools, consume seeds reserved for planting and engage in other strategies that further drive them into poverty. Farmers believe that the most effective way to improve their capacity to adapt to climate-related shocks is by improving their general standard of living. The study then examined how agroforestry techniques help farmers reduce their vulnerability to these climate-related shocks. By comparing farmers engaged in an agroforestry project with a control group of neighbouring farmers it was proven that agroforestry does help reduce their vulnerability to climate related-hazards. Engagement in agroforestry improves households' farm productivity, off-farm incomes, wealth and the environmental conditions of their farms. Thus, agroforestry techniques should be used as part of future adaptation programs to help subsistence farmers reduce their vulnerability to climate-related hazards.	
1.1.3.1	Characterization of climate adaptation options in target regions	Paper on the Role of Local Institutions in Adaptation to Climate Extremes in Mountain Yunnan	Lu C. The Role of Local Institutions in Adaptation to Climate Extremes in Mountain Yunnan, China–A Q-squared Approach. Draft paper under review. Climate extremes like the frequently occurred drought and flash flood severely threat the rain-fed agriculture and mountain farmers' livelihoods in Southwest China. Local institutions play an important role in coping and adaptation when the external support and intervention is not available immediately or limited. This paper examines local institutions and their role in adaptation strategies in climate extremes with empirical studies in rural mountain Yunnan by using both quantitative household survey	

			data and qualitative participatory rural appraisal. The result shows that public, private and civic local institutions play a critical role in shaping adaptation to climate change. They facilitate households to local resources and strengthen their adaptive capacity. However poor and vulnerable households and groups have limited resources and assets to involve in public and private institutions. Involvement of local institutions in designing, planning, supporting and implementing adaptation policies and projects is important to support and enhance greater role of local institutions in adaptation to climate extremes.	
1.1.2.1		Report on Agroforestry species for farming systems and reduced soil erosion under climate change	Part of the Carbon Benefits Toolbox, available at http://www.goes.msu.edu/cbp/planning.html The toolbox was launched at SBSTA in Bonn, 2011	UNEP-GEF,WWF
1.1.2.1		Paper on adaptation potential of agroforestry species under climate change	Re-evaluation of data. Low priority at this stage.	University of Göttingen, BMZ, ZALF,
1.1.3.2 1.1.2.1		Guidebook for smallholders with candidate adaptation practices	Lasco RD, Habito CMD, Delfino RJP, Pulhin FB, Concepcion RN. 2011. Climate Change Adaptation for Smallholder Farmers in Southeast Asia. World Agroforestry Centre, Philippines. 65p This paper has three major parts. The first part discusses the projected impacts of climate change to smallholder farmers. The second part, presents the main concepts of climate change adaptation. The last part discusses the various options available for smallholders to adapt to climate change including through the use of agroforestry systems.	WWF; UNEP; VAAS;

1.1.2.2		Interactive, web-based digital vegetation maps as decision-support tool for present and future climates based on ecological suitability and potential application of useful tree species developed	Two interactive digital vegetation maps were made available globally in 2011: (i) The Useful Tree Species for Africa map, covering continental Africa; and (ii) The Vegetation and Climate Change in Eastern Africa (VECEA) map covering Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia. Both these maps are designed as decision-support tools that enable the selection of "useful tree species" that are expected to be adapted to the ecological conditions of the mapped natural vegetation types. The UTSA map was developed as one of the tools for the Carbon Benefits Project. In the case of the VECEA map, the potential distribution of vegetation types were projected for six possible future climates based on maximum entropy suitability modeling of each vegetation type, downscaled bioclimatic data available from CIAT (and also from the CCAFS website) and a grid-based consensus algorithm. The Useful Tree Species for Africa map is available from: URL http://www.worldagroforestrycentre.org/our_products/databases/useful-tree-species-africa The VECEA map is available from: URL http://sl.life.ku.dk/English/outreach_publications/computer based_tools/vegetation_climate_change_eastern_africa.aspx	WWF; UNEP, Rockefeller
1.1.2.1		Farmers' preferences for tree functions and species in regions of low, intermediate and higher rainfall in the Sahel (journal article published)	One journal article published about farmers' preferences in Burkina Faso, Mali, Nigerand Senegal (Faye et al. 2011). Two journal articles submitted about variation in growth and fuelwood properies of five preferred species related to region, soil type, land-use type and rainfall in Mali (Sotelo Montes et al., under review).	INRAN; INERA; IER; IFAD
1.1.2.1	Improved understanding of	Journal paper on a method for evaluation	Aster Gebrekirstos • Meine van Noordwijk •	University of Göttingen,

	vegetation responses to climate	of climate responses of trees from long-term datasets	Henry Neufeldt • Ralph Mitlöhner (2011) Relationships of stable carbon isotopes, plant water potential and growth: an approach to asses water use efficiency and growth strategies of dry land agroforestry species Tree structure and Function 25:95–102. Global climate change is expected to modify patterns of rainfall variability and the composition of vegetation responds to that, especially in dry regions of Africa . Assessment of vegetation level vulnerability, climate change resilience and human adaptation options requires understanding of the diversity, among tree species in the current vegetation, of genetic and phenotypic growth strategies and response to fluctuating water availability. tree water use and water use efficiency (WUE) must also be determined to support decision-making in tree domestication and reforestation efforts. For instance, under drought prone conditions, species with a wide capacity to withstand hydrological changes may be an advantage while species with better growth performance could be suitable in areas of nonlimiting water conditions. A number of environmental factors exert stress on plants, which can affect the rate of photosynthesis or stomatal conductance, and thus influence Ci and carbon isotope ratio (d13C) in plant matter. Therefore, growth, plant water potential and stable carbon isotopes were considered simultaneously as a measure of stress tolerance. study of interannual variation through tree ring growth and isotope composition adds a further dimension and allows to scale up to the life time of trees. These results suggest that d13C in tree rings can be useful in estimating historic changes in plant WUE and hence in screening drought tolerant species in the face of expected climate changes, as well as for assessing the functional diversity and risk reduction in mixed vegetation.	University of Erlangen, BMZ/GIZ

1.1.2.1		Journal paper: Comparison of winter chill models for fruit trees (International Journal of Biometeorology 55, 411-421)	Luedeling E and Brown PH, 2011. Equivalence of winter chill models for fruit and nut trees around the world. International Journal of Biometeorology 55, 411-421. Production of temperate fruit and nut trees depends on sufficient winter chill during the dormant season. This is necessary for regular crop development during the growing season and ultimately for obtaining economically satisfactory yields. Horticultural scientists have developed several models for quantifying winter chill, and different models are used in different places. It is often tacitly assumed that models are more or less equivalent and that chilling requirements determined in one location should also be valid elsewhere. This study examined this premise by calculating relationships between different chilling metrics around the world, based on 4000+ weather stations. Results showed clearly that models are not equivalent, and that transferring estimates based on a given model from one location to another can lead to substantial errors. Conversion factors between chilling models varied strongly around the world, and can roughly be estimated based on mean temperature. This study showed that models currently in use can produce misleading results, highlighting the need to produce better models and use them more appropriately than is currently practiced.	University of California Davis
1.2.1.3	Climate impacts projected for trees, agroforestry systems and other ecosystems	Journal paper: Global projection of climate change impacts on winter chill for temperate fruit trees (PLoS ONE 6(5), e20155)	Luedeling E, Girvetz EH, Semenov MA and Brown PH, 2011. Climate change affects winter chill for temperate fruit and nut trees. PLoS ONE 6(5), e20155. Production of temperate fruit and nut trees depends on sufficient winter chill during the dormant season. This is necessary for regular crop development during the growing season and ultimately for obtaining economically satisfactory yields. Based on a global dataset of 4000+ weather stations, winter chill was projected globally for 20 climate scenarios: 1975, 2000, future (mid 21st century and end 21st century, both times two emissions	University of California Davis, The Nature Conservancy, Rothamsted Research

			scenarios and three climate models). Results indicated that substantial changes in winter chill have already happened, and future changes will likely be substantial. In cold climates, production sites are expected to gain winter chill (because frost is not considered effective for chilling), temperate regions will see little changes, and warm climates are likely to see substantial decreases in winter chill. For many warm growing regions, such as the Mediterranean region, North Africa, South Africa, Southern Australia, California, Southeastern China and the Southeastern US, winter chill declines by mid and end 21st century will be substantial making it likely that tree cultivars currently grown there will no longer be viable.	
1.2.1.3		Journal paper: Impact of climate change on temperate vegetation (under review)	Luedeling E. Warm winters delay spring phases of temperate plants. This manuscript was rejected after review by Nature Climate Change, and has not yet been submitted elsewhere. The study re-examines an existing long-term dataset on the phenology of several hundred plant species in the UK, which is considered as a major piece of evidence showing that phenology advances in response to warming. Using PLS regression analysis, a novel approach to relating phenology to weather, the study shows clearly that most species respond to warming during certain phases of the winter with a delay rather than an advance in spring phases. This is probably due to later fulfillment of chilling requirements. The study has potential to contribute to our understanding of plant responses to warming by adding information on an effect that is contrary to the bloom-advancing effect of spring warming.	No partners
1.2.1.3		Journal paper: Impact of climate change on Tibetan Plateau vegetation (PNAS 107	Luedeling E, Yu H and Xu J, 2011. Replies to Shen, Chen et al., and Yi and Zhou: Linear regression analysis misses effects of winter temperature on Tibetan vegetation. Letter to Proceedings of the	Kunming Institute of Botany

		(51), 22151-22156)	National Academy of Sciences (PNAS) 108(19), E95. This study related spring phenology on the Tibetan Plateau to temperature, using PLS regression. Analyses were done separately for steppe and meadow regions. Phenology was derived by remote sensing. Results indicated that in spite of continued warming between 1982 and 2006, spring phenology advanced until about the mid-1990s, and retreated after that. Relating this finding to temperature conditions in the months preceding green-up of the Tibetan grasslands indicated that two contrary processes affected plant phenology. Warming in spring advanced phenology, whereas warming in winter led to delays, probably due to vernalization effects. The results have implications for projecting changes to grassland dynamics in response to climate change, which are unlikely to be as linear as commonly assumed.	
1.2.1.3		Journal paper: Estimate climate change impacts on parkland agroforestry in the Sahel (under review)	Luedeling E and Neufeldt H. Carbon sequestration potential of parkland agroforestry in the Sahel. Climatic Change. Revised version submitted. This study explored the potential of newly established parkland systems in the Sahel to sequester carbon and to generate carbon credit revenues for smallholder farmers. The biophysical potential to sequester carbon was based on a literature review and ecological niche modeling. Assuming that parklands occupied their maximum possible extent, potentials were quite substantial. However, establishing new parklands for carbon credits appeared fairly unprofitable for farmers. Hypothetical carbon projects were designed to test this, and the new present value of engaging in carbon sequestration activities was calculated, for both the project and the farmers. Results indicated that carbon projects are only profitable if they target a lot of farmers, preferably with large land holdings. Farmers benefit relatively little from project activities,	No partners

			making it unlikely that carbon gains could provide sufficient incentives for farmers to participate in carbon schemes. Few project designs targeting small farmers were profitable, casting doubts on the prospects of carbon projects to alleviate poverty in the Sahel.	
		Journal paper: Estimate climate change impact on Biome shifts in West Africa (published)	Heubes, J., Kühn, I., König, K., Wittig, R., Zizka, G. and Hahn, K. (2011), Modelling biome shifts and tree cover change for 2050 in West Africa. Journal of Biogeography, 38: 2248–2258. Objectives: (1) to model trends and the extent of future biome shifts that may occur by 2050, (2) to model a trend in tree cover change, while accounting for human impact, and (3) to evaluate uncertainty in future climate projections. Methods: We modelled the potential future spatial distribution of desert, grassland, savanna, deciduous and evergreen forest in West Africa using six bioclimatic models. Future tree cover change was analysed with generalized additive models (GAMs). We used climate data from 17 general circulation models (GCMs) and included human population density and fire intensity to model tree cover. Consensus projections were derived via weighted averages to: (1) reduce inter-model variability, and (2) describe trends extracted from different GCM projections. Results: The strongest predicted effect of climate change was on desert and grasslands, where the bioclimatic envelope of grassland is projected to expand into the desert by an area of 2 million km2. While savannas are predicted to contract in the south (by 54 ± 22 × 104 km2), deciduous and evergreen forest biomes are expected to expand (64 ± 13 × 104 km2 and 77 ± 26 × 104 km2). However, uncertainty due to different GCMs was particularly high for the grassland and the evergreen biome shift. Increasing tree cover (1–10%) was projected for large parts of Benin, Burkina Faso, Côte d'Ivoire, Ghana and Togo, but a decrease was projected for coastal	Univ. of Frankfurt, Senckenberg Institute, Frankfurt, Centre for Biodiversity and CC, Frankfurt

			areas (1–20%). Furthermore, human impact negatively affected tree cover and partly changed the direction of the projected change from increase to decrease. Main conclusions: Considering climate change alone, the model results of potential vegetation (biomes) show a 'greening' trend by 2050. However, the modelled effects of human impact suggest future forest degradation. Thus, it is essential to consider both climate change and human impact in order to generate realistic future tree cover projections.	
1.2 Breeding strategies for future climatic conditions				
1.3 Species and genetic diversity for climate change				

Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
	Characterize climate-related risk and survey current formal and informal responses to risk with	Synthesis of tools that relate climate change adaptation to enhancement of	van Noordwijk M, Onyango L, Kalinganire A, Joshi L, Hoang MH, Ndichu N and Jamnadass R, 2011. Rural livelihoods in changing, multifunctional landscapes. In: Van Noordwijk M, Hoang MH, Neufeldt H, Öborn I, Yatich T, (eds.) How Trees And People Can Co-	MONRE; DENR; CILSS; GTZ; MARD; CERED; DONRE

	potential for transfer & upscaling	environmental services (TulSEA)	adapt to Climate Change: Reducing Vulnerability Through Multifunctional Agroforestry Landscapes. Nairobi: World Agroforestry Centre (ICRAF), pp 36-62 http://www.worldagroforestry.org/sea/publication?do=view_pub_detail&pub_no=BC0319-101 In the context of the synthesis of TUL-SEA tool application in Southeast Asia a concept of 'landscape intensification' emerged that describes how lowland-upland relations shift together, and under what conditions intensification of one part of the landscape reduces buffering (e.g. .of rainfall variability) for others. A number of book chapters was drafted and will be finalized in 2012.	
		Paper on increased adaptive capacity through livelihood diversification with tree crops	See 1.1.3.1	VI; CARE; RF; CAS; BMZ; ZALF; COMART
		Workshop on building climate resilience for food security and rural livelihoods	Workshop with FAO and World Bank on Climate Smart Agriculture, 26-28 July 2011 in Rome. http://www.climatesmartagriculture.org/29795-01142282b2e217996d2d41b42c1e0cb63.pdf	CGIAR; GTZ; UNDP; FAO; ADB; IFAD; NARIs, ROs
		Paper on past climatic responses and impacts as a basis to enhance adaptation and ecosystem resilence	Gebrekirstos A, H. Neufeldt & R. Mitlöhner (2011) Exploring climatic signals in stable isotopes of Sclerocarya birrea tree ring chronologies from the Sahel region in West Africa The instrumental record of climate is just too short to understand how climate changes in Africa. We explored the potential of stable isotopes in tree rings as a climate proxy. The pilot measurements showed the potential of stable isotopes in tree rings of S. birrea as climate proxy. This study is the first of its kind in the region.	GIZ, DFG, Robert Bosch, BMZ, University of Göttingen, university of Erlangen

			Julia Krepkowski, Achim Bräuning, Aster Gebrekirstos Growth dynamics and potential for crossdating and multi-century climate reconstruction of Podocarpus falcatus in Ethiopia (under review) We combined high-resolution electronic dendrometer measurements with wood anatomical investigations of microcores from the outermost stem parts collected in monthly intervals . Tree-ring width measurements of stem disks resulted in tentative tree ages of 500 years that were confirmed by radiocarbon dating. Further sampling in areas with different rainfall regimes, additional radiocarbon dating and measurements of stable isotopes would enable the establishment of a multi-century-long tree-ring series for climate reconstruction as a basis to enhance adaptation.	
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				
2.3.1.1	Measure environmental responses to past climatic variability to predict and model future climate impacts	Paper on tree histories as basis for understanding the challenges current climate variability poses to agriculture and food systems	Gebrekirstos, A., Bräuning, A., van Noordwijk, M., Mitlöhner, R., (2011). Understanding past, present, and future climate changes from East to West Africa. Agricultural Innovations for Sustainable Development 3(2): 77-86. Climate change affects all sectors of society at local, regional and continental scales, but available evidence is not sufficient to guide policies. Unraveling past climatic events is a must to understand the present and to derive reliable scenarios of future climate change. This paper uses the approaches and results from from three independent projects developed with different partners in Africa and Germany. These projects have the common goal to put the short existing	DFG, BMZ, GIZ, University of Göttingen, Erlangen University

			instrumental climate records in Eastern and West Africa into a longer perspective, to reconstruct climate variability during historical times and to unravel large-scale variations of the East African–South Asian Summer Monsoon (ASM) circulation during El Niños and La Niñas, and to investigate the impact of climate variability on the adaptation and water use of important forest and agroforestry tree species in the face of climate changes. This paper shows the need for interdisciplinary and international collaborations to extend research frontiers and to develop regional and sub regional climate models and climate teleconnections at a scale relevant for decision-makers.	

Theme 3, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
	Assess impacts of CC mitigation on poverty alleviation, food security, and environmental health at multiple scales	Report on mitigation effects from tree planting from the WKIEMP project in W. Kenya	Mitigation effects from tree planting calculated and reported in an ICRAF working paper: Place, F. et al. 2010. Impact Assessment of WKIEMP: Focus Group Discussions, Household Survey Analyses, and Land Use Change Detection in the Lower Nzoia, Lower Yala, and Lower Nyando River Basins and an end of project economic analysis Place, F. et al. 2011 Economic Analysis of the Western Kenya Integrated Ecosystem Management Project Upon Project Completion submitted to the World Bank. The mitigation effects from tree planting were measured in a study of 362 households, distributed over eleven project micro-catchments in	KARI, WB

			the project. The study contrasts adoption and impact between households participating in the Western Kenya Integrated Ecosystem Management Programme (WKIEMP) and those which did not. Trees on farms prior to the project and planted during the project were counted, including the type of tree and dominant species. Across all types of trees, beneficiary households planted an average of 440 trees during the 2004-2009 period as compared to 127 for the control households. The additional 313 trees can potentially sequester significant amounts carbon. This depends on the type of tree and management system. Permanent shrubs which were repeatedly pruned and rotational shrubs were assumed to generate 6 kg of carbon per year. However, the types of timber trees commonly planted by farmers can produce upwards of 30 kg per year of wood under good growing conditions and management, or about 15 kg per tree of carbon. However, since most of the trees planted are in the less favorable environment of lower Nyando, a more conservative estimate of 10 kg per tree is used. The total of nearly 160 additional timber (and fruit) trees can be expected to sequester about to 1.60 tons of carbon per year which could provide an additional $23 per year per household than would be generated by the control households (at a price of $4 per ton of CO2, where 1 ton of carbon = 3.67 tons of CO2). Across all 4,451 WKIEMP households this would amount to a net present value of about $751,946 for timber and fruit. The amount for the fodder and soil fertility trees would be approximately $431,768.	
	Assessing bioenergy feedstock potentials from viewpoints of livelihood/food security/ environmental sustainability	Publication, policy recommendation	Miyuki; report published, later reproduced as ICRAF working paper Ndegwa G, Moraa V, Jamnadass R, Mowo J, Nyabenge M and Iiyama M. (2011). Potential for biofuel feedstock in Kenya. ICRAF Working Paper No. 139 Nairobi: World Agroforestry Centre. http://dx.doi.org/10.5716/WP11272.PDF. Many developing countries, Kenya included, want to diversify their domestic energy supply hence reduce dependence on highly volatile fossil fuel prices, enhance access to energy in rural areas, promote rural development and to reduce carbon emissions. This study was done to assess the potential for supply of biofuel feedstock for bioethanol and biodiesel production for domestic consumption and export. To achieve this, key feedstocks were identified and their	Japanese government, BIA (Bioenergy in Africa), ODI

			environmental suitability, production and yields analyzed. Gross margin as a tool was used to make an economic analysis of the production of the feedstocks compared to that of the most prominent food and cash crops. A review of the national biofuel strategies, policies and regulations currently adopted in Kenya was also done. The study established that sweet sorghum and castor are the most environmentally suitable bioethanol and biodiesel feedstock respectively. In terms of gross margins, sweet sorghum has the highest gross margin at KSh 67,584 followed by sugarcane at KSh 37,746 and cassava at KSh 20,240 per hectare for bioethanol feedstocks. For biodiesel feedstocks, sunflower has the highest gross margin at KSh 2,921 per hectare. It is expected that this study will play a significant role in guiding the policy makers in making important decisions to drive the biofuels sector forward.	
3.2 Institutional arrangements and incentives for mitigation				
3.2.1.1	Assess barriers to entry and factors affecting carbon market for differentiated social groups, including women, and the range of emerging institutional arrangements and incentives for better inclusion and benefits	Publication, story and films on website	VIRED Institute, 2011. Making Carbon Finance for Sustainable Agriculture Work for the Poor in Western Kenya: Social Impact Assessment report. Presented at the Sustainable Agriculture in a Changing Climate (SACC) project workshop, 11-13 January 2011, in Kisumu, Kenya. This social impact assessment was conducted for the proposed agro forestry, agriculture and sustainable land management project in the lower and mid Nyando river catchment in Nyanza Region of western Kenya by CARE Kenya. The project is aimed at supplementing benefits the farmers derive from the improved farming methods with benefits from carbon finance revenues generated from the carbon sequestration potential of the project. The assessment aim was to understand how the proposed interventions of the sustainable land management/carbon project that will be designed in 2011 might affect members of participating communities/households and	Vi, CARE, TIST Mali/Guinea partners? S Asia partners?

			recommend measures that should be taken to enhance positive social impacts and avoid or mitigate potential risks/negative social impacts. Misiko, M, 2011. An analysis of institutions and potential project benefits in Nyando, western Kenya: a study report. Presented at the Sustainable Agriculture in a Changing Climate (SACC) project workshop, 28-30 June 2011, in Kisumu, Kenya. This report highlights relevance of local institutions in Nyando to core activities of a project called Sustainable Agriculture in a Changing Climate being coordinated by CARE International. It also reports on smallholder tree planting preferences and benefits, key challenges and suggested solutions.	
	Methodology and PDD for grassland carbon finance project , China	PDD, story on website	1) Cowie A, Penman T, Gorissen L, Winslow M, Lehmann J, Tyrrell T, Twomlow S, Wilkes A et al. 2011. Towards sustainable land management in the drylands: scientific connections in monitoring and assessing dryland Degradation, climate change and biodiversity, in Land Degradation and Development 22: 248-260 2) Marco Gemmer , Andreas Wilkes, Lucie M. Vaucel, 2011, Governing Climate Change Adaptation in the EU and China: An Analysis of Formal Institutions, in Advances in Climate Change Research 2(1): 1-11	FAO, Ministry of Agriculture, Chinese Academy of Sciences
3.2.1.4	Pilot institutional arrangements, incentive mechanisms and MRV protocols for carbon trade	Contracts with at least 1,000 smallholders for carbon payments	6 local management committees formed; 800 participating households; 130 trainers trained; over 50,000 trees planted. B**aseline household survey** training, implementation and analysis carried out in SACC/CCAFS site; Report, survey instrument, training materials, and data, all available for downloading at: http://ccafs.cgiar.org/resources/baseline-surveys. **Benefit sharing** project report and presentation to stakeholder workshop on results of participatory research examining potential benefits from the project with different groups, including women, and strategies for equitable benefit sharing. Trees species,	Vi, CARE, TIST Mali/Guinea partners?

			their uses and values to different groups was also explored. **Institutional analysis results** informing formation of six local management committees and proposal for Phase2 institutional arrangements. **Carbon measurement and monitoring -** refined household-level spreadsheet model (the 'carbon calculator tool') developed for calculating carbon potential within different types of farms; 10 NGO field staff trained, and implementation in sentinel sites. Remote sensing tools for carbon monitoring available within the Carbon Benefits Project toolkit at: (http://www.goes.msu.edu/cbp/). **Household livelihood and incentive strategies**. Participatory research in 6 villages undertaken; data for 'IMPACT' household input-output farm model collected from 40 households; testing and incorporation of agroforestry component into IMPACT.	
		Comparative analysis of choice experiments in the design of carbon payments	Ajayi et al: Auction design for payments for environmental services: Lessons from field trials in Malawi and Indonesia. Manuscript prepared and under review. Summary: Payments for environmental services programs use direct incentives to improve the environmental impacts of private land use decisions. An auction offers an approach to efficiently allocating contracts among least-cost landholders, which can improve the overall cost-effectiveness of the approach. However, experiences with auctions in developing country settings are limited. We compare the results of two case studies that use auctions to allocate payments for environmental service contracts in Indonesia and Malawi. While the settings and the contracts differ, regularities in auction design allow comparisons and general lessons about the application of auctions to payments for environmental services programs	Malawi Forestry Dept, Extension Dept
3.2.3.2	Workshops and capacity building initiatives to increase the uptake and improve the design of incentives mechanisms and institutional arrangements	Decision-makers trained in target regions re:options and policy choices for incentivizing and rewarding smallholders for	In January 2011, a taskforce meeting was held to identify capacity needs for negotiators at the UNFCCC. Following this, two workshops were held in Africa and Asia in May 2011 where negotiators and land managers were trained and discussed on REDD concepts involving monitoring, reporting and verification as well as safeguards. Two research papers were produced as outcomes from the meeting	Gov't agencies, University networks (RUFORUM, ANAFE, SCARDA)

