Beyond the panda: farm animals at risk

School kids and street food

Special Section: biodiversity and climate change

Improving lives through biodiversity research
A child carrying drinking water through deep floodwaters in Bangladesh. Millions of people have been affected by severe flash flooding following particularly heavy monsoon rains across South Asia. Climate change is increasing the incidence of severe storms and flooding.

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Teshoma Adera stands in his barren, stony and infertile field outside Bilak village, Ethiopia. Looking up at the sky, he explains there have been just two days of rain all year. His crops failed dramatically, leaving his family with just one month’s supply of food, after which they will be dependent on food aid. Agricultural biodiversity provides farmers and breeders with the traits they need to develop drought resistant crops.

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A child carrying drinking water through deep floodwaters in Bangladesh. Millions of people have been affected by severe flash flooding following particularly heavy monsoon rains across South Asia. Climate change is increasing the incidence of severe storms and flooding.

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Improving nutrition and health with the quinoa mill

Picture this: a bright sun beating down on a 12,500 km² salt lake 4000 metres above sea level. This is the Uyuni Salt Flats in the southern Bolivian altiplano, one of the most astonishing settings on Earth. It is also one of the harshest environments in the world, with temperatures ranging from -18°C to a high of 27°C. The soils around the salt lakes are sandy and infertile and rainfall is scarce. When temperatures drop at night, frost settles over the land. The harsh environment makes it difficult to reach, with only the odd bus willing to venture down the few dirt roads and paths that link this region to the rest of the country.

Despite the harsh and isolated conditions, hundreds of communities of Aymara and Quechua origin (descendants of the Incas) have built their lives here, learning to adapt to the inhospitable conditions over thousands of years.

Life for the women in these communities is far from easy. Collecting dry sticks for fuel involves travelling long distances on foot, and water has to be hauled from underground wells in heavy buckets. A trip to the market to buy fruits and vegetables can take up to three days.

The communities around the salt flats depend on agriculture for their livelihoods, but the harsh conditions mean that their foods are limited to a few products such as quinoa, bitter potatoes, faba beans and llama meat. Efforts by national and international organizations to create a market for the local crops for the last 20 years or so have helped these communities to improve their incomes but, in the case of quinoa, commercial cultivation has had some unintended consequences.

Astudillo, Mickey Leland International Fellow from the Congressional Hunger Center in the USA, to conduct a two-year study on the impact of commercial quinoa cultivation on communities in southern Bolivia.

Quinoa is a highly nutritious grain providing a good source of protein, amino acids, vitamins and minerals. The communities formerly consumed quinoa with every meal. But, as Astudillo soon discovered, they had come to prefer less nutritious foods instead, such as rice and pasta.

Astudillo discovered that one of the main reasons for the change in preference was the length of time needed to process quinoa for food. Quinoa grains are covered with a layer of saponins, a substance with a bitter taste that is often found in plants and that can be toxic if consumed in large quantities. The saponins need to be removed before the grains can be consumed. Women are responsible for this laborious, back-breaking task. Processing 12 kg of quinoa grain can take as long as six hours and involves a long process of roasting or toasting the grains, stepping on them in a stone bowl with...
bare feet while they are still hot to loosen the saponins, winnowing the grains to get rid of the saponin dust and, finally, rinsing the grains in water before drying them out in the sun. With more time spent in the fields to meet growing market demand for local crops and less time to spend in the kitchen, the women find it easier and quicker to prepare a plate of pasta or rice.

Working with Rolando Copa, a local mechanic and inventor, Astudillo developed a small machine that reduces processing time from six hours to seven minutes. Furthermore, processing with the machine causes far less damage to the grain than manual processing, keeping the grains intact and conserving their nutritional qualities.

The machine was tested in various communities in the region with great success. The women were delighted at the prospect of having a machine do the hard work for them. Most families cannot afford to buy their own machine, but for a small fee they can pay to use a community machine to process their grains.

“The needs of these farming communities are great and large investments are required to lift them out of poverty,” said Astudillo, “but this small machine can still have a significant impact on their lives, by reducing the burden on women, improving livelihoods and facilitating the consumption of a nutritious grain. This is a low-input, high-impact model for any organization committed to practical rural development and the improvement of the lives of marginalized populations.”

By Cassandra Moore, Bioversity International

Based on “The potential of small holder technology in quinoa producing communities of the Southern Bolivian Altiplano,” by Damiana Astudillo (http://www.underutilized-species.org/features/quinoa.htm).
New potatoes for Bolivian farmers

For nearly two decades, the PROINPA Foundation (Promotion and Investigation of Andean Products) of Bolivia has been helping low-income Andean farmers to cope with weather- and pest-related challenges. This has been accomplished in large part by integrating genetic and technological resources, and has recently fostered the development of new, disease-resistant varieties of potato. Under the direction of PROINPA and using wild relatives of the common potato, farmers and scientists have created successful new varieties that are resistant to some of the most common potato pests plaguing the country.

The importance of the potato to the diets and livelihoods of rural Bolivians is difficult to overstate. Each year, potato is grown on approximately 130 000 ha of land in the country, generating food and income for nearly 200 000 farmers and their families. It is estimated that the annual consumption of this root vegetable is upwards of 80 kg per person. Despite its abundance, however, the potato has proven to be vulnerable to frosts and droughts, as well as to some 266 diseases and pests, including viruses, fungi, bacteria, nematodes and insects. Perhaps the most dangerous of these is late blight, caused by the fungus Phytophthora infestans. Widely distributed in the potato-growing area of Bolivia, late blight has in recent years caused annual crop losses of up to US$30 million and has forced farmers to apply harmful fungicides to their crops.

The development of the ‘Jaspe’ variety began back in 1984, when Dr Nelson Estrada of the Columbian Agricultural Institute crossed various strains of cultivated potato crops with wild potato relatives. The types that resulted were selected for favourable qualities by farmers in Bolivia, Peru and Colombia during the 1990s. Over the next five years, a variety that came out of this initial selection, and which showed great promise due to its resistance to the late blight fungus, was further evaluated by farmers and scientists from the high Andes and the valleys. They found that the variety—‘Jaspe’—resisted not only late blight but also a strain of root-knot nematode and a harmful virus. Meanwhile, potato processing plants judged it suitable for processing into French fries. In 1995, ‘Jaspe’, along with five other types, was finally released to farmers in the valley of Cochabamba for small-scale cultivation.

Today, three of those released varieties—‘Jaspe’, ‘Robusta’ and ‘India’—are being cultivated by Bolivian farmers. Since their release over ten years ago, ‘Jaspe’, ‘Robusta’ and ‘India’ have made measurable impacts on the well-being of farmers across Bolivia. The potato varieties perform well in a variety of different agro-ecosystems and altitudes; it is estimated that some 70% of farmers in the Altiplano zone and the Inter-Andean valleys of Cochabamba and Santa Cruz have adopted them since 1995. This translates into plantings covering 40% to 70% of the total cultivated area in each zone—equivalent to nearly 13 300 ha. The economic impact of these plantings is estimated to be around US$5.3 million per year and growing. Should the varieties continue to spread throughout Bolivia, where approximately 63 000 ha of potato are sown in all, annual earnings may top US$7.5 million.

The success of the new varieties is further evidence that the solution to many modern agricultural dilemmas may be found by looking into the wild. Living untamed for thousands of years, the wild relatives of crops harbour valuable traits that can be introduced into common cultivated varieties. As the PROINPA experience has shown, the incorporation of genes from wild relatives has the potential to increase yields and profits—good news for the millions of small-scale farmers across the globe whose crops are regularly threatened by both climate- and pest-related challenges.

By Julio Gabriel, PROINPA

Translated from the Spanish and edited by Megan Brandeland, Bioversity International

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Ecosystem services atlas offers new hope for Kenya’s poor

A new atlas makes a first attempt to provide a detailed picture of the links between people, land and prosperity in Kenya. In a country where maps and information are still hard to come by, this atlas provides a refreshing, easy-to-understand overview of where Kenya’s rural poor are located in relation to the different ecosystem services (land, food, water, trees, tourism) they depend on for their livelihoods.

“Using this knowledge we can move forward to protect our environment, provide economic opportunity for everyone and build a strong democracy,” said Wangari Maathai, Nobel Peace Laureate and a member of the Kenyan Parliament. Maathai wrote the foreword to the atlas, which was launched earlier this year in Nairobi, Kenya.

The atlas contains 96 different maps that superimpose statistical information about population and household expenditures with spatial data on ecosystems and their services, including water availability and the presence of livestock and wildlife populations in a particular region. The atlas also analyses the links between poverty and environmental resources.

“There is a crippling division between sectors and disciplines within the areas of poverty and the environment. This is an effort to cross these boundaries,” explained Robin Reid, landscape ecologist at the International Livestock Research Institute (ILRI) and one of the lead authors of the atlas.

The atlas is the result of a joint effort involving the Kenyan Central Bureau of Statistics, Kenya’s Department of Remote Surveys and Remote Sensing, ILRI and the World Resources Institute (WRI), among others.

For the majority of the poor, environmental resources offer the surest route out of poverty, providing them with important goods and services that can be used to improve their livelihoods. Information about these resources and their relationship to people’s well-being is critical for policymakers and development organizations, allowing them to target their efforts and focus on areas that have the greatest potential for poverty reduction.

Mohammed Said, a lead scientist at ILRI and co-author of the atlas, gives an example of the kind of analyses available in the atlas: “One of the maps shows the spatial coincidence of poverty and milk production. Most of the areas with high milk production have a low incidence of poverty, but further investigation is needed to determine whether households in these communities became less poor once they became high milk producers or whether a certain amount of capital had to be in place to support a high milk production system.”

Kenya’s poverty map provides a model for other countries to follow. Studies are already underway to recreate a similar effort in Uganda.

“This book is going to change the lives of Kenyans,” said Edward Sambili, Permanent Secretary to Kenya’s Ministry of Planning and National Development. “It is going to reduce poverty.”

By Cassandra Moore, Bioversity International

Based on a press release by ILRI
Gates Foundation funds efforts to rescue endangered crop diversity

The Global Crop Diversity Trust and the United Nations Foundation have announced a joint initiative to safeguard 21 of the world’s most critical food crops. The Bill and Melinda Gates Foundation is funding the initiative with a US$37.5 million grant, which includes US$7.5 million in matching funds from the Government of Norway.

“This is the largest grant to support crop diversity ever made. This initiative will rescue the most globally important collections of the world’s most important food crops,” said Cary Fowler, Executive Director of the Trust. “It will secure at-risk crop diversity collections in poor countries and document their astonishing diversity, making it available to meet the food needs of the poor.”

The unprecedented effort will help developing country genebanks—many of which are underfunded and in disrepair—to secure over 95% of their endangered crop diversity. It will fund the largest single regeneration effort in history. In addition, it will fund a comprehensive global information system that will allow genebanks worldwide to be searched for traits needed to combat new diseases and cope with climate change.

“Our effort to help hundreds of millions of small farmers and their families overcome poverty and hunger rests in part on food security,” said Sylvia Mathews Burwell, President of the Gates Foundation’s Global Development Program. “But there can be no food security without first securing the basis of our food production—the genetic diversity of every crop, in particular those most important to the poor, which unfortunately are neglected by modern plant breeding. We invite others to join us in securing this resource of immeasurable value.”

“By providing access to crop genetic information, plant breeders across Africa may be able to adapt their crops to varieties that will grow in different climate conditions. Investing in this future may help stave off potential catastrophic damage to some agricultural systems due to climate change. Not only will this partnership combat hunger and protect crop diversity, but it also helps nations prepare for the impacts of climate change,” said Timothy E. Wirth, president of the United Nations Foundation.

The genetic diversity found within each crop is the raw material that enables plant breeders and farmers to develop higher-yielding, more nutritious and stress-resistant varieties. It is also the cornerstone of successful adaptation to climate change, providing the raw material for new ‘climate-ready’ crop varieties. However, much of this diversity held in genebanks is threatened by decades of underfunding and neglect, as well as by wars and natural disasters.

