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COPENHAGEN AND BEYOND

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INTERVIEW WITH BRUCE CAMPBELL

DIRECTOR, CGIAR CHALLENGE PROGRAM
ON CLIMATE CHANGE, AGRICULTURE
AND FOOD SECURITY (CCAFS)

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NORMAN BORLAUG

HONORING THE LEGACY OF AN EXTRAORDINARY
SCIENTIST AND LEADER





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A photograph showing the silhouettes of a person and several oxen in a hazy, golden light, likely at sunrise or sunset. The person is on the right, holding a bucket, and the oxen are on the left. The background is a bright, hazy sky.

COPENHAGEN AND BEYOND

By Gerald Nelson, International Food Policy Research Institute

Once a bit player in climate change negotiations, agriculture now plays a role more in line with its significance in the run up to Copenhagen.



NO

The journey that has taken agriculture from bit player to significant presence in climate change negotiations continues apace. The Center for International Forestry Research (CIFOR) has been instrumental in bringing forestry and concerns about forest degradation to the negotiations. More recent efforts by the International Food Policy Research Institute (IFPRI), the Food and Agriculture Organization (FAO) of the United Nations, and others

have highlighted the full range of agricultural issues. Barely mentioned at the December 2008 Poznan meetings of the United Nations Framework Convention on Climate Change (UNFCCC), agriculture was explicitly recognized in the June UNFCCC negotiating text. Continued efforts to ensure that specific agricultural adaptation and mitigation measures remain on the agenda in Copenhagen in December, whether or not agreement is reached,

are critical for the future of millions of rural people in developing countries.

In early 2009, IFPRI researchers worked with an international group of experts to recommend agricultural adaptation and mitigation options and lay out the synergies between the two in a series of briefs that complement publications from CIFOR, FAO and the World Agroforestry Centre.

Conservation farming can contribute importantly to cost-effective reduction of greenhouse gas emissions.

*Credit:
Neil Palmer, CIAT*



“Reducing deforestation and forest degradation is key to slowing the concentration of greenhouse gases in the atmosphere,” stresses Markku Kanninen, principal scientist at CIFOR and organizer of Forestry Day at Copenhagen. “But cost-effective reduction of emissions can also be achieved through improved farming methods that build up carbon, better management of irrigation and livestock to cut methane emissions, and better fertilizer use to reduce nitrous oxide emissions.”

Wendy Mann, senior advisor and coordinator of FAO delegations to the climate change negotiations, adds that FAO’s February 2009 submission to the UNFCCC emphasizes (1) formulating an agricultural initiative similar to reducing emissions from deforestation and forest degradation, or REDD, to test measurable, reportable and verifiable payment schemes; (2) establishing a range of funding and delivery mechanisms to realize agricultural mitigation potential; and (3) a more comprehensive approach to integrating soil carbon sequestration into the scope of land use, land use change and forestry accounting; the Clean Development Mechanism; and other financial compensation mechanisms.

Intergovernmental Panel on Climate Change Chair Rajendra Pachauri and UNFCCC Executive Secretary Yvo de Boer are among the key players who agree that adaptation in agriculture is essential. But how can adaptation needs be met, with or without a Copenhagen agreement?

Investing in food security and adaptation

“A work plan that includes immediate and significant funding is necessary to ensure that climate change adaptation gets underway in 2010,” stresses IFPRI senior research fellow Gerald Nelson. “We will release estimates of the agricultural adaptation costs in early October, but our preliminary findings suggest that costs are substantially higher than earlier estimates. Fortunately, adaptation investments will also contribute to food security. In other words, any expenditure on food security is also an investment in climate change adaptation.”

“There are three key categories of adaptation activity that can begin immediately,” says Bruce Campbell, director of the CGIAR’s Challenge Program on Climate Change, Agriculture and Food Security. “They are improved and better-coordinated

research, systematic global information and data collection and dissemination, and strengthened knowledge of local conditions that can be shared among areas with similar environments.”

The CGIAR and others are already working on gene discovery and improving plant tolerance for heat, drought, and submergence, but much basic research and field testing remains to be done. Furthermore, research to build agricultural resilience to climate change suffers from poor coordination globally.

A set of research and test sites covering all current agroclimatic zones around the globe could be used to test crop germplasm under widely varying conditions and explore the potential for new crop varieties and management systems under future climate scenarios. Coordinating efforts with national research sites using a common set of data management protocols could lay the foundation. Existing CGIAR and national sites could form the core, with new locations added to ensure that management techniques and germplasm resources are subjected to the widest possible range of climates. In addition, regular and repeated observations of the earth’s surface are critical for clarifying important connections between agricultural productivity and forest degradation.

Some of the tools for facilitating agricultural adaptation are already in the hands of individual researchers, research institutions, data centers and genebanks around the world. Improved information sharing will allow, for instance, far-flung regions to share information on management systems that perform well in one location today and may be critical to farmers elsewhere after 20 years of

climate change. Creative collection mechanisms by which individuals contribute unique data from their global positioning system units, cell phones, and digital cameras can offer powerful, cost-effective synergies when combined with data collected using traditional methods, providing open-source information.

Thinking locally while acting globally

Agriculture is intensely local and requires in-depth knowledge of biophysical and socioeconomic conditions. “It is essential that we work with farmers in the developing world to learn from their knowledge of managing agriculture and its interactions with local climate,” says Rodney Cooke, director of the Technical Advisory Division of the International Fund for Agricultural Development. However, as Mark Holderness of the Global Forum on Agricultural Research points out, “In many parts of the world, national research and extension systems lack the human and physical resources to acquire information and translate it into locally useful products.”

Investment in laboratory scientists is badly needed, as are partnerships joining national systems and international centers. Within countries, agricultural extension services that specifically address climate change adaptation include those disseminating local cultivars of drought-tolerant crop varieties, teaching improved management systems and gathering information to facilitate national research work.

“Farmer networks can be effective information-sharing mechanisms and have the potential to provide cost-effective links between government efforts and farmer activities,” points out Nora Ourabah, senior policy officer

at the International Federation of Agricultural Producers.

As extreme weather will likely increase with climate change, countries already vulnerable to natural disasters have a wealth of knowledge on how to respond. Lessons learned in drought-prone Ethiopia and flood-prone Bangladesh could prove invaluable in other parts of the world as climate changes. Proactive information exchange and preparation will save money and lives, and organizations that are active in disaster relief will play important roles.

Information exchange should emphasize those adaptations that also mitigate greenhouse gas emissions and promote sustainable development. Conservation tillage helps soil retain water, small irrigation facilities conserve water, and agroforestry systems improve the storage of both carbon and water—and all have significant mitigation potential.

Success in building resilience among vulnerable farmers in developing countries demands long-term support from the international community, close collaboration among stakeholders working on agriculture and climate change, and committed funding. A work plan must emerge from Copenhagen that delineates specific agricultural adaptation and mitigation activities and how to acquire funding. Three events there will focus on agriculture: an FAO-sponsored event on December 10, Agriculture and Rural Development Day on December 12 (hosted by the Faculty of Life Sciences at the University of Copenhagen), and Forest Day on December 13. This combined effort promises to formulate a comprehensive program for climate change and agriculture beyond Copenhagen.



Interview with Bruce Campbell

Bruce Campbell is Director of the CGIAR Challenge Program on Climate Change, Agriculture and Food Security (CCAFS). He shares his thoughts about CCAFS and his new role as the program director.

For more information on CCAFS, please visit the website at: <http://www.ccafs.cgiar.org>

Q: What are the primary goals of the CCAFS Challenge Program?

BC: There is accumulating evidence that climate change poses a significant threat to the food security and livelihoods of hundreds of millions of people who depend on small-scale agriculture. The overall goal of CCAFS is to help overcome this threat by providing farmers, policy makers and donors with new knowledge and tools that better enable them to adjust their actions in response to observed and anticipated changes in the climate.

Q: How will the program add value to and complement the ongoing work of the CGIAR Centers on climate change?