		GHG emission reductions	discussions. http://www.asb.cgiar.org/PDFwebdocs/redd_dev_dividend.pdf http://www.asb.cgiar.org/PDFwebdocs/redd_strengthening_mrv_kenya.pdf http://www.asb.cgiar.org/PDFwebdocs/redd_safeguards.pdf	
3.2.3.2		Training of decision-makers trained in target regions re: options and policy choices for incentivizing and rewarding smallholders for GHG emission reductions (RUPES)	Leimona B, van Noordwijk M, Joshi L, Catacutan D, Yatich T, Dietz J, Mwangi H, Gathenya JM, Muthuri C, Sinclair FL, Bhattarai S, Onyango L, Suyanto, Kalinganire A, Noordin Q, Bayala J, Gebrekirstos A, Tscherning K and Duque-Piñon C, 2011. Supporting multifunctionality through realistic, conditional and voluntary actions to enhance trees as source of environmental services. In: Van Noordwijk M, Hoang MH, Neufeldt H, Öborn I, Yatich T, (eds.) How Trees And People Can Co-adapt to Climate Change: Reducing Vulnerability Through Multifunctional Agroforestry Landscapes. Nairobi: World Agroforestry Centre (ICRAF), pp 79-122 http://www.worldagroforestry.org/sea/publication?do=view_pub_detail&pub_no=BC0321-11 The LUWES (Land-use planning for low-emissions development strategies) tool was developed for assisting local government planning agencies to explore strategies that will reduce emissions with minimum negative impact on economic development. The tool was applied in two districts in Indonesia and was well received. A book chapter summarizing the experience and evolving paradigms of 'Payments for Ecosystem Services' was published, and the material	IFAD, MARD, MONRE

			used for various workshops and training events in Asia and E Africa..	
		Opportunity Costs workshops (REALU project)	• **Opportunity cost training workshops**: A number of workshops based on the manual on Estimating the Opportunity Costs of REDD+ were held at regional, national and sub-national levels: ○ Africa regional training workshop on opportunity cost held in Arusha from 22nd to 25th November, 2010 About 50 Participants from Tanzania, DRC, Ghana, Ethiopia, Cameroon, Mozambique, Kenya, Liberia, Uganda and America ○ Asia regional training workshop on opportunity costs held in Bangkok from 25th to 29April, 2011. 25 participants were involved ○ Latin America regional training workshop on opportunity costs held in Cali from 16th to 20th May, 2011. 25 participants were involved. National and sub-national level training workshops on opportunity costs methods for government departments and key civil society stakeholders were held as follows: ○ *Cameroon:* 18th – 12th March 2011 in Limbe with 25 national stakeholders participating; ○ *Vietnam:* 12th May 2011 in Hanoi with 20 national stakeholders participating ○ *Indonesia* (2 workshops): 30 National agricultural researchers were trained in Bogor on opportunity costs analysis and new software for exploring REDD scenarios; in a provincial level workshop held in Jambi province from February 22nd to 23rd , 2011 23 participants from the Provincial Planning Agency – Bapeda were trained on the use of the new REDD-Abacus software ○ *Peru:* A workshop involving both technical people and decision makers was held from September 4th – 9th, 2011. The workshop was jointly organized with The Ministry of Agriculture (MINAM) and GIZ (the German cooperation agency). 50 participants expected.	IISD

3.3 On-farm mitigation practices and landscape implications				
3.3.2.2	Measure GHG fluxes and develop MRV	Papers on non-CO2 GHG fluxes from complex agro-ecosystems	Thiongo et al, 2011. Forest soil as sink or source of greenhouse gases: a case study of species effects on nitrous oxide and methane fluxes in Karura forest, Kenya. Paper presented at the 6th Non CO2 Greenhouse Gases Conference. Amsterdam, 2-4 Nov 2011. Understanding the processes responsible for the fluxes of non-CO_2 GHGs from soil will help in better predictions of future concentrations of these gases in the atmosphere. The study objectives were to (1) assess the effect of forest type on CH_4 and N_2O fluxes, (2) evaluate the effect of soil water content on CH_4 and N_2O fluxes and (3) determine the relationship between N availability and terrestrial N_2O and CH_4 fluxes. The study was carried out in Karura forest, in central Kenya. Gas fluxes were measured from a natural forest stand and three different exotic plantations using static chambers. The study showed that the forest consumes more CH_4, and emits more N_2O, in the wet season. Greater N_2O emission and CH_4 consumption was measured from the natural forest as compared to the exotic plantations. These findings will help improve forest management practices and decisions to reduce greenhouse gas emissions in Kenya. Experimental design for testing effect of biochar on gas fluxes has been completed, a pot trial for conducting the above experiments was established and a pyrolysis stove for production of biochar will arrive in Kisumu by end of January 2012. Also, site selection for field trials was completed. Plans are underway to implement the experiments in 2012.	WWF; UNEP; MSU; CSU; CORNELL CIFOR
		Terrestrial carbon measurement and monitoring prototype	A protocol for Measuring and Monitoring Soil Carbon Stocks in Agricultural Landscapes was produced and made available under the Carbon Benefits Project toolkit. A proposal to extend this work was produced with the aim to quantify the uncertainties in soil carbon	WWF; UNEP; MSU; CSU; AfSIS

		methodology	estimates and improve guidelines for planning soil carbon measurements.	
		Book chapter	Luedeling et al, 2011. Review of carbon sequestration potential of agroforestry in Africa. In: Kumar BM & Nair PK: Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges, 61-84. This review collated information on the carbon sequestration potential of agroforestry systems throughout Africa, distinguishing between the biophysical, the technical, the economic and the practical potential. While many cited studies indicated high biophysical potentials, the few analyses that examined profitability of sequestration activities for farmers mostly found very low potentials. Data from many studies that were reviewed was not directly useable due to a range of methodological problems. The study highlights the need to collect better data. It also casts doubts on the profitability of carbon sequestration activities for smallholder farmers, at least when it comes to revenue from carbon sales.	

Theme 4, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
4.1 Linking knowledge with action				
4.1.1	Knowledge management and communication strategy for conservation agricultural with trees (CAWT) developed and operationalized	Knowledge and Information Sharing Products (KISPs) in CAWT for different stakeholder groups.	Stakeholder workshops were held in the districts of Machakos (Kenya), Mbarali (Tanzania) and Bugesera (Rwanda) to gather the information and communication needs of the different stakeholder categories. Participants included ministry of agriculture officials, national scientists, NGOs, farmer representatives and media. A	IFAD, SUA, KARI, ISAR

		Web page on CAWT within ICRAF and partner organizations websites	communication strategy has been developed to guide development of KISPS. A web page has been created within ICRAF websites under the banner evergreen agriculture but due to the rising interest in the farming practice a separate website for evergreen agriculture has been developed and is set for uploading and populating.	
4.1.3	Establishment of Best Practices Scaling up Sites on ecosystems management and conservation including agroforestry, evergreen agriculture and water harvesting	One new site established in Ekalakala, Masinga district in Kenya. Two others underway in Kinango and Kibwezi	Sites have been established in Kibwezi and Ekalakala with water harvesting and conservation agriculture with trees demonstration plots. Farmers in Kibwezi report increased yields and a student will analyse changes in soil carbon and yields in 2012. The site in Ekalakala is currently with water harvesting technologies and a CAWT demonstration plot will be established in 2012.	UNEP, WRMA, WFP
	COP 17 in Durben, South Africa Forest Day 5 in Durban Agriculture and Rural Development Day 3 in Durban	Learning Events on Landscape approaches and climate-smart agriculture	Learning Event on 'Making climate smart agriculture work for the poor' at COP17 Learning Event on 'Climate-smart agriculture is evergreen' at ARDD3 Discussion Formun on Landscape approaches at FD5: The place of agroforestry, afforestation and reforestation in REDD+ Forest Day 5: Scientists discuss a landscape approach to REDD+ Coordinated Issues marketplace theme: Landscape approaches. The place of agroforestry, afforestation and reforestation in REDD+ Poster presentation: REALU - a whole landscape approach to reducing emissions	Danone, MoFA Finland, MAg Kenya, FAO, Vi AF ASB

	34th session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) in Bonn, Germany	Side event: Sparing versus Sharing: Addressing drivers of deforestation and forest degradation	A side event was held on the 'Sparing versus Sharing' discussion http://www.asb.cgiar.org/conference-proceedings/sparing-vs-sharing-addressing-agricultural-drivers-deforestation-reflections- A side event at SBSTA34 during which the Carbon Benefit Toolbox was released that provides measurement and modelling tools for carbon and greenhouse gas MRV as well as supporting tools for decision-making.	UNEP; WWF; MSU; CSU; ASB
4.2 Data and tools for analysis and planning				
	Integrated assessment framework and toolkit for analyzing likely effects of specific adaptation and mitigation options in target regions	Methods and tools made available widely to partners and on website Covered under (Toolbox for REDD+ and AFOLU project Cycle management available and accessible to practitioners and policy makers at various levels: REALU project)	Bernard, F., Minang, P., Van Noordwijk,M. (2011) Review of current tools and methods for REALU value chain. A project Report for the REALU Project. Part I of this report identifies a number of perspectives for clarifying the range of tools and methods employed. These include: i) Project cycle perspective and compliance aspects; ii) Nature of tools – for scientists –, i.e. spatial, dynamic, non-spatial, qualitative; iii) Process tools for stakeholder decision making. Part II provides a detailed description of the range of tools and methods existing for REDD+ and REALU developed by ICRAF, the ASB Partnership for Tropical Forest Margins as well as other international organizations such as James Hutton Institute, Environmental Network Ltd and Landscape Denmark. Part III presents visual representations of the current set of tools (as discussed in the workshop) and highlights and discusses the gaps and outstanding issues with the intent of generating discussion. It also presents visual representations of other external tools. The two tool sets are synthesized in order to identify overlaps and gaps. The conclusion provides recommendations for the way forward.	ASB; UNEP

			Appendix 1 and Appendix 2 respectively provide a brief preliminary description of external tools and methods, as well as guidelines available for REDD+ and REALU. Website forthcoming	
		Remote sensing databases and maps of vegetation conditions and recent historical changes in Africa developed Covered under Milestone 4.2.1.5 Need some specific outputs for 2011	Algorithms and programs developed for calibration of satellite image archives to ground reflectance for a range of sensors. These include for Landsat imagery and other sensors such as Quickbird, WorldView2, ASTER and MODIS. The calibrations also include corrections for terrain-induced radiance effects. Work initiated to translate current scripts into Python and Java for use on open source platforms, as well as development of interactive web- interfaces for map generation. These calibrations are critical to the development of maps of soil functional properties including soil carbon, vegetation cover and land degradation risk factors given that the image database used represent multiple dates, seasons and sensor generations. E.g. the methods allow us to calibrate Landsat MSS and TM imagery so that these are in the same units as Landsat ETM+. Africa databases compiled including: at continental scale NDVI data from AVHRR; at basin scale MODIS vegetation density, reflectance corrected visible and near infrared bands, and emissivity; and at patch scale Landsat Multi Spectral Scanner (MSS) and Landsat Thematic Mapper (TM) and Enhanced TM (ETM) data from 1972. Land health metrics are being derived from these databases and will also contribute to CRP5 Information Systems.	AFSIS;
4.3 Refining frameworks for policy analysis				
	Synthesis of case studies on the impacts of CC in diverse	Results/lessons from pilot REDD,	PES papers published from PRESA:	CARE, development and

	agricultural systems	PES, carbon payment projects for smallholders synthesized in journal article, webstory (RES Synthesis – Technical Advisory Notes for donors) (PRESA+RUPES) Ghana	1. Article in press: Jindal, R., et al., Social dimensions of procurement auctions for environmental service contracts: Evaluating trade-offs between cost-effectiveness and participation by the poor in rural Tanzania. Land Use Policy (2011), doi:10.1016/j.landusepol.2011.11.008 2. John Kerr, Mamta Vardhan and Rohit Jindal 2012. Prosocial behavior and incentives: Evidence from field experiments in rural Mexico and Tanzania. Ecological Economics 73: 220–227. Web stories from small holder carbon payments: 1. ***Carbon payments for watershed management.*** Jun 23, 2011 http://presa.worldagroforestry.org/blog/2011/06/23/carbon-payments-for-watershed-management/ 2. ***Carbon project brings new income – and risks – to Uganda farmers.*** May 9, 2011 http://presa.worldagroforestry.org/blog/2011/05/09/carbon-project-brings-new-income-and-risks-to-uganda-farmers/ 3. ***Supporting communities for sustainable ecosystems in western Uganda.*** Mar 17, 2011 http://presa.worldagroforestry.org/blog/2011/03/17/supporting-communities-for-sustainable-ecosystems-in-western-uganda/	donor partners,
	Regional policy and program choices identified	Analytical papers and policy briefs that consider the implications of 2010 climate agreements and legislation on national plans and policies for sustainable development in the tropical forest	http://www.asb.cgiar.org/ourresources?tid=1000 Meyfroidt, P.; van Noordwijk, M.; Minang, P.A.; Dewi, S.; Lambin, E.F. 2011 Drivers and consequences of tropical forest transitions: options to bypass land degradation? Download Tata, H.L.; Widayati, A.; Mulyoutami, E.; van Noordwijk, M. 2011 Co-existence of people and orangutan in Sumatra -Stabilising gradients for landscape multifunctionality	COMESA, NEPAD, COMEFAC, Gov't agencies, development organizations, conservation organizations

		margins	Clark, W.C.; Tomich, P.T.; van Noordwijk, M.; Guston, D.; Catacutan, D.; Dickson, N.M.; McNie, E. 2011. Boundary work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR). National Academy of Sciences. Hoang M H, Hoan DT, Thoa P M, van Noordwijk M and Minang PA (2011). Benefit distribution across scales to reduce emissions from deforestation and forest degradation (REDD+) in Vietnam. Land Use Policy (in press)	
		Synthesis papers, reports and policy briefs summarizing experience with avoided deforestation, REDD pilot studies for key policy processes.	http://www.asb.cgiar.org/ourresources?tid=1000 Minang, P.A.; Bernard, F.; van Noordwijk, M.; Kahurani, E. 2011 Agroforestry in REDD+: Opportunities and Challenges Santos-Martin, F.; Bertomeu, M.; van Noordwijk, M.; Navarro, R. 2011 Why smallholders plant native timber trees away from the forest margin : Lessons from Leyte, the Philippines Robiglio, V.; Minang, P.A.; Asare, R. 2011 On-farm timber production for emission reduction with sustainable benefits at the tropical forest margins Janudianto.; Mulyoutami, E.; Joshi, L.; Wardell, D.A.; van Noordwijk,	COMESA, NEPAD, COMEFAC, Gov't agencies, development organizations, conservation organizations (CARE, WWF, Conservation International, Nature Conservancy)

			M. 2011 Recognizing traditional tree tenure as part of conservation and REDD+ strategy	
		Edited volume: Energy policy, society and environment in the Amazon	Santos, Ione Vieira; Porro, Noemi Sakiara Miyasaka ; Porro, Roberto 2011. Interventions to curb deforestation and stability in access to land: A comparative study between two land regulation modalities in the Transamazon region, Brazil. Roma: International Land Coalision, available at http://americalatina.landcoalition.org/sites/default/files/ICRAF-PARA_Brazil_web_14.03.11.pdf This paper addresses the interaction between the application of environmental laws and the stability of beneficiary families in agrarian reform settlements, in a context of increasing environmental concerns pressured by climate change. It compares two types of land regulation in the Amazon – settlement projects and sustainable development projects. It examines four main issues: forms of accessing land, the legal situation of land property, actual places of residence, and conditions for family farming. It shows that the type of land regulation per se does not affect the mobility of families, but rather that families' desire to work for themselves, without landlords, is the core reason why many leave behind hard-earned reformed plots to pursue new opportunities elsewhere.	CIFOR, CIAT
		Meta-analysis of rangeland management impacts on SOC in China (publication)	1) Wang, SP, Wilkes, A, Zhang, ZC, Chang, XF, Lang, R, Wang, YF, Niu, HS, 2011, Effects of management and land use change on soil carbon in China's grasslands, in Agriculture, Ecosystems & Environment 142 (2011) 329– 340, doi:10.1016/j.agee.2011.06.002	Chinese Academy of Sciences

CASE STUDIES

• Title: **Explaining the greenhouse gas effect to coffee farmers in East Java (Indonesia)**

• Case type: Capacity strengthening/ communications

• Brief description of the activity

Putting a volunteer farmer in a sack helps to explain to farmers on the forest edge how global warming works: the gasses released in burning fuel or the forest put another layer around the earth that makes us all hotter, just as the 'sacked' farmer experiences

• Result of activity

The described approach was used in the background of efforts to involve farmers in measurements of carbon stocks in their own landscape. It provided a common point of reference and laughter, opening up for discussions on how 'shade trees' in the coffee gardens function.

• Partners involved and their role

The trainings were provided by professors and lectures of Brawijaya University, in cooperation with the Ministry of Forestry and local NGO's

• Research on which the activity is based

Reference: Hairiah K, Dewi S, Agus F, Velarde SJ, Ekadinata A, Rahayu S and van Noordwijk M. 2011. Measuring Carbon Stocks Across Land Use Systems: A Manual. . Bogor, Indonesia. World Agroforestry Centre - ICRAF, SEA Regional Office. 154 p

• Web address for further information (if available)

http://www.worldagroforestry.org/sea/Publications/files/manual/MN0050-11/MN0050-11-1.PDF

• Title: **Incentives for smallholder farmers to join AFOLU project in western Kenya**

• Case type: Capacity strengthening/ non-research partnerships

• Brief description of the activity

Smallholder farmers are generally interested in planting trees as these represent important assets and provide multiple benefits, thus raising farmers' adaptive capacities. However, incentives for planting more trees are often not explicit because there are up-front costs (seedlings, nurture, watering, etc.) that need to be covered. Funded by the Rockefeller Foundation and CCAFS, CARE, together with ICRAF has been developing an AFOLU project to be validated by the VCS and CCB standards that will provide the initial inputs to overcome the barriers.

• Result of activity

The project is still in a pilot phase but aims to sign up a total of 50,000 households in Nyanza province, in particular the Nyando River catchment and sequester up to 1.5m tons of CO_2 over the whole project duration next to significant livelihood improvements for the farmers. Within the first year over 1000 farmers have signed up to the scheme.

• Partners involved and their role

CARE is leading the project, with scientific backstopping from ICRAF. Rockefeller Foundation and CCAFS are providing the funding for the first two years of the project

• Research on which the activity is based

VIRED Institute, 2011. Making Carbon Finance for Sustainable Agriculture Work for the Poor in Western Kenya: Social Impact Assessment report. Presented at the Sustainable Agriculture in a Changing Climate (SACC) project workshop, 11-13 January 2011, in Kisumu, Kenya.

Misiko, M, 2011. An analysis of institutions and potential project benefits in Nyando, western Kenya: a study report. Presented at the Sustainable Agriculture in a Changing Climate (SACC) project workshop, 28-30 June 2011, in Kisumu, Kenya.

• Web address for further information (if available)

http://www.careclimatechange.org/carbon-finance-initiatives/sacc

• Title: **Raising awareness on climate change and agroforestry among national partners (Philippines)**

• Case type: Capacity strengthening/Non-research partnerships

• Brief description of the activity

ICRAF Philippines is providing training and other forms of capacity building to national and local partners to increase their awareness on the role of agroforestry and tree-based systems in climate change mitigation and adaptation. Among the topics highlighed is how smallholders can potentially access the emerging carbon market such CDM and REDD+. Staff from national government agencies, NGOs and people's organizations participated in this activity.

• Result of activity

There is better appreciation on how agroforestry and tree-based systems can mitigate climate change and help farmers adapt to climate risks. There is higher interest on carbon finance for forestry projects. A national REDD+ strategy has been drafter with participation from ICRAF scientists.

• Partners involved and their role

Partners include the University of the Philippines (resource persons/participants), the Department of Environment and Natural Resources (sponsors/participants), NGOs (participants), people's organizations (participants) and the Philippines Senate (sponsor/resource person), among others.

• Research on which the activity is based

References:

Lasco, Rodel D., Florencia B. Pulhin, Leonida A. Bugayong, and Marlo D. Mendoza. 2011. An assessment of potential benefits to small holders of REDD+ components in the Philippines. Annals of Tropical Research, 33: 31-48.

Lasco RD, Habito CMD, Delfino RJP, Pulhin FB, Concepcion RN. 2011. Climate Change Adaptation for Smallholder Farmers in Southeast Asia. World Agroforestry Centre, Philippines. 65p.

• Web address for further information (if available)

• Title: **Multiple livelihoods combining traditional crops and new income streams**

• Case type: Combining traditional farmer-developed technologies and 21st-century science.

Traditional Faidherbia albida/maize intercrop in Mbarali, Tanzania

• Brief description of the activity: Smallholder farmers in the river valleys of southern Africa have cultivated *Faidherbia albida* for hundreds of years obtaining increased cereal yields, wood for traditional canoes, fuel-wood, and livestock fodder for the household. ICRAF is measuring carbon stocks in this cropping system so that payment for carbon sequestration can join the stream of livelihoods provided to households.

• Result of activity: Tree cover and carbon sequestration on densely-populated smallholder landscapes, with increased livelihood options. In Malawi, an average of 6 tons of wood biomass per hectare is stored per hectare, at the same time roughly doubling maize yields. Improved maize yields have been linked to improved rain-use-efficiency and recycled nitrogen from tree leaves, which are shed just prior to the cropping season.

• Partners involved and their role: Cooperative study with ICRAF and the Forestry Research Institute (FRIM) of the Forestry Department of Malawi.

ICRAF/FRIM team measuring Faidherbia biomass.

• Research on which the activity is based:

Sileshi, G., F.K. Akinnifesi, O.C. Ajayi, and B. Muys. 2011. *Integration of legume trees in maize-based cropping systems improves rain-use efficiency and yield stability under rain-fed agriculture.* Agricultural Water Management 98:1364-1372.

Kaonga, M.L., and T.P. Bayliss-Smith. 2009. *Carbon pools in tree biomass and the soil in improved fallows in eastern Zambia.* Agroforestry Systems 76:37-51.

Saka AR, Bunderson WT, Itimu OA, Phombeya HSK, Mbekeani Y (1994) *The effects of Acacia albida on soils and maize grain yields under smallholder farm conditions in Malawi*. Forest Ecol Manage 64: 217-230.

• Web address for further information (if available):
http://www.worldagroforestry.org/evergreen_agriculture

• Title: Parkland trees and livelihoods: adapting to climate change in the West African

• Case type: Research/Capacity strengthening

• Brief description of the activity

Identify tree/shrub species and seed sources that can provide the best quality wood for construction, fuel and other uses under future climatic conditions in the Sahel, and then work with rural communities to establish rural woodlots of these species. Explaining to farmers how the project is designed to identify species and seed sources that can provide the best quality wood for the future climate. They said: “We have only a few good trees for energy in our field now so we must plant trees for the future.”

• Result of activity

Some species have better wood properties for construction, fuel, etc. in drier locations, while others have better wood properties in more humid location. The principal recommendation to date is to promote the use species that are better adapted to drought and have better wood properties in drier locations. The project is working with rural communities to collect seed of these species in drier locations for establishment of rural woodlots.

• Partners involved and their role

The principal research partners are two universities in Brazil (University Federal of Parana-UFPR, University Federal Rural of Rio of Janeiro-UFRRJ) and the NARs in Mali and Niger, and the principal extension partners are two IFAD-funded development projects in Mali and Niger.