Among the priority crops covered by the Gates-funded initiative are many ‘orphan crops.’ Particularly important to the poor, these crops have been largely bypassed by modern plant breeding because of their lack of importance in wealthy markets, despite their high-yielding, nutritious qualities. Some orphan crops, such as yam, cannot be grown from seeds but need to be cultivated from cuttings.

Samples stored at ultra low temperatures in the CIP (International Potato Centre) genebank. Thanks to the Gates Foundation grant, research on cryopreservation will reduce the costs of conserving crops such as sweet potato and yam by up to 75%.
roots or cell cultures, making their regeneration and conservation more complex and expensive. The grant will finance research on inexpensive conservation techniques for such crops, including cassava, sweet potato, yam, taro and coconut. These new technologies are expected to reduce conservation costs by 75% and improve the security of collections of orphan crops.

The initiative will also increase communication among plant breeders and farmers around the world through the creation of an information system that aims to include data on 4 million samples of more than 2000 species of more than 150 crops—amounting to 85% of the diversity of all agricultural crops. The initiative will fund development of a state-of-the-art genebank management software system, document at least 100 000 new samples and evaluate at least 50 priority collections for 100 different traits.

The new initiative also ensures that developing countries and international agricultural research centres will be able to send at least 450 000 distinct seed samples to the Svalbard Global Seed Vault (see story below). Finally, of the total grant, US$15 million will go to the Trust’s endowment to ensure the health and availability of priority collections in perpetuity.

“It is virtually impossible to exaggerate the importance of crop diversity. It is a vital part of the solution to many of the world’s great challenges, from environmental conservation to climate change and food security,” said Norway’s Minister of International Development, Erik Solheim. “Put simply, crop diversity allows us to grow food, and this partnership with the Gates Foundation provides an opportunity to meet a host of food security challenges far into the future.”

By Julian Laird, Global Crop Diversity Trust

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Svalbard Global Seed Vault

At the beginning of 2007, the Norwegian government unveiled the architectural design for the Svalbard Global Seed Vault, to be carved deep into frozen rock not far from the North Pole. The site was chosen, in part, because the ground there is perpetually frozen, providing natural back-up refrigeration that would preserve the seeds should electricity fail. Yet even here project architects had to consider how to offset the potential impacts of climate change.

The design accommodates even worst-case scenarios of global warming in two main ways. Firstly, the vault will be located some 130 m above current sea level. This puts it well above the 7 m rise that would accompany the melting of Greenland’s ice sheet or even a 61 m rise that could result from the unlikely total meltdown of Antarctica.

Secondly, scientists determined the impact of rising air temperatures on the permafrost, which is normally between -4°C and
The design accommodates even worst-case scenarios of global warming.

The town of Longyearbyen in Svalbard, where the seed vault is being constructed.

-6°C. They found that the permafrost would warm much more slowly than the air. In addition, the deeper into the mountain, the colder it will remain. Therefore, the vault will be located an extraordinary 120 m into the rock, ensuring that rising external air temperatures will have limited influence on the surrounding permafrost.

In contrast to the vault’s utilitarian interior, which consists of concrete walls and no windows, “the exterior structure shoots out of the mountainside,” according to project manager Magnus Bredeli Tveiten, of Statsbygg, the Norwegian government’s Directorate of Public Construction and Property. The entrance will be a narrow triangular structure of cement and metal, illuminated with artwork which changes according to the special lighting conditions of the Arctic. In the summer months, the entrance “will gleam like a gem in the midnight sun,” Tveiten said. Throughout the dark winter, when the sun never rises, it will glow with gently changing lights.

Construction was completed in September 2007, and the vault will officially open in late winter 2008. “By investing in a global permafrost safety facility for seeds, the Norwegian Government hopes to contribute to combating the loss of biological diversity, to reduce our vulnerability to climatic changes and to enhance our ability to secure future food production,” said the Hon. Terje Riis-Johansen, Minister of Agriculture and Food, Norway.

“This design takes us one step closer to guaranteeing the safety of the world’s most important natural resource,” said Cary Fowler, Executive Director of the Global Crop Diversity Trust, which will co-fund the vault’s operations and pay for the preparation and transport of seeds from all developing nations to Svalbard. “Every day that passes, we lose crop diversity. We must conserve the seeds that will allow agriculture to adapt to challenges such as climate change and crop disease. This design is as awesome structurally as it is attractive aesthetically, and both are fitting tributes to the importance of the biological treasure to be stored within.”

By Julian Laird, Global Crop Diversity Trust

For more information, contact Julian Laird, j.laird@croptrust.org
Beyond the panda: farm animals at risk

The conservation of farm animal diversity is often overshadowed by efforts aimed at charismatic species, like the majestic bald eagle, the untamed white tiger and the adorable panda bear. This is troubling, given the vital role livestock play in the livelihoods of farmers and consumers across the globe. According to a report released by the FAO Commission on Genetic Resources for Food and Agriculture (The State of the World’s Animal Genetic Resources for Food and Agriculture), the biggest factor in the gradual loss of livestock breeds is industrial livestock production, especially in developing countries where animal diversity is richest.

“In the next 40 years, the world’s population will rise from 6.2 billion to 9 billion, with all the growth occurring in developing countries,” said FAO Assistant Director-General Alexander Müller in his address to the Commission. “We need to increase the resilience of our food supply by maintaining and deploying the widest possible portfolio of plant and animal genetic resources, which are vital and irreplaceable.”

As demands for meat, milk and eggs continue to rise, so does the world’s reliance on high-yielding animals and the products they supply. Adding to the problem is the fact that genetic material from highly productive breeds can now be transported easily across the globe, making it easier for farmers to replace their native breeds. As native varieties are slowly phased out, so are many valuable traits—such as disease resistance or increased tolerance of harsher environmental conditions—which may be useful in dealing with future changes in climate.

“One livestock breed a month has become extinct over the past seven years, and time is running out for one-fifth of the world’s breeds of cattle, goats, pigs, horses and poultry,” said Müller. According to the FAO report, the problem is occurring mostly in developing countries, which until recently have managed to hang on to a large number of their indigenous breeds. In Viet Nam, for example, the percentage of indigenous sows declined from 72% of the total population in 1994 to only 26% in 2002. Of its 14 local breeds, five are classified as vulnerable, or facing moderate risk of extinction, two are considered to be in a critical state with very few populations left and a restricted range, and three are at extremely high risk of disappearing completely.

The report warns that these trends are unlikely to reverse unless adequate resources are devoted to the management of animal genetic diversity. “From a research viewpoint, it’s clear that if we’re going to manage the world’s remaining livestock genetic resources, we’ll have to characterize the remaining populations to decide which are worth saving and why,” said Carlos Seré, Director General of the International Livestock Research Institute (ILRI) in Kenya. “We’ll have to find ways of broadening the use of those populations deemed useful, and we’ll have to conserve the most important livestock genetic diversity for possible future use—by poor and rich farmers alike.”

Currently, the conservation of animal genetic resources is greatly lacking in the majority of developing countries. According to the FAO report, 48% of the world’s countries report that they have no national in vivo, or live animal, conservation programmes; 63% report having no in vitro programmes, that is, the conservation of embryos, semen or other genetic material, with the potential to reconstitute live animals at a later date. Similarly, structured breeding programmes are absent or ineffective in most countries. “Frameworks for wide access to animal diversity and for equitable sharing of the benefits derived from their use need to be put in place, at both national and international levels,” said Clive Stannard of the FAO Commission.

Unlike the situation in Europe and North America, where a few high-performance breeds have virtually wiped out traditional types, the loss of genetic diversity in many developing countries is not yet complete. Many important species of livestock can still be saved if efforts are made to reverse these trends. Experts from...
Highly resistant to gastrointestinal infections and other diseases, red Maasai ‘hairless’ sheep have long been valued by East African pastoral societies. Unfortunately, with the introduction of the Dorper sheep from South Africa, pure bred red Maasai sheep have almost completely disappeared.

Pop quiz for all of you biodiversity experts out there. What animal is most in danger of extinction? Answer the cheetah or white rhino or panda and you fail. Answer the disease-resistant Sheko cattle of southern Ethiopia or the big-horned Ankole cattle of Uganda and you could be right.

We are losing livestock genetic diversity at an unprecedented rate. Of the 7616 breeds of domestic livestock reported, 1491, or 20%, are classified as being ‘at risk’. The ongoing loss of our livestock diversity is tantamount to losing a road map for survival—the key to ensuring food security, and environmental stability and improving the human condition.

Here are five rare ‘vintage’ breeds of Africa that could be part of that road map.

N’Dama cattle
The thickset humpless N’Dama, thought to have been developed in the highlands of Guinea, is kept by farmers in 20 countries of West and Central Africa. Over some 7000 years these beef cattle developed resistance to a deadly disease transmitted by the tsetse fly. The N’Dama and a few other so-called trypanotolerant West African livestock breeds are well known for their ability to survive and produce milk, meat and other products in tsetse-infested areas, where susceptible zebu and European breeds cannot.

Sheko cattle
Only a few thousand Sheko cattle remain alive. These relatively small animals, which are related to West Africa’s ancient N’Dama cattle, are found only in the mountainous farmlands of south-western Ethiopia, where the Sheko people bred them for millennia for their natural resistance to the tsetse-transmitted disease that kills both cattle (trypanosomiasis) and people (sleeping sickness). This disease is largely responsible for holding back development across vast areas of Africa’s prime humid and subhumid regions.

Red Maasai sheep
Red Maasai ‘hairless’ sheep (they do not produce wool) have traditionally been kept by the pastoralist societies of East Africa. Highly resistant to gastro-intestinal parasite infections and other diseases, they thrive in harsh environments ranging from drought-prone savannas to humid zones. These traits make the genes these sheep carry invaluable to the world. But the introduction of Dorper sheep from South Africa has caused, in little more than 15 years, pure-bred Red Maasai to almost completely disappear.

Ankole cattle
There are about 3.2 million Ankole cattle in five countries of eastern and central Africa. The Ankole are drought- and disease-resistant and beloved by their keepers for their uncommon gentleness, beauty, rich milk and tasty meat. Rapidly expanding human populations, infrastructures and markets, however, are forcing more and more farmers to replace their indigenous Ankole cattle with exotic breeds, such as the black-and-white Holstein-Friesian dairy cows, which produce much more milk. At their current rates of decline, these hardy, graceful animals could disappear within the next 50 years or less.

Kuri cattle
These hamitic longhorn humpless cattle inhabit the hot, humid shores and archipelagos of the Lake Chad basin in Cameroon, Chad, Niger and Nigeria. They are kept by both pastoral herders, who migrate long distances each year in search of grass, and by settled mixed crop-and-livestock smallholders. They are large-bodied, typically white and carry distinctive bulbous horns. They are highly fertile animals and excellent milk and meat producers. They are adapted to both extremely hot and humid aquatic environments, being able to withstand extended droughts while also being excellent swimmers (and very fond of wallowing in water).
Childhood obesity in Italy: diets, diversity and nutrition

Italy is famous for its food: a rich culinary heritage developed over countless generations and admired the world over for its varied ingredients and renowned health benefits. At the heart of Italy’s culinary tradition is diversity: the many different varieties of traditional fruits, vegetables and cereals that typify the famous Mediterranean diet. The nutritional and health benefits of the Mediterranean diet are well known. A diet largely based on plant foods and low in saturated fats contributes to lower incidences of heart disease, diabetes and obesity.

But even Italy—cradle of the Mediterranean diet—is not immune to the complex and multi-faceted global epidemic that is currently unfolding before our eyes. Results of a 2007 pilot study commissioned by the Italian Ministry of Health revealed that Italian children too are beginning to tip the scales. In the provinces of Terni and Bari, about one-third of the children evaluated were found to be overweight or obese.

Childhood obesity is harmful, not only to physical but also to mental and social health and well-being. Overweight and obese children have increased incidences of diabetes, high cholesterol, high blood pressure and orthopaedic problems. When coupled with bullying and social marginalization, these physical ailments can manifest themselves in low self-esteem, negative body image and depression.

In an effort to minimize the number of children who have to deal with issues like these, the Italian Ministry of Health plans to use the data gathered from the pilot studies in Terni and Bari to set up a national, school-based system for monitoring weight trends among 8 to 9-year-old children. The goal is to address how the public health sector can influence these trends for the better.