BC: Farmers and other resource users manage their livelihoods and landscapes in an integrated way that encompasses many activities. The Centers work from the perspective of their mandates, whether livestock, forests, specific crops or what have you. Innovations resulting from that work, such as drought-tolerant crops and better management of livestock, fisheries and so forth, are necessary but not sufficient for coping with climate change. Rural communities need integrated options, based on the combined use of different crops, management practices and payments for ecosystem services at a range of spatial levels. A conducive policy context is also important.

CCAFS will foster adaptive capacity by offering a range of options to farmers, communities and policy makers. Its

work will be integrative, drawing on the strengths of the Centers, but ensuring that climate change solutions are framed in the context of household portfolios and multifunctional landscapes. We'll also complement the Centers' work by tackling cross-cutting research issues. An example is our proposed work on payment for environmental services for farmers.

Our research partnership with the Earth System Science Partnership, or ESSP, will further strengthen the complementary nature of our work with the Centers. Through this partnership, we can tap into the considerable skills of the climate change research community and link these to the applied research skills of the CGIAR. Specifically, we look to the ESSP for expertise in climate modeling, downscaling climate forecasts to specific regions in support of production decisions and risk insurance approaches and modeling to inform decisions about trade-offs between food security, livelihoods and environmental goals.

In all these ways, we hope to facilitate connections across Centres — connections that will make the whole greater than the sum of the parts.

Q: The CCAFS Challenge Program is working closely with several non-CGIAR partners. What is the CP's partnership approach?

BC: I spent some time researching and writing about partnerships with several colleagues. The result was a document called "Navigating Amidst Complexity: A Guide to Implementing

Effective Research and Development to Improve Livelihoods and the Environment.” The principles and best practices of participatory partnership are not rocket science. So, it’s amazing how often they aren’t followed, to the detriment of collaborative endeavors. In CCAFS, we’ll involve partners from the outset — in defining the work program, formulating impact strategies and so on.

Q: In your new role as director of the program, what do you see as its biggest opportunities? Its biggest challenges?

BC: CCAFS will bring together the complementary strengths of the CGIAR, the ESSP and their respective partners to address the most pressing and complex challenge to food security in the 21st century. This collaboration will unite the world’s best talent in agricultural science, development research, climate science and earth system science. I think this collaboration is the CP’s biggest opportunity. Our key challenge, perhaps, is to establish and maintain effective partnerships, while ensuring that CCAFS remains an integrated endeavor. Ensuring that the collaborating institutions work well with multiple partners will be a balancing act.

Q: What should we expect for agriculture at COP15? What are the likely outcomes?

BC: I don’t think anyone expects that a very detailed program for agriculture will emerge from COP15. But there does appear to be an opportunity

for putting agriculture firmly on the post-Copenhagen agenda. In this regard, CCAFS is working with a large consortium of players to jointly host an “Agriculture and Rural Development Day” at COP15. The purpose of this event is to establish a work plan for fully incorporating agriculture into the post-Copenhagen agenda.

Q: You come to the CCAFS Challenge Program from CIFOR with a forest background. How will you bridge the divide between forests and agriculture to address land use in the climate debate?

BC: My early work dealt with livelihoods in dryland Africa, covering everything from small-scale irrigation to harvesting of forest products. So, in coming to CCAFS, I feel I’m returning to that focus. At CIFOR, I led the forests and livelihoods program, which is all about the synergies and tradeoffs between environmental and livelihood goals. So, I don’t see a clear divide between forests and agriculture. They’re all part of the mosaic in which farmers live and work. Where I do see a pronounced divide is between global environmental and local livelihood goals. The challenge for research is to put in place incentives that advance the global environmental agenda, while at the same time reducing poverty. This challenge is part of the CCAFS agenda.

Q: Do you think recent calls for stronger support of agriculture will translate into strong support for the CCAFS Challenge Program? What are the best opportunities for making that happen?

BC: The evidence suggests that CCAFS will receive massive support for a number of reasons. Climate change is at the top of the international agenda because of the devastating impacts it is likely to have in our lifetime. Food security is back on the agenda, as evidenced by discussions in various global fora. Then, there is the desire of CGIAR stakeholders, from farmers to donors, for a more integrated CGIAR. CCAFS is at the intersection of all those forces: climate change, food security and cross-Center partnerships. To secure strong support, the program needs to achieve efficiency and low transaction costs, demonstrate an ability to act as an honest convenor of diverse partners and develop a sharply focused strategy for ensuring that research has an impact.

Q: CCAFS emphasizes the importance of communications between scientists and stakeholders in its work. How do you envision that work being carried out?

BC: We intend to build communications into all aspects of our work. But we want to go about this in a strategic way, so that our communications are constructed solidly on the basis of our goals and proposed impact pathways. For this purpose, we’ll undertake stakeholder analyses, investigate researcher-stakeholder relationships, build consensus on impact pathways, form partnerships with key players in these impact pathways and ensure that key messages get to the appropriate players at the right time.



RESEARCH



RESEARCH HIGHLIGHTS

Trees Grow into the Job

As trees in tropical forests grow bigger, they absorb more carbon than previously thought, heightening their role in mitigating climate change.

An international team of scientists including researchers from the Center for International Forestry Research (CIFOR) have discovered that rainforest trees are getting bigger, sequestering more carbon from the atmosphere and slowing climate change.

According to the findings, tropical trees in undisturbed forests around the world are absorbing nearly a fifth of the carbon dioxide (CO₂) released by fossil fuels. That is significantly more than the greenhouse gas emissions produced by the world's transport sector. The researchers estimate that remaining tropical forests remove a massive 4.8 billion tons of CO₂ from the atmosphere each year. This includes a previously unknown carbon sink in Africa that mops up 1.2 billion tons of CO₂ annually.

Published in *Nature* earlier this year, the 40-year study of African tropical forests, which account for one third of the world's tropical forest, shows that each hectare of intact African forest has for decades trapped an additional 0.6 tons of carbon per year. Combined with data from South America and, to a lesser extent, from Asia, the study's analysis of the records of 250,000 trees reveals that, on average, the remaining

“Tropical giants,” such as this Moabi tree (*Baillonella toxisperma*) in Gabon, are collectively absorbing up to a fifth of the carbon dioxide released by fossil fuels.

Credit:
Terry Sunderland,
CIFOR



undisturbed forests trap carbon and thus constitute a globally significant carbon sink.

According to the report’s lead author, Simon Lewis of the University of Leeds, “Tropical forest trees are absorbing about 18% of the CO₂ added to the atmosphere each year from burning fossil fuels, substantially buffering the rate of climate change.” The reason why the trees are getting bigger and absorbing more carbon is unclear. A leading suspect is the extra atmospheric CO₂ itself, which may act as a fertilizer. However, Lewis warns, “Whatever the cause, we cannot rely on this sink forever. Even if we preserve all remaining tropical forest, these trees will not continue getting bigger indefinitely.”

The Intergovernmental Panel on Climate Change reports that human activity emits 32 billion tons of CO₂ each year globally, but only 15 billion tons actually stays in the atmosphere and contributes to climate change. The new research

shows where some of the “missing” 17 billion tons per year has gone.

One of the report’s co-authors, Douglas Sheil of CIFOR and Uganda’s Institute of Tropical Forest Conservation, says he was previously unconvinced of the role that forests play in removing CO₂ from the atmosphere.

“Prior to working on the report, I was like many scientists who used to dismiss the campaigners’ slogan that forests are the lungs of the world,” Sheil recalls. “We believed that forests were basically in equilibrium with the atmosphere, neither adding to nor subtracting from its gaseous composition. Our findings give the lungs metaphor a basis after all.”

CIFOR colleague and fellow co-author Terry Sunderland adds that, while there is no question rainforest trees are getting bigger and storing more CO₂, it is vital that more carbon uptake studies like those in Africa and South America be carried out in Asia.