• Research on which the activity is based

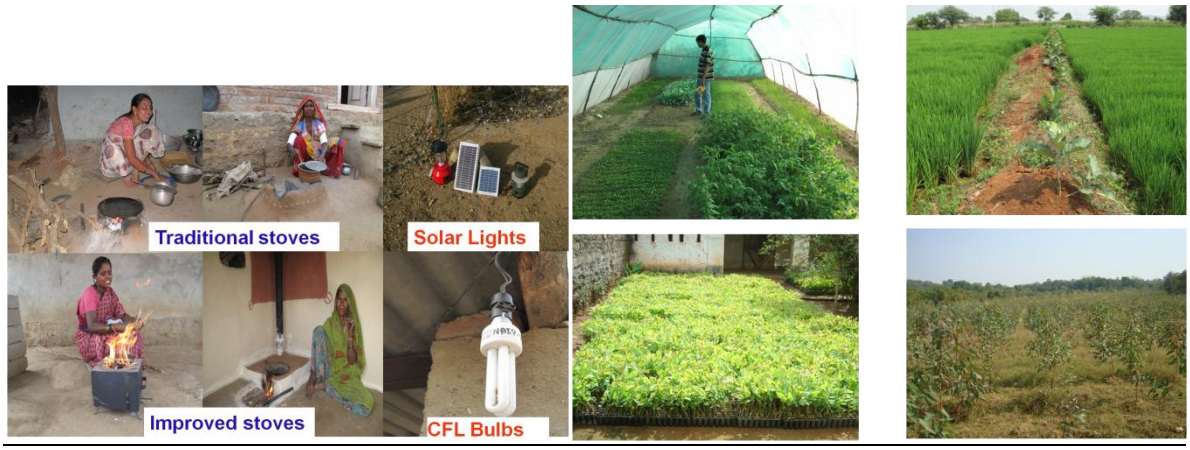
Reference: Sotelo Montes C, Silva DA, Garcia RA, GIB, Weber, JC. 2011. Calorific value of *Prosopis africana* and *Balanites aegyptiaca* wood in the West African Sahel. Biomass and Bioenergy 35:346-353.

• Title: TAKING THE HEAT OUT OF FARMING

• Case type: Capacity strengthening/ communications

• Brief description of the activity

An innovative agroforestry project is helping Indian smallholders to improve their livelihoods and reducing emissions.



• Result of activity

This project has enabled small holders to adopt emission reducing and carbon sequestering farming practices, including agroforestry in a grid of a thousand ha or more as a single entity, registered as society for all negotiations. They have started savings on energy use, mainly in lighting; fuel wood for cooking and in irrigation pumps, and input use in their farming. They are also having additional employment opportunities, especially in producing the planting materials.

• Partners involved and their role

The partners, Central Research Institute for Dryland Agriculture, Vivekanand Parvatiya Krishi Anusandhan Sansthan , Maharana Pratap University of Agriculture and Technology, Orissa University of Agriculture and Technology, and OUTREACH provided the technical backup and training for ensuring the correct application of the interventions in four different ecologies.

• Research on which the activity is based

This is a pilot study which is based on the newly developed protocol and methodology for small holders by ICRAF

• Web address for further information (if available)

www.naip.icar.org.in

CLIMATE CHANGE, ADAPTATION, MITIGATION - Publications

1 . **Chaudhury, M.; Ajayi, O.C.; Hellin, J.; Neufeldt, H. World Agroforestry Centre (ICRAF), Nairobi (Kenya) 2011**. **Climate change adaptation** and social protection in agroforestry systems: enhancing adaptive capacity and minimizing risk of drought in Zambia and Honduras. -- Nairobi, Kenya: World Agroforestry Centre (ICRAF) ICRAF Working paper no. 137, 31p.. [2011269] ICRAFP

2 . **Cooper, P.J.M.; Coe, R. University of Reading, Berkshire (U.K.) 2011**. Assessing and addressing **climate**-induced risk in Sub-Saharan rainfed Agriculture: foreward to a special issue of Experimental Agriculture. Experimental Agriculture 47 (2) p. 179-184. [2011020] ICRAFP

3 . **Dawson, I.K.; Vinceti, B.; Weber, J.C.; Neufeldt, H.; Russell, J.; Lengkeek, A.G.; Kalinganire, A.; Kindt, R.; Lillesø, J-P.B.; Roshetko, J.; Jamnadass, R. World Agroforestry Centre (ICRAF), Nairobi (Kenya) 2011**. **Climate change** and tree genetic resource management: maintaining and enhancing the productivity and value of smallholder agroforestry landscapes: a review. Agroforestry Systems 81(1) p. 67-78. [2011016] ICRAFP

4 . **Gathenya, M.; Mwangi, H.; Coe, R.; Sang, J. University of Reading, Berkshire (U.K.) 2011**. **Climate** and land use induced risks to watershed services in the Nyando river basin, Kenya. Experimental Agriculture 47 (2) p. 339-356. [2011021] ICRAFP

5 . **Jamnadass, R.; Gebrekirstos, A.; Neufeldt, H.; Muthuri, C.; Dawson, I.; Kindt, R.; Nyberg, Y.; Dietz, J.; Bayala, J.; Kuyah, S.; Ong, C.K.; Montes, C.; Weber, J.; Hairiah, K.; van Noordwijk, M. World Agroforestry Centre (ICRAF), Nairobi (Kenya) 2011**. Trees as providers of environmental services in multifunctional landscapes are vulnerable to **climate change**. In: van Noordwijk M, Hoang MH, Neufeldt H, Oborn I and Yatich, T. (eds). How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes. Nairobi: World Agroforestry Centre (ICRAF) p. 63-77. [2011280] ICRAFP

6 . **Kakaï, R.G.; Akpona, T.J.D.; Assogbadjo, A.E.; Gaoué, O.G.; Chakeredza, S.; Gnanglè, P.C.; Mensah, G.A.; Sinsin, B. 2011**. Ecological **adaptation** of the shea butter tree (Vitellaria paradoxa C.F. Gaertn.) along climatic gradient in Bénin, West Africa. African Journal of Ecology 49 (4) p. 440-449. [2011178] ICRAFP

7 . **Kalame, F.B.; Aidoo, R.; Nkem, J.; Ajayi, O.C.; Kanninen, M.; Luukkanen, O.; Idinoba, M. University of Helsinki, Helsinki (Finland). Viikki Tropical Resources Institute (VITRI) 2011**. Modified taungya system in Ghana: a win–win practice for forestry and **adaptation** to **climate change**?. Environmental Science and Policy 14 (5) p. 519-530. [2011132] ICRAFP

8 . **Lasco, R.D; Habito, C.M.D.; Delfino, R.J.P.; Pulhin, F.B.; Concepcion, R.N. World Agroforestry Centre (ICRAF), Los Baños (Philippines) 2011**. **Climate change adaptation** for smallholder farmers in Southeast Asia. -- Los Baños, Philippines: World Agroforestry Centre (ICRAF) 65p.. [B16910] 551.583 LAS ICRAFP

9 . **Lasco, R.D. World Agroforestry Centre (ICRAF). SEA Regional Office. Bogor (Indonesia) 2011**. **Climate** smart rural development. Tempo V (3) p. 8-9. [2011342] ICRAFP

10 . **Loo, J.; Fady, B.; Dawson, I.; Vincetil, B.; Baldinelli, G. Bioversity International, Rome (Italy) 2011**. **Climate change** and forest genetic resources - state of knowledge, risks, and opportunities. -- Rome, Italy: Food and Agriculture Organization of the United Nations (FAO) Prepared for the Thirteenth Regular Session of the Commission on Genetic Resources for Food and Agriculture, 18-22 July 2011, FAO Headquarters, Rome Background study paper no. 56, 29p.. [2011217] ICRAFP

11 . **Luedeling, E.; Steinmann, K.P.; Zhang, M.; Brown, P.H.; Grant, J.; Girvetz, E.H. World**

Agroforestry Centre (ICRAF), Nairobi (Kenya) 2011. **Climate change** effects on walnut pests in California. Global Change Biology 17(1) p. 228-238. [2011007] ICRAFP

12 . **Luedeling, E.; Girvetz, E.H.; Semenov, M.A.; Brown, P.H. World Agroforestry Centre (ICRAF), Nairobi, (Kenya) 2011**. **Climate change** affects winter chill for temperate fruit and nut trees. PLoS ONE 6 (5) 13p.. [2011304] ICRAFP

13 . **Luedeling, E. World Agroforestry Centre (ICRAF), Nairobi (Kenya) 2011**. Adapt now to **climate change**. Food Technology 65 (9) p. 120. [2011371] ICRAFP

14 . **Neufeldt, H.; Kristjanson, P.; Thorlakson, T.; Gassner, A.; Norton-Griffiths, M.; Place, F.; Langford, K. World Agroforestry Centre (ICRAF), Nairobi (Kenya) 2011**. Making **climate**-smart agriculture work for the poor. -- Nairobi, Kenya: World Agroforestry Centre (ICRAF) ICRAF Policy Brief no. 12, 6p.. [2011267] ICRAFP

15 . **Neufeldt, H.; van de Sand, I.; Dietz, J.; Minh Ha, H.; Yatich, T.; Lasco, R.D.; van Noordwijk, M. World Agroforestry Centre (ICRAF), Nairobi (Kenya) 2011**. **Climate change**, **climate variability** and **adaptation** options. In: van Noordwijk, M., Minh Ha, H., Neufeldt, H., Oborn, I. and Yatich, T. 2011. How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes. Nairobi: World Agroforestry Centre (ICRAF) p. 15-35. [2011312] ICRAFP

16 . **Shiday, B.M.A.; Nkunika, P.O.Y.; Sileshi, G.W.; French, J.R.J.; Nyeko, P.; Jain, S. University of Melbourne, Richmond (Australia). Department of Forest and Ecosystem Science. 2011**. Potential impact of **climate change** on termite distribution in Africa. British Journal of Environment and Climate Change 1 (4) p. 172-189. [2011256] ICRAFP

17 . **Singh, V.P. 2011**. Addressing the challenges of **climate change** for securing sustainable livelihoods in India. 7th G.B. Pant Memorial Lecture on the Occasion of the Golden Year Jubilee Celebrations of the G.B. Pant University of Agriculture and Technology, 17 Nov. 2010, Pant Nagar, Udham Singh Nagar, Uttrakhand, India [2011213] ICRAFP

18 . **Thorlakson, T. Harvard University Weatherhead Centre, Cambridge MA (USA) 2011**. Reducing subsistence farmers' vulnerability to **climate change**. -- Nairobi, Kenya: World Agroforestry Centre (ICRAF) ICRAF Occasional paper no. 16, 74p.. [2011183] ICRAFP

19 . **van Noordwijk, M.; Hoang, M.H.; Neufeldt, H.; Öborn, I.; Yatich, T. (eds) World Agroforestry Centre (ICRAF), Bogor (Indonesia) 2011**. How trees and people can co-adapt to **climate change**: reducing vulnerability through multifunctional agroforestry landscapes. -- Nairobi, Kenya: World Agroforestry Centre (ICRAF) 133p.. [B17128] ICRAFP

20 . **Xu Jianchu. World Agroforestry Centre (ICRAF), Chiang Mai (China) 2011**. **Climate change** in the Asian highlands: socio-economic implications for the Mekong Region. In: Lazarus K, Badenoch N, Dao N and Resurreccion BP (eds.). Water rights and social justice in the Mekong Region. London, UK. Earthscan p. 197-216. [2011093] ICRAFP

21 . **Xu Jianchu. World Agroforestry Centre (ICRAF), Chiang Mai (China) 2011**. The impact of **climate change** on water resources and local livelihood in the Asian highlands. In: Rayanakorn K (eds.) Climate Change Challenges in the Mekong Region. Chiang Mai, (China). World Agroforestry Centre (ICRAF) p. 9-33. [2011091] ICRAFP

22 . **Xu Jianchu; Daniel, R. World Agroforestry Centre (ICRAF), Chiang Mai (China) 2011**. Linking **climate change** risks and rights of upland peoples in the Mekong. In: Lazarus K, Badenoch N, Dao N and Resurreccion BP (eds.). Water Rights and Social Justice in the Mekong Region. London: Earthscan p. 217-244. [2011094] ICRAFP

23 . **Yatich, Y.; Swallow, B.; Ajayi, O.C.; Minang P,; Wakhayanga, J. 2011**. Community-based **adaptation** to **climate change** in Africa: a typology of information and institutional requirements for promoting uptake of existing **adaptation** technologies. In: Chidumayo E, Okali D, Kowero G and Larwanou M (eds.) Climate

Change and African Forest and Wildlife Resources. African Forest Forum, Nairobi, Kenya, Gävle, Sweden p. 161 - 175. [2011263] ICRAFP

24 . **Zhang, L.; Yi, H.; Renfu, L.; Wang, J.; Xu, J. World Agroforestry Centre (ICRAF), Chiang Mai (China) 2011**. The impact of **climate change** on agriculture and **adaptation** in China. In: Climate change challenges in the Mekong region. . Chiang Mai. World Agroforestry Centre (ICRAF) China p. 77-109. [2011092] ICRAFP

CCAFS Centre General Funds
2011 Contribution to Outputs: ICRISAT

Theme 1, Adaptation to Progressive Climate Change

1.1 Adapted Farming systems to changing climate conditions
Analogue sites for benchmark testing of crop management adaptation options have been establish in Kenya and Zimbabwe. Baseline data has been collected and experiments for crop model calibration established. A project website will help share information and data.

1.3 Species and genetic diversity for climate change
Knowledge on heat tolerance and specific drought tolerance traits in sorghum, chickpea, groundnut and millet has been generated. In rabi sorghum in India APSIM has been used to identify TPE and the value of stay-green traits in specific drought environments

Theme 2, Adaptation Pathways for Current Climate Risk

2.1 Managing climate risk and building resilient livelihoods
In-depth climatic analysis across scales linked with vulnerability and adaptation strategies was undertaken in six S and SE Asian countries. Crop and economic models were used to examine the impact of climate change and these data shared and communicated in policy-dialogues in Sri Lanka, Thailand and Vietnam.

2.3 Prediction of climate impacts, and enhanced climate services
A range of simple spread-sheet tools to analyse climate and climate risks, including ex-ante model analysis, have been used to enhance climate knowledge of partners in meteorological and agriculture services. Weather based advisories have been successfully used in five districts of Kenya. Seasonal forecasts in the drier regions of Zimbabwe have also been piloted using participatory crop modelling to increase the level of interaction and knowledge sharing. Similar seasonal forecasting linked with crop management risk analysis is underway in AP in India.

Theme 3, Pro-Poor Climate Change Mitigation

3.3 On-farm mitigation practices and landscape implications
Assessment and potential for c-sequestration in India journal article produced.

Theme 4, Integration for Decision Making

4.3 Refining frameworks for policy analysis
Calibration of models for inputs into IMPACT model, and IMPACT models runs for groundnut and sorghum completed

2011 Activity Plan for CCAFS Centre General Funds: Activities, Deliverables & Partners

CG Centre:	ICRISAT

Table A. Main contacts persons in the Centre

Contacts	Name(s) (specify roles if more than one)	Email
Climate Change Contact Point	Peter Craufurd	p.craufurd@cgiar.org
Admin. Issues	Peter Ninnes	p.ninnes@cgiar.org
Communications	Jerome Bossuet or Alina Paul	j.bossuet@cgiar.org; a.paul@cgiar.org
Others (if needed, specify role)	Lieven Claessens (Alternate to Peter Craufurd)	l.claessens@cgiar.org

Table B. Bilateral funded projects under CCAFS (2011)

ID#	Name of project	Approximate budget under CCAFS (2011) (1)	Donor	Principal investigator (also list any key contacts in EA, WA or IGP, if applicable)
1	Vulnerability to Climate Change Adaption Strategies and Layers of Resilience - RETA 6439	644	ADB	Cynthia Bantilan (c.bantilan@cgiar.org)
2	Testing potential adaption strategies for rainfed agriculture in semi arid and dry sub-humid tropics	490	BMZ	David Harris (d.harris@cgiar.org)
3	Managing Risk, Reducing Vulnerability and Enahancing Productivity under Climate Change	28	IDRC	KPC Rao (K.P.Rao@CGIAR.ORG)

Notes:

(1) If a bilateral project is contributing to more than one CRP, this is only the CCAFS activities.

Table C. Activity tables by Themes/Objectives

Note:

(1) Activities should be approximately US$250.000 in value, inclusive of all costs, i.e. including personnel, overhead etc.
(2) The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that Regional Program Leaders can plan synthesis and coordination activities. They will not be used for any later reporting.
(3) Milestone numbers will be provided by Theme Leaders.

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.1.1.1	Analysis of climate and characterisation of four important crop growing areas in Kenya and Zimbabwe and their analogue locations On station and simulation based research to iteratively test the potential of improved soil, water and crop management strategies together with contrasting crop genotypes to mitigate the impacts of increased temperature. Capacity building through 2 PhD programmes initiated	Analogue locations identified and household surveys conducted in (i) cool/dry, (ii) cool/wet, (iii) warm/dry and (iv) warm/wet growing environments On-station adaptation experiments in Kenya and Zimbabwe initiated 2 female PhD students registered at Hamburg	• On-station experiments to evaluate the performance of selected crops, varieties and management practices under different temperature regimes were established at 5 locations in Kenya – Katumani, Kampi-Ya-Mawe, Kabete, Embu and Ol Jororok. In addition to the differences in temperature regime, Katumani and Kampi Ya Mawe represent low rainfall regimes and Kabete and Embu represent high rainfall regimes within SAT. • An identical set of trials was implemented at 4 sites in Zimbabwe: Sanyati and Chiweshe, representing higher rainfall areas; Chiredzi and Matobo, representing lower rainfall areas. • Experiments were initiated to evaluate the performance of three different varieties representing different maturity groups (early, medium and late) of maize, sorghum, beans, and pigeonpea; to assess effectiveness of fertilizer use with and without soil and water conservation on sorghum and maize; to evaluate the effect of plant population on performance of pigeonpea and beans with and without soil and water conservation; and to evaluate the effectiveness of seed priming, with water and with P, on four test crops under early and delayed planting conditions. The first season results will be available in March (Kenya) and May (Zimbabwe) 2012. • Questionnaire-based baseline surveys of communities at each of 8 sites have been completed and data are being analysed. • Two female PhD students, one in Kenya and one in Zimbabwe, have started their studies focusing on gender dimensions of climate change • A project website was established and one information leaflet and one newsletter were published.	NARES: *Kenya* Kenyan Meteorological Dept (KMD). Kenya; Kenyan Agricultural Research Institute (KARI), Kenya; *Zimbabwe* Meteorological Department (ZMD). Zimbabwe; Midlands State University, (MSU) Zimbabwe ARI: Hamburg University, Faculty of Life Sciences, Germany
1.2 Breeding strategies for future climatic conditions				
1.3 Species and genetic diversity for climate change				
1.3.1.1	Mini-core/reference/ association panels of ICRISAT mandate crops phenotyped for heat and oher climate change adaptive traits	Pearl millet & chickpea mini-core Plus collections screened for heat tolerance Groundnut and chickpea	Heat tolerance • In 2011, a pearl millet nursery comprising of 85 advanced breeding lines and 2 populations was planted in three diferent datesin summer to coincide the high temperature of ≥ 42 $^{\circ}$C at flowering in at least one of the planting dates. This nursey was evaluated at 6 locations across 3 Indian states (Rajasthan, UP, and Gujarat).	ARI: University Western Australia

		mini-core collections screened for root and drought traits	• Heat tolerant lines (maintainers, B-lines, germplasm, composits) were identified with >60% seed set when the air temperature during flowering exceeded ≥42°C. In addition, four B-lines (ICMB 00333, ICMB 02333, ICMB 03555, and ICMB 04999 which were earlier identiifed as heat tolerant in 2010) again confirmed to be heat tolerant. These lines and a hreat tolerant composit will be tested in 2012. Water use • Sorghum, chickpea and groundnut mini-core have been screened for root-related traits (capacity to extract water using a lysimetric system) and the capacity to limit transpiration under conditions of high VPD, which saves water. Germplasm showing transpiration sensitivity to high VPD have been identified, and these also show a positive relationship to their degree of tolerance to terminal drought. • TPE has been defined for rabi sorghum in India and effect of stay-green and other water use related traits modeled in APSIM • Crop simulation modelling has been started in chickpea to evaluate the effect of root traits on seed yield and to assess whether crop phenology matches latitude for chickpea adaptation	

Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.1.1.4	Analysis long term daily climate data for selected SAT locations in six countries Farm level surveys of the perception of climate change, assessment of past and present adaptation practices and understanding institutional factors Policy dialogues to provide a common platform for research, policy and other stakeholders, including grassroot stakeholders, to develop strategies for climate change	Changes in daily climate analysed in four locations in India and two in each of other countries Reports on vulnerability and adaptive capacity to climate change in four ICRISAT VLS sites in India Farmers' perceptions documented Farmers' strategies to cope with risk and vulnerability documented Policy dialogues held in Bangladesh and Vietnam	• In-depth climatic analysis at different scales (National, regional, districts, Mandal/tehsil and village) were undertaken to characterize long term trends in climatic variables in six partner countries. Characterized the study regions into groups based on extent of vulnerability with a set of bio-physical and socio-economic indicators determining the exposure, sensitivity and adaptive capacity to climate change. This enabled us to prioritize the research domain towards the most vulnerable region in these countries. • A series of farm survey were done to collect both quantitative and qualitative information on farmer's perceptions of trends in climate, and the agro-socio economic context from their experience. These were analyzed and validated with a theoretical framework to compare with measured changes. • Grass root level adaptation strategies were winnowed from the quantitative and qualitative data analysis from the study regions. Constraints to effective climate change adaptation were identified from the rural communities and were transformed into policy statements. The "best fit" potential adaptation strategies and constraints were described at different levels of association (household, community, national/governmental, International). A "Write Shop" was organized to validate the results from analysis and to formulate policy statements to inform the concerned authorities for action through policy dialogue in these countries. • Ex-ante analysis of future climate change impacts on major crops were undertaken for major locations with validated crop models in India (Sorghum and groundnut, DSSAT) and Vietnam (Rice, and other crops, WOFOST). Economic analysis of climate change impacts on major crops on were quantified by econometric model on climate sensitivity on net farm revenue. • A series of country specific policy dialogues were convened on "Building climate resilient agriculture in Asia" for Sri Lanka, Thailand and Vietnam. The policy statements were conveyed to the key persons from the ministries, government and non-governmental organization and developmental agencies belonging to the respective countries.	**NARES:** India, Bangladesh, Thailand, China, Vietnam, Sri Lanka

2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				
2.3.1	Develop a comprehensive system that integrates locally relevant information on climate, soil, crop and market and serves as a decision aide for climate risk management in planning farm operations	Spread sheet based tools "Climate analyser", "Risk analyser" and "Cost to value calculator" Risk and return profiles of investments in fertilizer, moisture conservation technologies, and improved seed More than 25 researchers from NARS in the target countries trained in use of APSIM, MarkSim, and spread sheet based tools. Weather based agro-advisory system developed and tested and its usefulness evaluated.	• Three spread sheet based tools "Rainfall Analyzer", "Temperature Analyzer" and "Cost to Value Calculator" were developed and availed to all project partners and other interested researchers and students. These tools are mainly used to conduct a quick analysis to characterize the climate of a given location using historical climate data (both observed and generated). The tools help in computing the monthly, seasonal and dekadal totals; generate descriptive statistics and plot trends. These tools are currently being updated to make them more user-friendly. • An ex-ante analysis to assess risks and returns associated with selected technologies was conducted for Machakos, Makindu, Kitui, Mwingi and Mutomo in Kenya using the long-term climatic data with crop simulation model APSIM. The technologies selected for this analysis include different levels of fertilizer, soil and water conservation practices, crops and cropping systems and seasonal climate forecast based decisions. Results indicate that substantial risk exists at all the locations, except Kitui, on investments in agriculture. This is not considered in developing technologies and is acting as a major constraint in adoption of these technologies. • Training programs involving project partners from Kenya, Tanzania, Ethiopia and Madagascar were conducted to familiarize them with various tools to analyze long-term climate data (spreadsheet based tools and INSTAT), methods and options to fill the missing data, climate data generation using stochastic weather generators (Marksim), and assessing impacts of variable climate on crops and identify management practices that reduce the negative impacts (APSIM). A draft training module explaining the potential applications of these tools was also developed. Three MSc students one each from UoN, Kenya; ARC, Sudan; and EIAR, Ethiopia also received training in use of crop simulation model APSIM which they were able to use in their thesis research. • Weather based agro-advisories were developed and evaluated for their usefulness with farmers in five districts of Eastern Kenya. A survey conducted to evaluate the usefulness of these advisories has shown that most farmers considered advisories as extremely useful in planning farm operations, an observation well supported by a willingness of 87% of the farmers to pay for the service if required. The results are currently analyzed for publication as a journal article.	Tanzania, Kenya, Ethiopia, Sudan, Madagaskar Tanzania Meteorological Agency (TMA), Tanzania, University of Nairobi (UoN), Nairobi, Kenya, Kenya Meteorological Department (KMD), Nairobi, Kenya, Ethiopian Institute of Agricultural Research (EIAR), Addis Ababa, Ethiopia, National Meteorological Agency (NMA), Addis Ababa, Ethiopia, Sudan Meteorological Authority (SMA), Sudan, Agricultural Research Corporation (ARC), Sudan.
2.3.1.2	Linking seasonal forecast to participatory crop modelling and ICT	Farmers' perceptions of climate change and coping	Zimbabwe	NARES: Zimbabwe, India

& 2.3.2.3	to enhance delivery of climate information	strategies in southern Zimbabwe documented Operational system of seasonal forecast delivery and 'best bet' natural resource management options tested in Zimbabwe Piloted ICT-based advisory with seasonal forecasts and GIS maps in one District in AP, India	• Farmers (n=81) coping strategies in two districts of Zimbabwe (Masvingo and Hwange) have been documented along with their perceptions of climate change from household surveys and focus group discussions.Results show that farmer expectations rather than actual meteorological data influence farmers' perceptions on climate change. However, the study finds both farmers and meteorological data reporting increases in temperatures. • With Zimbabwe Met. Dept, seasonal forecasts were delivered to farmers in two districts using participatory methods. Farmers were given forecasts, forecasts plus advice, and forecast, advice plus participatory crop modelling of crop management options under different climate scenarios. Baseline and case studies were conducted. India • GIS-based drought maps with rainfall scenarios have been issued to farmers in Addakkal Mandal of Mahbubnagar, Andhra Pradesh (http://vasat.icrisat.ac.in). These maps estimate the surface water available to meet village requirements (human, livestock & irrigation) and runoff. • Agro-advisories, including daily rainfall, are being provided to 197 farmers through a local KVK (IT-based knowledge centre). Around 6500 SMS and voice messages have been broadcast to date. • Long-term (10-16 years) cropping system experimental data for sorghum/pigeonpea and sorghum/chickpea has simulated in APSIM to quantify risk. These data are being used to evaluate ENSO phase effects as the basis of providing a seasonal forecast to farmers in two districts of AP in 2012.	Zimbabwe Meteorological Department, AGRITEX, NGOs ARIs: University of Reading, University of Tasmania, Wageningen, IIT, Mumbai, IMD

Theme 3, Pro-Poor Climate Change Mitigation

Mile-stone # (3)	Activity in 2011	Deliverables in 2011	Status of the activity /deliverable	Partners
3.1. Low-carbon agricultural development pathways				
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				
3.3.1.1	Assess impact of different cropping systems on carbon sequestration in	Research paper "Carbon sequestration in Indian	• Paper in review for in Geoderma • Life-cycle analysis of nitrogen losses in sweet sorghum at different	National Soils Bureau, India

	dryland systems in India	soils of tropical and subtropical environments:Assessment and Potential" for Geoderma On-going C-seq. & NO2 measurements in cropping systems and in long-term on-station experiments	N-rates completed. Evaluation of nitrous oxide emissions from a long-term Conservation Agriculture experiment at Patancheru in progress	

Theme 4, Integration for Decision Making				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.3 Refining frameworks for policy analysis				
4.3.1.1	Assess impact of climate change and genetic strategies for climate change on ICRISAT mandate crops in SAsia, WCA and ESA Integrate DDSAT groundnut crop model into IMPACT model and develop new routines for adoption of new technology pathways in IMPACT	Impact runs for groundnut completed and sorghum in progress Groundnut model integrated into IMPACT	• Two popular and widely adopted sorghum and groundnut cultivars were calibrated for South Asia (India) and WCA and drought, heat tolerance and yield potential traits simulated under current climate and future climates (reported in full in CRP2) • Experiments at Patancheru, Gulbarga and Jamnagar with four cultivars each of pigeonpea and groundnut for model calibration completed	S. Nedumaran (s.nedumaran@cgiar.org)

Case study-CCAFS

Title: Communicating probabilistic forecast information to smallholder farmers

Case type: Communications

Brief description of the activity: Since many agricultural investment decisions have to be made well before the growing season starts without knowing what the season is going to be, good reliable forecasts have the potential to improve farm planning and reduce risks. Despite the availability of good reliable seasonal climate forecasts, its use in in farm level decision making has not received much attention. One of the major constraints in the use of seasonal climate forecasts is lack of timely access to information in a format that can be easily understood. The forecast released by Met. Department is mainly probabilistic in nature and is not easily understood by farmers and their support agents.