In line with this approach, the pilot studies gathered information on environmental factors, such as snacking habits and levels of physical activity, rather than focusing on genetic variables like birth weight or parental weight. Parents were asked what they thought of their children’s weight status and diet, while teachers and administrators were questioned about school lunches and physical activity in schools. The body mass index (BMI)—an estimation of body fatness based on height and weight—was assessed in the children.

The results of these pilot studies, though dispiriting, did not come as much of a surprise, considering the dramatic increase in the number of overweight European children in the past 30 years. According to the data on BMI, 32% of children in Terni and 35% in Bari fell in the categories of overweight or obese. And it was not just a specific subset of kids—the whole distribution was shifted up, with a large number of children on the border of becoming overweight. Similarly alarming was the fact the parents were relatively oblivious to the state of their children’s weight.

For instance, of the children found to be overweight, 61% of their parents considered them to be of normal weight. Meanwhile, 20% of the obese children were deemed ‘normal’ by their parents.

Although these results cannot be attributed to any single variable, one of the principal culprits is thought to be simplification of the diet, from one rich in traditional vegetables, pulses and cereals, to one that is much less diverse and that depends on the ready availability of cheap, refined carbohydrates and fats.

In an effort to modify the trend, the Italian Ministry of Health is embarking on a new programme—*Guadagnare salute*—that is based on the principles of the World Health Organization’s ‘Gaining Health’ initiative. At the core of this programme lies the simple goal of making the best choice the easy choice. In other words, the programme seeks to make it easier to eat a healthy diet by promoting the cultivation and availability of traditional fruits and vegetables. The ultimate goal is to create a new food culture dedicated to food quality, with consumers knowledgeable about nutrition and the role agricultural biodiversity can play in maintaining a healthy diet.

Agricultural biodiversity not only helps to ensure food security by making harvests more stable over time. It also makes important contributions to the health of the environment by restoring vital nutrients to depleted soils and improves human health through better nutrition. Diverse agriculture is a vital component of a diverse diet, and a diverse diet made up of nutrient-rich traditional
foods can have a significant impact on human health. There is also evidence that traditional crops are generally nutritionally superior to non-indigenous transplants.

“Returning to the eating habits of the past, to a culture that promotes nutrient-rich traditional crops as the source of ingredients needed for a balanced and healthy diet, will result in both nutritional and cultural gains,” said Nancy Binkin of the Istituto Superiore di Sanità, who led the study. “Valuing and building on the culinary traditions of the past and ensuring that the wealth of knowledge that accompany these traditions is not lost, is also about preserving a vital part of the Italian history, culture and identity.”

With its rich culinary heritage and long history of scientific research in the area of agricultural biodiversity, Italy is well placed to take a leading role in making dietary diversity play a key role in turning the obesity epidemic around.

No one would be surprised to hear that African children are undernourished. The hunger epidemic on the continent has existed for decades and is likely to worsen as climate change further threatens many already fragile agricultural environments. What makes today's hunger crisis unusual, though, is that it is often not due to a lack of calories. Many undernourished African children are getting enough food to meet daily energy needs and to fill their stomachs. The problem is that many of the calories they consume are void of nutrients, resulting in vitamin and mineral deficiencies of all kinds.

A study by the Food and Agricultural Organization of the United Nations (FAO) and Sokoine University in Tanzania surveyed students in 20 of Tanzania’s public schools. The survey looked beyond the calories consumed to the levels of micronutrients in daily diets. Deficiencies in important vitamins and minerals in children can lead to reduced resistance to infectious diseases, stunted growth and problems with concentration.

Almost all of the 1180 fifth- and sixth-grade students surveyed purchased food from street vendors; two-thirds bought additional snacks from the vendors on a daily basis. The snacks include fried potatoes, fried cassava, fried rice, rice and beans, fried banana, fried groundnuts with sugar, and sweetened and flavoured water. Among these purchases—which set the students back around 11 US cents or less a day—the favourite was fried cassava, consumed by half the students as a mid-morning snack. “It’s bulky, energy dense and satisfies the students’ hunger for a longer period of time than many of the other types of snacks,” noted Joyce Kinabo of Sokoine University, who coordinated the study. Unfortunately, fried cassava is no more nutritious than the other offerings.

The convenience and low cost of street foods make them appealing to children who have little money to invest in filling their stomachs. One solution to improving childhood nutrition in Tanzania—and presumably in many other countries as well—thus
may lie in enhancing the healthiness and safety of street foods.

The vendors surveyed for the Tanzanian study mostly relied on wholesale markets for their ingredients, making choices on what to sell based on a combination of customer preferences and cost. The vendors observed that children buy energy-dense snacks like fried banana and sugared groundnuts because they are cheap and keep the children’s stomachs full for several hours. When asked why they sell fatty and fried foods to the students rather than more nutritious fruits and vegetables, they replied that the latter are prohibitively costly to purchase and prepare. They could not afford to sell them nor the children to buy them.

Increasing the micronutrient value of street foods in Tanzania may be as simple as adding legumes and spices to the children’s favourite snack, fried cassava, or adding reconstituted milk to the menu. Another option would be to focus on fruit, an attractive alternative also from the perspective of farmers’ livelihoods.

It is estimated that 50 to 60% of Tanzania’s annual harvest is lost in transit or waiting to be sold. The authors of the study recommend investing in solar dryers to dry fruit for sale. This would benefit the vendor by increasing product variety, the consumer by making nutrient-rich foods more accessible and the farmers by increasing demand for local produce.

The nutritional content of street foods was not the only concern arising from the study. Sanitation and quality control issues were also highlighted. Regulation of food quality is sporadic in Tanzania and few of the vendors surveyed had received any formal instruction in handling and preparing food under safe conditions. Training in the management of street food businesses is offered by the government, the private sector and NGOs but few street vendors attend these courses. In fact, most vendors do not legally register their business at all. Furthermore, clean water and garbage disposal areas tend to be scarce and snacks are often exposed to dirt and dust while lying around waiting to be served in old newspapers. The authors of the study worry that poor hygiene—and the food-borne illnesses it can cause—may offset many of the nutritional benefits that might be gained from using better-quality foods. Ensuring that street food vendors are taken into account in the Ministry of Education’s School Feeding strategy might address this by helping to enforce standards and address problems. Health officers do carry out inspections and offer advice and instruction to schools to improve conditions.

Addressing the sale of street foods is a new approach to the issue of nutrient deficiency in Africa. It will require the collaboration of entire communities: farmers, schoolyard vendors and children. Stimulating the market for nutritious, locally grown foods will also contribute to the stimulation of crop diversity. As Gina Kennedy of the Nutrition and Consumer Protection Division at FAO observed, “By expanding and diversifying the types of food bought from vendors, and by ensuring their affordability, street foods could become a major part of the solution to problems of poor nutrition among school children.”

By Megan Brandeland, Bioversity International

Green living

If you are ever in Peru, be sure to visit Casa Blanca, an organic farm about 35 km outside Lima, in the valley of the Lurin River. Hidden away behind a large wooden gate and high stone walls, this one-hectare farm is an oasis in the middle of the desert lands that surround Lima’s vast urban sprawl.

The farm is owned by Ulises Moreno and Carmen Felipe-Morales, both agronomists and both firm believers in the potential of agricultural biodiversity to lift Peruvians out of poverty.

Carmen and Ulises are no ordinary couple. They have dedicated their lives to sharing their knowledge and experience in organic farming with others. “I have made several important decisions in my life,” Ulises recounted. “One was to marry my wife,” he said smiling. “The other was to create this farm and make it our home.”

With their doctorates in agronomy completed, Ulises and Carmen had to decide what they wanted to do with their lives. With no desire to work behind the closed doors of academia, they decided to put their beliefs and training into practice and created an entirely self-sufficient organic farm, which they now call their home.

“Everyone is welcome to our home,” Ulises said, and he meant it. Ulises and his wife regularly host farmer workshops, student seminars and other activities to show people what can be achieved with a small piece of land and lots of initiative. They also host university students who come to study on the farm for weeks at a time.

Casa Blanca is home to a wide variety of crops, including cassava, potato, sweet potato, beans, maize, plantains, strawberries and several aromatic herbs. Because Ulises and Carmen do not use any form of pesticide or insecticide, the farm is also home to an astonishing array of animals and insects. These, Ulises explained, are a natural solution to pests. He held up his favourite ‘ally’: a toad. “He helps me by eating the insects,” Ulises explained. The farm’s rich diversity has made it a popular site for study by researchers, who come from all over the country to investigate the different species that thrive in this miniature ecosystem.

A glass case on display for visitors portrays all the insect types that have been identified on the farm to date.

Ulises explains how the biodigester works. A mixture of compost, rumen and crop residues is fed into the machine. The fermentation process releases a biogas that is used for cooking and heating.

Ulises and Carmen are proud of the strawberries they grow on their farm, from which they make a delicious organic ice cream. The strawberries have been planted under the shade of the cassava trees next to rows of garlic. “The pungent odour of the garlic protects our strawberries from pests, and the shade of the cassava tree keeps them cool,” Ulises explained.

But the farm’s greatest secret is the guinea pigs. “We eat the meat,” Ulises said (guinea pigs are a specialty food in Lima). But they also use the manure from their 1000 or so guinea pigs as fertilizer and mix it with crop residues to produce compost. The compost is
A race against time: deadly wheat disease spreads east

It may be just a question of time before Ug99, a virulent form of a deadly wheat disease, wreaks havoc on the world’s wheat harvests, depriving 75% of the global population of its main food supply and robbing poor farmers of their livelihoods. Earlier this year, scientists confirmed that Ug99, a highly virulent strain of Stem rust, has jumped the Red Sea from East Africa to Yemen and the Arabian Peninsula and is expected to spread further east. Unlike previous races of the pathogen, the wind can carry spores of Ug99 for thousands of miles, sparking the risk of a global pandemic. Experts estimate that initial losses in wheat yields could reach more than US$1 billion.

“Of the 50 genes we know for resistance to stem rust, only ten work even partially against Ug99,” explained Rick Ward, head of the Global Rust Initiative hosted by Bioversity International. Serious outbreaks of Stem rust have occurred before. In the 1950s, the disease caused huge losses in wheat yields to countless farmers in Mexico and North America, leading to severe food shortages and even famine. The solution came when Borlaug found resistance genes in farmers’ varieties and wild relatives.

Norman Borlaug, father of the Green Revolution, Nobel Prize laureate and, more recently, winner of the US Congressional Gold Medal, said “This thing has immense potential for social and human destruction.”

Carmen and Ulises do not make any financial profit from their farm. The money they make from the sale of their compost and fertilizer (sold at the symbolic price of 1 Sol, around 33 US cents) and from the odd consultancy is just enough to cover their costs.

“We wanted a quiet, happy life,” Ulises said. As the wooden gate closed behind us and we headed back to Lima’s vast metropolis, we realized that this is exactly what they have achieved.

By Cassandra Moore, Bioversity International

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Ug99, a highly virulent strain of stem rust, could cause losses of billions of US dollars to wheat farmers worldwide.
Crop wild relatives may hold solution to deadly wheat disease

Farmers and plant breeders have long looked to the wild relatives of crops to find solutions to their problems. The solution to the deadly wheat disease known as Ug99 may in all likelihood be found in the rich diversity of wheat and its wild relatives (see ‘A race against time: deadly wheat disease spreads east’, p. 14). Bioversity International has been working on a global project to protect important and threatened crop wild relatives since 2004 (for more on crop wild relatives, see Geneflow 2006 Special Section). Armenia—one of the five countries involved in the project—is an important centre of diversity for wheat, with about 13 wild species and more than 360 cultivated varieties.

“Armenia is home to important wild wheat species,” said Annie Lane, coordinator of the crop wild relatives project. “The solution to Ug99 might be in Armenia.”

Wild relatives of crops offer a critical source of genes that can provide resistance to a wide range of diseases, pests and environmental stresses. Yet, over-exploitation, habitat loss and climate change threaten wild relatives where they grow.

Bioversity and its partners are working to protect crop wild relatives by encouraging their in situ conservation—in farmers’ fields and in the wild—thereby ensuring that they are available to meet future agricultural challenges.