“Indonesia is deeply interested in REDD and carbon payment schemes, yet deforestation in Indonesia is contributing to the country’s status as the world’s third largest emitter of greenhouse gasses,” he reports, referring to the United Nations Framework Convention on Climate Change Program on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD). “If carbon payment schemes such as REDD are to succeed in Indonesia, they must be based on accurate assessments of the amount of carbon stored in the country’s forests. These calculations need to be based on local and realistic figures.” The reported implications for future carbon payment schemes are echoed in the comments of another of the report’s co-authors, Lee White, Gabon’s chief climate change scientist.

“The removal of nearly 5 billion tons of carbon dioxide from the atmosphere by intact tropical forests, based on realistic prices for a ton of carbon, should be valued at around US\$21 billion per year,” White asserts. “This is a compelling argument for conserving tropical forests.”

Rich polluting countries can assist with conserving forests by, Lewis says, “transferring substantial resources to countries with tropical forests to reduce deforestation rates and promote alternative development pathways.”

Sunderland cautions that any investment in REDD or similar carbon payment schemes must first formalize and enforce land rights for forest dwellers. “It’s absolutely essential that a significant proportion of any payments for environmental services, such as REDD payments, are made to those who rely on forests for their well-being,” he says. “After all, up to a billion of the world’s poorest people rely on forests in one way or another for their livelihoods.”

Credit Where it's Due

Including agriculture in the market for carbon offset credits is key to ensuring Africa a fair deal regarding incentives to mitigate climate change.

Drawing on more than 15 years of research, the World Agroforestry Centre is providing evidence that, while agriculture contributes significant amounts of greenhouse gases, it can also mitigate climate change, sequestering an estimated 5.5-6.0 gigatons of carbon dioxide (CO₂) per year by 2030. It must therefore be part of any post-Kyoto climate agreement.

Seeking to ensure that African nations are not excluded from carbon markets, the 19-member Common Market for East and Southern Africa (COMESA) and the World Agroforestry Centre are collaborating to provide the science to support the African Biocarbon Initiative.

Agriculture is a leading driver of deforestation, linked in one way or another to almost 80% of deforestation globally. Susan Chomba, consultant to the African Biocarbon Initiative with the World Agroforestry Centre, says agriculture must be viewed as part of the solution, not just part of the problem.

"In working with COMESA, we're synthesizing extensive research carried out on ecosystem services and livelihood benefits under the ASB Program at sites across the tropics and reviewing existing scientific literature," Chomba says, using the abbreviation for alternatives to slash and burn. "What is becoming clear is that agriculture can reduce its own emissions and offset significant emissions from other sectors by removing CO₂ from the atmosphere and storing it in plant biomass and soils. Agriculture can also reduce emissions from other sectors by replacing fossil fuels with biofuels."

Agroforestry and conservation agriculture practices such as minimum tillage increase carbon stocks both above and below ground. Traditional parkland systems in the West African Sahel can store up to 87.3 tons of carbon per hectare in their biomass and soil, 10 times the 9 tons stored in degraded lands. Improving soil carbon increases productivity and improves livelihoods and local food security, helping to alleviate poverty and making African smallholder farmers more resilient to climate change.

While evidence continues to mount that agriculture can mitigate climate change, current mechanisms of the United Nations Framework Convention on Climate Change deal only with afforestation and reforestation. A significant step forward would be for nations to agree to the Reducing Emissions from Deforestation and Forest Degradation (REDD) scheme during the UN Climate Change Conference in Copenhagen in December. However, World Agroforestry Centre scientists believe REDD alone will not be enough.

"The current version of REDD fails to deal with agriculture and other drivers of deforestation," says Peter Minang, global coordinator for the ASB Partnership at the World Agroforestry Centre. "Payments alone won't address those causes, because most of the people who depend on agriculture for food and a livelihood won't receive the REDD payments."

George Wamukoya of COMESA adds that 70-80% of rural Africans depend on agriculture, livestock and forests for their livelihoods. If climate change

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Agroforestry systems, such as these fodder trees on a farm near Mount Kenya, increase carbon stocks both above and below ground.

Credit: Vanessa Meadu, World Agroforestry Centre



A black and white photograph of Norman Borlaug, an elderly man with a weathered face, wearing a light-colored short-sleeved button-down shirt, a straw hat, and light-colored trousers. He is standing in a field of tall grain, possibly wheat, and is focused on writing in a notebook held in his hands. The background is a vast, slightly blurred field under a bright sky.

HONORING THE LEGACY OF AN EXTRAORDINARY SCIENTIST & LEADER

NORMAN BORLAUG

The CGIAR joins the many friends, colleagues and admirers of Dr. Norman Borlaug, who passed away on September 12 at the age of 95, in mourning the loss of this truly extraordinary agricultural scientist and leader and in paying tribute to him for a lifetime of indefatigable effort to alleviate the suffering of the poor and hungry.

A tribute appearing on the website of the International Maize and Wheat Improvement Center (CIMMYT) recounts many highlights of Borlaug's work, particularly his innovative approach to the development and promotion of high-yielding, disease-resistant wheats. First developed by Borlaug and his team in Mexico during the 1950s, the new varieties, along with improved farming practices, were introduced and widely adopted in South Asia during the 1960s. Varieties based on Borlaug's pioneering work are now grown on 80 million hectares around the world.

Borlaug complemented his scientific work with bold advocacy for the policy and institutional changes needed to bring improved wheats and other agricultural technologies within the reach of small farmers in developing countries. His tireless efforts on both the scientific and policy fronts made possible a revolutionary transformation of agriculture in Asia and elsewhere, which rescued millions from hunger and earned him the 1970 Nobel Peace Prize.

Well aware of the need for further recognition of excellence in agricultural

research, Borlaug played a key role in establishing the World Food Prize in 1986, which is now considered the "Nobel Prize" for food and agriculture. About 25 men and women have been awarded the prize for outstanding contributions to boosting the quantity, quality and availability of global food supplies.

Though Borlaug is no longer with us, his achievements continue to inspire redoubled commitment to research for the ongoing fight against hunger.

Borlaug's own achievements conveyed an unmistakable message to the world about the power of agricultural research as an indispensable tool for achieving global food security and defeating rural poverty. That idea proved so compelling as to give rise to the CGIAR and to the comprehensive program of research in which it is engaged across the globe with many valued partners.

Though Borlaug was associated most closely with CIMMYT, as a plant breeder and leader of the Center's wheat research, he offered critical guidance over the years to the

CGIAR as a whole. He also inspired and supported younger scientists in all of the CGIAR-supported Centers and in many partner institutions as well, nurturing scientific excellence as well as a genuine passion for improving smallholder agriculture through problem-solving research.

One of the hallmarks of Borlaug's approach was his unwavering, lifelong commitment to bringing up new generations of scientists for the fight against hunger. Over six decades, he traveled to more than 100 countries, visiting thousands of farmers and agricultural scientists in their fields. The task of strengthening national research capacity is today more necessary than ever, as agriculture confronts many daunting challenges, including the reemergence of food price inflation and the unprecedented threat to agriculture posed by global climate change.

Coping effectively with those challenges, as Borlaug did in the face of last century's pressing demands on agriculture, will require that the CGIAR complete the reform process now under way and go on to achieve new rounds of impact.

The success of that effort will take all of us, doing the best work of our lives, inspired by the enduring spirit and ideals of our irreplaceable friend and colleague. We can best honor Borlaug's memory by redoubling our own efforts to advance the tasks that fully absorbed his attention and energy and that now command our full commitment as well.

Continued from page 13

mechanisms deal only with forest emissions, he says, many African nations will be effectively locked out of carbon markets.

“African countries without tropical forests would have little to gain from REDD,” he observes. “There will be no incentives for them to adopt sustainable agricultural systems that store carbon.”

The data studied by World Agroforestry Centre scientists support an approach that considers greenhouse gas emissions from agriculture, forestry and other land uses (AFOLU).

Minang says agriculture in developing countries is one of the world’s largest, most efficient storers of carbon, but until now there has been no reliable method to verifiably determine how much carbon they remove from the atmosphere or calculate incentive payments.