Result of activity: To address this problem, we have developed and tested weather based agro-advisory services to communicate the forecast information in an easily understandable format to farmers in Machakos, Makueni, Kitui, Mwingi and Mutomo districts of Eastern Kenya. The advisory is an interpretation of the seasonal climate forecast issued by Kenya Meteorological Department (KMD) and provides a succinct summary of agricultural implications of the forecast. Farmers benefitted either by being more cautious while investing in seasons predicted to receive low rainfall, or by making necessary investments in seasons predicted to receive good rainfall. In the survey conducted to evaluate the usefulness of advisories almost all farmers who have received the advisories rated them as extremely useful in planning farm operations and nearly 87% of them expressed willingness to pay for the service if required.

Partners involved and their role: Key partners in this work are KMD providing forecast and related information, KARI with identifying appropriate technologies for the predicted season type and AEOs providing information on farmer preferences.

Research on which the activity is based: This research is component of the work on developing strategies for effective management of climate risks by smallholder farmers (Theme 2).

Web address for further information (if available): Not available

Title: Coping with variable climates: the use of seasonal climate forecasts and participatory simulation modeling in semi-arid Zimbabwe

Case type: Example of innovative and successful communications activities

Brief description of the activity*:* The goal of the study is to assist smallholder farmers in achieving sustained improvements in food and nutritional security through better access to climate information and the technologies and other strategies that can improve adaptation to poor years and enable them to better exploit good years. There is a need to expand the concept of agricultural extension beyond simply the use of productive inputs such as fertilizers, seed and better technologies and to include the use of information based inputs such as climate forecasts which may serve to reduce risks at farm level. This could help decision makers make better farm management decisions and prepare themselves for more effective adaptation to climate variability.

Result of activity*:* With the Zimbabwe Meteorological Services Department, seasonal forecasts were delivered to farmers in two districts using participatory methods. Farmers were given the forecasts, forecasts + advice, and forecasts + advice + participatory crop modeling of crop management options under different climate scenarios. Case studies using a Participatory Farm Management (PFM) approach (Participatory Budgets combined with Resource Allocation Mapping) were used in quantifying and analyzing the use of resources at farm and household level, and hence the role of season crop forecast information in coping and adaptation strategies. Preliminary indications are that enhanced communication of climate related information is an important component of the options to assist in adaptation and decision making for farmers.

Partners involved and their role: The Zimbabwe Meteorological Services Department (ZMD) provided/presented the forecast to the farmers and the Department of Agricultural Technical and Extension Services of Zimbabwe (AGRITEX) assisted with technical advice to the farmers.

Research on which the activity is based: Theme 2.3-Prediction of climate impacts, and enhanced climate services

Web address for further information (if available): Not available

Case study-CCAFS

Title: Enhancing grass root level resilience to climate change impacts in Sri Lanka

Case type: Capacity Strengthening/Communication-Policy advocacy

Brief description of the activity:

Villages in Puttalam, Anuradhapura and Humbantota district of Sri Lanka were studied to exam the extent of climate change and various components of vulnerability including exposure, sensitivity and adaptive capacity. Farmers' perception with quantitative and qualitative analysis of micro-level information and then triangulation of farmers' potential and efficient adaptation strategies and existing constraints were studied in Relevant policy options were formulated from the study findings and were mainstreamed into the developmental programs and policy. Similar activities were replicated in other partner countries, namely Bangladesh, Thailand, Vietnam, India and China.

Result of activity: The analysis revealed an increasing variability in climatic characteristics in the study regions and farmers were experiencing the impact of these changes. The southern districts of Sri Lanka are highly vulnerable to climate change impacts. A set of grass-root level adaptation strategies and constraints that the farmers experienced were sketched out at different levels of interventions (household, community, National and International) embedded with sociological dimensions and governance structures. The findings resulted in formulating a set of policy needs and road map that is translated into key messages and policy statements. These were echoed in the stakeholder consultation and "Policy Dialogue" amongst the apex policy makers including ministers, planners and development practitioners. Other stakeholder includes various governmental or non-governmental organizations, research organizations, international and donor organizations, farmer's organization, developmental and executing agencies.

Partners involved and their role: The partner in this work includes Sri Lanka Council for Agricultural Research Policy (SLCARP) and climatic data sets from national meteorological stations (Metrology Department) and village level sociological information (Transparency International).

Research on which the activity is based: This research is part of work on improving climate change resilience among the small holder farmers of semi arid tropics. This work is closely linked to CRP2 work component a) 1.1 for Foresight and Strategic Planning; and 1.2) Village Level Studies respectively.

Web address for further information (if available): Not available

ICRISAT 2011 publications related to climate change for CCAFS

Articles published in peer-reviewed journals listed by ISI/Thomson Reuters

1. Dixit, P.N., Cooper, P.J.M., Dimes, J., and Rao, K.P.C., 2011. Adding value to field-based agronomic research through climate risk assessment: a case study of maize production in Kitale, Kenya. *Experimental Agriculture. Cambridge,* 47 (2), 317-338.

2. Jagadish, S.V.K., CAIRNS, J.E., Kumar, A., Somayanda, I.M., Craufurd, P.Q. 2011. Does susceptibility to heat stress confound screening for drought tolerance in rice? Functional Plant Biology 38: 1-9

3. Jagadish, S.V.K., Muthurajan, R., Rang, Z.W., Malo, R., HEUER, S., Bennett, J., and Craufurd, P.Q. 2011. Spikelet proteomic response to combined water deficit and heat stress in rice (Oryza sativa cv. N22). Rice DOI: 10.1007/s12284-011-9059-x

4. Kesava Rao, A.V.R., and Wani, S.P. 2011. Evapotranspiration paradox at a semi-arid location in India. Journal of Agrometeorology. 13(1): June. pages. 3-8.

5. Mapanda, F., Wuta, M., Nyamangara, J., and Rees, R.M. 2011. Effects of organic and mineral fertilizer nitrogen on greenhouse gas emissions and plant-captured carbon under maize cropping in Zimbabwe. *Plant and Soil,* 343 (1), 67-81 (DOI: 10.1007/s11104-011-0753-7).

6. Rao, K.P.C., Ndegwa, K.Kizito W.G., and Oyoo, A. 2011. Climate variability and change: Farmer perceptions and understanding of intra-seasonal variability in rainfall and associated risk in semi-arid Kenya. Experimental Agriculture. 47: 1-25

7. Sommer, C., Zucca, A., Grainger, M., Cherlet, R., Zougmoré, Y., Sokona, J., Hill, R., Della Peruta, J., Roehrig and Wang, G. 2011. Application of indicator systems for monitoring and assessment of desertification from national to global scales. Land Degrad. Develop. 22: 184–197.

8. Varshney, R.K., Bansal, K.C., Aggarwal, P.K., Datta, S.K., Craufurd, P.Q. 2011. Agricultural biotechnology for crop improvement in a variable climate: hope or hype? Trends in Plant Science 16: 363-371.

9. Vogt, J.V., Safriel, U., Von Maltitz, V., Sokona, Y., Zougmoré, R., Bastin, G., and Hill, J. 2011. Monitoring and assessment of land degradation and desertification: towards new conceptual and integrated Approaches. Land Degrad. Develop. 22: 150-165.

Articles in other Peer Reviewed Journals

1. Huda, S., Victor Sadras, Wani, S.P., and Mei, Xurong. 2011. Food Security and Climate Change in the Asia-Pacific Region: Evaluating Mismatch between Crop Development and Water Availability. International Journal for Bio-resource and Stress Management (IJBSM). June 2011. 137-144.

Invited Book chapters

1. Craufurd, P.Q., Jagadish, S.V.K., and Padgham, J. 2011. Impacts of climate change on rainfed agriculture and adaptation strategies to improve livelihoods. In: *Integrated Watershed Management in Rainfed Agriculture* (Eds SP Wani, J Rockstrom, KL Sahrawat), pp. 421-440. CRC Press, Leiden, Netherlands

Climate Change CRP 7
IFPRI Annual Technical Report
2011

I. Summary

Theme 3.2 Institutional arrangements and incentives for mitigation

Activities under this Theme were conducted in collaboration with research partners from IFAD country offices in Ghana, Morocco, Mozambique, Vietnam; the CSIR- Soil Research Institute, Ghana; Eduardo Mondlane University, Mozambique; Institute of Ag. Environment, Vietnam; and the National School of Agriculture, Morocco. Research activities focused on identifying and developing test sites for agricultural mitigation options.

In 2011, IFPRI and its research partners recorded initial soil organic carbon conditions to establish baseline information for the period 2010-2050, which helped in identifying the portfolio for mitigation practices. A cost-benefit analysis that simulates the adoption of these practices was carried out for Ghana, and Morocco. Similar cost-benefit analysis for Mozambique is nearly complete. Based on these analyses, the implicit cost of a mitigated ton of carbon was determined to be in the range of $34 to $188 per ton of CO2eq depending what type of mitigation package was adopted These results are being prepared for future publication.

In Vietnam, alternative paddy mitigation practices were assessed for two seasons of paddy rice in the Red River Delta. One season includes measurements for CH_4 and N_2O. The Institute of Agricultural Environment has submitted a final report, which is also in the process of being published as a journal article.

Two workshops on climate change mitigation in agriculture, economics and institutional support, were held in Ghana and Mozambique. In Morocco, work on the institutional potential to promote farmers' participation to climate change mitigation was presented at a seminar on "Moroccan Agriculture and Climate Change" held by the General Council of Agricultural Development.

4.3 Refining frameworks for policy analysis

Research activities under this theme were conducted in collaboration with IRRI, ILRI, ICRISAT, CIMMYT, ICRAF, CIP and CIAT; and research partners from non-CGIAR organizations in Africa such as FANRPAN and ASARECA; and in Asia such as Chinese Academy for Agricultural Sciences; and advances research institutes in the United States, such as The University of Florida, and Washington State University with support from theme 4.3 and bilateral donors.

Improvements to the IMPACT modeling suite includes better integration with the DSSAT crop modeling suite, and development of a metric to represent share of population at risk of hunger.

Two workshops on climate change mitigation in agriculture, economics and institutional support, were held in Ghana and Mozambique. In Morocco, work on institutional potential to promote farmers' participation to climate change mitigation was presented at the institutional seminar on "Moroccan Agriculture and Climate Change" held by the General Council of Agricultural Development.

II. Activity Reporting

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.2 Breeding strategies for future climatic conditions				
1.3 Species and genetic diversity for climate change				
Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				

Theme 3, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
3.2 Institutional arrangements and incentives for mitigation				
3.2.1.3 linked to Milest one 3.3.1.1 AND 3.3.2.2	Identify and develop test sites for agricultural mitigation options	Choose/Establish pilot study areas, conduct in-depth economic analysis of viable mitigation practices at study areas	For the test sites, the soil organic carbon initial conditions were recorded, the baseline for soil organic carbon for the period 2010-2050 was determined, and a portfolio of mitigation practices identified. A cost-benefit analysis that simulates the adoption of these practices was carried out for Ghana, Morocco, and it's almost completed for Mozambique. The implicit cost of a mitigated ton of carbon was also determined. Journal articles and reports are in the process of being written. In Vietnam, alternative paddy mitigation practices were assessed for 2 seasons of paddy rice in the Red River Delta in Vietnam. One season included measurements for CH4 and N2O. A final report is available from the collaborator, Institute of Agricultural Environment. A journal article is currently being drafted.	IFAD country offices in Ghana, Morocco, Mozambique, Vietnam, CSIR- Soil Research Institute, Ghana; Eduardo Mondlane University, Mozambique; Institute of Ag. Environment, Vietnam; National School of Agriculture, Morocco
3.3 On-farm mitigation practices and landscape implications				

Theme 4, Integration for Decision Making				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.3 Refining frameworks for policy analysis				
4.3.1.1	Develop models, scenarios and presentation of land use change within agriculture and trade-offs with non-agricultural land	Enhanced and interlinked set of data and quantitative tools, which include spatial databases, detailed mapping of food system characteristics and human welfare, and a detailed characterization of the impact of changes and uncertainty in the state of natural resources on global food systems	Improvements to the IMPACT modeling suite included better integration with the DSSAT crop modeling suite, development of a metric to represent share of population at risk of hunger.	CG Centers,
4.3.1.2	Analyse empirical results from climate change research with indications of appropriate technologies to mitigate GHG emissions	Critical and quantitative evaluation of the key drivers of change and uncertainty in global food systems, and development of plausible future scenarios that encompass the evolution of various driving forces and their impact on food		CG Centers, ZALF, FANRPAN, ASARECA, ARIs, NARES

		and nutrition		
4.3.1.4 This is a 2012 milest one	Strengthen the capacity of country programme partners to analyse and address policy issues, in particular those related to improving access by small farmers to new market opportunities in agriculture, especially for high value products, and for climate change mitigation and other environmental services	Capacity strengthening activities held with NARS in developing countries that reflect the real needs of targeted individuals and institutions for meeting agricultural development, poverty, hunger alleviation and natural resource management while also decreasing gender and regional imbalances	Two workshops on climate change mitigation in agriculture, economics and institutional support, were held in Ghana and Mozambique. In Morocco, work on institutional potential to promote farmers' participation to climate change mitigation was presented at the institutional seminar on "Moroccan Agriculture and Climate Change" held by the General Council of Agricultural Development.	Universities in Africa and South Asia, Government Agencies and Research Institutions in East and West Africa, and the IGP

III. Case Studies

Capacity Strengthening Activities

During a series inception workshop held in Morocco, Ghana, Mozambique, and Vietnam for the IFAD funded project on climate change mitigation in agriculture, the most pressing needs for each country were identified. During these meetings, the lack of understanding of what climate change is, lack of knowledge of the potential impact of climate change on the agricultural system, a general confusion between the concepts of adaptation and mitigation, and the lack of data on how different agricultural systems can contribute and mitigate climate change appear to be the most pressing issues.

Two capacity strengthening activities were conceived and carried out based on this information.

A. A country-level assessment of mitigation potential of the food-crop systems carried out with the full support and involvement of local technical personnel. Key staffs from universities and government agencies were selected and fully involved in the modeling of climate change effects on main crop systems and potential for mitigation. The purpose of this exercise was to create a core group of people capable of understanding the issues related to climate change and capable of basic modeling and modeling needs. The country partners were instrumental in gathering and elaborating the data to perform the assessment. An example of the work can be found at: http://ifadifpri.files.wordpress.com/2011/08/ifad-ifpri-newsletter_august20111.pdf
   The country partners were: CSIR- Soil Research Institute, Ghana; Eduardo Mondlane University, Mozambique; Institute of Ag. Environment, Vietnam; Institut National de la Research Agronomique, Morocco
B. A series of workshops to raise awareness and build capacity to understanding the basic issues related to agriculture and mitigation was organized with ministry staff, policy makers, national assembly, and stakeholders in civil society organizations and non-governmental groups as targets. We offered a policy dialog meeting ("Climate Change and Access to Markets in Mozambique: The Role of Institutions") and a thematic workshop ("Climate Change and Access to Markets in Mozambique Policies and Organizational Architecture") for policy researchers, policy advisors, and policymakers in Mozambique. The policy dialogue and workshop brought together approximately 50 decisionmakers and stakeholders from key institutions working on climate change issues and carbon market interventions. In Ghana, where the technical capacity is a little more advanced, we instead offered a technical workshop "Climate Change in Agriculture: Opportunities and Challenges." The objective of the workshop was to provide participants with the necessary background information on climate change issues pertaining to mitigation in agriculture, the problems regarding required data collection, methods and approaches for quantification, and a general overview of the potential benefits for smallholder farmers.
   The Ghana Business News on Friday, November 11 extensively reported on the workshop on Climate Change in Agriculture: Opportunities and Challenges

Innovative Communication Strategies

Preparation of policy briefs, joint publications, and other communications materials to reach an external audience as part of the IFAD project on Climate Change Mitigation and Agriculture: Materials produced by the Partnership, such as PowerPoint presentations, meeting notes, reports, briefs, and articles are continually posted to the Partnership blog.The following websites were updated for a more informative communication platform on climate change research at IFPRI:

http://www.ifpri.org/climatechange/

http://www.ifpri.org/book-775/ourwork/researcharea/climate-change

http://icccfs.ifpri.info/

Part of this effort was the preparation of a Bi-Monthly Newsletter: The Partnership has been producing a bi-monthly newsletter on climate change mitigation in agriculture This e-newsletter is widely circulated among IFAD and IFPRI staff, as well as our multiple collaborators and stakeholders in the pilot countries.All the in-country collaborators contributed to the material posted on this blog. local institutions involved in the .

V. Publications

Peer reviewed publications:

Matthews, R. and De Pinto, A.: "Should REDD+ fund 'sustainable intensification' as a means of reducing tropical deforestation?" Carbon Management. (Forthcoming)

Herrero, M., C. Ringler, J. van de Steeg, P. Thornton, T. Zhu, E. Bryan, A. Omolo, J. Koo, and A. Notenbaert. 2010. Climate variability and climate change and their impacts on Kenya's agricultural sector. Nairobi, Kenya. ILRI.

Herrero, M., C. Ringler, J. van de Steeg, P. Thornton, T. Zhu, E. Bryan, A. Omolo, J. Koo and A. Notenbaert. 2010. Climate Variability and Climate Change: Impacts on Kenyan Agriculture, IFPRI Project Note.

De Pinto, A., Maghalaes, M., Ringler, C.: "Challenges Facing Agricultural Access to Carbon Markets" in Climate Change Mitigation and Agriculture. Edited by E.K. Wollenberg. (2011).

Climate Change, Agriculture and Food Security (CCAFS)

Annual Report

International Institute of Tropical Agriculture

CRP7 - Program Participant Agreement No. CRP-138-11

Introduction:

Climate change is predicted to strongly affect African smallholder farming systems, which are the main focus of IITA's research for development efforts. In addition, agriculture is an important driver of deforestation in West and Central Africa, thereby contributing to the emission of greenhouse gases. As part of the CGIAR, IITA is strongly interested in contributing to climate change adaptation and mitigation in African smallholder systems. IITA is particularly strong in the field of agricultural intensification, requiring a combination of (i) improved planting material, (ii) robust plant health systems, (iii) integrated soil fertility management, and (iv) creating enabling socio-economic settings at the household level and along the value chain, including post-harvest processing. It is in these areas where IITA has a comparative advantage that it tries to contribute to the CGIAR CRP7 program on Climate Change, Agriculture and Food Security (CCAFS).

IITA has participated in a number of planning meetings in 2011 and developed a work plan accordingly. The Program Participant Agreement between the Lead Center (CIAT) and IITA was signed in September 2011. However, activities to contribute to the CCAFS program started as early as 2010. Although IITA is one of the smallest centers in CRP7 in terms of financial support received, it feels that CRP7 is of strategic nature for its target agricultural community. In addition, IITA perceives strong potential links between CRP7 and CRP1.2. Therefore, IITA has the ambition to increase its level of engagement and output in CRP7 over the coming years.

Below is a summary of the key IITA deliverables that appeared in the CCAFS log frame for 2011.

Milestone #	Activity in 2011	Deliverables in 2011
1.3.2.2	Develop new germplasm catalogues on existing and released cassava germplasm. Output 1.3.2	Framework for cassava catalogues developed and GxE databases identified for upload to Atrials M1.3.2.2
2.3.3.6	Assess risks and test strategies for adaptation to significant crop biotic threats due to climate change. Output 2.3.2	Framework developed and applied to identify and monitor significant new biotic threats in cassava and banana throughout Africa wide M2.3.2.7
3.1.1.1 + 3.1.1.2	Develop new knowledge and tools to assess potential emission reductions from various crop systems and technology options to improve productivity and enhance food security. Output 3.1.1	Develop tools to evaluate the carbon footprint of coffee and cocoa systems at plot and regional level. M3.1.1.2
4.3.2.1	Assessment of cocoa and coffee based agricultural systems for carbon sequestration potential to mitigate risk of climate change and enhance food security Output 4.3.2	First deliverables in 2012

With the total IITA budget (W1+2 + Bilateral) in CRP7 < 1.5 million USD in 2011, the reporting requirements for this year neither requires reporting on outcomes (once every 3 years), nor does it require an assessment of its impact (once every 5 years). Hence, the report will be restricted to a succinct summary of the activities (>0.5 page) and a two example case studies (0.5 page each).

Summary of the activities:

Milestone 1.3.2.2.:
The germplasm catalogue work was initiated on cassava in 2011. A framework was developed based on the cassava trait ontology. A first version of the catalogue is expected to come out in 2012. This work feeds in well with IITA's developing work on genomic selection, using both molecular and phenotypic information. A 25k USD project proposal was written and approved by the IITA cassava team to start identifying and uploading cassava trials into the Agtrials database. At present, IITA is close to meeting the target of having 80 trials uploaded. The work will continue into 2012 and IITA is in an excellent position to continue uploading many more trials.

Milestone 2.3.3.6:
A number of activities related to climate change took place in 2011 by a relatively large IITA plant health team. Activities include bananas and cassava as mentioned in the 2011 CCAFS log frame. Examples of some of the activities conducted in IITA are (i) modelling of climate impact on distribution and abundance of pests on a.o. cassava, bananas, and plantains in collaboration with CIP and based on thermal response data of target insects and mites such as cassava green mite, Typhlodromalus aripo, cassava mealy bug, and banana aphid. These data are presently being used to develop the phonological models. (ii) A study on the pupa stage of six native and invasive tropical tephritid fruit fly species affecting fruits and vegetables. Substantial variations were found in their response to combinations of temperature and humidity. Response functions will be used to present distribution maps using phenological and GIS modelling. (iii) On-farm surveys with 351 cassava producers in the moist and dry savannas of Benin and Cameroon revealed that the large majority of farmers perceive a recent change in climate variability, affecting their planning for planting and harvesting. Results will guide adaptation research. (iv) IITA studied the example of flower trips Megalurothrips sjostedti Trybom (Thysanoptera, Thripidae) to model the complexity of the interactions between insect pests and different environmental variables which are susceptible to be influenced by 'climate change'. This includes looking at host plants suitable (often leguminous plants) for feeding and reproduction of pests. (v) A review report on the effect of climate change on below ground micro-organisms was written. This was mostly a desk-top study and the results were presented to the FAO by mid 2011.