“Good protection of crop diversity and wild relatives is the best insurance policy we can have,” said Emile Frison, Director General of Bioversity International. “You never know what the next problem will be. But whatever it is, agricultural biodiversity is likely to provide the solution.”

By Cassandra Moore, Bioversity International

Adapted from ‘Billions at risk from wheat super-blight,’ by Debora Mackenzie, New Scientist, 3 April 2007.
Managing crop agrobiodiversity as a global public good

The centres supported by the Consultative Group on International Agricultural Research (CGIAR) hold the world’s largest collections of plant diversity, containing over 600 000 accessions of some 3000 staple crop, forage and agroforestry species essential to human food security.

The CGIAR has recently reconfirmed its resolve to ensure that biodiversity is put to work for humanity. The collections of crop diversity held in trust by 11 of the CGIAR centers are among the most important public goods managed by the CGIAR system, providing vital resources for agricultural growth and development. Together the Centers hold over 600 000 accessions of some 3000 staple crop, forage and agroforestry species important for global food security.

The centres stepped in to provide the necessary injection of funds to enable an ambitious rehabilitation exercise. The first phase of the exercise came to a successful conclusion at the end of 2006, coinciding with the confirmation of funds for a second phase of the project, which began implementation in 2007.

An analysis of the capacity of the centre genebanks to meet international standards for security and accessibility revealed critical gaps. Fortunately, the World Bank (employed with project funding) enabled centres to make a massive impact on backlogs in accession management—backlogs that were threatening the sustainability of genebank operations. About 190 000 accessions were duplicated for safety, and safety duplication agreements were negotiated between genebanks within and outside the CGIAR system. Regeneration backlogs at all centres were reduced by almost 200 000 accessions, and processing backlogs by over 400 000. Over 80 000 accessions were characterized at six centres.

Accessibility, a key element of centres’ in-trust commitments under the International Treaty on Plant Genetic Resources for Food and Agriculture, requires that accessions be characterized and their qualities documented in a form that is comprehensive and readily available to users. The System-wide Information Network for Genetic Resources (SINGER) was established under the auspices of SGRP in 1994 to help centres meet these responsibilities, linking the collections held in the centre genebanks and allowing cross-searching of all centre databases from a single entry point.
The project provided for the upgrading of SINGER information operations in the centres. New Web and database servers allow more rapid replication of data from individual centres to SINGER, increase data storage capacity and provide improved facilities for the SINGER team to test and validate their development work. The centres have been supported through a help-desk service and on-site visits, assistance with database design, Web services, genebank information system analysis and staff training. A new SINGER database has been created with enhanced data quality and completeness, and a new Web site put on line.

A review by an external panel of experts in 2005 provided reassuring confirmation that the project was on track and recommended undertaking a second phase. The reviewers considered the genetic resources held by the centres to be critical for meeting the Millennium Development Goals and that under-resourcing the centre genebanks would have a negative impact on a very important component of global agrobiodiversity.

This was a highly successful exercise, generating valuable results on a number of fronts and lifting the CGIAR genebank operations to a new level. The centres gained valuable experience in working to a common agenda, developing and applying common standards, sharing knowledge and supporting each other’s operations to overcome constraints and reduce risks. A greater understanding was gained of the realities of managing large and complex operations in a climate of financial stringency, with the need to achieve economies and streamlining without sacrificing quality. That spirit of collaboration is likely to be redoubled as the centres work together to support the establishment and implementation of a global system for the conservation and use of crop diversity.

By Ruth Raymond, Bioversity International

Pohnpei Banana Market Study

The study kept track of the volume and varieties of banana purchased by each participating market as well as the number of markets selling each variety.

In developed countries, most people would be hard pressed to find more than one banana variety at their local market. That would come as a shock to the inhabitants of the Pacific island of Pohnpei—a country with which few can compete in terms of the diversity of bananas available to consumers. Last year, results of the first Pohnpei Banana Market Study revealed that 17 different varieties of banana were sold in the Pohnpei region over a period of two months.

Coordinated by the Island Food Community of Pohnpei (IFCP) and the Pohnpei Office of Economic Affairs, the study kept track of the volume and varieties of banana purchased by each participating market as well as the number of markets selling each variety. Fourteen markets participated in the study.

“The market people were...”

Two of the market vendors who participated in the Pohnpei banana market study pose in front of their stall. The man on the left holds a bunch of Karat bananas.
friendly and helpful,” said University of Hawaii student and IFCP intern Angela Parvanta. “I went every day to the markets, and the market staff provided the information that was recorded in their receipt books.” The objective of the study was to obtain information that could be used in campaigns to promote local foods, such as the nutrient-rich yellow-fleshed banana varieties.

While the majority of the banana varieties on sale were of the ‘Utin Menihle’ and ‘Utin Ruk’ strains, the less common but more nutritious yellow-fleshed strains still made up 12% of the stock. Coordinators of the study expect to see this number grow in the coming years as a result of an ongoing campaign to promote yellow-fleshed varieties and raise awareness of their health benefits. The study showed that, over the course of eight weeks, nearly 22 tonnes of bananas were purchased from farmers by local markets—an impressive figure in light of the fact that the study took place during the slow summer months.

Projects like the Pohnpei Banana Market Study are important because they provide current data on locally marketed foods. Over the long term, these data can be used to track the distribution of local crops and to raise awareness of those varieties that appear to be struggling. In 1998, for instance, the ‘Karat’, which is today the State Banana of Pohnpei, could not be found in markets in the island state. Once word of its beta carotene and other provitamin A carotenoid content began to circulate, however, local people took action. Within one year—about the time it takes for a banana to fruit and produce—the ‘Karat’ began to reappear in markets and today it is available in no less than eight.

As a token of appreciation to all those involved in the inaugural Pohnpei Banana Market Study, Let’s Go Local t-shirts and photographs of their markets were handed out to market vendors. These gifts will serve as daily reminders of the fact that people lie at the heart of the effort to produce more diverse, nutritious crops for the Pohnpei region. According to the IFCP, “Pohnpeian community participation and empowerment is the cornerstone of our work.”

By Megan Brandeland, Bioversity International

Based on an article by Lois Engleberger that appeared in the Kaselehlie Press.

For further information, visit www.islandfood.org or contact Lois Engleberger nutrition@mail.fm

The Pohnpei banana market study revealed that seventeen different varieties of banana were sold in the Pohnpei region over a period of two months.
Introduction to the Special Section: Biodiversity and climate change

In the past century, the average surface temperature of the Earth has risen by about 0.74°C. While that may not seem much, the increase has already started to challenge the survival of many plant and animal species. In Australia and the Caribbean, rising sea temperatures are killing coral reef communities (see related story, p 23). Across the Arctic, polar bear populations are dying off as many of the ringed and bearded seals they rely on for food are wiped out. In the case of sea turtles, whose sex determination depends on temperature, many more females are being hatched than males. As we are already seeing, the extinction of organisms that cannot adapt quickly to changing environmental conditions leads to permanent, irreversible changes in valuable ecosystems across the globe.

The challenge of this special issue of GeneFlow is to demonstrate to our readers how climate change has and will continue to affect biodiversity, as well as how biodiversity, in turn, can help to mitigate the effects of climate change.

For hundreds of millennia, changes in temperature have been closely tied to changes in the concentration of atmospheric carbon dioxide. Most scientists attribute this relationship to the greenhouse effect, a naturally occurring process that is needed to keep the Earth warm and habitable. Greenhouse gases like carbon dioxide, water vapour and ozone allow sunlight to enter the atmosphere, but prevent heat from leaving. In recent decades, however, the burning of fossil fuels such as oil, gas and coal, coupled with the loss of forests and changes in farming practices brought about by the demands of rapid population growth, have resulted in the highest concentrations of greenhouse gases in 400 000 years.

The elevated levels of greenhouse gases now present in our atmosphere pose different threats in different parts of the globe. In coastal areas, for example, rising sea levels due to melting ice caps and glaciers threaten wild fish stocks and ponds. Meanwhile, increases in both the frequency and intensity of extreme weather events such as drought, storms and flooding are projected to be felt most strongly in tropical regions. Changing rainfall patterns and rising temperatures in sub-Saharan Africa—where FAO reports that 95% of cropland is rainfed—will be devastating to the yields of rural farmers.

The risk that climate change poses to biodiversity warrants special attention. Global warming creates a negative feedback loop for biodiversity: as biodiversity loss increases, so do opportunities to use it to combat climate change. More than simply reducing the number and variety of organisms inhabiting a specific region, climate change has the potential to wipe out crucial agricultural biodiversity that may help farmers cope with shifting environmental conditions. A prime example of this can be seen in the loss of the wild relatives of crops, which are a crucial source of genes for traits such as drought tolerance and pest resistance. These traits will be sorely needed in the future. Yet one study predicts that by the year 2055, nearly a quarter of the populations of several wild species of cowpea, groundnut and potato will be extinct.

While many people assume that the solution to climate change lies solely in the reduction of greenhouse gas emissions or the increased uptake and storage of carbon, it could be that the most promising solution to this complex problem lies in the conservation and use of biodiversity. Each species of plant or animal...
in a given ecosystem occupies a different niche. Because every organism is adapted to a unique set of environmental conditions, the greater the total number of species occupying a particular area, the more will be able to survive climate-induced stresses. A farmer who plants only one type of crop, for example, is in trouble if that crop cannot adapt quickly enough to changing conditions.

These simple principles have led many individuals and organizations to invest in research dedicated to making the best of biodiversity—that is, to increasing the number of species occupying a given area and to helping existing plants and animals to better adapt to the anticipated changes in climate. For example, researchers are developing flood- and drought-resistant crop varieties that may help poor rural farmers combat famine if unexpected weather events arise. Another project employs computer modelling strategies that superimpose climate change data with information on the current distributions of various plant and animal species. The goal is to use this information to decide what species will thrive best in which environments.

机构政策旨在保护既丰富多样的地区，又是特别对气候变化敏感的地区，也被提出作为应对问题的解决方案。虽然生物多样性与气候变化之间的联系开始在近年来获得更多的关注，但这种关注主要集中在科学和政策领域。公众对生物多样性可以缓解气候变化影响的潜力并不了解。然而，气候危机已经迫在眉睫。我们鼓励我们的读者，与家人和朋友分享以下故事。让他们知道减少能源消耗和回收利用并不是他们唯一能够做的来帮助的。他们也可以通过消费本地市场特有的水果和蔬菜，确保更少常见和潜在受到威胁的植物物种的安全。我们希望这些故事能说服你不仅欣赏生物多样性在缓和气候变化影响方面的作用，而且也要做些什么。

By Megan Brandeland, Bioversity International

Disappearing pollinators

“If the bee disappears from the surface of the earth, man would have no more than four years to live. No more bees, no more pollination, no more plants, no more animals, no more man.” — Albert Einstein

While it is debatable whether or not Einstein actually made this foreboding remark, it indicates the critical importance of pollinators for food security and the dangers that entire ecosystems face when the number of pollinators begins to shrink. Yet decreasing populations of pollinators, such as bees and butterflies, have been documented in both North America and Europe—principally because of habitat changes due to warmer weather. This poses a threat to crop productivity and crop conservation.

Warmer temperatures obstruct migratory patterns for pollinators and destroy their habitats, leading to a decline in pollinator species and crop pollination.

Around the world, fruit, nut and vegetable crops depend on pollinators for seed production. As pollinators travel from plant to plant collecting nectar for their energy source, they transfer pollen, which fertilizes the female parts of other plants. With higher temperatures, pollinators will have to react to new climatic patterns and the consequences for the crops that depend on them could be dire. Warmer temperatures obstruct migratory patterns for pollinators and their habitats, leading to a decline in pollinator species and crop pollination.
Many beekeepers point to higher regional and local temperatures as the cause for the recent outbreak of colony collapse disorder in the United States of America, which has resulted in the disappearance of millions of bees. Instead of returning to their colonies, scientists suspect that the bees are dying in the fields, possibly due to stress, exhaustion or starvation. The climate crisis has created volatile temperatures in North America and has increased the dry periods that disrupt nectar flow, which in turn disturbs the bees’ food supply. The outbreak has caused bee losses of 30 to 60% on the west coast of the USA and up to 70% in parts of the east coast and Texas. Twenty-four states across the country have been affected.