The recently launched Carbon Benefits Project — involving the World Agroforestry Centre, United Nations Environment Programme, Colorado State University, World Wildlife Fund and others — combines the latest remote sensing technology and analysis with infrared soil carbon spectroscopy, ground-based measurement and statistical analysis to measure and predict more accurately carbon storage in all land uses.

“We now know enough not to use uncertainty as an excuse for not including all types of land use in a climate change strategy,” Minang asserts.

Current research is investigating the biocarbon potential of different African countries and landscapes. In the humid tropics of Africa, well-managed systems combining trees and crops can store 29-53 tons of carbon per hectare, and agro-ecosystems that mimic natural

forests, such as cocoa agroforests in Cameroon, can store up to 180 tons.

Results such as these support the development of an AFOLU mechanism (REDD phase two or REDD plus) that would offer Africa incentives to mitigate climate change. The World Agroforestry Centre has released, in cooperation with COMESA, two policy briefs on this issue: Policy Brief 4 — The case for investing in Africa’s biocarbon potential and Policy Brief 5 — Africa’s biocarbon interests — Perspectives for a new climate change deal.

Coastal Resilience

By conserving and restoring mangrove forests, Solomon Islanders diversify their livelihoods while addressing climate change.

Mangrove forests furnish ecosystem services made all the more valuable by climate change. They protect coastal communities from storm damage, which may become even more important as the effects of climate change become increasingly evident. Like all plants,

mangroves take up carbon dioxide, making the mangrove forest ecosystem a net store for carbon. Conserving and restoring mangrove forests may therefore play an important role in mitigating climate change. Mangroves further provide firewood, building materials and food for humans, as well as habitat and spawning grounds for fish.

Yet mangroves are being cleared or degraded at the alarming annual rate of 1-2% annually, their area declining by a third since the 1980s. Multiple pressures threaten the world’s remaining 15-18 million hectares, including pollution, fuel wood collection, land clearance for aquaculture and coastal development, and natural disasters.

The ability of terrestrial forests in the tropics to sequester carbon has spurred the quantification of this ecosystem service and the trading of carbon offset credits, through which buyers offset their own carbon emissions and owners of forested land are rewarded for the carbon their trees sequester. Offset projects either protect existing forests, regenerate lost or degraded forests by planting trees, or both.

Mangrove restoration at the community level in the Western Province of Solomon Islands.

Credit: Anne-Maree Schwarz, WorldFish



The project “Poverty alleviation, mangrove conservation and climate change: Carbon offsets as payments for mangrove ecosystem services in Solomon Islands” explores whether mangroves can be included in such carbon offset projects. If replanting mangroves and using them sustainably can qualify poor rural communities along tropical coasts to link into the global carbon market, the income they earn may be invested for educational, health and conservation uses.

As trading and registry procedures are not yet well established for the nascent voluntary carbon offset market — especially for mangroves — local communities, nongovernmental organizations and governments need a roadmap to show the way from identifying the ecosystem services that their mangroves provide to quantifying carbon sequestration, registering for credits and managing trust funds. The goal of the project is to provide that roadmap.

Funded by the Australian government through AusAID and led by the WorldFish Center, the project is the first of its kind in the Indo-Pacific. The clear title that Solomon Islanders often have to mangroves through customary marine tenure and long-standing chiefly systems potentially ensures strong local mechanisms and procedures to support this pioneering approach to establishing a system of payment for coastal environmental services.

The project studies contrasting sites in three of the nine provinces of Solomon Islands. A site on the island of Ranonga in Western Province suffered a major earthquake and tsunami in 2007 that severely damaged previously intact mangroves. The project reinforces community mangrove restoration already begun. A second site in Choiseul Province possesses one of Solomon Islands’ larger intact tracts of mangroves, which

is adjacent to a community-run conservation area that encompasses a terrestrial forest. A third site in Malaita Province is heavily utilized by the residents of the country’s most populous island. The contrast among the study sites will maximize the applicability of project findings to other threatened mangrove ecosystems in the Indo-Pacific.

WorldFish’s key partner in the project is the Ministry of Environment, Conservation and Meteorology, which is supported by nongovernmental organizations working on complementary projects.

The partners specifically work to

- determine the ecosystem services that mangrove forests provide to rural Solomon Islanders,
- build stakeholder and community awareness and capacity through workshops and the preparation of educational materials,
- estimate the carbon storage potential of the sites using remote sensing data and ground truthing,
- review offset market case studies and assess the potential for mangrove forests’ inclusion in trading schemes, and
- work with the Solomon Islands government to determine policy about engaging communities with the international carbon offset market.

Tropical mangrove forests connect sea and land and play a critical role in the health and productivity of coral reefs and inland forests. As such, their conservation and restoration extends environmental benefits to these neighboring ecosystems.

By offering a hand up instead of a handout, the project aims to empower Solomon Islanders to climb out of poverty even as they adapt to climate change and contribute to mitigating this global challenge.

Whither Wheat

As climate change makes tropical wheat environments less favorable, new varieties and conservation agriculture will help wheat beat the heat.

Excess heat hurts wheat yields on more than 9 million hectares globally. This number will increase, as the Intergovernmental Panel on Climate Change predicts that global temperatures will rise by 1.8°C to 4.0°C by the end of the century. Current heat-stressed areas, which include some of the world’s poorest regions, will likely suffer yield losses.

“To maintain food security, we have to increase the yield potential of staple crops by 1.5% to 2% a year,” says Matthew Reynolds, a wheat physiologist at the International Maize and Wheat Improvement Center (CIMMYT), adding that crop productivity is currently increasing annually by around 1%. “Climate change reduces yield potential, so not only do we have to go from less than 1% to at least 1.5%, but climate change is making that much more difficult to achieve.”

South Asia’s Indo-Gangetic Plains will be among the areas hardest hit by warmer temperatures, water scarcity and heightened soil salinization. A productive wheat-growing area that includes India, Pakistan, Nepal and Bangladesh, this region is home to more than 1.2 billion people, many of whom are farmers growing annual rotations of rice and wheat. By 2050, over half the region is expected to suffer heat stress and possible desertification. If wheat yields fall as a result, the situation for the region’s 480 million poverty-stricken people will become even worse.



Mathew Reynolds, wheat physiologist at CIMMYT, explains that the yield potential of staple crops needs to increase by up to 2% a year to maintain global food security. Climate change is making this harder to achieve.

Credit: CIMMYT

Climate change brings more than heat and drought. Variation in precipitation patterns will likely dry out some places while flooding others. Hotter and more humid conditions will encourage pests, diseases and weeds. In the tropics, heat is expected to shorten the grain-filling period for wheat, damaging product quality, according to the recent CIMMYT publication *Wheat Facts and Futures*.

But there is some good news. Wheat is planted on 240 million hectares worldwide. As some areas become hostile to wheat, others will become more receptive, such as the high latitudes, where a temperature increase of a few degrees is expected to boost wheat yields. Cool, high-latitude spring wheat environments, as in Canada and Siberia, will benefit most, as farmers will be able to plant earlier and replace current cultivars with high-yielding winter wheats, according to the report. And higher atmospheric carbon dioxide can enhance photosynthesis, which will likely boost plant growth and yields.

However, areas with shaky food security are unlikely to benefit. To help farmers in

developing countries deal with climate change, researchers in an international network that includes CIMMYT and the International Center for Agricultural Research in the Dry Areas are developing new varieties suited to warmer, drier environments and promoting resource-conserving farming practices. At CIMMYT, scientists have been breeding for heat-stressed areas for several years, and these resources can be deployed to newly heat-stressed regions. However, regions that are already hot and dry will require tougher varieties. Targeted breeding and strategic physiological characterization used to select varieties that display traits associated with heat and drought tolerance (such as cooler canopies and the ability to store starch in the stem) will help these areas. The varieties can be crossed with landraces that are particularly heat tolerant to increase wheat's genetic diversity. Wild relatives are also used in wide crossing to introduce exotic traits not found in wheat. The resulting synthetic wheats have been bred for disease resistance and more stress-adaptive root systems.