Milestone 3.1.1.1/2 and 4.3.2.1:
Activities in these milestones relate to coffee systems in East Africa and on cocoa systems in West and Central Africa. In East Africa, we conducted a study on adaptation and mitigation in coffee systems. We looked at production constraints x altitude gradients through surveys. We also quantified shade plants and carbon stocks in coffee systems using algometric relationships for shade trees. Through exchange visits with CIAT, we explored the use of the cool farm tool – to be applied in 2012. Intermediate results on the above are currently being published in 2 book chapters and 1 report. A case study will be presented in this report. In Cameroon and Nigeria, similar surveys were conducted on cocoa systems to quantify the relationship between yield and major crop constraints, including shade tree sizes and densities. The latter study is still ongoing and results will be published in 2012. A chapter was written in

the Climate Change Mitigation and Agriculture book edited by Wollenberg et al. and published by Earth scan on agriculture (and cocoa in particular) as a driver of deforestation.

Case study 1 – Banana x coffee intercropping for climate change adaptation and mitigation

Case study type C: Innovative and successful communications strategies

Coffee production is essential for East Africa's national economies and the livelihoods of many smallholder farmers. Adaptation and mitigation of climate change will be important to coffee farmers in the future. We developed a classification system which distinguishes seven different East African coffee production systems and assess their adaptation and mitigation potential. The results indicate that shaded, intercropped coffee production systems combine several sources of adaptive capacity with mitigation and can thus play an important role in securing the importance of coffee for East Africa in the future and at the same time conserve the environment. In particular, we focused on the potential of coffee x banana intercrop systems, combined with shade trees where/when possible. We investigated the adaptation potential of the systems, as well as the perception of the coffee stakeholders (i.e. private and public) in this system. The intercrop systems are generating more revenue and appear to be more climate resilient (e.g. less foliar disease and more drought resistant) than full sun coffee systems. A policy brief has been developed for Uganda in collaboration with Wageningen University and the national coffee research institute. Discussions with policy makers and private sector stakeholders (including major exporters and coffee authorities) were organized in Uganda, Rwanda, and Burundi, mostly through feedback workshops. In addition, we managed to reach out through the media, including through newspapers and live interviews on radio stations including BBC Network Africa and Voice of America radio. As a result of these communication efforts, private sector partners and policy makers are now recommending the intercrop practice (a.o. documented in newspapers) in Uganda. In Rwanda, the coffee authority has moved away from full sun systems and is contemplating the use of banana intercropping. In Burundi, a dialogue has started, but the government bodies are not yet ready to embrace this technology, although the national research partner are now permitted to run trials on this technology. All in all, policy briefings, meetings, and media attention have put climate change adaptation through smart coffee shade systems on the agenda. Some sample websites include;
http://portals.wi.wur.nl/files/docs/Policybrief_coffeexbanana_climate_2012.pdf
http://www.google.com/hostednews/afp/article/ALeqM5h2GT9enETkRtUikVg-kghoheXfZQ?docId=CNG.a09cbb10fc4d0d2855786791358aa2ad.521

Case study 2 – Cassava production and processing for improved food security and system resilience

Case study type B: Innovative results from capacity strengthening activities

Cassava has been recognized as a key staple and food security crop for millions of African farmers. With the assistance of cassava materials provided by CIAT and in collaboration with national agricultural research partners, IITA has been leading breeding and IPM activities to combat major pest- and disease outbreaks on this crop. IITA is conducting research on the impact of climate change on the spiraling whitefly populations that are the key vectors for cassava viral diseases. Other key pests such as the cassava mealy bug and the cassava green mite are also being researched by IITA (see summary of the activities above). The breeding program has been very successful and many of the cassava varieties

found across Africa originate from IITA's activities. Increasing attention is being paid to the development of drought-resistant cassava varieties, asides improving the production potential and plant health, IITA have been increasingly investing in post-harvest processing. IITA's impact on cassava in Africa is impressive; this has been achieved through huge capacity development efforts. In the past three decades, IITA has trained more than 9000 researchers and technicians in ten African countries in processing and finding new uses for high quality cassava flour (HQCF). As a result, the private sector in Madagascar, Nigeria, Tanzania, and Uganda have begun using HQCF as a raw material for processing secondary products such as biscuits and noodles. http://www.iita.org/cassava. More information can be provided.

2011 Activity Plan for CCAFS Centre General Funds:
Activities, Deliverables & Partners

CG Centre:	IITA

Table A. Main contacts persons in the Centre

Contacts	Name(s) (specify roles if more than one)	Email
Climate Change Contact Point	Piet van Asten (IITA CRP7 focal point – Systems Agronomist)	p.vanasten@cgiar.org
Admin. Issues	Hilde Koper (Contracts and Grants officer)	h.koper@cgiar.org
Communications	Katherine Lopez (Head of Communication)	k.lopez@cgiar.org
Others (if needed, specify role)	Paula Bramel (DDG Research)	p.bramel@cgiar.org

Table B. Bilateral funded projects under CCAFS (2011)

ID#	Name of project	Approximate budget under CCAFS (2011) (1)	Donor	Principal investigator (also list any key contacts in EA, WA or IGP, if applicable)
1	REDD-ALERT: Reducing Emissions from Deforestation and Degradation through Alternative Landuses in Rainforests of the Tropics	68,000 USD	EU	Jim Gockowski (j.gockowski@cgiar.org) in WA
2	Architecture of REALU: Reducing emissions from all land uses (Phase II)	79,000 USD	ICRAF	Jim Gockowski (j.gockowski@cgiar.org) in WA
3	LEAD-USAID: Mapping and evaluating improved intercrop and soil management options for Ugandan coffee farmers	50,000 USD	USAID	Piet van Asten (p.vanasten@cgiar.org) in EA

Notes:

(1) If a bilateral project is contributing to more than one CRP, this is only the CCAFS activities.

Table C. Activity tables by Themes/Objectives

Note:

(1) Activities should be approximately US$250.000 in value, inclusive of all costs, i.e. including personnel, overhead etc.
(2) The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that Regional Program Leaders can plan synthesis and coordination activities. They will not be used for any later reporting.
(3) Milestone numbers will be provided by Theme Leaders.

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of Activity / Deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.2 Breeding strategies for future climatic conditions				
1.3 Species and genetic diversity for climate change				
1.3.2.2	Develop new germplasm catalogues on existing and released cassava germplasm	Framework for cassava catalogues developed and GxE databases identified for upload to Atrials	The germplasm catalogue work was initiated on cassava in 2011. A framework was developed based on the cassava trait ontology. A first version of the catalogue is expected to come out in 2012. This work feeds in well with IITA's developing work on genomic selection, using both molecular and phenotypic	NCRRI Nigeria, SARRNET

	Output 1.3.2	M1.3.2.2	information. A 25k USD project proposal was written and approved by the IITA cassava team to start identifying and uploading cassava trials into the Agtrials database. At present, IITA is close to meeting the target of having 80 trials uploaded. The work will continue into 2012 and IITA is in an excellent position to continue uploading many more trials.	

Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of Activity / Deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				
2.3.3.6	Assess risks and test strategies for adaptation to significant crop biotic threats due to climate change Output 2.3.2	Framework developed and applied to identify and monitor significant new biotic threats in cassava and banana throughout Africa wide M2.3.2.7	A number of activities related to climate change took place in 2011 by a relatively large IITA plant health team, including on bananas and cassava. Examples: (i) modelling of climate impact on distribution and abundance of pests on a.o. cassava, bananas, and plantains in collaboration with CIP and based on thermal response data of target insects and mites (cassava green mite, cassava mealy bug, and banana aphid). Phenological modeling on climate x target pest and preditors is ongoing. Other studies on biotic stress x climate change are on (i) the effects of temperature and humidity on survival of the pupal stage of six native and invasive tropical tephritid fruit fly species, (ii) flower trips pests including looking at host plants suitable for feeding and reproduction of pests, and (iii) a reviw of the effect of climate change on below ground micro-organisms.	FAO, AU, ASERECA, ECOWAS, COMESA, other centers

Theme 3, Pro-Poor Climate Change Mitigation

Mile-stone # (3)	Activity in 2011	Deliverables in 2011	Status of Activity / Deliverable	Partners
3.1. Low-carbon agricultural development pathways				
3.1.1.1 And 3.1.1.2	Develop new knowledge and tools to assess potential emission reductions from various crop systems and technology options to improve productivity and enhance food security Output 3.1.1	Develop tools to evaluate the carbon footprint of coffee and cocoa systems at plot and regional level. M3.1.1.2	Activities focus on coffee systems in East Africa and on cocoa systems in West and Central Africa. In East Africa, we conducted a study on adaptation and mitigation in coffee systems. We looked at production constraints x altitude gradients through surveys. We also quantified shade plants and carbon stocks in coffee systems using algometric relationships for shade trees. Through exchange visits with CIAT, we explored the use of the cool farm tool – to be applied in 2012. Intermediate results on the above are currently being published in 2 book chapters and 1 report.	ICRAF, CIAT
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				

Theme 4, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of Activity / Deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.3 Refining frameworks for policy analysis				
4.3.2.1 is a 2012 milest one	Assessment of cocoa and coffee based agricultural systems for carbon sequestration potential to mitigate risk of climate change and enhance food security Output 4.3.2	Report on the assessment approach and intermediate results of carbon sequestration potential of various cocao and coffee based system arrangements and implication to food security M4.3.2.1	In Cameroon and Nigeria, surveys were conducted on cocoa systems to quantify the relationship between yield and major crop constraints, including shade tree sizes and densities. The latter study is still ongoing and results will be published in 2012. A chapter was written in the Climate Change Mitigation and Agriculture book edited by Wollenberg et al. and published by Earth scan on agriculture (and cocoa in particular) as a driver of deforestation. A report on climate change adaptation and mitigation in coffee x banana systems was written, and followed up by a stakeholder workshop and the writing of a policy brief.	ICRAF, CIAT, CIFOR

Publications by IITA staff on climate change per milestone

Milestone 1.3.2.2:

- Meseka, S. K., Menkir, A. and Ajala, S. (2011). Genetic analysis of performance of maize inbred lines under drought stress, in: Journal of Crop Improvement, volume 25, number 5, pages 521-539, ISSN 1542-7528, 2011. [DOI]
- Van Asten, P. , Fermont, A. , Taulya, G. (2011). Drought is a major yield loss factor for rainfed East African highland banana. Agricultural Water Management 98(4): 541 – 552
- Taulya, G. , Van Asten, P. , Leffelaar, P. A. , Giller, K. (2011) . Drought stress, nitrogen and potassium deficiency effects on dry matter partitioning in East African highland bananas. In: CIALCA conference 'Challenges and Opportunities for Agricultural Intensification of the Humid Highland Systems of Sub-Saharan Africa'. Kigali 24-27 October 2011. Book of Abstracts p.191.
- Badu-Apraku, B. and Akinwale, R. (2011). Identification of early-maturing maize inbred lines based on multiple traits under drought and low N environments for hybrid development and population improvement. Canadian Journal of Plant Science, volume 91, number 5, pages 931-942, ISSN 0008-4220, 2011. [DOI]
- Oyekunle, M., Badu-Apraku, B. and Aken 'Ova, M. (2011). Performance of early-maturing single, three-way and double cross hybrids under drought stress and well-watered conditions. Abstract of paper presented at the Annual Meeting of the African Crop Science Society, 10-13 October, 2011, Maputo, Mozambique.
- Okogbenin, E., Setter, T., Ferguson, M., Mutegi, R., Alves, A., Ceballos, H. and Fregene, M. (2011). Phenotyping cassava for adaptation to drought, CGIAR Generational Challenge Programme, chapter 11.3.1, pages 395-410, ISBN 978-970-648-178-8, 2011.
- Badu-Apraku, B., Fakorede, M., Oyekunle, M. and Akinwale, R. (2011). Selection of extra-early maize inbreds under low N and drought at flowering and grain-filling for hybrid production. In: Maydica, volume 56, pages 29-41, ISSN 0025-6153, 2011.
- Tambo, J. A. and Abdoulaye, T. (2011). Climate change and agricultural technology adoption: the case of drought tolerant maize in rural Nigeria. Mitigation and Adaptation Strategies for Global Change, pages 1-16, ISSN 1381-2386, 2011.

Milestone 2.3.3.6.:

- Beed F (2011). The impact of climate change on countries' interdependence for microbial genetic resources for agriculture. Chapter 5. Background Study Paper No. 48. p 38-58 and 74-78. Commission on Genetic Resources (FAO). ftp://ftp.fao.org/docrep/fao/meeting/017/ak532e.pdf
- Beed F, Benedetti A, Cardinali G, Chakraborty S, Dubois T, Garrett K and Halewood M (2011). Climate change and micro-organism genetic resources for food and agriculture: state of knowledge, risks and opportunities. Background Study Paper No. 57, Commission on Genetic Resources for Food and Agriculture, prepared for 13th Regular Session. http://www.fao.org/docrep/meeting/022/mb392e.pdf

- Hoeschle-Zeledon, I. (2011). Climate change and plant health, in: R4D Review, volume 6, pages 6-11, ISSN 2071-3681, 2011.
- Bhattacharjee, R., Ntare, B. R., Otoo, E. and Yanda, P. Z. (2011). Regional impacts of climate change: Africa. In: Shyam Singh Yadav, Jerry L. Hatfield, Robert Redden, Hermann Lotze-Campen, Anthony Hall (Eds.), Crop Adaptation to Climate Change. pages 66-77, chapter 3.3, Wiley-Blackwell, ISBN 978-0-8138-2016-3, 2011.
- Muranaka, S., Fatokun, C. and Boukar, O. (2011). Stability of Striga gesnerioides resistance mechanism in cowpea under high- infestation level, low soil fertility and drought stresses. In: Journal of Food, Agriculture and Environment, volume 9, number 2, pages 313-318, ISSN Online: 1459-0263, 2011.
- Nicol, J.M., Turner S.J, Coyne, D.L., den Nijs, L., Hockland, S. & Tahna Maafi, Z. 2011. Current nematode threats to world agriculture In: J. Jones, G. Gheysen and C. Fenoll (Eds), Genomics and Molecular Genetics of Plant-Nematode Interactions. Springer, pp. 21-43.
- Njab, M. R. (2011). The effect of temperature on the biology of the banana aphid (Hemiptera: Aphididae), vector of banana bunchy top virus. Fifth year thesis, University of Dschang, Cameroon. Registered number: CM04-06ASA0077. 60pp.

Milestone 3.1.1.1/2:

- Norgrove, L., Hauser, S. (In press). Carbon stocks in shaded Theobroma cacao farms and adjacent secondary forests of similar age in Cameroon. *Tropical Ecology 54(1)*.
- James Gockowski and Piet Van Asten (2011). Agricultural Intensification as a Climate Mitigation and Food Security Strategy for Sub-Saharan Africa. In: Eva Wollenberg, Maja-Liisa Tapio-Bistrom, Maryanne Grieg-Gran, Alison Nihart (Eds). Climate Change Mitigation and Agriculture. Routledge, 456p.

Milestone 4.3.2.1:

- Van Rikxoort, H. , Jassogne, L. , Laderach, P. , Van Asten, P. (2011), Building "climate smart" East African coffee production systems. In: CIALCA conference 'Challenges and Opportunities for Agricultural Intensification of the Humid Highland Systems of Sub-Saharan Africa'. Kigali 24-27 October 2011. Book of Abstracts p.29.
- Jassogne, L. , Nibasumba, A. , Wairegi, L.W.I. , Baret, P. , Deraeck, J. , Mukasa, D. , Wanyama, I. , Gatarayiha, C. , Ghislaine, B. , Van Asten, P. (2011). Coffee-banana intercropping systems as an opportunity for smallholder coffee farmers. In: CIALCA conference 'Challenges and Opportunities for Agricultural Intensification of the Humid Highland Systems of Sub-Saharan Africa'. Kigali 24-27 October 2011. Book of Abstracts p.215.
- Kangire, A., van Asten, P., Verhagen, J., Koomen, I. (2011). 'Towards climate smart agriculture: lessons from a coffee × banana case'. Experiences from research for policy support in Uganda. Policy Brief, 2p.

2011 Activity Plan for CCAFS Centre General Funds: Activities, Deliverables & Partners

CG Centre:	ILRI

Table A. Main contacts persons in the Centre

Contacts	Name(s) (specify roles if more than one)	Email
Climate Change Contact Point	Mario Herrero	m.herrero@cgiar.org
Admin. Issues	Robert Nzioka	r.nzioka@cgiar.org
Communications	Susan MacMillan	s.macmillan@cgiar.org
Others (if needed, specify role)	Douglas Ikongo (admin assistant to M Herrero), please copy on all correspondence	d.ikongo@cgiar.org

Table B. Bilateral funded projects under CCAFS (2011)

ID#	Name of project	Approximate budget under CCAFS (2011) (1)	Donor	Principal investigator (also list any key contacts in EA, WA or IGP, if applicable)
1	Phils contract with Coopenhagen	939,600	CCAF	Mario Herrero
2	Supporting the vulnerable:Increasing the adaptive capacity of Agro pastorolists to Climatic change in West and Southern Africa using a Transdisciplinary research approach	490,236	GTZ	Mario Herrero
3	Climate Change Adaptation for Smallholder Agriculture in Kenya	24,110	IFPRI	Mario Herrero
4	Global Futures Project	155,762	IFPRI	Mario Herrero
5	Sharpen climate change focus in relation to the research being conducted under the Global Futures Project by enhancing th eability of the regional partners/analysts to realistically modelt he trade-offs and consequences and better inform a wide range of p	18,789	IFPRI	Mario Herrero
6	Environmental Efficiency and Animal Production for sustainable Development	16,361	IRD	Mario Herrero
7	Dynamic Interactions Among People, Livestock and Savanna Ecosystems Under Climate Change	17,411	MSU	Said Mohammed

8	A framework for enhancing EO capacity for Agriculture and Forest management in Africa as a contribution to GEOSS	428,970	EU	Mario Herrero
9	Index-based Insurance Products for Managing Climate Risks in East Africa	88,765	World Bank	Andrew Mude
10	Index Based Livestock Insurance	171,502	University of CORNELL	Andrew Mude

Notes:

(1) If a bilateral project is contributing to more than one CRP, this is only the CCAFS activities.

Table C. Activity tables by Themes/Objectives

Note:

(1) Activities should be approximately US$250.000 in value, inclusive of all costs, i.e. including personnel, overhead etc.
(2) The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that Regional Program Leaders can plan synthesis and coordination activities. They will not be used for any later reporting.
(3) Milestone numbers will be provided by Theme Leaders.

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.1.3.1	Data assembly (including systems and the analytical framework), analysis and synthesis	Documentation of future vulnerability of livestock systems globally to target interventions	Activity completed, although methodological refinements are planned for the future. Outcome: ILRI/CCAFS research contributing to IPCC AR5 WG2 (Adaptation) (Thornton, contributing author) on the subject of vulnerability and livestock systems. Deliverables contributing to this activity are: Ericksen P, Thornton P, Notenbaert A, Cramer L, Jones P, Herrero M. 2011. Mapping hotspots of climate change and food insecurity in the global tropics. CCAFS Report no. 5. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark Notenbaert, A., Karanja, S., Herrero, M., Maute, F., Moyo, S., 2011.	INRA-led consortium of 27 partners

			Derivation of a household level vulnerability index for climate change and adaptation. *Regional Environmental Change* (in press) Ng'ang'a, S.K., Steeg, J. van der, Notenbaert, A., Moyo, S., Herrero, M. 2011. Household livelihood strategies and livestock benefits dependence in Gaza province of Mozambique. *African Journal of Agricultural Research* 6(3): 560-572 Robinson T, Thornton P K, Franceschini G, Kruska R, Chiozza F, Notenbaert A, Cecchi G, Herrero M, Epprecht M, Fritz S, You L, Conchedda G and See L (2011). *Global Livestock Production Systems*. FAO, Rome 152 p. Thornton PK, Jones P G, Ericksen P J and Challinor A J (2011). Agriculture and food systems in sub-Saharan Africa in a four-plus degree world. *Philosophical Transactions of the Royal Society Series A* 369, 117-136. doi:10.1098/rsta.2010.0246	
1.2 Breeding strategies for future climatic conditions				
1.3 Species and genetic diversity for climate change				

Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.1.1.2	Workshops, syntheses, report writing	Documentation of how agro-pastoralists are coping with climate risk in West and Southern Africa, Already covered by Milestone 2.1.1.2 and piloting options as to how they may cope with increased climate risk in the future	Activity completed and reported in the following publications: Karanja, S., Diarra, L., Notenbaert, A., Herrero, M. 2011 Coping strategies and vulnerability of households in Mali and Mozambique. BMZ Project report: Supporting the vulnerable: Increasing the adaptive capacity of agro-pastoralists to climatic change in West and Southern Africa using a trans-disciplinary research approach. ILRI, Nairobi, Kenya, 91 p. Bryan, E, Ringler, C, Okoba, B, Roncoli, C, Silvestri, S and Herrero M. 2011. *Coping with Climate Variability and Adapting to Climate Change in Kenya: Household and Community Strategies and Determinants. Report to the World Bank.* Report 3a of the project "Adaptation of Smallholder Agriculture to Climate Change in Kenya". IFPRI – KARI - U of Georgia – ILRI. International Food Policy Research Institute, Washington DC, 63 p. Silvestri S., Bryan E., Ringler C., Herrero M., Okoba B. Climate change perception and adaptation of agro-pastoral communities in Kenya. 2011. *Regional Environmental Change*, in press	PIK, University of Kassel, IER (Mali), IIAM (Mozambique), IFPRI
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				

Theme 3, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
3.1.2.2	Consultations, workshop, analysis, syntheses	Greenhouse gas emissions from livestock systems by country: updating the IPCC	Activity completed. This activity is reported in several publications as described below. Outcomes: emission factors for livestock in use by IPCC. CG scientists (Herrero), contributing author of IPCC AR5 WG3 (Mitigation) bringing	IIASA, FAO

		numbers	developing country perspectives and CCAFS outputs to the AR5. Herrero, M., Hávlik, P., Rufino, M., Notenbaert, A., Thornton, P., Obersteiner, M., Blümmel, M., Duncan, A., Wright, I. 2011. Global livestock: biomass use, products, emissions and excretions. PNAS (in preparation) (datasets ready and in use in the AR5 RCP scenarios) Bouwman, AF, K Klein Goldewijk, KW Van der Hoek, AHW Beusen, DP Van Vuuren, J Willems, MC Rufino, E Stehfest. 2011. Exploring global changes in nitrogen and phosphorus cycles in agriculture induced by livestock production for the period 1900-2050. *PNAS*, doi/10.1073/pnas.1012878108	
3.1.2.1		*Framework for comparison of environmental footprint of agricultural systems (ILRI) (2011)	Activity delivered: This activity is part of the modified household level data collection and analysis tool, IMPACT and its suit of models. A such, it is reported in: Quiros, C., Rufino, M. and Herrero, M. 2012. Developing generic tools for characterising agricultural systems for climate and global change studies'. International Livestock Research Institute, Nairobi, Kenya 43 p.	
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				
3.3.1.1	Workshop, syntheses	Scoping study on carbon sequestration in livestock systems in developing countries	Activity delivered. Additional activities planned for 2012/13. Reports: Peters, M, Rao, I, Fisher, M., Subbarao, G., Martens, S., Herrero, M, van der Hoek, R, Schultze-Kraft, R., Miles, J, Castro, A., Graefe, S., Tiemann, T., Ayarza, M and Hyman, G. 2011. Chapter 13: Tropical Forage-based systems to mitigate climate change. *CIAT Flagship Report: 2011*, CIAT, Cali, Colombia, (in press). A key deliverable towards this output was the development of an intermediate scale rangeland model for climate change and carbon sequestration studies. The model developed is reported in: Boone, R., Conant, R.T. and Hilinski, T. 2011. G-Range: development and use of a beta global rangeland model. Project Report. Colorado State University, International Livestock Research Institute and CCAFS. 66 p. Carbon sequestration measurement protocols have been established and field data collection has begun in Mali, Burkina Faso and in southern Ethiopia.	Under development

			Datasets for validating the models for different regions are being collated. Other outputs contributing to this work are: Bryan, E, Ringler, C, Okoba, B, Koo, J, Herrero, M and Silvestri, S. 2011. *Agricultural Land Management: Capturing Synergies between Climate Change Adaptation, Greenhouse Gas Mitigation and Agricultural Productivity. Report to the World Bank.* Report 3b of the project "Adaptation of Smallholder Agriculture to Climate Change in Kenya". IFPRI – KARI - U of Georgia – ILRI. International Food Policy Research Institute, Washington DC, 100 p. Herrero, M., Thornton, PK, Havlík, P. and Rufino, M. 2011. Livestock and greenhouse gas emissions: mitigation options and trade-offs. In: Wollenberg, E., A. Nihart, M.L. Tapio-Bistrom, and C. Seeberg-Elverfeldt (eds) (2011) *Climate Change Mitigation and Agriculture,* Earthscan, London, UK, p. 316-332.	