A Cornell University study has estimated that honeybees annually pollinate more than US$14 billion worth of seeds and crops in the USA, mostly fruits, vegetables and nuts.

Scientists are working to determine the exact cause of the puzzling phenomenon. Elsewhere in the world, cases of missing bees have been reported but have not been definitively attributed to be colony collapse disorder. In general, however, it is safe to say that increases in habitat loss around the world are threatening pollinator populations and the ecological services they provide.

While humans may be able to adapt over time to changes in habitat or temperature, climate change poses an immediate threat to creatures with more sensitive life cycles, such as pollinators. The recent loss of bees in the USA is a reminder of the interdependence of the ecosystems we inhabit and the need to protect even the smallest links in these systems.

By Candice Chow, Bioversity International

Adapted from ‘Honeybees Vanish, Leaving Keepers in Peril,’ New York Times, 23 February 2007, and information from the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA).

Climate change threatens wild relatives of key crops

Wild relatives of crops such as potato, cowpea and groundnut are at risk of extinction, threatening a valuable source of genes that are needed to boost the ability of the cultivated crops to resist pests and tolerate drought, according to a new study released by scientists of the Consultative Group on International Agricultural Research (CGIAR). The culprit is climate change, the researchers said.

The study found that in the next 50 years as many as 61% of the 51 wild groundnut species analysed and 12% of the 108 wild potato species analysed could become extinct as the result of climate change. Most of the wild potato and groundnut species that remained would be confined to much smaller areas, further eroding their capacity to survive.

“Our results indicate that the survival of many species of crop wild relatives, not just wild potato, groundnuts and cowpea, are likely to be

A bee on a bottle gourd (Lagenaria spp) flower. Bees can enhance the productivity of agricultural systems by improving the pollination of crops.

A bee on a bottle gourd (Lagenaria spp) flower. Bees can enhance the productivity of agricultural systems by improving the pollination of crops.
seriously threatened, even with the most conservative estimates regarding the magnitude of climate change,” said the study’s lead author, Andy Jarvis, an agricultural geographer with the International Center for Tropical Agriculture (CIAT) and Bioversity International. “There is an urgent need to collect and store the seeds of wild relatives in crop diversity collections before they disappear. At the moment, existing collections are conserving only a fraction of the diversity of wild species that are out there.”

The extinction of crop wild relatives threatens food production because these plants contain genes for traits such as pest resistance and drought tolerance that breeders use to improve the performance of cultivated varieties. The reliance on wild relatives to improve their cultivated cousins on the farm is expected to intensify as climate change makes it too hot, too cold, too wet or too dry for many existing crop varieties to continue producing at their current levels.

Though not apparent to the average consumer, the wild relatives of crops play an important role in food production. All food crops originated from wild plants. When they were domesticated, their genetic variation was narrowed significantly as farmers carefully selected plants with traits related to taste and appearance as well as to yield. When trouble arises on the farm—attempts by pests or diseases or, more recently, stressful growing conditions caused by climate change—breeders tend to dip back into the gene pool of the robust wild relatives in search of traits that will enable the domesticated variety to overcome the threat.

In recent years, genes available in wild relatives have helped breeders develop new types of domesticated potatoes that can fight devastating late blight and new types of wheat more likely to survive drought conditions. Wild relatives of the groundnut have helped breeders provide farmers with varieties that can survive a plant pest known as the root-knot nematode and a disease called early leaf spot. In fact, according to the report, more than half of new domesticated groundnut varieties developed in the last five years have incorporated traits from wild relatives.

According to Jarvis, the vulnerability of a wild plant to climate change can depend on its ability to adapt by, for example, extending its range slightly up a slope, even by only a few metres, to find cooler weather. “What scientists must do is identify which wild relatives are most likely to suffer from climate change and give them priority for conservation,” said Jarvis.

“The irony is that plant breeders will rely on wild relatives more than ever as they work to develop domesticated crops that can adapt to changing climate conditions,” said Annie Lane, the coordinator of a global project on crop wild relatives led by Bioversity International and co-author of the study. “Yet because of climate change, we could end up losing a significant amount of these critical resources at precisely the time they are most needed to maintain agricultural production.”

By Jeff Haskins, Burness Communications

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Wild peanuts – this one is in Bolivia—have already made substantial contributions of disease resistance to cultivated varieties.
Great Barrier Reef faces extinction

Australia’s Great Barrier Reef could become functionally extinct by 2030 as a result of massive coral bleaching brought about by climate change. This is one of many alarming conclusions reached by the Intergovernmental Panel on Climate Change (IPCC) in a report released this year.

Warmer waters have caused large-scale coral bleaching of the reef before. In 2002, an increase in water temperatures affected 60 to 95% of the reefs in the Great Barrier Reef Marine Park, according to a study by the World Wide Fund for Nature (WWF) and the Government of Queensland.

Coral bleaching occurs when environmental stresses, such as higher water temperatures or pollution, either cause the coral to reject the symbiotic algae that normally live on them or cause the algae to lose their pigments. The algae give the coral its colour, so when the coral is stripped of them it turns white. Recovery of the coral reefs is possible, but requires water temperatures to remain stable for at least ten years.

The report of the IPCC predicts that if measures are not taken to curb global warming, temperatures in Australia could increase by as much as 1 to 2°C by 2030, leading to annual coral bleaching. Massive coral mortality is a feature of many severe bleaching episodes.

The Great Barrier Reef is a UNESCO World Heritage Site, attracting over one million tourists annually, and one of the largest marine life systems in the world. The park’s vast network of reefs, about 2900 in total, is home to thousands of species. The death of the Reef would mean the loss of these species, as well as severe financial losses for the many people who depend on the reef for their livelihoods.

However, rising temperatures are not the only factors threatening the reef. Over-fishing and pollution are also affecting the health of the marine park in which it is located. Over the past 40 years, the numbers of nesting loggerhead turtles have declined by between 50 and 80% and the commercial harvest of sharks and rays has increased fourfold since 1993.
The first things most people think about when the subject of climate change comes up are rising temperatures and the gradual melting of polar ice caps. Images of disheartened polar bears clinging to receding ice floes and visions of catastrophic floods draw our attention away from the equally dismal dry state of affairs across much of Africa, west Asia, and the Near East, where millions of rural farmers rely on rainfed agriculture.

It is estimated that the greatest agricultural challenge of the next century will be to devise ways to produce more food with less water. One approach is to increase the efficiency with which plants use water. Before scientists can make use of the latest techniques in molecular biology to improve the water-use efficiency of common plant varieties, however, they must first figure out what traits are important for such efficiency and how best to identify them in the field and laboratory.

“The identification of traits for water-use efficiency can help us to tag the genes known to improve those traits, which in turn can help in the selection for improved genotypes,” said Abdallah.
Bari, scientist at Bioversity International’s regional office for Central and West Asia and North Africa. Some traits that may help plants to use water more efficiently and better handle drought include quicker seedling establishment, delayed senescence or leaf death, and early flowering. Although it can be a long and laborious journey from the classification of traits to the large-scale production of improved crop varieties, the development of less-thirsty versions of common cultivars will be worth the time and effort for the benefits they will provide to both small- and large-scale farmers across the globe.

The greatest agricultural challenge of the next century will be to devise ways to produce more food with less water

In response to a request by the Government of Morocco, researchers have begun to explore the diversity of fig and olive trees in hopes of identifying varieties that use water most efficiently. During a recent field experiment at the national research centre, scientists measured trunk width, annual shoot growth, leaf area, root features and various water parameters to see how fig trees respond to limited water conditions. They found that certain varieties respond significantly better than others—confirmation that many existing fig types already have genes that can help them tolerate water scarcity.

The most common variety of olive found in Morocco, ‘Picholine marocaine,’ provides further evidence of the untapped genetic potential of Mediterranean crops to meet water-scarcity challenges. It is not uncommon to find that each picholine tree in a single orchard has a slightly different genotype. This is encouraging news: the greater the number of genotypes, the greater the number of different traits available and the greater the chances that some of those traits will be useful in improving water-use efficiency. In the future, researchers hope to identify the varieties of picholine that are most tolerant of drought, and eventually to include drought-tolerance traits in other olive varieties.

Researchers at the Institut National de la Recherche Agronomique (INRA) in Morocco are also seeking to develop methods for speeding up the often difficult process of screening for drought-tolerance traits in almonds. Using high-quality image analysis, qualitative measurements like shell shape, colour and marking are converted into numeric values, making it much easier to detect even small differences among varieties. Combined with information on water-use efficiency and qualities like gas exchange rates, this computer-generated phenotypic data promises to make it quicker and cheaper to identify drought-tolerant varieties of almonds and other important Mediterranean crops.

Agriculture consumes more than two-thirds of the water used by humans. As the global population rises and demands for food increase, the development of less-thirsty crops will become ever more urgent. Climate change experts foresee that global temperatures will rise between 1.5 and 2.5°C. The fragile, arid lands of North Africa and the Near East will become even more vulnerable as a result of increasing water scarcity. Fortunately scientists have already taken a step in the right direction. By exploring the diversity of important Mediterranean crops to identify water-use efficiency traits, they are providing farmers with the ultimate insurance against climate change.

By Megan Brandeland,
Bioversity International
Water saving in olive orchards: partial rootzone drying strategy

The agricultural sector accounts for more than two-thirds of freshwater consumption worldwide; in many countries, irrigation is the principal water user. As water becomes increasingly scarce, the need to produce more food with less water poses an enormous challenge. Today, maximizing water use now has a higher priority than maximizing yield.

In Tunisia, annual rainfall has traditionally been diverted to an agricultural sector dominated by olive groves. Having seen a reduction in its annual rainfall in recent years, Tunisia has begun to experiment with irrigation techniques that will at once intensify olive production and improve water efficiency.

A technique known as partial rootzone drying was recently put to the test in the region of Sfax in central Tunisia. The strategy involves partly wetting the area around each olive plant. The hope was that by allowing some of the roots access to water, the plant would continue to grow despite the fact that the roots in the dry soil were instructing the plant to shut down.

Researchers assessed the extent to which partial irrigation affected the quantity and quality of the fruit and oil. They found that, although the trees grown using the partial rootzone drying technique saw yield reductions in the first year, during the second year yields did not vary much from the norm. This suggests that there are stages when the stress brought on by strategies like partial rootzone drying is not harmful to yield. In fact, in some cases the reduction in yield caused by water restriction was compensated for by an improvement in fruit and oil quality.

Tunisia is not the only country facing an increase in water demand from the agricultural sector as water resources shrink every day. The partial rootzone drying strategy may be one method by which we can maintain yield while improving product quality and water-use efficiency.

By M. Ghrab, K. Gargouri, M. Ayadi and H. Bentaher, Olive Tree Institute, Tunisia

Red alert for green fuel

A new UN report cautions against a rapid switch to biofuels and describes the potentially harmful impacts of using them on a widespread scale, including biodiversity loss, a contribution to global warming and high food prices.

The push for energy security is currently focusing on ethanol, as more and more countries around the world turn to ethanol as a fuel source. Ethanol is a renewable fuel produced by producing alcohol from the sugars and starch found in crops like maize, sugarcane and sugar beet. Less commonly used crops that can also be used to produce ethanol include rapeseed, oil palm, cassava, soybean, barley, wheat, rice, sorghum, sunflower and potato.

As countries strive to improve their economic growth while decreasing their dependence on oil imports and mitigating the impact of fossil fuels, they are promoting large-scale production of such energy crops and setting targets to increase biofuel use in transportation. In March 2007, European Union leaders pledged that 10%
of transport would run on biofuels by 2020, while the USA and Brazil (the two leading producers of ethanol) signed a cooperation agreement to support research on biofuels and the development of new technologies to promote their use.

Developing countries are readying themselves to meet the West's growing demand for biofuels by dedicating more and more land to the cultivation of energy crops. Already, rainforests in Asia are being cleared to make way for growing energy crops and the EU has announced plans to give aid to developing countries that grow energy crops for rich nations.