Breeding and crop management research under the Cereal System Initiative in South Asia (CSISA), a large collaborative project led by the International Rice Research Institute and funded by the United States Agency for International Development and the Bill & Melinda Gates Foundation, should also help farmers cope with climate change. The goal of CSISA is to use new science and technologies to boost cereal production and productivity, particularly for rice and wheat, in South Asia's most important grain baskets. Physiological approaches are incorporated with conventional breeding to increase genetic diversity, even as the CSISA target area suffers dramatic temperature increases and constricted water resources.

Agronomic practices play an important role in the ability of wheat to withstand climate change. Conservation agriculture encompasses a set of cropping practices that includes reduced soil tillage, the retention of crop residues and crop rotation. This optimizes the root environment and the availability of essential nutrients and water, permitting cultivars to achieve their genetic potential. The adoption of conservation agriculture has been slow in developing countries, but it is key to solving the climate change puzzle.

"You need different strategies to improve agriculture productivity, especially in terms of climate change," said Reynolds. "You need to think about other species, about the soil, about genetics, about economic imperatives — everything. In the end, we must look beyond our own expertise and focus on how different technologies can be complementary to avert a major catastrophe."

Shadow of a Drought

A drought-screening facility for transgenic plants promises further gains as drought-tolerant rice varieties begin to emerge.

Since the dawn of agriculture, drought has been the bane of farmers, especially those who grow rice, a crop with special water requirements. Most rainfed areas receive a reasonable amount of rain during the growing season, but its erratic distribution and deficits at such critical stages as flowering and grain-filling can seriously curtail productivity. In Asia alone, 23 million hectares, or 20% of the continent's rice land total, are prone to drought under

current climatic conditions. Climate change is likely to worsen water scarcity in many rice-growing areas.

Most farmers in drought-prone rainfed areas grow varieties bred for irrigated conditions. As irrigated varieties are highly susceptible to drought, farmers are lucky to harvest even half a ton per hectare when droughts occur.

To help farmers cope with water scarcity, the International Rice Research Institute (IRRI) has developed several new breeding lines that yield as well as other varieties under normal conditions and have a yield advantage of up to 1 ton per hectare under drought. Two of these drought-tolerant lines have been recommended for official release, one in India and the other in the Philippines.

"IRRI has intensified efforts to develop drought-tolerant and aerobic cultivars to cope with the looming water shortage," says David Mackill, leader of IRRI's rainfed program. (Aerobic rice is cultivated intensely in the lowlands for high yield but in dry paddies, not flooded ones, to save water.) "Drought-tolerance has been a complex trait to improve,



and I'm very happy to see recent progress in developing drought-tolerant lines at IRRI."

To support and expand scientists' development of drought-tolerant rice varieties using genetic modification, IRRI established a drought-screening facility and a protocol that mimics drought conditions in lowland rice fields. In the past, genetically modified drought-tolerant breeding lines were tested mostly under artificial conditions using pots, as field trials would violate biosafety requirements. The drought-screening facility allows scientists to better predict the yield these lines would have in the field.

The facility has a flooded control plot of genetically modified rice to allow scientists to compare the performance of the tested varieties under different conditions and ensure that any selected material would perform well under a variety of conditions.

During the dry season of 2007, the first drought-screening experiment using the facility was carried out to test the effects of a gene for drought tolerance provided by the Japan International Research Center for Agricultural Sciences. Scientists were pleased to observe that the data on yield under irrigated and drought conditions inside the drought-screening facility were similar to those obtained from non-transgenic field experiments at IRRI. The drought-screening facility was thus found to succeed in creating realistic drought conditions.

"The facility allows us to assess a large population of plants to take into account possible variation in the effects of a

With advances in technology, both farmers and scientists can look forward to more climate-resilient varieties of rice. *Credit: IRRI*

transgene on plant growth and yield performance," explains crop physiologist Rachid Serraj. "IRRI is able to generate large numbers of transgenic lines, so it is more efficient to select and discard plants early on, keeping only those that show promise.

"We assess the impact of water deficit on plant growth and use non-destructive measurements to analyze crop performance," Serraj continues, adding that plants' flowering, tillering, grain formation, transpiration, canopy temperature, photosynthesis, leaf rolling, tillering ability, root biomass, and spikelet fertility are other parameters that are measured.

Sometimes a transgenic plant performs better than others under drought but yields less under normal conditions. IRRI looks for candidate genes that are activated by drought to avoid any yield penalty under normal conditions.

"The drought-screening facility has greatly helped in our transgenic research, so we plan to establish a similar and bigger facility in the future," states Serraj. "This will allow us to test more candidate genes."

Capitalizing on Cassava

As the global climate changes and the going gets tough for other staple crops, tough but neglected cassava may finally get going.

Cassava may be about to experience something of a heyday. With climate change expected to take its toll on staples like rice, wheat and maize, the



Improving cassava varieties to make more resilient to climate change could result in an additional 60 million hectares of land becoming suitable for production of this crop.

Credit: Neil Palmer, CIAT

potential of cassava — famously hardy when the going gets tough — is growing by the day.

Climate change models run by the International Center for Tropical Agriculture (CIAT by its Spanish acronym) show that by 2050 almost one fifth of cassava-growing land is expected to benefit from rising temperatures and changes in rainfall. This is good news for one of the world’s most important sources of carbohydrates, and improving cassava varieties to make them even more resilient could result in an additional 60 million hectares of land becoming suitable for cassava production.

Grown across the tropics for its energy-packed tuberous roots, cassava is of particular value to smallholders because of its remarkable ability to tolerate drought and poor soils. Cassava is predominantly grown as a food crop in Africa and Latin America, while Asia leads in the industrial production of the crop. Processing cassava starch is a major employer.

Improved cassava varieties that capitalize on the crop’s inherent resilience could

become the cornerstone of climate change adaptation to protect food supplies and livelihoods. This is particularly true in Latin America — cassava’s center of diversity — which has much to gain from improved varieties. While some parts of the region are likely to see increases in cassava suitability, models show large areas where suitability is expected to fall. It is at these frontiers that improved cassava could have the greatest impact.

According to Andy Jarvis, a climate change expert and the leader of CIAT’s Decision and Policy Analysis Program, it is essential to develop cassava lines with improved tolerance to heat, cold, drought and flooding.

“The message coming out of the modeling is that there is no single trait that provides global gains for cassava,” says Jarvis. “Instead, breeding must tackle multiple constraints.”

If this happens, new technologies could benefit one third of current cassava fields in Latin America by 2050 and nearly triple the area suitable for cassava production. But, Jarvis adds, there is no time to lose.

“The scientific community must make these decisions now,” he says. “It takes a minimum of a decade from beginning work on crop improvement to getting the new variety into farmers’ fields. So we need to look closely at what the models tell us about the future challenges and tailor our research to match. With the right science and the right priorities, cassava could become a super crop, but we have to move now.”

Jarvis stressed the importance of research-and-development networks, such as the Latin American and Caribbean Consortium to Support

Cassava Research and Development (CLAYUCA by its Spanish acronym), for ensuring that new technologies reach farmers quickly. The CIAT-coordinated network, which celebrated its 10th anniversary in July, has members from the public and private sectors in 16 countries, all working to improve the generation and exchange of new cassava-related technologies. The initiative has been responsible for the development, adaptation and transfer of several technological platforms for cassava production, processing and utilization that are helping farmers increase yields and incomes and improve livelihoods.

“Collaboration and dissemination are essential for climate change adaptation,” says Jarvis. “Networks like CLAYUCA are vastly improving the impact of cassava research. They enable high-speed links between laboratories and farmers’ fields.”

Uncertainties remain about the impact of climate change on cassava’s susceptibility to pests and diseases and, therefore, the extent to which increases in area planted to the crop will mean higher production. Tropical whitefly — infestations of which have wiped out entire plantations in Asia and Africa — have been reported in southern Brazil, where cassava starch processing is about to boom.