Theme 4, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.2.1.9	Model development, testing and documentation	Documentation for GLOBIOM-Livestock, a global integrated assessment model with explicit treatment of livestock issues Put under Milestone 4.2.1.8 (I will rephrase that Milestone a bit so that this fits better)	Activity delivered, but refinements will be ongoing in the following years. Outcome: The revised GLOBIOM model developed by IIASA/ILRI, and incorporating livestock explicitly is being used as one of the key models in the IPCC AR5 to estimate the impacts of the new RCP climate change scenarios on food production, land use change, GHG emissions and others. (Havlik: IIASA/ILRI, Herrero, ILRI). The revised Globiom model and its applications are described in several publications as follows (this is a sample of papers, there are more): Hávlik, P. Herrero, M., Valin, H., Obersteiner, M., Schmid, E., Rufino, M., Mosnier, A., Bötcher, H., Frank, S., Fritz, S., Fuss, S., Kraxner, F., Notenbaert, A and Thornton, P.K.. 2011. The role of livestock systems transition in the future food production and climate change mitigation. PNAS (in preparation)	IIASA

			Reisinger, A., Havlik, P., Riahi, K., van Vliet, O., Obersteiner, M and Herrero, M. 2011. Implications of alternative metrics for global mitigation costs and greenhouse gas emissions from agriculture. Climatic Change (submitted) Havlík, P., Herrero, M., Mosnier, A., Obersteiner, M. Schmid, E., Fuss, S. And U.W. Schneider. 2011. Production system-based global livestock sector modelling: good news for the future. Paper presented at the 2011 European Association of Agricultural Economists Conference, August 30 to September 2, 2011, ETH Zurich, Zurich, Switzerland. Havlík, P., Obersteiner, M. Mosnier, A., Schmid, E., Herrero, M., et al. GLOBIOM – Global Bioshpere Management Model: Mechanisms and Applications. Presentation at "Localisation, commerce, changement climatique et politiques publiques" at INRA SAE2 General Assembly, 12-15 September 2011, Batz-sur-Mer, France.	
4.3 Refining frameworks for policy analysis				
4.3.4.1	Writeshops, syntheses	Global review of livestock issues in global change	Activity ongoing, almost complete as a PNAS special issue Outcome: Livestock and Global Change session included in Planet under Presure conference as a result of research emerging from the global reviews. Several papers are in the pipeline in PNAS relation to this initiative (can provide details if required).	IFPRI, IIASA, PIK, FAO, PBL

I. Activity Summary

Activity 1.1.2.1 consisted of two components: (i) hydrological modeling of sea level rise in the Mekong Delta and (ii) assessment of improved rice germplasm in the coastal areas of Vietnam. The outputs of the modeling component encompass a high-resolution GIS data base on water levels and salinity concentrations in the Mekong Delta. Thus, it will now be possible to project aggravating flood and salinity problems within the delta and to identify future hotspots of flood/ salinity stresses in rice production. The component on germplasm development addresses both Mega-Deltas of Vietnam, namely the Red River and Mekong Delta. The goal is to develop more resilient varieties (in terms of flood and salinity stresses) that can then be disseminated to farmers living in areas with high vulnerability.

Activity 1.1.2.1 consisted of (i) socio-economic studies in Indonesia and (ii) compilation of a typhoon data base for the Philippines. An ongoing household survey on drought impacts in Indonesia complements a project conducted within IRRI's Consortium of Unfavorable Environments (CURE). For the Philippines, we have compiled a comprehensive GIS data base on all typhoons making landfall in the Philippines in the years of 1970-2006. The data base provides information on individual typhoon characteristics including wind speed, rainfall and – most importantly – the provinces affected along the track of each typhoon.

Activity **1.1.2.1** consisted of field experiments as well as model assessments. Rice production trials have been laid out in different agro-hydrological zones of the Mekong delta for testing adaptation options, namely variety selection and adjusted fertilizer management. Varietal testing and agronomic experiments have only started in Oct. 2011, so that there is no available data at this point. The 2nd component of this activity specifically addresses heat stress in different regions of India. Three experimental stations have been equipped for screening rice germplasm under heat stress. The 3rd component of this activity comprises an impact assessment of a combined drought- and submergence-tolerant rice variety conducted as part of the Global Futures for Agriculture Project that was coordinated by the International Food Policy Research Institute (IFPRI).

Activity 2.1.1.4 consisted of a statistical analysis of long-term trends in seasonal rainfall patterns in Luzon (Philippines) based on meteorological data recorded from 1979 to 2010.

Activity 3.3.1.1 was composed of two deliverables, namely field experiments with supplementary litearture studies as well as socio-econoimic studies. The field experiments comparing different crop management practices were conducted in the Philippines, Indonesia and Vietnam. In the Philippines, the experiments focused on 'Alternate-Wetting-and-Drying' and in Indonesia on direct seeding. In Vietnam, the emission measurements were part of two larger projects dealing with Climate Change mitigation in the central part of the country and the Mekong delta, respectively (see Part C: Case studies). In both regions, we initially had to build up laboratory and field infrastructure. The two literature surveys that supplemented our field measurements on mitigation comprised a quantitive analysis of published methodologies for chamber measurements as well as an environmental impact assessment of mitigation technologies.

The socio-economic components of **Activity 3.3.1.1** consisted of (i) a Participatory Rural Appraisal (PRA) in the Mekong Delta and (ii) a comparative study of alternative uses of straw in Vietnam and the Philippines. The PRA in different agro-hydrological zones was designed to facilitate a constraint analysis of cropping systems within a broader Climate Change project (see Part C: Case studies). For the future, the PRA will be expanded to assess possible mitigation and adaptation technologies in terms of economical and bio-physical factors. The study on alternative straw management assessed different options, such as rapid composting and mushroom culture, as a means to avoid straw burning in the Mekong Delta, Vietnam and Central Luzon, Philippines.

Activity 4.2.1.6 consisted of a combined empirical/modeling approach to assess the possible impact of climate variability on rice production in the Philippines.

II. Activity Reporting

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of activity / deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.1.2.1	Identifying climate change impacts and adaptation pathways in major rice growing areas with specific vulnerabilities	Regional case studies on sea level rise conducted in Bangladesh[1)] and Vietnam		NARES in India, Bangladesh, Indonesia, Vietnam, and the Philippines
		Comp. 1) Hydrological assessment of seal level rise in the Vietnamese Mekong Delta This study builds on a previous study on sea level impacts in the Mekong Delta by using advanced versions of a hydrological model and improved GIS tools. Water levels and salinity concentrations were simulated under different climate change scenarios. Besides the simulation of the existing irrigation infrastructure, this study also projected effects of different water control alternatives or variations in water resources such as water extraction, canal excavation and building hydraulic structures. The results of the model simulation clearly show water levels will be strongly affected throughout the entire Mekong Delta in case of elevated sea level. In contrast, impacts on salinity are more location-specific and vary according to season and inter-annual fluctuations. **Comp. 2) Improving Rice Tolerance of Submergence and Salinity to Cope with Climate Change in Coastal Areas of Vietnamese Deltas** This project focuses on flooding and salinity problems in the Vietnamese deltas, namely Red River and Mekong Delta. The project has initiated the development of more resilient varieties that could withstand current and future consequences of sea level change and deliver them to farmers living in areas with high vulnerability. By developing adapted, submergence- and salt-tolerant rice varieties, the project will contribute to enhancing and sustaining future livelihoods in coastal zones of the Red River and Mekong River Delta areas, which are among the hotspots for agricultural losses caused by sea level rise. This study builds on a previous study on sea level impacts in the Mekong Delta by using advanced versions of a hydrological model and improved GIS tools. Water levels and salinity concentrations were simulated under different climate change scenarios. Besides the simulation of the existing irrigation infrastructure, this study also projected effects of different water control alternatives or variations in water resources such as water extraction, canal excavation and building hydraulic structures. The results of the model simulation clearly show water levels will be strongly affected throughout the entire Mekong Delta in case of elevated sea level. In contrast, impacts on salinity are more location-specific and vary according to season and inter-annual fluctuations.		

1.1.2.1	Identifying climate change impacts and adaptation pathways in major rice growing areas with specific vulnerabilities	Regional case studies on climate extremes conducted in India[2], Indonesia, and the Philippines		ARI in Japan, Germany, USA, Australia
		Comp. 1) Field experiments on coping with climate extremes in the Mekong Delta Due to financial constraints, field experiments on coping with climate extremes could only be conducted in Vietnam and not in the other target countries mentioned. Rice production trials have been laid out in different provinces of the Mekong Delta within the 2nd half of 2011. These experiments include different options of increasing the resilience of the rice production systems, namely variety selection and adjusted fertilizer management. At present, however, varietal testing and agronomic experiments are still going on. **Comp. 2) Compiling a typhoon data base for the Philippines in GIS format** The GIS data base on all typhoons making landfall in the Philippines covers 27 years (1970-2006). In this time span, the Philippines was hit by 212 typhoons with an average of 6 typhoons per year and minimum and maximum frequencies of 1 and 14, respectively. The UNISYS website (http://weather.unisys.com/hurricane/index.html) provides a wealth of information on each typhoon including satellite data of typhoons and charts on the track, wind speed etc. After downloading the tracking data, we have compiled a GIS data base and re-constructed the respective 'weather footprint' of each typhoon, i.e. those provinces that have been affected by strong winds and/ or strong rainfall along the track of a typhoon. The data base also specifies the stage of the rice crop when the typhoon hit the Philippines, so that we can in the next step work on a detailed damage assessment for rice production in the Philippines (see Act. 4.1).		

1.1.2.1	Identifying climate change impacts and adaptation pathways in major rice growing areas with specific vulnerabilities	Rice production systems with high vulnerability to changes in temperatures and precipitation mapped		
		Comp. 1) Field experiments on coping with climate extremes in different agro-ecological zones of the Mekong Delta While aim of this component is to provide to farmers and management agencies the technologies and knowledge that will improve food security in the Mekong Delta, namely: • improvement of salinity and submergence resilience of locally-adapted rice varieties and elite lines • develop integrated soil, crop, nutrient and water management options • identify biophysical, social and economic factors determining the capacity of farmers to adapt to climate change and • conduct an in depth analysis for land use planning in coastal areas The work has started in 2011 in four provinces of the delta to address environmental challenges in each of the agro-hydrological zones within the Mekong Delta. **Comp. 2) Exploring novel sources of heat escape, avoidance, tolerance across diverse rice accessions** The major limitation in exploring and identifying rice accessions with different physiological mechanisms to adapt to increasing temperatures has been (i) limited space in the temperature controlled environments and (ii) persisting question of testing under natural vs controlled condition. Hence, based on the results obtained from our GIS analysis and after validation using the past 10 years climate data, we have identified hot spots across South Asia comprising of two regions which are hot and dry (Punjab and Hyderabad, India) and two hot and humid regions (Tamilnadu in India and Jessore in Bangladesh) to test a wide range of diverse rice germplasm coming out of different abiotic stress breeding programs at IRRI. The diverse set of entries comprises of 150 wide hybridization lines from the wild rice breeding program, 150 elite salinity tolerant lines, 40 heat tolerant donors and which will include advanced breeding lines once they become available in 2013, 50 advanced drought breeding lines and 300 indica varieties which have been used for association mapping with an idea to extend the knowledge obtained on phenotyping from controlled environment studies for heat escape (early morning flowering), heat tolerance (having the ability to set seed even with flowering under extreme high temperatures) and heat avoidance (through evaporative cooling; reducing their canopy temperature) under field conditions. These sites are being provided with on the plot fully automated weather stations, soil, water and air temperature sensors and hand held narrow view infra red sensors to record canopy climatic conditions and also leaf and panicle temperatures. The overall aim is to establish and standardize stations across these heat stress hot spots for field phenotyping of wide range of genetically diverse entries and interesting breeding material to design and implement a systematic high temperature breeding program under realistic field conditions. **Comp. 3) Research to sharpen the climate change focus in relation to the research being conducted under Global Gates Futures project** In this study, the ORYZA2000 crop growth simulation model was used for an ex-ante Impact Assessment of a Combination Drought- and Submergence-Tolerant Rice Variety in the Presence of Climate Change in South Asia under climate change. Our analysis indicate that the economic benefits of a combined drought- and flood tolerant rice variety more than outweighs the cost of developing this new variety, especially in light of global climate change. The development and release of this new variety in South Asia would provide a net economic benefit of about US$1.8 billion for the region alone.	

		In addition, results from our partial equilibrium market models suggest that production, consumption, and rice exports in South Asia would be higher with the drought- and flood-tolerant variety (as compared to the case where this new variety is not developed). Rice prices in South Asia are expected to be lower if the drought- and flood-tolerant variety is developed and released. Hence, rice would be more affordable to poor consumers and would likely improve the nutritional status of the poor in the region. These results imply that substantial economic benefits can be achieved from the development of an improved rice variety that is tolerant to the dual stresses of drought and flood. This type of technology would allow rice producers to adapt to worsening global climate and make them able to mitigate the adverse effects of climate change in the future. In the long-run, the returns to the investment of developing this particular "climate change tolerant" variety is high. Thus, we strongly encourage policy makers and donors to fund the research, development, and dissemination of new rice varieties that are more tolerant to droughts and floods, so that farmers can better cope with the changing global climate in future.

1.2 Breeding strategies for future climatic conditions				
1.3 Species and genetic diversity for climate change				
Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of activity / deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.1.1.4	Quantifying losses in rice production caused by droughts and cyclones/ typhoons in regional case studies	Historical records on yield losses compiled for droughts (India[3], Thailand[3]) and cyclones/ typhoons (Bangladesh[3], Philippines)		NARES in India, Bangladesh, Thailand, and the Philippines
		Comp. 1) Inter-annual yield fluctuations and typhoon occurrence in selected provinces of the Philippines The typhoon data base described n Act. 1.3 was used for statistical check of the often cited 'common wisdom'- that typhoons exert a major impact on rice yields in the Philippines. We conducted a correlation test between reported losses (derived from official statistics) and wind speeds. However, there was no correlation detectable even when we narrowed down the analysis to sensitive plant growth stages of the rice crop. Apparently, other events that accompany typhoons, like flash floods, might be a greater cause of yield loss in rice as compared to the wind speed. **Comp. 2) Long-term trends in seasonal rainfall patterns in Luzon (Philippines)** This trend analysis is based on meteorological data recorded at weather stations located Los Banes, Philippines (14° 10' 44" N / 121° 13' 32" E) in the years of 1979 to 2010. The weather records of the recent years revealed anomalies during the growth of the dry season rice crop (Jan-April). Most of the recent dry seasons in the Philippines had more rainfall and lower solar radiation than typically recorded in the dry seasons of the 1980's and 1990's. This change in seasonal patterns adversely affects the yield potential of rice. This 3-decadal data base also allowed a thorough statistical analysis of rainfall probability of each day of the year, thus, on the onset of the dry and wet season respectively, as well as the resulting daily evaporation for water balance.	
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				

Theme 3, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of activity / deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				
3.3.1.1	Assessing region-specific mitigation potentials in rice production through improved irrigation and fertilizer management	Emissions in farmers' fields under different management options determined in different rice growing regions		NARES in India, Indonesia, Vietnam, and Philippines
		Comp. 1) Emission measurements in farmers' fields in the Philippines, Indonesia and Vietnam This study aims on proving net GHG emission reduction from water saving strategies in farmers' fields. Studies in this field have been conducted on experimental stations in the last decade. Reality data from farmers' fields – with the intension of exploring CDM options- are lacking. Jointly with NARES partners, IRRI conducted emission measurements in the following locations: • Central Luzon, Philippines • Central and Western Java, Indonesia • Central Vietnam and Mekong Delta, Vietnam In the Philippines field measurements of GHG emissions from 12 farms have been conducted in the dry seasons of 2010 and 2011. Half of the study fields adopted the water saving technology Alternate-Wetting-and-Drying, the other half grew rice in continuously flooded conditions. Methane and nitrous oxide emissions have been recorded in weekly intervals throughout the growth period. A comprehensive data base of emission, soil and agronomic data has been compiled. In 2012 and 2013 these activities will be continued. In Indonesia, the measurements addressed the impact of direct seeding. Measurements are ongoing and results only tentative at this point In Central Vietnam field measurements started in 2011. After a training workshop given by IRRI staff to our Vietnamese partners in May 2011, emission data have been collected for the first complete season (June to September). In the Mekong Delta experiments have started end of 2011 after another training workshop in November. These two experiments represent – to our knowledge -- the first GHG emission measurements from rice fields in Vietnam. In both Vietnamese sites, experiments will be continued in 2012. **Comp. 2) Literature search on published methodologies for chamber measurements in rice fields** This literature search was derived from on an internet site called 'ISI Web of Knowledge'. This tool allows screening published articles according to freely selected search criteria. In our case we have compiled screened for all published articles with relevant topics (methane, nitrous oxide, greenhouse gas, and rice). In the first step we have identified 13 journals (with peer review publishing procedures) that contain articles on emissions from rice fields. In the next step, these journals have		

		systematically been screened and the relevant articles have been downloaded (as PDF) and compiled with links in a data base. The initial screening yielded 219 articles ('total counts') dealing directly or indirectly with GHG emissions from rice fields Then, this relatively high number has been narrowed down to 112 articles with an explicitly described methodology for manual chamber measurements. For each article, we have individually recorded the following parameters of the methodology: replicate chambers per plot; measurements per day; gas collections per measurement; exposure time of individual chambers; intervals between sampling dates; number of seasonal cycles studied. The study included a statistical analysis of these parameters to determine minimum requirements for reliable quantifications of emission rates. **Comp. 3) Environmental Impact Assessment of Potential Mitigation Technologies in Rice Production (literature review)** This study assesses the environmental impacts of (I) water saving, direct seeding and (iii) efficient nitrogen management in rice production. These approaches have a proven potential for mitigating GHG emissions, but may eventually also imply collateral effects on the environment. Water saving technologies are -- in principle -- desirable features of irrigated rice production systems, but the change from wetland ecosystems to non-flooded environments will change landscape functions and biodiversity. Direct seeding entails more problems with weeds that have to be dealt with in an environmentally fashion. In contrast, efficient fertilizer application appears without adverse impacts on the environment – given the current state of 'over-fertilization' in many rice-growing regions of Asia.	
3.3.1.1		Socioeconomic constraints and possible incentives for adoption of mitigation options in rice identified in different rice growing regions		ARI in Japan, Germany, USA, Australia
		Comp. 1) Participatory Rural Appraisal in the Mekong Delta The Participatory Rural Appraisal (PRA) comprises a constraint analysis of cropping systems that were carried out in 4 provinces of the delta. While the PRA's focused on current farming practices, the results also indicate constraints for adopting possible mitigation technologies in terms of economical (labour cost and profit) and bio-physical factors (soil type, irrigation infrastructure). However, the PRA is still ongoing, so that the available data base is only tentative**.** **Comp 2) Assessing feasibility of alternative uses of rice straw in the Mekong Delta, Vietnam and Central Luzon, Philippines** This study assesses possible alternatives to the commonly practiced burning of rice straw in the fields. Different options, such as rapid composting and mushroom culture have been considered as a means to avoid the harmful affect of straw burning in terms of air pollution and greenhouse gas emission. In two case studies in the Mekong Delta, Vietnam and Central Luzon, Philippines, farmers have been asked to describe their perception about alternative uses of rice straw and to name factors that may affect their adoption of these alternative uses. The study also recorded the green house gas emissions of alternative uses of rice straw and identified policy options to enhance adoption of the alternative uses of rice straw.		

Theme 4, Integration for Decision Making				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of activity / deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.2.1.6	Outlining decision support systems for integrated adaptation/ mitigation in different rice production systems	Simulation models on yields and emissions in rice production systems assessed for their use in decision support systems[4]		NARES in India ARI in Japan and Germany
		Comp. 1) Climate-driven yield fluctuations in selected provinces of the Philippines This study comprises a combined empirical/modeling approach to assess the possible impact of climate variability on rice production in the Philippines. We collated climate data of the last two decades (1985-2002) and as well as yield statistics of six provinces of the Philippines, selected along a North-South gradient. Data from the climate information system of NASA were used as input parameters of the model ORYZA2000 to determine potential yields and, in the next steps, the yield gaps defined as the difference between potential and actual yields. Both simulated and actual yields of irrigated rice varied strongly between years. However, no climate-driven trends were apparent and the variability in recorded actual yields showed no correlation with climatic parameters. We conclude that neither long-term trends nor the variability of the climate can explain current rice yield trends and that agroecological, seasonal, and management effects are over-riding any possible climatic variations. On the other hand, the lack of a climate-driven trend in the present situation may be superseded by ongoing climate change in the future.		
4.3 Refining frameworks for policy analysis				

Footnotes:

The CCAFS funds provided to IRRI in 2011 have been considerably lower as originally expected and have been released only in December 2011. In conjunction, these two drawbacks required several adjustments in the planned activities/ deliverables in 2011:

[1] Regional case studies on sea level rise were only possible for Vietnam. Due to financial and time constraints, this activity could not be implemented for Bangladesh.

[2] Regional case studies on climate extremes were only possible for Indonesia, and the Philippines. Due to financial and time constraints, this activity could not be implemented for India.

[3] The analysis of historical records on yield losses was only possible for the Philippines. Due to financial and time constraints, these activities could not be implemented for India, Thailand and Bangladesh.

[4] With the given amount and timing of fund release, it was not possible to hire personnel to work on the development of simulation model for climate change research. The IRRI activities in this regard were limited to model applications, namely an empirical/modeling approach to assess the possible impact of climate variability.

III. Case studies

Case Study 1: Vietnamese Mekong Delta

IRRI's activities on Climate Change in the Mekong Delta are embedded in a comprehensive project on impact assessment, adaptation and mitigation (CLUES = Climate Change affecting Land Use in the Mekong Delta: Adaptation of Rice-based Cropping Systems). The Mekong Delta is Vietnam's main rice area and accounts for half of the annual rice production. The Delta's rice land use is divided into agro-hydrological zones which are characterized by distinct patters of flood duration and depth, water availability and the salinity regimes. Over the last 30 years Vietnamese farmers have been adapting to the changing environmental conditions by modifying and diversifying their production systems and water management. But the recent and forecasted agro-hydrological changes threaten the viability of these farming and social systems and subsequently food security within South East Asia. Significant constraints which limit the ability of the farmers to adapt to the new hydrological regime include the availability of suitable cultivars, soil nutrient management options, the lack of knowledge of the potential threats from acid sulphate soil inundation and planning tools.

The overall aim of IRRI's Climate Change research in the Mekong Delta is to increase the adaptive capacity of rice production systems. The immediate objective is to develop and disseminate technologies and knowledge that will improve food security in the Mekong Delta. There are five main project objectives:

- improvement of salinity and submergence resilience of locally-adapted rice varieties and elite lines
- build capacity for quantification soil nutrient cycling , including the emissions of greenhouse gases, from rice fields
- develop integrated soil, crop, nutrient and water management options
- identify biophysical, social and economic factors determining the capacity of farmers to adapt to climate change
- in depth analysis for land use planning in coastal areas

We have selected four target areas that represent a specific agro-ecological zone of the Mekong Delta. In the context of this proposal, a target area comprises an experimental farm plus the surrounding villages which will be used for socio-economic studies as well as participatory research. The investigations in these target areas will also serve as 'entry points' to engage and build capacity with the local provincial officials and farmers for future uptake of technologies in other locations of the respective zone

Case Study 2: Central Vietnam (Vu Gia/ Thu Bon River Basin)

In a similar setting as for the Mekong Delta, IRRI's Climate Change activities in Central Vietnam form part of a comprehensive regional assessment (LUCCi = Land Use and Climate Change Interactions in the Vu Gia/ Thu Bon River Basin, Central Vietnam). The Vu Gia/ Thu Bon river basin is characterized by heterogeneous topography with large portions of flood-prone areas as well high incidences of poverty as compared to other Vietnamese regions. The LUCCI project will develop strategies for sustainable land use in Central Vietnam considering the regional socio‐economic development, national planning elements as well as regional climate change projections. The research merges both, natural and social science approaches. Thematically, the project focuses on analyzing the impacts of different land use systems and crop management on GHG emissions as well as climate change impacts on existing land uses, the natural environment and the society.

The task of IRRI in this concerted effort is to investigate the specific role of rice production as a means for mitigation as well as adaptation. In 2011, IRRI's activities have focused on creating sound logistics for the envisaged experiments. We have established a state-of-the-art laboratory for GHG analysis and lectured local staff in two training courses on the various procedures for conducting emission measurements. As an initial result, our NARES partners were able to record emissions over one growing season in 2011.