However, according to the UN report, “Sustainable Bioenergy: A Framework for Decision-Makers,” without strict environmental regulations, energy crop production can have negative impacts, particularly on climate change and food production, as well as irreversible consequences for agricultural biodiversity.

While the production of energy crops could help local farmers and boost the economies of developing countries initially, the UN report warns that “use of large-scale mono-cropping could lead to significant biodiversity loss, soil erosion and nutrient leaching”—significant retrograde steps in the long term.

Additionally, converting fields to the production of energy crops rather than food crops could reduce the quantity and variety of crops available for food, driving up global food prices. For example, the USA currently converts about 20% of its maize into ethanol and has already decreased its maize exports, hurting Mexicans who rely on the cheap imported grain. After prices soared in Indonesia, millions can no longer afford palm oil. In Germany, the replacement of barley with heavily subsidized energy crops means that the traditional October beer festival will cost consumers more than the customary hangover, with beer prices rising by an estimated 5.5%.

The cost of this beloved Italian staple has risen by an astonishing 20% as durum wheat is increasingly used as a source of biofuel.

As for its effect on climate change, the demand for energy crops has led farmers to clear forests and grasslands to make room for large plantations, removing natural carbon sinks—reservoirs that remove carbon dioxide, a major greenhouse gas, from the atmosphere. Energy crops are meant to absorb the same amount of carbon emitted by the use of biofuels, making the source carbon neutral (i.e. no carbon is added to the atmosphere). However, fossil fuel inputs used to grow, harvest and ferment bioenergy crops can add more carbon dioxide to the atmosphere than is being removed. When the whole life cycle of bioenergy crops is taken into account, using biofuels can have a greater negative impact on climate change than using gasoline.

Yet, biofuels can still be a viable energy source when produced sustainably, with appropriate mitigation of the potential risks. Produced on a proper scale, with food security and biodiversity in mind, biofuels can be a beneficial alternative to fossil fuels around the world, not just for transportation but for other utilities as well.

By Candice Chow, Bioversity International

For further information, visit the website of UN-Energy at http://esa.un.org/un-energy/
Indigenous peoples and climate change

Indigenous peoples survive in some of the most marginal and fragile ecosystems on Earth. For generations they have relied on traditional methods of caring for the plants and animals unique to their communities. In this way, they have played a crucial role in maintaining biodiversity in many delicate environments across the globe. As temperatures continue to rise due to global warming, the traditional knowledge of indigenous peoples, though often overlooked, will become vitally important in helping ecosystems adapt to climate change.

Around the world, biodiversity is a safeguard against catastrophe. By cultivating several different species of crop, each of which is adapted to slightly different environmental conditions, farmers are usually able to produce at least some kind of yield, even during bad years. Now scientists predict that some of the most diverse areas on Earth will experience the greatest effects of climate change, with potentially disastrous impacts on indigenous peoples. According to Jan Salick, Darrell Posey Fellow of Ethnoecology at the University of Oxford, UK, “As climate change threatens biodiversity, it simultaneously removes the major defence that indigenous peoples have against variation and change. Their primary tool for adaptation is at risk.”

Because indigenous peoples inhabit a wide variety of habitats—from mountains to islands and deserts—they will experience the effects of climate change in many different ways. People living in polar regions are projected to be the hardest hit by climate change. As ice sheets and permafrost melt, they will face hardships in hunting, fishing, travelling and building permanent homes. In alpine areas, the upward movement of tree lines and mountain plants will push many high-altitude plant species right off the top of the mountains. This could be devastating to the Tibetan and Andean highlanders who depend on their local flora for medicines, food and grazing. As weather patterns become more and more irregular, some people in temperate ecosystems will no longer be able to depend on the dry periods needed for preserving fish and seaweed.

An additional challenge is that many indigenous peoples have difficulty relating their own experiences to scientific explanations of what is happening to the climate. “Scientific causal explanations of climate changes may be seen as removed and abstract,” said Salick. “Invisible gases are being put out into the atmosphere by anonymous corporations and states.” An example of this disassociation between science and tradition is the traditional belief that harsh weather conditions are some sort of punishment for man’s misconduct. In Tibet, for example, it is believed to be the wrath of local deities that is to blame for hail and thunderstorms.

Humans have been altering the climate since long before the present fossil fuel era. Human activities like deforestation and agriculture have been blamed for increases in atmospheric carbon dioxide for the last 8000 years. Although the magnitude of the present changes in climate are much greater than anything experienced in the past, the ways in which indigenous peoples cope have remained much the same for hundreds, if not thousands, of years. As Salick pointed out, “Above all, in times of disaster and climate change, people depended on diversity—diversity of crops and varieties, of wild plants, and of environments.”

Using crop diversity is only one of the different means that local people use to deal with changing climates. Migration, irrigation, water conservation techniques, varying the locations and elevation at which plants are cultivated, and livelihoods adaptation have also proven successful. In the Kalahari Desert, for instance, lower precipitation has meant a shift from rain-fed agriculture to smaller-scale, manually watered gardening and a switch from cattle to goats. Meanwhile, unusual wet spells in British Columbia have led the Gitga’at people to shift from sun-drying their
With large-scale changes in climate looming, the future of our planet is anything but bright. At least, this is the opinion of Louis Verchot, lead scientist for climate change at the Kenya-based World Agroforestry Centre (ICRAF), a member institute of the Consultative Group on International Agricultural Research (CGIAR).

“We’re talking about large-scale human migration and the return to large-scale famines in developing countries, something that we decided 40 or 50 years ago was unacceptable and did something about,” Verchot told BBC News.

The CGIAR includes 15 centres, with the shared mission of securing the food security and improving the health and well-being of impoverished peoples around the globe. The centres are spearheading a host of initiatives aimed at creating heartier crops, using rapidly dwindling natural resources more efficiently and better managing greenhouse gases.

At a time when the amount of land available for rice cultivation is dwindling rapidly as a result of climate change, researchers at the International Rice Research Institute (IRRI) are working to boost rice yields by harnessing the power of the sun. Normally, plants get the energy they need to grow by taking in carbon dioxide and converting it to sugar—a process known as photosynthesis. However, photosynthesis in rice is less efficient than in other plants, such as maize, that use an extra chemical process for capturing carbon dioxide. In fact, almost 40% of the carbon dioxide absorbed by rice is lost in a wasteful process known as photorespiration. Scientists at IRRI hope to create more efficient rice varieties by transferring genes from maize and wild relatives of rice that suppress photorespiration.

In an effort to ease the pressure on farmers in the traditionally rain-starved West Asia and Northern Africa region, another CGIAR centre is helping to improve an age-old agricultural practice known as ‘water-harvesting.’ Researchers at the International Center for Agricultural Research in the Dry Areas (ICARDA) are evaluating numerous traditional water harvesting systems in hopes of sharing the most successful techniques with farming communities. They are also using technology to improve existing water-harvesting methods. In Jordan, for example, scientists have used polymer sheets to

“With climate change we’re definitely talking about a crisis, and it’s coming within our lifetimes”
minimize evaporation from the soil surface and coax the soil to store more water, thereby ensuring better water provision for the arid summer months.

In addition to initiatives aimed at soil, water and the molecular machinery of plants, other CGIAR-sponsored projects are encouraging scientists to keep their heads in the clouds—to address the management of greenhouse gases.

Poor farmers are some of the most crucial players in the removal of atmospheric carbon dioxide. Yet most of them are missing out on the benefits of carbon removal programmes because of their inability to calculate just how much carbon they are eliminating from the air. Farmers sequester carbon simply by growing crops, which take carbon dioxide from the air to grow. The carbon remains in the cells of the plant and in the soil; as long as the plant residues are not burnt and no-till agriculture is practised, the carbon remains undisturbed and is not released back into the atmosphere as carbon dioxide gas. Measuring this contribution can be difficult, however. Scientists from ICRAF, in conjunction with Michigan State University (USA), have developed a tool that promises to give rural farmers in developing countries the compensation they deserve. Based on highly accurate satellite imagery, this technology makes it easier to calculate how much carbon is being stored in forests and agricultural fields. In addition, it is much cheaper than on-the-ground verification methods and can be used from thousands of kilometres away. ICRAF believes that, with this technology, rural communities have the potential to receive millions of dollars in carbon credits.

Another pair of initiatives aimed at combating a different, and even more damaging, greenhouse gas is being coordinated by the International Maize and Wheat Improvement Center (CIMMYT) and the International Center for Tropical Agriculture (CIAT). Nitrogen is an essential nutrient for plant growth, but when farmers apply large amounts of nitrogen fertilizer to their crops, much of the nitrogen is converted by soil microbes into nitrous oxide—not only a harmful greenhouse gas but also a key contributor to the depletion of the ozone layer. With the help of a new handheld sensor developed by scientists at CIMMYT, farmers will be able to determine just how much fertilizer is needed, thereby improving yield economics and decreasing the amount of nitrogen wasted in the soil.

Meanwhile, scientists from CIAT and the Japan International Center for Agricultural Sciences have found a chemical in the roots of an African grass that can slow the conversion of the nitrogen in fertilizers into nitrous oxide. By slowing this conversion process, a greater percentage of nitrate—one of the forms in which nitrogen is available to plants—is retained. Consequently, farmers do not need to apply as much fertilizer.

The number and diversity of CGIAR-managed initiatives aimed at addressing climate change is encouraging, not only to the millions of impoverished farmers who stand to benefit directly but also to consumers across the globe who will be able to enjoy cleaner air, higher quality grains and produce and enhanced protection of valuable natural resources. By applying the latest technologies and working to preserve valuable indigenous knowledge and practices, the centres of the CGIAR are playing an important role in the fight against climate change.

“It’s much easier to solve a problem before we get to a crisis,” Verchot said. “With climate change we’re definitely talking about a crisis, and it’s coming within our lifetimes.”

By Megan Brandeland, Bioversity International
Tony Blair, former Prime Minister of Britain, described the Stern Review on the economics of climate change, released last year by economist Nicholas Stern, as "the most important report on the future published by the government in our time in office." Economists, scientists, development experts and politicians across the country hailed the report as a major step forward in setting out the actions needed to deal with climate change and in drawing a line under attempts to use economic arguments to avoid taking action.

The Stern Review is notable for the emphasis it places on adaptation to climate change rather than on mitigation. The Review talks about the need to accelerate adaptation efforts in developing countries, noting that "adaptation is essential to manage the impacts of climate change that have already been locked into the climate system."

Yet Stern stops short of calling for the conservation of the genetic diversity of crops. The conservation and availability of crop diversity was presumably beyond the scope of his report, even if it underpins some of his recommendations. And perhaps the economist would be surprised by how much at risk our most important natural resources may be.

Genetic diversity may be behind every meal eaten every day, by anyone anywhere, but its continued availability is too often taken for granted at the political and every other level. The Millennium Development Goals, responsible for shaping so much of development policy over the past several years, include objectives which require crop diversity for delivery, yet they also do not specifically call for the conservation of such diversity. This is symptomatic of the problems facing global public goods, which Stern seeks to redress with his recommendations.

Global public goods "are not abstract concepts; they are instruments to address real-world problems," according to a report by the International Task Force on Global Public Goods, a group of experts convened by France and Sweden to identify and prioritize the global public goods that are crucial for poverty reduction and development. "When they are not provided in adequate measure, global ills spread." Although not abstract, genetic diversity is not easily understood by non-specialists; and funding tends to flow to those promising an immediate result, as opposed to a more intangible insurance policy that will secure future food security.

The Global Crop Diversity Trust is raising an endowment that will protect against unpredictable funding for crop diversity conservation.

In China, research has shown how growing different varieties of rice in the same field can improve resistance to rice blast, a common disease affecting rice plants in the region.

Although not abstract, genetic diversity is not easily understood by non-specialists.
Special Section

Experts have warned that the effects of climate change will be felt sooner than was previously thought—several decades sooner, in fact. Professor Martin Parry, co-chairman of the Working Group on Impacts, Adaptation and Vulnerability of the Intergovernmental Panel on Climate Change (IPCC), recently warned governments that serious consequences, such as reduced crop yields and water shortages, are now inevitable. Parry was speaking at a meeting to launch a report by the IPCC in September 2007. As a result of the slow international response to the global climate crisis, Parry said “We now have a choice between a future with a damaged world or with a severely damaged world.”