Jarvis recognizes the limitations of climate models but stresses the need for action.

“There’s simply no time to wait and see,” he says. “With the right research combined now with the right partnerships and the right methods for dissemination, cassava can fulfill its potential as a crop capable of thriving in the face of climate change.”

Animal Attraction

A report predicts that many African farmers will shift from crops to hardier livestock as temperatures rise and rainfall patterns shift under climate change.

A new study has found that, by 2050, hotter conditions and shifting rainfall patterns could render 500,000 to 1 million square kilometers of marginal African farmland that is home to 20-35 million people unable to support even subsistence agriculture. This may make livestock production an attractive alternative for millions of poor farmers across Africa, according to the study published in a special edition of the journal *Environmental Science and Policy*.

"Livestock, particularly animals that are known to be tolerant of heat and drought, can survive in conditions that are far more severe than what crops can tolerate," explains Philip Thornton, an International Livestock Research Institute (ILRI) scientist and one of the paper's co-authors. "Livestock can provide poor households with a buffer against the risk of climate change and allow them to take advantage of increasing demand for animal products in Africa."

"Any increase in livestock must be managed sustainably," adds Carlos Seré, director general of ILRI. "But our research shows there are many areas in Africa where farming communities will add more livestock to their agriculture systems. We should prepare now for this inevitability."

The analysis, *Croppers to livestock keepers: Livelihood transitions to 2050 in Africa due to climate change*, is one of several studies published in the journal that emerged from an April 2008

conference at Oxford University on food security and environmental change.

Thornton and colleague Peter Jones of Waen Associates in the United Kingdom sought to identify farm-dependent areas of Africa that might be most vulnerable to climate change. They focused on the arid and semi-arid regions where scant precipitation routinely causes crops to fail in at least 1 out of every 6 growing seasons.

The researchers then considered the impact of climate change in these regions and found that, even if climate change is moderated by global reductions in carbon emissions, many farmers will likely face considerably worse growing conditions. The key measure was whether climate change would cause the number of reliable crop-growing days to drop below 90 between 2000 and 2050.

They concluded that, under scenarios in which carbon emissions remain high, the number of reliable growing days would drop below 90 for almost 1 million square kilometers of marginal farmland in Africa. Assuming a lower emissions scenario, they project that 500,000 square kilometers would fail to maintain the 90-day standard.

The researchers warn that, if reliable growing periods drop below 90 days, "maize cultivation, already marginal, will basically no longer be possible as a normal agricultural activity." They add that in some places rain could become so scarce that even drought-tolerant crops such as millet would be difficult to grow. Under these conditions, they say, livestock could be the key to keeping food on the table and earning income.

The study notes that livestock can provide a significant income boost to

farmers on marginal lands within a day's travel of urban areas, where growing demand for meat and dairy products fuels lucrative markets. Thornton and Jones point out that looking to livestock as a bulwark against challenging climates is not novel, as across Africa livestock is a crucial coping mechanism for poor people trying to survive in difficult environments.

Thornton says the research goal is to use climate change projections to pinpoint areas in Africa where it is appropriate to promote livestock ownership on smallholder farms and to help farmers deal with the inherent risks. He added that policy decisions would benefit greatly from better local data, including projections of temperatures and rainfall patterns.

He and Jones acknowledge a mismatch between the kind of localized climate change information that is needed and what is available. Even at regional scales, different climate models sometimes disagree on how rising temperatures may affect rainfall. The researchers say that investments in generating detailed data are warranted by their potential to bring new precision and efficiency to aid programs for alleviating poverty in rural Africa.

They caution that better data will inevitably show that, in parts of Africa where growing conditions are already difficult, only so much can be done to help farmers adapt to climate change. It is important for development agencies and governments to understand that, as climates become more inhospitable to agriculture in some places, there may be "a point at which households and farming systems become so stressed that there are few alternatives to an exit from farming."

Irrigation Revisited

Asia urgently needs to learn how to use water more wisely to feed the additional 1.5 billion people who will live there by 2050, warns a new report

A comprehensive new study of irrigation in Asia warns that, without major reform and innovation in the way water is used for agriculture, many developing nations will face the politically risky prospect of having to import more than a quarter of the rice, wheat and maize they need to feed their growing populations. The International Water Management Institute (IWMI) and the Food and Agriculture Organization of the United Nations (FAO) recently released the report during 2009 World Water Week in Stockholm, attracting widespread media attention.

Irrigation will play a key role in producing food to feed the 1.5 billion additional people who will live in Asia by 2050. This is the main finding of the report, titled *Revitalizing Asia's Irrigation: To Sustainably Meet Tomorrow's Food Needs*. The authors use numerical modeling to assess the options Asian states can use to meet future food requirements. The report outlines three such options: 1) import large quantities of cereals from other regions, 2) improve and expand rainfed agriculture, and 3) focus on improving yields from irrigated farmlands.

IWMI director general Colin Chartres says, "Of the three options, the best bet for Asia is to revitalize its vast irrigation systems, which account for 70% of all irrigated land in the world. Relying on trade to meet much of the future food demand would only impose a huge and politically untenable burden on the economies of many developing

countries, and rainfed farming is far too uncertain, given climate change predictions."

Compiled by lead authors Aditi Mukherji of IWMI and Thierry Facon of FAO and funded by the Asian Development Bank, the report draws on the work of over 700 leading experts, in-depth research and computer-based forecasting models. Asian agriculture registered dramatic advances during the 1960s and 1970s through a combination of irrigation, improved crop varieties and fertilizers. The resulting Green Revolution made it possible to avert widespread hunger and raise living standards. From 1970 to 1995, the area under irrigation in Asia more than doubled, making it the world's most irrigated continent.

However, this extensive irrigation infrastructure is not currently used to its full potential, because the conditions that prevailed when it was built no longer exist. In the 1960s and 1970s, farmers mostly grew cereals such as rice and wheat. They relied on large, centrally managed, supply-driven

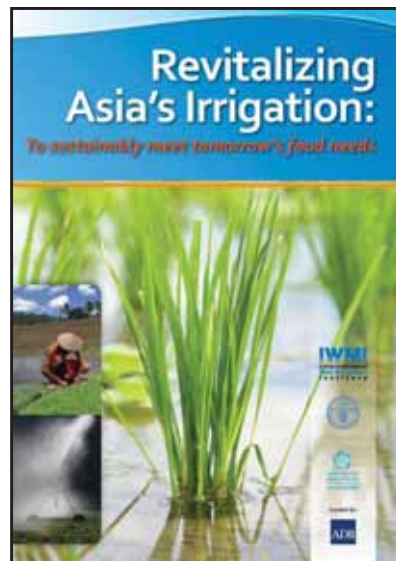
irrigation schemes to provide water and secure their livelihoods. Today, however, many have diversified to grow more fruit and vegetables in response to changing markets. Such farming methods need more flexible and responsive management that delivers water on demand.

In large parts of Asia, cereal crops will remain dominant. The current state of surface irrigation infrastructure provides suboptimal service, even in large cereal-based systems; hence the need for drastic reforms.

With yesteryear's large, outdated irrigation schemes unable to meet needs, farmers have installed millions of groundwater pumps across Asia to secure their own supplies. Since there is little regulation of groundwater extraction, water tables have dropped dramatically enough in some places to disrupt surface water flows and the habitats they support. Meanwhile, the old combination of large irrigation developments, mono-cropping and heavy fertilizer use continues to take a toll on the environment. The uncertainties of climate change and its effect on rainfall and runoff complicate the question of how best to ensure food security in Asia while conserving natural resources.