IWMI 2011 ANNUAL TECHNICAL REPORT TO CRP7 (CCAFS)

1. OUTCOME

Title: IWMI's vulnerability mapping included into Sri Lankan National Climate Change Adaptation Strategy for 2011-2016

What is the outcome of the research:

The use of IWMI recommendations and methodology for vulnerability mapping to CC in national adaptation planning document in Sri Lanka

What outputs produced in the 3 preceding years resulted in that outcome:

- Eriyagama, N., Smakhtin, V. (2010). Observed and projected climatic changes, their impacts and adaptation options for Sri Lanka: a review. In: Evans, A; Jinapala, K. (Eds). Proceedings of the National Conference on Water, Food Security and Climate Change in Sri Lanka, Colombo, Sri Lanka, 9-11 June 2009. Vol. 2. Water quality, environment and climate change. Colombo, Sri Lanka, IWMI. pp. 99-117
- Eriyagama, N., Smakhtin, V., Chandrapala, V., Fernando, K. (2010) Impacts of Climate Change on Water Resources and Agriculture in Sri Lanka: A Review and Preliminary Vulnerability Mapping. IWMI Research Report 135, http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/PUB135/RR135-High_res.pdf

What partners helped in producing the outcome:

Ministry of Disaster Management and Human Rights, Sri Lanka
Centre for Poverty Analysis (CEPA), Sri Lanka

Who used the output?

- Ministry of Environment of Sri Lanka
- Sri Lankan Delegation at COP16
- ADB

How was the output used?

It was used in preparation of Sri Lanka's Second National Communication (SNC) on Climate Change to the UNFCC. The process also involved commenting on draft reports prepared under 5 thematic areas, and also the final summary report. IWMI's recommendations on storage for adaptation to CC, and findings from IWMI Research Report (RR 135) referenced above were incorporated into the thematic reports as well as into the final summary report. The report was submitted to UNFCC before COP 16 in Mexico.

It was subsequently used for preparation of the National Climate Change Adaptation Strategy for Sri Lanka. This project was funded by ADB. The ADB team modified and refined the CC Vulnerability Index in RR 135 in order to identify vulnerability hotspots in 5 sectors (including water, agriculture, infrastructure etc.) within the country. The National Climate Change Adaptation Strategy has been prepared by drawing on results from this mapping exercise. This document was also one of the supporting tools for Sri Lanka's team at COP 16 (along with the SNC).

What is the evidence for this outcome:

- National Climate Change Adaptation Strategy for Sri Lanka 2011 to 2016 and Sri Lanka's SNC on Climate Change to the UNFCC.
- Several Newspaper Articles in National Media in 2011 (scanned versions can be provided on request). Articles covered a range of topics related to climate change such as groundwater use, flood prevention and urban agriculture:

1. Major food crisis looming: Experts. by Indika Sakalasooriya, Business Editor, Daily Mirror – January 18, 2011 *(This was the first article which featured IWMI research)*
2. Lankan economy to be marred by floods and droughts in future - by Nishadi Eriyagama, IWMI – February 03, 2011
3. Floods are only part of the story by Nishadi Eriyagama, IWMI – February 16, 2011
4. Groundwater holds future for local water management by Aditya Sood, IWMI – February 22, 2011
5. Climate change will drive food prices by Terry Clayton, IWMI –March 23, 2011
6. Climate change – Adapting to the future by Herath Manthrithilake, IWMI – March 14, 2011

- Increased awareness among the general public on impacts of climate change as evidenced by feedback received by IWMI from readers of the newspaper articles.

NOTE: main "action" related to it occurred in 2010, with some overflow into 2011

2. SUMMARY OF ACTIVITIES

All CCAFS-related research activities at IWMI in 2011 were carried out under CCAFS Theme 1: *"Adaptation to Progressive Climate Change".* Within this Theme, all activities were grouped under one Output: "1.*1. Adapted Farming systems to changing climate conditions*". More specifically, activities included:

- GCM downscaling to the basin level and hydrological modelling under different CC scenarios in the Volta and Nile basins – with an aim to examine how water availability will change at the basin scale due to progressive CC.
- Engaging local communities and stakeholders in identification, enhancement and testing future adaptation scenarios and agricultural risk management strategies in Volta and Nile Basins.
- Basin water allocation modelling and economic analyses for improved water allocation under CC scenarios in Volta, Blue Nile, Ganga Basins and Nepal
- Inventory of water storage types in the study basins – to develop a detailed account of already available/ used measures/ structures that buffer against increasing variability of water resources due to progressive CC
- Regional trend analysis – to examine if climatic changes are already happening
- Inventory and evaluation of previous geo-hydrological studies, socio-economic and geo-physical surveys in over 10 countries of Sub-Saharan Africa – a comprehensive desktop analyses, aiming, inert-alia, on developing the succinct picture of the status and prospects of groundwater use in small farming systems.

Most of the above activities are completed in full, more specifically:

- The dynamic regional climate model CCLM was used to simulate CC impacts in both the Nile and the Volta basins with a spatial resolution of 0.5^{o} under A1B climate scenarios (2001-2100). These simulations were then used as inputs to hydrological SWAT model to evaluate implications for river flows and groundwater recharge. The planning model was

subsequently used to determine the combined impact of CC and planned water resource development (irrigation and hydropower) in both basins. These tools combine efectively provide a DSS to support water resolurces basin-wide planing with implications for small-scale farmers.

- Socio economic household surveys conducted in both Volta and Nile basins (ca. 500 in each) to identify community water sources, costs and benefits of different water storage options and farmers perceptions of CC. In depth ethnographic field studies conducted in both basins to determine and evaluate community issues associated with a range of water storage options for irrigation.
- A combination of models was used to evaluate impacts of CC and implications for different water storage options in Volta, and Blue Nile. For evaluating different storage options, an alternative to cost benefit analyses, based on an outranking methodology, was developed. Though relying on the underlying principle of economic efficiency, the approach proposed avoids some crucial weaknesses of cost-benefit analysis and places greater emphasis on socioeconomic and environmental criteria.
- Various scenarios of future climate and alternate water management strategies have been assessed using a planning model in the Upper Ganga river Basin, India. In Nepal, detailed land use maps for 4 sub-basins within the Koshi river basin are being prepared as input to the basin model which will evaluate future water availability, use and management options (such as small scale storage systems) to adapt to future CC.
- An inventory was made of existing and prospective water storage in the Ghanaian Volta and the Ethiopian Blue Nile basins. For both, this was believed to be the first attempt to draw together information on the full spectrum of storage types. Based on published and grey literature it provides as much quantitative data as possible, but highlights both the dearth of readily available information and the lack of integrated planning of storage in both basins. Recommendations were made for improved water stoarge planning in the future. A similar inventory is being done for Nepal.
- The modified Mann-Kendall trend detection test, accounting for the scaling behavior of climate time series was applied to 28 rainfall variables capturing main climate features controlling rainfed agriculture production and having an impact on human livelihoods. The analysis in Ghana revealed: i) a reduction in the number of wet season days totalling less than 20 mm of rainfall, between latitudes 6° and 9.5° N; ii) a delay (about 0.5 day.year^{-1}) in the wet season onset at several locations throughout the country; iii) a lengthening (about 0.1 day.year^{-1}) of rainless periods during the wet season in the south and centre of Ghana. This methodology was applied either to observed rainfall from the past or rainfall time series simulated by regional climate models to assess future changes. These analyses were carried out in Volta (Ghana), and Mekong (Southeast Asia) and Upper Ganges basins.
- Groundater potential in Volta Basin was mapped, and a conceptual framework for allocating groundwater for agriculture and other uses has been developed. Detailed socio-economic studies across 9 countries in sub-Saharan Africa examining groundwater use being assembled into a Book. Locally-specific detailed hydrogeological sudies in a small river basin in Ethiopia were completed completed, outlining the prospects of groundwater use in small-scale farming systems.

3. CASE STUDIES

CASE STUDY 1

Title: Developing and disseminating tools for decision support for adaption planning in Indian River basins
Case type: Capacity strengthening activities /communications activities
Brief description of the activity: Two workshops with stakeholders (50 participants -17 Feb 2011; and 120 participants -21 Feb 2011) – disseminate the tools and build capacity in their use. A newsletter "Climarice" circulated to all stakeholders
Result of activity. Improved knowledge on vulnerability to CC and awareness of the decision support tools for adaptation planning in rice-producing regions of Godavari, Krishna and Cauvery river basins
Partners involved and their role Norwegian Embassy, State Government officials (AP), NGOs, research scientists and farmers
Research on which the activity is based
Vulnerability index was developed and mapped for the Godavari and Krishna basins of Andhra Pradesh (AP). IPCC definition was used that considers the exposure, sensitivity and adaptive capacity aspects. Variables (district wise data) under each of these categories were used to construct the index with time series data for 30 years. Districts were grouped under different levels of Vulnerability (Very high, high, moderate and low). An optimization model was developed that maximizes production and crop income and minimizes water use under mid and end-century CC scenarios. The final output is optimum land and water use under these scenarios with and without different management options such as alternate Wetting and Drying or Machinery transplanting). The model was applied for Godavari, Krishna and Cauvery basins.

CASE STUDY 2

Title: National Conference on Climate Change and Water in Nepal
Case type: Successful communications activities
Brief description of the activity: 2-day conference on issues of climate change and water resources in Nepal, and their implications for country's economy and food security
Result of activity: The Conference was a huge success. It was attended by over 150 senior government officials, academics, donors and NGO's. The media also covered the event (newspapers and TV). Interviews were given by Dr Luna Bharati (Head of IWMI-Nepal office) and Dr Denis Wichelns (acting Deputy Director General of IWMI at that time). A side (but important) effect of the conference was a boost in IWMI's visibility in Nepal, followed by requests by various NGO's and Government officials to partner in projects and activities, some of which have materialised in Projects since then. The papers from the conference are being published in a special issue of Hydro-Nepal.
Partners involved and their role: The event was funded by CCAFS regional coordinator and co-funded by IWMI through additional staff time and participation of 6 IWMI staff (most of them – senior) with either key note talks or focused technical presentations. Department of Hydrology and Meteorology, Department of Irrigation of Nepal were involved in co-organizing and presenting at the Conference
Research on which the activity is based

The bulk of previous research on climate change and water at IWMI in 2008-2011 – to show case what can be done as is being done in assessment of CC impacts and in adaptation to them in Nepal, South Asia, and (to a lesser extent) other geographical regions where IWMI is active.

CASE STUDY 3

Title: Evaluating the water use of coffee globally under current and future climates
Case type: innovative non-research partnerships
Brief description of the activity: This is a small activity and project that started in 2011 and is not yet fully complete. IWMI and Nestle joined forces to evaluate the water footprint of coffee globally, and, in more detail, in Viet Nam (as one of the major coffee producers).
Result of activity: The on-going partnership between IWMI and Nestle
Partners involved and their role: Both Nestle and IWMI are co-funding the study. Yet IWMI does all research and Nestle evaluates its results for the company's operational and reputational risks in areas where coffee is procured by Nestle, with implications for improving the livelihoods of farmers involved. IWMI's main interest is in developing an IPG – publically available information on the potential implications of CC for coffee market, which involves many poor countries. Both parties respect each other's objectives and work well together
Research on which the activity is based: The ongoing research that is conducted by IWMI; Publications are anticipated in 2012

CASE STUDY 4

Title: Understanding CC impacts on water in urban-rural interface
Case type: communication; capacity strengthening
Brief description of the activity: Stakeholder platform meetings in Accra (January 2011) and Addis (February 2011) discussed how better water management in urban-rural interface can increase the resilience of cities to CC. IWMI presented findings from CC downscaling, hydrological modeling, adaptation to flooding, and water demand management. A field visit within the Akaki Basin in Ethiopia helped the participants to observe the pollution levels in the river at specific points and to interact with farmers about the problems they face due to changing climate.
Result of activity: For many of the participants, the presentations and field visit in particular was an eye-opener about the potential impacts of CC on vulnerable communities.
Partners involved and their role: Main partners involved in execution of the project include Council for Scientific and Industrial Research -Water Research Institute (CSIR-WRI) in Ghana; Department of Civil Engineering at Addis Ababa University; Ethiopian Development Research Institute (EDRI) The workshops brought together climate change and water management experts, decision-makers and representatives of vulnerable communities to collectively design adaptation strategies for the water-use sectors in the two cities
Research on which the activity is based
This was part of the ongoing research project on managing rural-urban water issues that is due to completion in mid-2012. The cities are viewed within the broader basin contexts, thereby focusing the research on urban-rural connectivity.

4. **A SMALL REMARK AGAINST EACH ACTIVITY / DELIVERABLE** *(provided in a separate spreadsheet)*

5. LIST OF PUBLICATIONS

Bharati L, Lacombe G, Gurung P, Jayakody P, Hoanh C. T, Smakhtin V. 2011. *The impacts of water infrastructure and climate change on the hydrology of the Upper Ganges River Basin*. Colombo, Sri Lanka: International Water Management Institute. 44 p. *IWMI Research Report 142*. doi: 10.5337/2011.210

Mccartney, M.P. & GIRMA, M.M. (submitted) Evaluating the downstream implications of planned water resource development, under current and projected future climate, in the Ethiopian portion of the Blue Nile River. Water International.

Forkuor, G., Mccartney, M.P. & Amisigo, B. (2011) Evaluating the implications of future water resources development under current and projected future climate in the Volta Basin. 3rd Ghana Water Forum, 5-7 September 2011, Accra, Ghana.

Eguavoen, I., Derib, S.D., Deneke, T.T., Mccartney, M., Otto, A. & Billa, S. (2011) Digging, damming or diverting? Small-scale irrigation in the Blue Nile, Ethiopia. ZEF Working Paper 84. Bonn, Germany. 29pp.

Xenarios, S., Asante, F. & Mccartney, M.P. (2011) Economic efficiency of water storage options: an application of the approach to Ghana. 3rd Ghana Water Forum, 5-7 September 2011, Accra, Ghana

Lacombe G, Hoanh Ct, Smakhtin V. 2011. Multi-year variability or unidirectional trends? Mapping long-term precipitation and temperature changes in continental Southeast Asia using PRECIS regional climate model. Climatic Change. doi: 10.1007/s10584-011-0359-3.

Lacombe, G., Mccartney, M.P. & Forkuor, G. (submitted) Drying climate in Ghana over the period 1960-2005: evidence from the resampling-based Mann-Kendall test at local and regional levels. Hydrological Sciences Journal.

Lacombe G, Smakhtin V, Hoanh Ct. Rainfall trends in central Mekong Basin: 1953 to 2004. *Submitted* to Theoretical and Applied Climatology

Altchenko, Y., Awulachew, S.B., Brida, A.B., Diallo, H.A., Mogbante, D., Pavelic, P., Tindimugaya, C. And Villholth, K.G. (2011) Management of groundwater in Africa including transboundary aquifers: Implications for meeting MDGs, livelihood goals and climate change adaptation. United Nations Economic Commission for Africa, African Climate Policy Centre, Working Paper 6, November 2011.

Tenalem Ayenew, Sileshi Mamo, Elias Ali, Abdela Abdu, Merhawi Gebreegziabher And Afework Desalegn (2011) Hydrogeological and groundwater potential evaluation, water quality assessment and socio-economic surveying for small-scale irrigation development in the Raya-Kobo valleys, northern Ethiopia. Final Report to IWMI, September 2011.

2011 Activity Plan for CCAFS Centre General Funds: Activities, Deliverables & Partners

CG Centre:	IWMI

Table A. Main contacts persons in the Centre

Contacts	Name(s) (specify roles if more than one)	Email
Climate Change Contact Point	Vladimir Smakhtin	v.smakhtin@cgiar.org
Admin. Issues	Amol Khisty	a.khisty@cgiar.org
Communications	Joanna Kane-Potaka	j.kane-potaka@cgiar.org
Others (if needed, specify role)	Pramod Aggarwal, IGP regional leader	p.k.aggarwal@cgiar.org

Table B. Bilateral funded projects under CCAFS (2011)

ID#	Name of project	Approximate budget under CCAFS (2011) (1)	Donor	Principal investigator (also list any key contacts in EA, WA or IGP, if applicable)
1	Re-Thinking Water Storage for Climate Change Adaptation in Sub-Saharan Africa	214,000	GTZ	Matthew McCartney
2	Environmentally Sustainable Water Resources Management in the Upper Ganga Basin under current and fiuture climates	110,000	WWF-India	Luna Bharati
3	Groundwater in sub-Saharan Africa: Implications for food security and livelihoods	117,000	Rockefeller	Paul Pavelic
4	Managing Water in the Rural-Urban Interface: The Key to Climate Change Resilient Cities	263,000	IDRC	Liqa Rashid-Sally/ Pay Drechsel
5	Developing research options to mainstream climate adaptation into farming systems in Cambodia, Laos, Bangladesh and India	15,000	ACIAR	Guillaume Lacombe
6	Water storage infrastructure development for coping with temporal and spatial variability in water resources in Nepal	44,000	CIDA	Luna Bharati
7	Climawater-II Rice	178,000	NorAID	KP Palanisami
8	Climate Change and Watershed Development – Krishna Basin	46,000	ACIAR	Paul Pavelic
9	Climate change and water management in Chinyanja Tiangle	69,000	BMZ	Xueliang Cai

10	Smart ICT for weatrher and Water Information	131,000	IFAD	Bharat Sharma
11	Revialising Irrigation in Pakistan	95,000	Dutch	Khalid Mohtadullah

:

Table C. Activity tables by Themes/Objectives

Note:

(1) Activities should be approximately US$250.000 in value, inclusive of all costs, i.e. including personnel, overhead etc. The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that Regional Program Leaders can plan synthesis and coordination activities. They will not be used for any later reporting.

(2) Milestone numbers will be provided by Theme Leaders.

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.1.1.6	GCM downscaling to the basin level and hydrological modelling under different CC scenarios in Volta and Nile basins,	Analyses of detailed climate change impacts, region-specific issues in and levels of preparedness to progressive climate change, as well as required adaptation measures in water and agricultural sectors in selected countries/ basins	The dynamic regional climate model COSMO-CLM (CCLM) was used to simulate climate change impacts in both the Nile and the Volta basins on a grid spacing of 0.5°. The simulations comprised 30 years of daily control runs using ECHAM5-OM (1971-2000) and 100 years of transient scenario runs using ECHAM5, A1B climate scenarios (2001-2100). The initial and boundary conditions were taken from the ECMWF Re-Analysis (ERA40). The SWAT model was used to evalaute hydrological implications (i.e. flows and groundwater recharge) and the WEAP model was used to determine the combined impact of climate change and planned water resource development (irrigation and hydropower) in both basins. Outputs: *McCARTNEY, M.P. & GIRMA, M.M. (submitted) Evaluating the downstream implications of planned water resource development, under current and projected future climate, in the Ethiopian portion of the Blue Nile River. Water International.* *FORKUOR, G., McCARTNEY, M.P. & AMISIGO, B. (2011) Evaluating the implications of future water resources development under current and projected future climate in the Volta Basin. 3rd Ghana Water Forum, 5-7*	WRI- Ghana, PIK, ZEF, NBI, PIK

			September 2011, Accra, Ghana.	
1.1.1.6	Engagement of local communities and stakeholders to identify, enhance and test future adaptation scenarios and agricultural risk management strategies in Volta and Nile Basins.		Socio economic household surveys conducted in both Volta and Nile basins (ca. 500 in each) to identify community water sources, costs and benefits of different water storage options and farmers perceptions of climate change. In depth ethnographic field studies conducted in both basins to determine and evaluate community issues associated with a range of water storage options for irrigation. Findings reported in a number of student theses and some summarized in ZEF working paper 84. *EGUAVOEN, I., DERIB, S.D., DENEKE, T.T., McCARTNEY, M., OTTO, A. & BILLA, S. (2011) Digging, damming or diverting? Small-scale irrigation in the Blue Nile, Ethiopia. ZEF Working Paper 84. Bonn, Germany. 29pp.*	WRI- Ghana, PIK, ZEF, NBI, PIK
1.1.1.6	Basin water allocation modelling and economic analyses for improved water allocation under CC scenarios- Volta ,– Blue Nile , Ganga and Nepal	Tools and guidelines to support the selection (and / or maintenance) of the most appropriate water storage options and/ or their combinations for river basin development planning under conditions of increasing climate variability and change	The concept of a water storage continuum was developed. A combination of models was used to evaluate impacts of climate change and implications for different water storage options in Volta, and Blue Nile. For evaluating different storage options, an alternative to cost benefit analyses, based on an outranking methodology, was developed. Though relying on the underlying principle of economic efficiency, the approach proposed avoids some crucial weaknesses of cost-benefit analysis and places greater emphasis on socioeconomic and environmental criteria. *XENARIOS, S., ASANTE, F. & McCARTNEY, M.P. (2011) Economic efficiency of water storage options: an application of the approach to Ghana. 3rd Ghana Water Forum, 5-7 September 2011, Accra, Ghana* WEAP water planning model has been set up for the Upper Ganges basin. Various scenarios of future climate and alternate water management strategies have been assessed. A paper / report will be completed by the end of February 2012. In Nepal, detailed land use maps for 4 sub-basins within the Koshi basin are being prepared. Once the land use maps are ready, the SWAT model will be set up for the sub-basins where we will evaluate current as well as future water availability and use and management options (such as small scale storage systems) to adapt to future changes in climate	WRI- Ghana, PIK, ZEF, AMU, WWF-India, IITM-Kanpur
1.1.1.6	Inventory of water storage types		Completed. An inventory was made of existing and prospective water storage in the Ghanaian Volta and the Ethiopian Blue Nile basins. For	WRI, AMU, Dept Irrigation of Nepal-

			both, this was believed to be the first attempt to draw together information on the full spectrum of storage types. Based on published and grey literature it provides as much quantitative data as possible, but highlights both the dearth of readily available information and the lack of integrated planning of storage in both basins. Recommendations were made for improved water stoarge planning in the future. JOHNSTON, R. & McCARTNEY, M.P. (2011) Inventory of Water Storage *Types in the Blue Nile and Volta River Basins Colombo, Sri Lanka: International Water Management Institute (Working Paper 140) 48pp.* Inventory of small scale storage systems in the hills of Nepal has been completed. The report/ pare will be finalized during 2012	
1.1.1.6	Regional trend analysis,	Replicable tools, models, methods and data supporting agricultural water management and access to water in river basins under changing climates and existing climate variability	The modified Mann-Kendall trend detection test, accounting for the scaling behavior of climate time series was applied to 28 rainfall variables capturing main climate features controlling rainfed agriculture production and having an impact on human livelihoods. The analysis in Ghana revealed: i) a reduction in the number of wet season days totalling less than 20 mm of rainfall, between latitudes 6° and 9.5° N; ii) a delay (about 0.5 day.year^{-1}) in the wet season onset at several locations throughout the country; iii) a lengthening (about 0.1 day.year^{-1}) of rainless periods during the wet season in the south and centre of Ghana This methodology was applied either to observed rainfall from the past or rainfall time series simulated by regional climate models to assess future changes. These analyses were carried out in Volta (Ghana), and Mekong (Southeast Asia) and Upper Ganges basins. Related publications: *LACOMBE G, HOANH CT, SMAKHTIN V. 2011. Multi-year variability or unidirectional trends? Mapping long-term precipitation and temperature changes in continental Southeast Asia using PRECIS regional climate model. Climatic Change. doi: 10.1007/s10584-011-0359-3.* *LACOMBE, G., McCARTNEY, M.P. & FORKUOR, G. (submitted) Drying climate in Ghana over the period 1960-2005: evidence from the resampling-based Mann-Kendall test at local and regional levels. Hydrological Sciences Journal.* *LACOMBE G, SMAKHTIN V, HOANH CT. Rainfall trends in central Mekong Basin: 1953 to 2004. Submitted to Theoretical and Applied Climatology*	WRI-Ghana, NBI, WWF-India, IHE-Delft, IITM-India, PIK- Potsdam

1.1.1.7	Inventory, evaluation of previous geo-hydrological studies, socio-economic and geo-physical surveys; RS/GIS analysis, field measurements, modelling	Improved understanding of groundwater recharge and management under existing and projected climate variability and land management – with recommendation for improved groundwater management as adaptation measure to climate change	Achievements include mapping groundater potential in Volta Basin, developed principles for allocating groundwater for agriculture and other uses (generic), detailed socio-economic studies across 9 countries examining groundwater use being assembled into a Book, and locally-specific detailed hydrogeological sudies in Raya-Kobo basin Ethiopia completed. Relevant outputs: *ALTCHENKO, Y., AWULACHEW, S.B., BRIDA, A.B., DIALLO, H.A., MOGBANTE, D., PAVELIC, P., TINDIMUGAYA, C. AND VILLHOLTH, K.G. (2011) Management of groundwater in Africa including transboundary aquifers: Implications for meeting MDGs, livelihood goals and climate change adaptation. United Nations Economic Commission for Africa, African Climate Policy Centre, Working Paper 6, November 2011.* *TENALEM AYENEW, SILESHI MAMO, ELIAS ALI, ABDELA ABDU, MERHAWI GEBREEGZIABHER AND AFEWORK DESALEGN (2011) Hydrogeological and groundwater potential evaluation, water quality assessment and socio-economic surveying for small-scale irrigation development in the Raya-Kobo valleys, northern Ethiopia. Final Report to IWMI, September 2011.* *GUMMA, M. K. AND PAVELIC, P. (submitted) Identifying groundwater potential zones across Ghana using remote sensing techniques. Environmental Monitoring and Assessment J.* *FORKUOR, G., PAVELIC, P., ASARE, E. AND OBUOBIE, E. (submitted) Modelling agricultural groundwater development potential areas in Northern Ghana using GIS/RS approach. Hydrological Sciences J.* *PAVELIC, P., SMAKHTIN, V., FAVREAU, G. AND VILLHOLTH, K.G. (2011) Water balance approach for assessing potential for small-scale groundwater irrigation in sub-Saharan Africa. Proc. Intl. Conf. on "Groundwater: our source of security in an uncertain future", 19 – 21 Sept. 2011, CSIR International Convention Centre, Pretoria, South Africa*	A number of local universities and NARES in 12 countries in sub-Saharan Africa
1.2 Breeding strategies for future climatic conditions				
1.3 Species and genetic diversity for climate change				

Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.2 Managing climate risk through food delivery, trade and crisis response				
2.3 Prediction of climate impacts, and enhanced climate services				

Theme 3, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				
Theme 4, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
4.1 Linking knowledge with action				
4.2 Data and tools for analysis and planning				
4.3 Refining frameworks for policy analysis				

The WorldFish Center

Summary of activities/deliverables organized by Output level (1 page)

OUTCOMES

According to Table 1 in Annex 9 we only need to report an 'outcome' every second year .