Climate change and water and energy constraints are all major challenges to agriculture in a world in which both cereal yields and per capita production are already stagnating and global food stocks are at their lowest since the early 1970s. It is equally true, but grabs fewer headlines, that as crop diversity is lost, options and solutions to these problems are lost for ever.

Agriculture is the economic foundation of most countries and the most likely source of economic growth for developing countries. Growth is most rapid where agricultural productivity has risen the most, and the reverse is also true. Agriculture’s part in fighting poverty is complex, but without the genetic diversity found in crops and their wild relatives it will never fulfill its potential. Crop diversity is one of humanity’s most potent weapons in the fight against hunger and poverty and in the struggle to respond to climate change. Yet you could be forgiven for thinking it is a secret weapon.

By Julian Laird, Global Crop Diversity Trust

Donors are stepping forward with generous support for the Trust, yet the low profile of the issue relative to its importance continues to be a challenge. This was brought home recently in the US House of Representatives Agriculture Committee, when Congressman Dennis Cardoza introduced an amendment on crop diversity conservation with the words “The Global Crop Diversity Trust may be one of the most important international organizations many of you have never heard of.”

According to the IPCC report, by 2020 up to 250 million Africans may be left short of water, while access to sufficient food will be “severely compromised.”

A global warning

Children among a diverse stand of the Andean grain Cañihua, in Sillustani, Juliaca, Peru.

Live Earth’s seven-point pledge

1. To demand that my country join an international treaty within the next 2 years that cuts global warming pollution by 90% in developed countries and by more than half worldwide in time for the next generation to inherit a healthy earth.

2. To take personal action to help solve the climate crisis by reducing my own CO₂ pollution as much as I can and offsetting the rest to become ‘carbon neutral.’

3. To fight for a moratorium on the construction of any new generating facility that burns coal without the capacity to safely trap and store the CO₂.

4. To work for a dramatic increase in the energy efficiency of my home, workplace, school, place of worship and means of transportation.

5. To fight for laws and policies that expand the use of renewable energy sources and reduce dependence on oil and coal.

6. To plant new trees and to join with others in preserving and protecting forests.

7. To buy from businesses and support leaders who share my commitment to solving the climate crisis and building a sustainable, just and prosperous world for the 21st century.

For more information, contact Julian Laird j.laird@croptrust.org or visit the Trust’s Web site at http://www.croptrust.org

To sign the pledge, visit: www.climateprotect.org/pledge
How climate change will affect the world

- If the average global temperature rise exceeds 1.5 to 2.5°C, 30% of animal and plant species will be at risk of extinction.
- In Brazil, climate change will cause losses of 24% of 138 tree species.
- In West and Central Africa, climate change will cause agricultural losses of up to 4% of GDP.
- In the Mediterranean, there will be an increase in forest fires, reduced water and increased drought.
- Northern Europe will be subject to waterlogging, increased winter storms and coastal flooding. London risks extreme incidents of flooding.

Source: The Guardian, 19 September 2007

For further information about Live Earth, visit http://www.liveearth.org

A new report by the Intergovernmental Panel on Climate Change warns that the effects of climate change will be felt several decades sooner than was originally expected.

Special Section

A entertainment event ever held brought the climate crisis to the attention of an estimated 2 billion people around the world. Live Earth took place over 24 hours on seven continents and was broadcast live on television, radio and the Internet.

“We created an unrivalled outreach mechanism to touch an unprecedented number of people with Live Earth’s message,” explained Live Earth Founder, Kevin Wall.

Live Earth was organized by the Alliance for Climate Protection, a charity set up by former US Vice-president Al Gore to “persuade people of the importance, urgency and feasibility of adopting and implementing effective and comprehensive solutions for the climate crisis,” according to its Web site. In early 2007, Gore won an Oscar for his documentary film about the climate crisis, An Inconvenient Truth. In late 2007, he and the IPCC were together honoured with the Nobel Peace Prize.

At the concert, some of the world’s richest people, including stars like Madonna and Angelique Kidjo, rubbed shoulders with some of the world’s poorest people, such as special guest Sharon Looremta, a young woman from a remote Maasai village in Kenya. “We lived for many years with lots of animals and food, but with time we have become poorer than any other human beings on earth,” Looremta said from the Live Earth stage at Wembley Stadium in the UK. “Our rivers have dried up. Our vegetation is drying up too because we do not get the rains we used to. Women cannot work and children are stopped from going to school because they must walk long distances to look for water.”

The show did more than raise awareness. People watching were urged to sign a seven-point pledge by text or online, committing themselves to planting trees, buying from green businesses and making a dramatic increase in their personal energy savings. The pledge also includes a commitment to put pressure on governments to join an international treaty that will cut global warming pollution by 90% in developed countries.

Raising awareness of ways that individuals can work to counter climate change, and mobilizing public support for such initiatives, is critical, but the report released by the IPCC stresses the importance of adaptation. “Mitigation has got all the attention, but we cannot mitigate out of this problem,” said Parry. The IPCC report urges developed nations to help countries in the developing world adapt to climate change and its predicted impacts, through the development of drought-resistant crops and improved water management technologies.

According to the report, by 2020 up to 250 million Africans may be left short of water, while access to sufficient food will be “severely compromised”. Ensuring that the world’s most vulnerable populations can survive the effects of climate change will depend on the commitment of governments to invest in solutions that can help them to adapt.

By Cassandra Moore, Bioversity International

Based on ‘How climate change will affect the world,’ by David Adam, a special report that appeared in The Guardian on 19 September 2007.
Have you gone to the beach and wished that the water were just a few degrees warmer? That it was slightly less of a shock to your senses when you took that first dip? If climate change has anything to do with it, your wish may soon come true, with dire consequences for the environment—especially if you plan on visiting a European beach.

Europe is endowed with a wide variety of ocean and marine environments. From the near-freezing waters of the Arctic to the mild waters of the Mediterranean, European seas are home to plant and animal diversity as well as being vital to the fishing, shipping and tourism industries. Unfortunately, today, seas across Europe are in danger. Europe is warming at a faster rate than the global average, with implications for its marine environments. Most of Europe’s seas have already begun to show signs of climate-induced changes, such as higher temperatures and shifts in species composition. The changes are projected to intensify in coming years.

All European seas have at least one thing in common. In every case, climate change has caused resident species to migrate northward in order to escape rising sea temperatures. This movement typically resembles the movement of plants and animals that is occurring on land, though the speed and direction along which it occurs varies.

In open seas southern species are projected to travel considerable distances into more northerly seas. Atlantic species, for example, will gradually creep into the Barents and Nordic seas, while subtropical species will overtake temperate ones in more southerly areas.

The situation in enclosed seas like the Mediterranean and the Baltic is slightly different because movement of species is limited. In an attempt to reach cooler climates, the northernmost species in enclosed seas will ‘shore up’ so to speak, meeting their ends on northern coastlines. Species further to the south, meanwhile, will try to get around the constraints of life in an enclosed environment by seeking new habitats in an eastward to westward direction.

Another distressing consequence of rising sea-surface temperatures is a reduction in sea ice cover. In northern seas like the Arctic and Barents, the loss of sea ice threatens to alter the habitats to which indigenous species such as fish, seals, whales and polar bears have spent centuries adapting. In the next 100 years, scientists predict that many northern European seas may be entirely free of ice during the summer months.

The melting of ice in the Arctic is not only a threat to the biodiversity of native species but also may be involved in a positive feedback loop whereby less ice cover leads to less reflection of the sun’s rays, more absorption of heat into the oceans and atmosphere and further warming. At the same time, the lighter, fresher water produced by the melting of Arctic ice may disrupt global ocean currents such as the Gulf Stream.

Climate-induced changes have been affecting the ecosystems of European seas for longer than many people realize. For example, they are assumed to be responsible for the 1930s collapse of the herring population in the English Channel. More recently, warmer waters have meant that fewer and fewer salmon are returning to north-eastern Europe to spawn.

When changes like these affect commercial marine species, the international fishing industry faces a whole new set of challenges. As major commercial species make their way into new waters, for example, fisheries treaties between neighbouring countries may need to be amended. Meanwhile, the issue of over-fishing will need to be addressed as fishers attempt to get the same amount of fish from a stock that has been reduced as a result of climate change.

The seas in Europe and across the globe play a vital role in regulating climate, absorbing greenhouse gases, providing habitats for diverse species of plants and animals and contributing to the life support systems of the planet. The tide is turning.

Most of Europe’s seas have already begun to show signs of climate-induced changes
For over 50 years, mushroom aficionado Ted Gange travelled around southern England—recording the appearance of mushrooms and toadstools in the soil, on tree roots and decaying wood. Though this may seem like a slightly peculiar vocation, for Gange the time invested has led to great returns. With the help of his son, Alan, a professor of ecology at the University of London, Gange’s decades of meticulous work have demonstrated for the first time the impact of rising temperatures on organisms that mature during the autumn months. His findings have recently found their way into the distinguished journal *Science*.

Until now, little attention has been paid to the effects of climate change on the timing of autumnal maturation. As a result, the dramatically altered fruiting patterns of many important species of fungi have largely been overlooked. Fungi play a crucial role in decomposing litter and debris, cycling nutrients throughout ecosystems, safeguarding plants against environmental change and as food sources for animals. Thanks to the Ganges, records on the fruiting patterns of 315 species of fungi over the last half-century are now available for further research.

Over a period of six months, Professor Alan Gange performed statistical analyses on more than 52,000 fungal fruitings from about 1,400 different areas. He found that the species that typically fruit early have been fruiting an average of 8.6 days earlier each decade and those that fruit late are fruiting around 7.5 days later each decade. These rates of change are higher than any rates previously reported, including those for fish, mammals, birds and plants. In addition, the length of the full fruiting period has, on average, more than doubled—from 33 to 75 days—over the past 50 years. Some fungal species have even begun to fruit twice a year—a phenomenon previously virtually unheard of.

The important discovery is that these changes in fruiting patterns have been occurring in conjunction with changes in temperature and rainfall patterns. A look into the history books shows that both August temperatures and October rainfall in the Salisbury area have been increasing steadily over the

## On the flip side: fungi reap rewards from climate change

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Calvatia gigantea, the famous giant puffball mushroom now fruits earlier than it used to.

past 56 years. Together, these have caused the doubling in the length of the fruiting season.

“I looked up the data on the average temperature for February in southern England during the 1950s, and it was 3.5°C,” said Professor Gange to BBC News. “In the current decade it’s 5.2°C. We used to get cold days and nights in February, which caused fungi to be dormant; these days we get very little of that.” This explains why some species now fruit twice a year—it is no longer cold enough in spring to slow their growth.

The connections between fungal fruiting patterns and climate change are also linked to patterns in the availability of nutrients to trees in deciduous forests. Fungi living in forests often act as a sort of intermediary, intercepting nutrients en route to trees and using them to produce the characteristic fruiting bodies we recognize as mushrooms and toadstools. Because fungi in many deciduous forests are fruiting earlier, the timing of nutrient availability to the trees in these forests must also be changing with climate.

A lifetime of work by Ted Gange has not only resulted in a great resource for studying some of the effects of global changes in climate, but has also led to an increased awareness of the impacts rising temperatures might have on plants and animals in the future.

By Megan Brandeland, Bioversity International

Biofuels are receiving lots of attention these days. Countries see them as a way to ease the ever-increasing costs of importing fossil fuels while at the same time combating global warming and reducing urban air pollution. But there is also concern that the bioenergy revolution could marginalize the poor, raise food prices, reduce biodiversity and degrade the environment (see related story, p.26).

Alarm bells have been ringing. Increased purchases of maize for bio-ethanol processing in 2005 quickly forced world maize prices up, leading to angry demonstrations in Mexico as the price of tortillas skyrocketed the following year. In early 2007, Presidents Chavez of Venezuela and Castro of Cuba traded angry accusations with the USA’s President Bush about who was harming as opposed to helping the poor through their biofuels policies.