The authors suggest that Asia needs to employ not one but several strategies for improving irrigation to achieve food goals under the varying economic, political and geographic conditions across the continent. They put forward five strategies for helping irrigation perform to its full potential and satisfy future food needs while safeguarding the environment:

1. reengineer large irrigation schemes to meet modern farming needs,
2. emulate farmers' initiatives where they have successfully employed their own irrigation methods,



The report shows that there is scope for doubling the agricultural productivity of Asia's irrigated lands, through sustained effort. Credit: IWMI

3. improve on existing reforms by engaging the private sector in irrigation,
4. boost knowledge through training, and
5. invest in other sectors that indirectly influence irrigation.

Investments in irrigation are closely linked to food and energy prices. The authors note that, with food and energy costs forecast to rise in future, there is renewed interest in investing in irrigated agriculture. However, they warn that reversing the degradation that has resulted from years of neglect calls for innovative methods. The report shows that there is scope to double the productivity of irrigated lands in Asia. To achieve this, farmers need more reliable irrigation systems that provide good service, help in improving soil health and improved crop varieties that resist pests. Only then can they ensure that Asia's future population does not go hungry.

Revitalizing Asia's Irrigation: To sustainably meet tomorrow's food needs is available at www.iwmi.org/SWW2009/ and www.waterknowledgehub.iwmi.org.

Water Works

A project in Africa and South Asia identifies promising agricultural water management solutions to unlock the potential of smallholder farming.

Most of the world's poor — some 1.7 billion people according to the World Bank — live in South Asia and sub-Saharan Africa (SSA). Of this number, some 510 million are still considered food insecure. In both South Asia and SSA, millions of poor farmers face water scarcity, in part because they lack adequate water storage, management facilities and know-how. The anticipated effects of global climate change are likely to further increase the number of food insecure on both continents, unless appropriate interventions are undertaken.

To address this challenge, the Agricultural Water Management (AWM) Solutions Project aims to unlock the potential of smallholder agriculture by focusing on investments in agricultural water management. The project is funded by a grant

from the Bill & Melinda Gates Foundation. Collaborators include two CGIAR Centers — the International Water Management Institute and the International Food Policy Research Institute — as well as International Development Enterprises (IDE), Food and Agricultural Organization of the United Nations, Stockholm Environment Institute, and CH2M HILL, Inc.

AWM is a promising investment option to improve the livelihoods and food security of the rural poor. Water management interventions can help smallholders avoid yield losses during dry spells, enjoy enough water security to invest in other agricultural inputs, diversify and grow higher-value crops, and improve access to water for other productive uses. However, water management often receives less attention than efforts to improve farmers' access to seed, fertilizer and credit.

This project aims to identify technological, institutional and policy interventions that can significantly improve the livelihoods of poor women and men farmers through enhanced agricultural production, on-farm income and food security. It will consider a wide range of options, from rope pumps used by farmers in Ethiopia to treadle pumps in India, community-managed small reservoirs in Ghana, and multiple-use systems across Africa and Asia that provide for both domestic and productive water needs.

Opportunities to enhance productivity of both irrigated and rainfed lands will be examined as part of the project. Research suggests that, in many parts of South Asia and SSA, doubling or even quadrupling rainfed crop yields is



This farmer Ziway, Ethiopia, uses a rope pump to access water to irrigate her small plot.
Credit: Nadia Manning-Thomas, IWMI, 2009, AWM Solutions Project.

possible with existing technologies for water and nutrient management. But these technologies have been slow to spread, and it remains a challenge to reach the poorest people, including women who in many countries make up the majority of farmers.

Understanding what makes AWM successful for smallholders requires looking at the factors that influence the adoption and successful out-scaling of water management interventions, from the natural resource base to credit and land-tenure systems, markets, communication networks, stakeholder interaction, and the broader policy environment. The project will generate knowledge about AWM interventions and how they operate in particular socioeconomic and physical environments, together with successful business models for effective implementation.

The project recognizes that too many farming systems, particularly in SSA, target AWM technologies and allocate irrigated land to male “heads of households,” ignoring the critical role of women in food production and their AWM preferences. Moreover, little information is available concerning gender for evaluating the feasibility and impacts of water management interventions. The project will ensure that the needs and conditions of poor farmers, especially women, are appropriately addressed in selecting AWM solutions.

Partnerships and outreach are key components of the project. The project team will work with local, national and regional partners in project planning and implementation and jointly ensure that project knowledge and outputs get into the right hands for optimal impact.

To provide a menu of promising AWM solutions and supporting dissemination

strategies, the project will develop three main outputs for use by policymakers, investors, nongovernmental organizations and smallholder farmers:

- platforms for policy dialogue and expressing investment briefs to inform AWM decision-making;
- tools and business models to evaluate the economic, social and environmental impacts of AWM interventions and support effective AWM implementation; and
- methods for selecting and applying appropriate AWM solutions.

The project started in February 2009 and will continue through December 2011 in Burkina Faso, Ethiopia, Ghana, Tanzania, Zambia, and the two Indian states of Madhya Pradesh and West Bengal. Activities are well under way and can be tracked on the project website at <http://awm-solutions.iwmi.org/> or by joining the mailing list by writing to AWMSolutionsProject@cgiar.org.

Off the Margin

Women recruited to bioreclaim degraded lands restore farmland previously considered useless and assert their right to own and cultivate it.

As climate change threatens to worsen desertification across the Sudano-Saharan region of West and Central Africa, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has developed an innovative technique for reclaiming severely degraded, abandoned farmlands and bringing them back into production.

This innovation is highly significant in a region where scarce and fragile arable

lands are under extreme pressure to produce more food for a burgeoning population amid climatic variation. At the same time, the recovered lands are restoring to Niger’s largely marginalized women their right to make a livelihood through agriculture. According to a study undertaken by the International Institute for Environment and Development, some areas of Niger “are witnessing the emergence of a first generation of women who do not work.”

The report adds: “In Jirtawa, we found a second generation of landless women who have never farmed because they never had the opportunity to help their mothers in her *gamana* (portion of land allocated to family members), as she was landless too.”

Extremely adverse weather and intensifying population pressure seriously affect agricultural productivity in the Sahel. In Niger, population growth has brought progressive fragmentation of farm holdings, whose ownership and farming rights are generally vested in men. This has systematically edged women out of farming, leaving them without the means to adequately care for their families or earn an income. Likewise, soils in Niger are severely degraded, as wind and water erosion remove nutrients and leave top soils that are hard to plow. Droughts cause crop failure in 2 out of every 5 years.

An ICRISAT research team led by Dov Pasternak has looked for ways to reclaim degraded land so that landless and marginalized women will benefit. Pasternak reports that 3 years of the Bioreclamation of Degraded Lands (BDL) Project have shown that, “by helping women grow indigenous vegetable and fruit trees, we have not only restored the self-worth of women

but also enabled them to provide better care for their families, besides making extra money.”

He estimates the value of fruit and vegetables produced at about US\$1,200 per hectare. The additional income is remarkable, considering that the women’s association in the project area allots only 100-300 square meters for each of its 50 members — and that this is the marginal environment of the Sahel.

The BDL system is a simple innovation with high potential for widespread adoption by farmers. It includes rebuilding the fertility of degraded soils, water management and general land reclamation using drought-tolerant trees and annuals. ICRISAT scientists have taught women how to create a favorable medium for planting crops that will enable effective rooting as well as how to manage soils to prevent waterlogging.

Additionally, farmers have learned how to harvest rainwater on the farm by using micro-catchments, or planting pits, known as *zai* holes, which are able to hold water for prolonged periods

after the rains. *Zai* holes also hold soil and compost to support the growth of locally adapted, deep-rooted and highly nutritious fruit and vegetable crops such as the Pomme du Sahel (*Ziziphus Mauritania*) and *Moringa stenopetala*.

Pomme du Sahel fruit is rich in iron, calcium and phosphorus, and it has ten times as much vitamin C as apples. The leaves of the Moringa tree, Niger’s most popular vegetable, have seven times as much vitamin C as oranges, four times as much vitamin A as carrots and four times as much calcium as milk.