IMPACT STUDIES

According to Table 1 in Annex 9 we only need to report in 'impact' every fourth year.

ACTIVITY SUMMARY

See Annex 1.

ACTIVITY REPORTING

In 2011 The WorldFish Center was involved in 11 bilateral projects under CCAFs and 6 activities/milestones by CCAFs Theme. There was 1 activity respectively under each of Themes 1-3 (see Table 1) and 3 under Theme 4 (Pro-Poor Climate Change Mitigation). Under Theme 1 (Adaptation to Progressive Climate Change) impacts of Climate Change impacts and their connection to AASs in Vietnam were reviewed, resulting in an adaptation tool box which led to an invited paper for the journal of Current Opinion in Environmental Sustainability (Badjeck et al. in press). Under Theme 2 (Adaptation Pathways for Current Climate Risk) Beth Timmers, in partnership with the Uganda Department of Fisheries (also NaFIRRI and KARDC), completed a study on climate change variability and fish value chains in Uganda (Timmers, 2011)

Carbon footprint analyses of rice/fish farming systems in Bangladesh were carried out under Theme 3 and Guidelines on Life Cycle Analysis (LCA) and aquaculture products were completed, together with Working Papers on Lifecycle Inventories and Lifecycle Assessment methodologies relevant to Bangladesh (Luecke, et al 2011a, 2011b). Partners in this work were VGREEN-KU, Bangladesh Agricultural University, Stockholm Resilience Center, and University of Bremen. Under Theme 4 (Integration for Decision Making) methodologies were developed to assess dynamic vulnerability in the fisheries and aquaculture sectors at scales from global to regional to national. During this Activity a workshop was held which led to a report plus methodology which was used by REPAO (Badjeck et al., 2010). A publication examining resilience in Aquatic Agricultural Systems was prepared for peer-review and submitted to Ecology and Society in December 2011 (Badjeck et al. submitted) while a further article was prepared for Nature and Faune (Badjeck and Diop, accepted). Capacity building activities via a scenario methodology training workshop were held in Ghana; and the experiences used to write a report.

As part of the Data and Tools for Analysis and Planning Section (4.2.1.1) we had hoped to be able to collect vulnerability indicators for fisheries and aquaculture based on the QUEST_fish [http://www.quest-fish.org.uk/] framework in both East and West Africa. This, however, remains incomplete and, due to prior publication claims, the data were not released until

December 2011. As a consequence analyses and publication will now have to be completed in 2012. The WorldFish Center's final obligation (Refining Frameworks for Policy Analysis) was to incorporate messages on fisheries and aquaculture in 'climate smart agriculture' and 'green economy' policy processes (side events at UNFCCC COP17) and provide reports for Rio+20. This involved the following in 2011: i) Input in the CRP7 high level report on the agricultural work program and the CSA workplan; ii) Messages for Agricultural and rural Development Day 2011 at COP17; iii) Participation in Oceans Day 2011 at COP17 when WorldFish staff collaborated with FAO to put together the NEPAD session on climate change for Ocean Day, liaising with REPAO; iv) NEPAD side event on African fisheries and climate change (with PaCFA) at COP17 where Daniel Jamu and Ndiaga Diop (also part of the scenario project), were Guest Speakers; v) Contributions to 'Green Economy in a Blue World' UN Multiagency report for Rio+20 resulted in a synthesis report 'Green Economy in a Blue World' launched in Manila, January 25th, 2012. http://www.unep.org/pdf/green_economy_blue.pdf; and vi) Contribution to Small Island Developing State (SID) green economy report which was submitted for SIDS sub-regional preparatory meetings for Rio+20, August 2011 http://www.sidsnet.org/provisional/docs/newsletter/SIDS_Unit_Newsletter-August_2011.pdf

PUBLICATIONS

Badjeck M-C et al. Fisheries management and adaptation to climate change in Peru: Scenarios as a creative solution to "wicked problems". Submitted to Ecology and Society.

Badjeck Marie-Caroline; Katikiro, Robert E.; Flitner, Michael; Diop, Ndiaga; Schwerdtner Máñez, Kathleen. 2010. Envisioning 2050: Climate Change, Aquaculture and Fisheries in West Africa. WorldFish Center Workshop Report 2125. The WorldFish Center, Penang, Malaysia. 28 pp (also available in French).

Badjeck, M-C and Diop, N. (Accepted). The Future is now: How scenarios can help Senegalese and Mauritanian fisheries adapt to climate change. Nature et Faune (FAO peer-reviewed open access bilingual journal on natural resources and food security in Africa)

Badjeck, M-C, E.H Allison, A.S Halls and N.K Dulvy. 2010. Impacts of climate variability and change on fishery-based livelihoods. Marine Policy 34 (3): 357-383.

Badjeck, Marie-Caroline; Katikiro, Robert E; Flitner, Michael; Diop, Ndiaga; Schwerdtner Máñez, Kathleen. (2010). Envisioning 2050: Climate Change, Aquaculture and Fisheries in West Africa. Dakar, Senegal 14-16th April 2010. Workshop Report N.2125. Penang/Bremen: WorldFish/ZMT

Leucke N, Phillips M, and Weirowski F. 2011a. 31 *Life Cycle Assessment on Aquaculture Products: Theory & Practice*. Penang, Malaysia: The WorldFish Center. Working Document.

Luecke N, Phillips M, and Weirowski F. 2011b. 28 *Life Cycle Assessment on Aquaculture Products: Theory & Practice. Case study: integrated farming in Bangladesh*. Khulna Bangladesh. Working Document.

Melody Braun, and Mustafa Saroar. 155 *Initial Participatory Research Assessment for Participatory Action Research on Climate Risk Management*. Climate Change, Agriculture and Food Security (CCAFS). Field Report.

Timmers B. 2011. 44 *Climate Change and Variability and Fish Value Chains in Uganda*. Penang, Malaysia: The WorldFish Center. Draft Report.

CASE STUDIES

Case study 1: Vulnerability of Fish Value Chains (Uganda)

Author: Beth Timmers

Brief description of the activity:

This study examined the vulnerability of fish production in Uganda using the concept of the value chain. Critically, such analyses can reveal context-specific response strategies. The purpose of the study was to identify current and potential impacts of climate change on fish value chains, and subsequent adaptation strategies. This study incorporates and builds upon information from earlier value chain analyses on fisheries and aquaculture production in Uganda to provide a more in depth understanding of issues facing the fish industry.

Climate change and variability will have different impacts on inland fisheries and aquaculture production. Relevant current and future global climatic changes include an increase in mean air temperature, shifting precipitation patterns, and an increase in extreme weather events. The IPCC's Fourth Assessment Report highlights the vulnerability of Africa, as a whole, to climate change and variability. Production of fish in Sub Saharan Africa is important not only for domestic food security, but also to community livelihoods and national economies. Particularly in the case of Uganda, adaptive capacity for capture fisheries and aquaculture is low. Although the exact impacts of climate change and variability are difficult to determine, this report seeks to explore the various impact pathways of the most relevant climatic issues facing *Lates niloticus* (Nile perch) and *Rastrineobola argentea* (mukene) fisheries and pond aquaculture in Uganda, including *Oreochromis niloticus* (Nile tilapia) and *Clarias gariepinus* (African catfish)

Result of activity:

Preliminary research was presented at a seminar in Kampala in order to get feedback from key stakeholders. The results of the activity will contribute to the CGIAR Research Program 3.7 *More Meat, Milk, and Fish By And For the Poor.*

Case Study 2: Investigating the vulnerability of and economics of adapting aquaculture in Vietnam to climate change.

Author: Nhuong Tran

Brief description of activity:

The Mekong River Delta of Vietnam, which supports a thriving aquaculture industry, is exposed to the impacts of climate change, and particularly sea-level rise and its attendant consequences of increased flooding (both coastal and riverine) and coastal salinity intrusion. Supported by the Economics of Adaptation of Climate Change (EACC) project implemented by the World Bank and funded by the governments of the Netherlands, Switzerland, and the United Kingdom, the CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS), the UK Natural Environment Research Council Quest thematic programme (QUEST-Fish), and the WorldFish Center conducted a study investigating the vulnerability and economics of adapting aquaculture in Vietnam to climate change. The study focused on grow-out of two export-oriented aquaculture species in the delta – the freshwater striped catfish and brackish-water tiger shrimp. The approach taken was firstly to understand the potential impacts of climate change on these systems. Then a costs and benefits analysis was conducted, at farm level, under scenarios of climate change with autonomous adaptation, and no climate change. The analysis was done for two time periods, from 2010-2020 (where projections of climate change impacts on input costs and price changes could be made with more confidence) and from 2010-2050 (where projections become more uncertain).

Result of activity:

The results suggest that shrimp farmers overall are able to bear the cost of adaptation over a longer time frame than catfish farmers. For both species, autonomous adaptation costs borne by farmers can be reduced or offset by planned adaptation measures such as construction of coastal and river dykes for controlling floods and salinity intrusion in the delta, while providing ancillary benefits to other economic sectors. The study, hitherto the first one in the region, raises a number of methodological issues that underpin more detailed economic assessments of climate change impacts and adaptation in the aquaculture industry. New primary data, thinking and approaches are needed to address the constraints of the study that relied on secondary data and limited stakeholder consultations. An interdisciplinary approach using qualitative and quantitative methods is needed to better understand farmers' preferences, willingness and ability to adapt to climate change. Further research efforts are needed to refine assessment methodology for economics of climate change impact and adaptation analysis in aquaculture sector in Vietnam to inform and support policy analysis and formulation in Vietnam as well as to replicate the assessment methodology to other countries and regions.

Case Study 3: Initial Participatory Research Assessment for Participatory Action Research on Climate Risk Management

Author: Melody Braun

Brief description of activity:

Observed and projected impacts of climate change in coastal portions of Bangladesh, one of the most vulnerable countries in the world, will have serious impacts on rural populations. Climate change will exacerbate existing natural and manmade vulnerabilities to flooding, water-logging

and salinization of land and water. The objective of this work was to analyze the vulnerability context of people in four villages in southern Bangladesh.

Result of activity:

The study evaluated the strength and weakness of people's current coping and adaptation strategies and assessed the potential of using an index-based insurance scheme, a strategy of designed diversification of income, or better information products for natural disasters to improve adaptive capacity. A participatory research appraisal was done with rural communities and other local stakeholders in four selected villages in Khulna, Jhalokhati, Bagerhat and Satkhira districts. The sites were selected along a gradient of salinity, from low to high salinity. The villages in Khulna and Satkhira are experiencing very high levels of salinity in water and soil. The village in Bagerhat is affected by salinity but at a lower level. The village in Jhalokhati is not affected yet by salinity in water or soil.
The methods used were based on agricultural calendars, risk prioritization matrices, and the researchers used semi-structured interviews and focus group discussions. The analyses were gender differentiated. The results allowed an assessment of risks, adaptive capacity and the needs of people in these communities. The study provides a baseline for future interventions and recommends activities for CCAFS for 2012+. Harikhali village in Khulna (Paikgacha upazila), and Dumuria village in Satkhira (Shyamnagar upazila) are high saline areas where shrimp farming is the main activity. Shrimp farming is a source of conflict between large shrimp farmers and small and medium land owners. Salinity is the main risk identified by people because more saline water severely affects livelihood opportunities by inducing food and water scarcity. In Dumuria, located close to the Sundarbans, people have become much more dependent on resources extracted from the forest, risking frequent attacks by tigers or pirates. Other risks reported include cyclones, heavy and irregular rain and floods. People discussed changes taking place in the last ten to twenty years, including; progressive increases in salinity, fewer freshwater fishes, less rice production, a perceived shift from six to three distinct seasons p.a., water level rises, increased temperature, and very erratic rainfall. To face this situation, they are seeking more consistent access to fresh water and more diversity in their livelihoods to improve vegetable production and varieties, as well as the possibility of reducing the level of salinity. Gabgachia village in Bagerhat, Morrelganj, is a medium saline area where people make a living from aquaculture and agriculture. Salinity has been progressively increasing, inducing a decline in tree coverage and vegetable productivity, and constitutes the main risk for people, affecting food production and health. The other expressed risks were floods and cyclones, which have become more frequent, unpredictable and severe. People identified their main needs as strategies to improve food security and access to freshwater. Jagannathpur village in Jhalokhati, Rajapur, is a non-saline area where the major production systems are rice paddies, vegetable gardens, livestock and poultry. The main risk identified by people were floods, followed by cyclones and surge, and seasonal dry spells, all of which have been increasing in the last ten to twenty years. The main need expressed by people was for better water management and the development of flood resistant and short- duration rice varieties. Some possible strategies have been developed to improve risk management in each village, based on the findings of the field visits, but more work needs to be done to explore other options.

SYNTHESIS OF THEME ACTIVITIES

2011 Activity Plan for CCAFS Centre General Funds: Activities, Deliverables & Partners

CG Centre:	WORLDFISH

Table A. Main contact persons in the Centre

Contacts	Name(s) (specify roles if more than one)	Email
Climate Change Contact Point	Dr Doug Beare	doug.beare@cgiar.org
Admin. Issues	Ms Shabeen Mohd Ikbal	s.ikbal@cgiar.org
Communications	Fiona Chandler	f.chandler@cgiar.org
Others (if needed, specify role)	Dr Neil Andrew (alternative contact point)	n.andrew@cgiar.org

Table B. Bilateral funded projects under CCAFS (2011)

ID#	Name of project	Approximate budget under CCAFS (2011) (1)	Donor	Principal investigator (also list any key contacts in EA, WA or IGP, if applicable)
1	Regional cooperation on knowledge management, policy and institutional support to the Coral Triangle Initiative	$72,000	UniQuest Pty Limited/ADB	Maripaz Perez Ma.Perez@cgiar.org

2	Climate Change Impacts, Vulnerability Assessments and Economic and Policy Analysis of Adaptation Strategies in Selected Coastal Areas in Indonesia, Philippines and Vietnam	$20,000	Economic and Environment Program for SEA	Maripaz Perez Ma.Perez@cgiar.org
3	Enhancing adaptive capacity to climate change impacts through well-managed water use for aquaculture integrated with small-scale irrigation in the Chinyanja Triangle in Africa (Malawi, Mozambique and Zambia)"	$381,629	German Federal Ministry for Economic Cooperation and Development	Suan Pheng Kam S.Kam@cgiar.org
4	Addressing Climate Change by Building Social and Ecological Resilience in the Lake Chilwa Basin	$502,761	Norwegian Ministry of Foreign Affairs	Daniel Jamu D.Jamu@cgiar.org
5	Wetlands Alliance Implementation Phase	$37,499	Swedish International Development Agency	Alan Brooks A.Brooks@cgiar.org
6	Sustaining, Ethical Aquatic Trade (Uni Of Stirling Led)[SEAT]	$16,964	European Commission	Froukje Kruijssen F.Kruijssen@cgiar.org
7	MRC- Climate Change Adaptation Initiative	$32,000	International Centre for Environmental Management	Alan Brooks A.Brooks@cgiar.org
8	V and A analysis in Solomon Islands CTI; CTSP Yr 3 activities	$91,875	World Wildlife Fund	Anna Schwarz A.Schwarz@cgiar.org

9	Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)	$200,000	Asian Development Bank	Edward Allison e.allison@cgiar.org
10	Poverty Alleviation, Mangrove Conservation and Climate Change; Carbon Offsets as Payments for Mangrove Ecosystem Services in Solomon Islands	$85,346	AusAID	Joelle Albert j.albert@cgiar.org
11	Developing Timor Leste's coastal economy: assessing potential climate-change impacts and adaptation options	$112,000	DEWHA	David Mills d.mills@cgiar.org

Notes:

(1) If a bilateral project is contributing to more than one CRP, this is only the CCAFS activities.

Table C. Activity tables by Themes/Objectives

Note:

(1) Activities should be approximately US$250.000 in value, inclusive of all costs, i.e. including personnel, overhead etc.
(2) The percentage allocation amongst regions will be used to understand where the major efforts are being directed, so that Regional Program Leaders can plan synthesis and coordination activities. They will not be used for any later reporting.
(3) Milestone numbers will be provided by Theme Leaders.

Theme 1, Adaptation to Progressive Climate Change				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
1.1 Adapted Farming systems to changing climate conditions				
1.1.3.3	Review impacts of climate change adaptation experiences and options in coastal and aquatic food production systems Identification and appraisal of adaptation options in Vietnam aquatic agricultural systems, including economic analysis and trade off analysis. The methods developed here will be used in Bangladesh and Mali in 2012 onwards.	i) Adaptation option portfolio (tool box) for AASs, options identified and disseminated in Vietnam, tool box drafted in Bangladesh. ii) Paper on vulnerability and adaptation in Aquatic Agricultural systems submitted to peer-reviewed journal	i) Completed. Adaptation option portfolio (tool box) for AASs, options identified and disseminated in Vietnam, tool box disseminated in Bangladesh. Building capacity by creating information and working in partnerships. ii) In progress. Invited paper in the special edition "marine themed' issue for summer 2012 of the journal Current Opinion in Environmental Sustainability . Proposal for the paper accepted: Adaptation Research in Fisheries: insights from case studies and the road ahead Authors: Marie-Caroline Badjeck Eddie Allison, Suan Pheng Kam, Alexandra Langner, Kirsten Abernethy. This is the outcome of the IMBER meeting in Paris in spring 2011. Paper on adaptation in Aquatic Agricultural systems – Abstract submitted to editors for approval; decision pending.	World Bank, ICEM, Mekong River Commission IMBER and GLOBEC.
1.2 Breeding strategies for future climatic conditions				

1.3 Species and genetic diversity for climate change				

Theme 2, Adaptation Pathways for Current Climate Risk				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
2.1 Managing climate risk and building resilient livelihoods				
2.2 Managing climate risk through food delivery, trade and crisis response				
2.2.2.2	Review of impacts of climate variability and change on fish value chains in Uganda, with emphasis on trade competitiveness and food security impacts. Key examples are nile perch fishery for export, tilapia fishery and aquaculture for urban markets, and dagaa and other fish for low-income consumers nationally and regionally.	Report on impacts of past climate variability and recent and anticipated climate change on supply, storage, transportation, local sale and regional /global trade in fish , ii) Briefing note identifying ways to adapt fish value chains to climate variability and change and ensure domestic supply and access is maintained	Completed. Report completed on the impacts of climate change and variability on the value chains for Nile perch and mukene (small pelagic) fisheries, and Nile tilapia and African catfish pond aquaculture. Adaptation options related to each value chain are outlined; Briefing Note not completed. WFC judgment was that the work was too preliminary to be used to influence policy.	Uganda Department of Fisheries, NaFIRRI and KARDC.
2.3 Prediction of climate impacts, and enhanced climate services				

Theme 3, Pro-Poor Climate Change Mitigation				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
3.1. Low-carbon agricultural development pathways				
3.2 Institutional arrangements and incentives for mitigation				
3.3 On-farm mitigation practices and landscape implications				
3.3.2.2	Review of existing Lifecycle Inventory and Lifecycle Impact Assessments related to selected species and aquatic production systems in Bangladesh as framework for the detailed carbon footprint analysis. Conduct LCA on rice/fish farming systems	Improve understanding and methodologies for measurement of carbon footprints from farming of fish and other aquatic products, with an emphasis on production systems from Bangladesh and integrated agriculture, forestry and aquaculture systems. Potential of key guidelines and tools developed. Results shared through websites, policy briefs and scientific article.	Guideline on Life Cycle Analysis (LCA) and aquaculture products completed (deliverable 1) and working paper on Lifecycle Inventory and Lifecycle Assessment methodology relevant to Bangladesh integrated aquatic-agricultural systems completed (deliverable 2). Two documents have been shared with WorldFish researchers in Bangladesh.	Centre of Excellence on Environmental strategy for GREEN business (VGREEN-KU) Kasetsart Thailand, Bangladesh Agricultural University, Stockholm Resilience Center, University of Bremen, GIZ

Theme 4, Integration for Decision making				
Mile-stone # (3)	**Activity in 2011**	**Deliverables in 2011**	**Status of the activity /deliverable**	**Partners**
4.1 Linking knowledge with action				
4.1.1.2	Methodologies developed to assess dynamic vulnerability in fisheries and aquaculture sector synthesized for different scales from the global, regional and national level to sectoral vulnerability. This includes foresight studies methods. Global Scenario for 2050 for fisheries and aquaculture. Finalize regional scenarios developed in Quest (West Africa) and link with CCFAS	i) Scenarios developed at the global and regional level (West Africa) and published .ii) Methodological briefs and tool kit manual (vulnerability resilience in AAS). Ii) Peer-review publication submitted iv) Scenario methods training in Ghana	i) Completed. Workshop report published in Q1 of 2011 with methodology. REPAO used our methodology at the regional, national and local level. ii) Completed. Peer-reviewed publication focuses on the Peruvian case study to be submitted in Dec 2010 (for Ecology and Society) iii) Article for Nature and Faune publication. iv) Completed. Capacity building activities in Ghana through a scenario methodology training (see Ghana report).	Network on fisheries policies in West Africa (ENDA/REPAO) CRC/The Integrated Coastal and Fisheries Governance (ICFG) Project for the Western Region of Ghana.
4.2 Data and tools for analysis and planning				

4.2.1.1	Collect vulnerability indicators fisheries and aquaculture based on QUEST_fish framework in Africa (East and West)	Draft regional characterization of vulnerability inland fisheries in Africa that can contribute to an overall vulnerability assessment of aquatic agriculture systems and CCFAS activities	i) Incomplete. Builds on a previous global project, funded by UK NERC (Quest_GIS). Due to prior publication claims, the data were not released until December 2011. Analysis and publication will now be completed in 2012.	Center for African Climate Change Research, University of Cape Town, FAO, Partnership on Climate Change, Fisheries and Aquaculture (PacFA) Quest_GIS project (GLOBEC /ESSP partners)
4.3 Refining frameworks for policy analysis				
4.3.4.4	Incorporate messages on fisheries and aquaculture in 'climate smart agriculture' and 'green economy' policy processes - side events at UNFCCC COP17 and reports for Rio+20.	i) Input in the CRP7 high level report on the agricultural work program and the CSA workplan , ii) Messages for Agricultural and rural Development Day 2011 at COP17; iii) Participation in Oceans Day 2011 at COP17 iv) NEPAD side event on African fisheries and climate change (with PaCFA) at COP17; v) Contributions to 'Green Economy in a Blue World' UN Multiagency report for Rio+20; vi) Contribution to SIDS green economy report	(i) Not done. (ii) Completed. (iii) Completed. Collaborated with FAO to put together the NEPAD session on climate change for Ocean Day liaising with REPAO and Daniel Jamu. Ndiaga Diop who was part of the scenario project was also a speaker; (iv) Completed – Daniel Jamu made a presentation at this combined workshop; (v) Completed. Synthesis report 'Green Economy in a Blue World' launched in Manila, January 25th, 2012. http://www.unep.org/pdf/green_economy_blue.pdf . Full report is in press vi) Comleted. Small Island Developing States green economy report submitted for SIDS sub-regional preparatory meetings for Rio+20, August 2011 http://www.sidsnet.org/provisional/docs/newsletter/SIDS_Unit_Newsletter-August_2011.pdf	CRP7 members, Partnership for Climate Change, Fisheries and Aquaculture (PaCFA), FAO, UNEP, UN DESA, NEPAD, Network on fisheries policies in West Africa (ENDA/REPAO), Grid Arendal, Norway