The BDL model has mobilized a group of 100 women in the Dosso Region, 120 kilometers from the capital, Niamey. They successfully demanded and obtained degraded land from their village chiefs and are now reclaiming their right under Nigerien land law to cultivate and own the land.

The World Vegetable Center and ICRISAT have jointly identified a short-duration cultivar of okra (*Albemoschus esculentus*), a favorite

food in Africa produced in the Sahel mostly by women and highly suitable for growing in *zai* holes. These and other crop trees are being tested for their value in reclaiming West Africa’s degraded farmlands, as they typically tolerate drought, high soil salinity and waterlogging.

These innovations hold the promise of greening vast swathes of degraded land to create a new horticultural frontier for Africa — one that is cultivated and sustained by strong, empowered women.

Dry Response

Agricultural research in the dry areas of Asia and North Africa considers the many ramifications of climate change in these vulnerable regions.

Climate change is a global problem, but some regions will be affected more than others — notably the dry areas of Central and West Asia and North Africa. Agriculture in these vast expanses is limited by a range of factors, including drought, land degradation, temperature extremes, pests and diseases. Climate change will aggravate each of these problems.

For over 30 years, the International Center for Agricultural Research in the Dry Areas (ICARDA) has focused on dry areas and, in particular, on helping farmers cope with climate variability. ICARDA is now tackling climate change issues more broadly, with greater emphasis on adaptation, mitigation and ecosystem resilience.

Farmers placing manure in *zai* pits in Niger.
Credit: ICRISAT



ICARDA is tackling the problem of land degradation and desertification by researching soil and water harvesting techniques and grazing management.

Credit: CGIAR



With drought becoming more frequent, it is important that countries respond proactively by integrating drought management into long-term development plans. ICARDA was a partner in the European Union's project Mediterranean Drought Preparedness and Mitigation Planning, which developed guidelines for managing drought risk using preparedness plans and early warning systems. Subsequently, ICARDA and its partners — the Mediterranean Agronomic Institute of Zaragoza, Food and Agriculture Organization of the United Nations, and national research centers — established the Network on Drought Management for the Near East, Mediterranean and Central Asia, which enables institutions in 38 countries to work together on predicting and responding to drought. Climate change creates multiple challenges, which ICARDA actively addresses.

Crop Resilience. More than 900 crop varieties developed using ICARDA breeding materials and adapted to dry areas have been released worldwide. ICARDA has developed cold-tolerant varieties of chickpea that can be planted in winter rather than spring. This allows the crop to escape terminal drought

and minimizes the temperature effects of climate change. The Center has bred barley varieties that mature early without losing yield. It combines conventional breeding with biotechnology to improve wheat's heat and drought tolerance, and a number of wheat varieties are now being tested in farmers' fields.

Pests and Diseases. Past experience in dry, hot environments and new modeling methods help ICARDA scientists understand how climate change may affect the distribution or severity of pests and diseases. Higher temperatures will favor some insect pests, which are likely to expand their ranges. One example is the Hessian fly, a major pest of wheat. Until recently it was confined to North Africa. Now it is threatening wheat production in central and southern Europe and is expected to move further north.

Livestock. Climate change will likely cause significant livestock losses. As conditions change, it becomes ever more important to have breeds that can cope. Central and West Asia and North Africa have a very wide diversity of animal breeds, many of which tolerate temperature extremes and remain

productive even on degraded rangeland. ICARDA and its partners help document this diversity to facilitate targeting breeds to specific environments and designing breeding programs. Additional research using phenotypic and molecular characterization helps identify adaptive traits that enable indigenous breeds to thrive under harsh conditions.

Water and Land Management.

Climate change will restrict river flows and groundwater recharge, accelerating land degradation in dry areas. ICARDA and its partners have developed technologies such as supplemental irrigation, water harvesting and conservation agriculture that conserve water and increase the quantity of grain or biomass produced per unit of water used.

ICARDA research has found water productivity per cubic meter as high as 2.5 kilograms of wheat grain under supplemental irrigation, which is much higher than the 500 grams under rainfed conditions and 1 kilogram under full irrigation. It has quantified the benefits of combining supplemental irrigation, zero tillage and adapted

cultivars. Crop models have been validated and used to better allocate water in irrigation basins.

Climate change is likely to accelerate land degradation and desertification in many areas. ICARDA is tackling the problem through water harvesting, soil and water conservation techniques, and grazing management. Experiments have shown that 40-50% of the rainwater that would otherwise be lost as runoff or evaporation can be harvested and used to grow tree cash crops, restore biodiversity, and improve plant cover and forage availability in rangelands, as well as to reduce soil erosion.

Carbon Dioxide Modeling.

The interaction of high carbon dioxide levels, high temperatures and water deficits is complex and not well understood, partly because it is difficult to study in the field. ICARDA uses simulation modeling to measure the effect of supplemental irrigation on wheat yield and water productivity under different carbon dioxide, temperature and rainfall scenarios.

Rural Climate Exchange: A New CGIAR Blog

A collaborative communications initiative strives to better connect international agricultural and environmental science to the climate change agenda.

In a new effort to promote dialogue and information sharing, the CGIAR Secretariat, with support from private-sector partner Burness Communications, launched a new institutional blog in late

June, dealing with CGIAR research and other activities that are relevant to global climate change. The blog is hosted on WordPress, a free, open-source platform.

In the first instance, the blog is intended to serve CGIAR staff and stakeholders as an up-to-date resource on relevant research and other developments.

In the run up to the 15th Conference of Parties (COP15) to the UN Framework Convention on Climate Change (UNFCCC), which will be held this December in Copenhagen, Denmark, it is especially important that such work and its implications for the COP15 negotiations be made as readily accessible as possible.

Increasingly, the blog should also help feed story ideas to international media, further raising the profile of CGIAR research. Colleagues at Burness are promoting it heavily for this purpose, with good signs of interest from wire services, like the Associated Press, and others.

Considerable effort has gone into creating content for the blog, resulting in an average of three to four posts per week. Communications colleagues at the Center for International Forestry Research (CIFOR), International Maize and Wheat Improvement Center (CIMMYT), International Food Policy Research Institute (IFPRI), World Agroforestry Centre and WorldFish Center have contributed importantly to this effort.

Rural Climate Exchange currently receives an average of just over a thousand visits per month, and the figure is rising steadily, as a result of several measures. Among these are regular updates on recent posts to a climate communications listserv (to which about 35 CGIAR climate change scientists and communications



specialists are subscribed); collaboration with other blogs dealing with climate change and related issues; and "live" blogging from major events, which taps into the immediate interest of event participants and others.

In the short time since it was launched, the blog has shown good potential for enhancing CGIAR communications on climate change. The Communications Team in the CGIAR Secretariat invites suggestions about ways to improve the content, promotion and use of the blog, and encourages readers of CGIAR eNews to participate in any of the following ways:

- Visit Rural Climate Exchange and offer comments on the posts.
- Let others know about the blog and include links to it on your Web site.
- Subscribe to the climate communications listserv for regular updates on blog posts by sending an email message to Barbara Eckberg (beckberg@worldbank.org), with the subject line "Subscribe to climatecomms@cgiar.org."
- As a listserv subscriber, contribute blog posts actively. For this purpose, send an email to Amelia Goh (agoh@worldbank.org), requesting a username and password for the blog site, so you can post materials yourself, or seeking Amelia's assistance in posting material for you.

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

RURAL CLIMATE EXCHANGE

CONNECTING AGRICULTURAL AND ENVIRONMENTAL SCIENCE TO THE CLIMATE CHANGE AGENDA

LEARN MORE & ENGAGE IN A DIALOGUE

on how agriculture research is enabling rural communities to mitigate climate change and adapt to its impact.

The Centers supported by the Consultative Group on International Agricultural Research (CGIAR) and their partners generate a wealth of knowledge that can better enable rural people in developing countries to mitigate climate change and adapt to its impacts. The purpose of this blog is to help bring such knowledge to light, so it can better serve global efforts to cope with climate change.

WWW.CGIARCLIMATECHANGE.WORDPRESS.COM