The potential environmental impacts of biofuels are also a major worry. The increasing demand for palm oil for biodiesel use is motivating the clearing of rain forests in South-East Asia that are the last refuges of endangered species such as the orangutan. Other
M. Woltering/ICRISAT

parts of the developing world are equally at risk. A riot erupted in Kampala, Uganda, in April 2007 over plans to clear forest reserves to plant sugar-cane for bioethanol; three people died.

The common assumption that biofuels are bad news for the poor and the environment should not go unquestioned. Remunerative biofuel enterprises could provide the poor with the means and motivation to invest in their environments rather than to degrade them through practices like deforestation. The partnership between the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Rusni Distilleries Ltd. in Andhra Pradesh, India, to develop ‘sweet sorghum’ as a bio-ethanol crop is a case in point.

Sweet sorghum, a dryland crop, has high sugar content in its stems, much like sugar-cane. Unlike sugar-cane, however, sweet sorghum also produces a food grain when it is grown to maturity before harvesting. Although sugar yield per hectare declines about 40% when the crop matures, the loss is compensated by the value of the grain. Sweet sorghum can be grown without irrigation, greatly reducing production costs relative to sugar-cane, which requires well-watered conditions. The crushed straw after the juice has been extracted also makes excellent livestock feed.

Elevating sorghum from a subsistence crop to a commercial biofuel crop can sharply raise farm incomes as well as food, feed and fuel outputs, rewarding better land care. In its pilot tests, Rusni observed that its contracting sweet sorghum growers (2000 small-scale farmers projected for 2007) generally double their incomes. Rusni also provides credit for inputs and an assured output price, and has formed links to research and extension organizations such as ICRISAT to provide improved seeds and crop management techniques.

The breeding of sweet sorghum varieties along with more fertilizer and other management inputs promises to boost productivity and incomes within the next 3 to 5 years in India. If biofuels could become the stimulant for the introduction of hybrids in Africa as well, their benefits to the poor could be enormous. This option is currently being explored. Jatropha spp. and Pongamia spp. are two oilseed tree species suitable for moderate to low-rainfall degraded wastelands that are much less environmentally sensitive than the forest zones required for oil palm. Development projects in India are establishing incentives and policies that give poor landless tribal groups access to these wastelands for planting, cultivating and harvesting these trees. These degraded areas are simultaneously rehabilitated by the addition of nutrients and organic matter and the harvesting of rainwater.

Pro-poor, environmentally responsible biofuels development will not happen without conscious efforts. Research and development organizations, in close concert with government, NGO and private sector agencies, can help transform biofuels into a golden opportunity for the poor.

By Mark Winslow, ICRISAT

Jatropha, widely grown in Mali as a garden shrub, yields oil-rich seeds suitable for the production of biodiesel.

High x High ICSA 654 x HSNR 93026-2

Hybrid sweet sorghums are being bred simultaneously for food and biofuel production.
Early in 2007, a severe frost settled over northern Peru. The subzero temperatures devastated the potato crop on which most of the population rely for their food and livelihood. The frost was completely unexpected. Not even the oldest farmers could remember having experienced such a severe frost in January. However, such extreme weather events will be one of the effects of climate change and this was a good practice run.

As Petronila Neyra Apasa looked out over her property at the fields of dead and stunted plants, she knew that it was not a total loss. Petronila plants many different varieties of potatoes in her fields, each of which thrives under slightly different conditions, a practice passed down by generations of Andean farmers before her. In this way she can be sure of getting at least some food from the land, no matter what the weather does.

Ensuring a good diversity of crops and crop varieties in their fields is not the only practice that modern-day Peruvian farmers inherited from their Incan ancestors. Other traditional practices have proven invaluable as well. On a remote farm two hours drive outside Juliaca in northern Peru, Lorenzio Mamani pointed to the thick stone walls surrounding the small plots where he grows seed potatoes and explained how they protect the plants at night by storing heat. The evidence could not be more graphic. The potato plants inside these pirkas were green and healthy while the majority of those in the open fields a mere three metres away were burnt by frost.

Petronila Apasa and other local Andean farmers are part of a project called Andean Agriculture in the Altiplano (ALTAGRO), which is run by the International Potato Center (CIP) and funded largely by the Government of Canada. Currently, ALTAGRO is working to raise incomes and increase food security in the altiplano, a high-altitude plain between Peru and Bolivia, which happens to be one of the poorest regions in the world. Potatoes are a crucial element in the lives of the people here, especially the nearly 2.25 million that live in poverty.

With the implementation of the ALTAGRO project comes a shift in numerous communities throughout the altiplano from a peasant economy to a market-based economy. “ALTAGRO encompasses the economic, biophysical, socio-cultural and environmental aspects of market-oriented development,” said CIP’s Carlos Leon-Velarde, who has been working with the project since it began. “The shift to a market economy will benefit not only the indigenous people of the altiplano but also consumers in both Andean and international markets.”

Because they depend directly on the material they plant to eat and to live, Andean farmers truly understand the value of their biodiversity.

CIP is applying its research technologies, in partnership with a non-governmental organization called Centro de Investigación de Recursos Naturales y Medio Ambiente (CIRNMA), to establish a model for rural development based on a comprehensive view of sustainable agriculture. One of the key components of the model is the integration of current agricultural technologies into existing farming systems, a move that would give local farmers the opportunity to play an active role in the on-site conservation of potato diversity.

Because they depend directly on the material they plant to eat and to live, Andean farmers truly understand the value of their biodiversity. Unfortunately, they are also predicted to be some of the hardest hit by climate change. Already heavy rains waterlog the soil and encourage potato weevils and diseases like Late blight. Frost kills the plants; and drought reduces yields. This is why work by CIP and local communities to conserve hundreds of varieties of native potatoes in situ is becoming increasingly important. In an area as poor as the altiplano, every potato matters.

By Paul Stapleton, CIP
What YOU can do to fight climate change

Plant a tree
A single tree will absorb one tonne of carbon dioxide over its lifetime. And a tree that shades a house can reduce the energy required to run the air conditioner and save an additional 90 to 900 kg of carbon over its lifetime.

Watch what you eat
• Buy locally grown and produced foods, and support local farmers’ markets
The average meal in the USA travels nearly 2000 km from the farm to your plate. Buying locally will save fuel and keep money in your community. Farmers’ markets reduce the amount of energy required to grow and transport the food to you by 20%.

• Buy fresh foods instead of frozen
Frozen food uses 10 times more energy to process, store and transport.

• Eat less meat
Methane is the second most significant greenhouse gas, and cows are one of the greatest methane emitters.

• Protect and conserve forests worldwide
Forests store carbon. When forests are burnt or cut down, their stored carbon is released into the atmosphere. Deforestation now accounts for about 20% of carbon dioxide emissions each year.

• Buy organic foods as often as possible
Soils on organic farms capture and store much more carbon dioxide than do soils on conventional farms. The use of fertilizer on conventional farms stimulates rapid decay of organic matter, releasing carbon dioxide. If we grew all of our maize and soybeans organically, we would remove over 250 million tonnes of carbon dioxide from the atmosphere!

• Buy recycled paper products
It takes 70 to 90% less energy to make recycled paper than to make paper from fresh lumber. Using recycled paper prevents the loss of forests worldwide.

To find more ways to mitigate climate change, visit:
• http://www.climatecrisis.net/takeaction/
• http://web.conservation.org/xp/CIWEB/programs/climatechange/
• http://www.stopglobalwarming.org

Compiled by Candice Chow, Bioversity International

A single tree absorbs one ton of carbon dioxide over its lifetime.

Climate change will increase the number and frequency of severe storms.
A semi-aquatic plant, rice thrives in the wettest of agricultural environments. Nevertheless, most rice varieties will be heavily damaged and even die if they remain underwater for more than a few days. And only a very few varieties growing in the vast rainfed lowland areas of Asia can tolerate 2 to 3 weeks of submergence and recover rapidly when the water subsides. This often spells disaster for thousands of impoverished Asian farmers, whose crops are unable to withstand the flooding that regularly wreaks havoc on their fields.

Now, relief may be at hand for rice farmers. Researchers at the International Rice Research Institute (IRRI) and the University of California (UC Riverside and UC Davis) have discovered a gene for submergence tolerance from a variety of rice known as FR13A. Looking to the future, researchers hope that this discovery will allow farmers to produce high yields even in the face of flooding.

Submergence tolerance has been a breeding focus at IRRI since the early 1970s, when FR13A and other tolerant varieties were first crossed with high-yielding semi-dwarf varieties. Semi-dwarf types are shorter than most traditional varieties and thus resistant to damage from rain and wind. However, farmers never adopted the varieties produced by these crosses either because they did not like their taste or because the varieties were ill-suited to the local production systems.

“For half a century, researchers have been trying to introduce submergence tolerance into the commonly grown rice varieties through conventional breeding,” said rice geneticist David Mackill, who leads the Rainfed Environments programme at IRRI. “Several traditional rice varieties have exhibited a greater tolerance of submergence, but attempts to breed that tolerance into commercially viable rice failed to generate successful varieties.”

That all changed when scientists began incorporating the Sub1 (short for Submergence 1) gene, discovered during the 1990s, into commercial rice varieties. With the help of the latest technology, a group of IRRI scientists produced successful submergence-tolerant versions of three widely grown rice varieties: Swarna and Samba Mahsuri from India and IR64 from IRRI. Not only do these strains survive extended periods of submergence, they also retain many other desirable properties of the original strains—including high yield, pleasant taste and good regional adaptation. Some have even been shown to produce greater yields than the original strains.

The success of the Sub1 strains has spurred the current development of commercial submergence-tolerant varieties in Bangladesh, India and Lao PDR. Although this work has taken some time to come to fruition, it has certainly been worth the wait. These new varieties possess some of the most advanced features farmers could want in a strain of rice. Some estimate that, in addition to helping farmers cope with a challenge that has faced them for generations, they have the potential to benefit over 70 million of the world’s poorest people.

By Megan Brandeland, Bioversity International

Based on information provided by David Mackill, Head, Plant Breeding, Genetics, and Biotechnology Division, IRRI (d.mackill@cgiar.org).

For further information, visit http://www.irri.org
Balanced on a wing: bird diversity and the cultivated floodplain

Cultivated floodplains represent the quintessential link between land and water. Characterized by low, flat areas of cropland that are susceptible to submergence by nearby rivers, lakes and streams, these are regions with potential for both high agricultural productivity and as a habitat for a wealth of wildlife. It may be in the cultivated floodplains that the balance between high-level rice production and biodiversity conservation is to be found.

Bringing floodplains into agricultural production generally requires flood control and drainage to manage water levels. These modifications, along with ploughing and land levelling, radically alter the ecology of the ecosystem and tend to eliminate much native vegetation. From a wildlife conservation perspective, converting wetlands to agricultural fields too often represents habitat simplification that favours the needs of one species—the crop—at the expense of many others.

While at first the goal of achieving high levels of food production while maintaining wetlands biodiversity may seem hopeless, International Rice Research Institute (IRRI) ecologist K.L. Heong maintains that a solution lies in the way we think about agricultural systems.

“If our goal is to optimize natural resources to maximize grain production or the number of bird species, for example,” said Dr. Heong, “we perceive the world quite differently than if we say we want to optimize the totality of services that humanity derives from an ecosystem over a period of many generations.”

One way we can understand how human activities influence ecosystems is by using indicator organisms—in particular, the kind with feathers. Birds are a very diverse group, with many species that depend on different resources for food, shelter and reproduction. This means that changes in abundance of a particular bird species can give us clues to specific things that have changed in the overall environment.

The loss of native vegetation resulting from the conversion of wetlands to agricultural areas poses a major threat to birds today. While there can be large numbers of birds in rice fields, there generally aren’t nearly as many species as are found in undisturbed wetlands. According to Tim Fisher, a prominent Philippines-based naturalist, “The bird species we see in rice fields tend to be the ones that are lucky enough to have an ecological niche that overlaps with some aspect of the rice system. Such species might do extraordinarily well because the system has essentially been optimized for them as well.” An example of this is the Eurasian tree sparrow, a rice pest that can eat large amounts of grain and which thrives in very high numbers in rice-growing areas throughout the Philippines.

Rare species, like the streaked reed-warbler, meanwhile, have proved quite sensitive to the conversion of wetlands into agricultural production areas. Breeding in China and wintering in reed-beds in the Philippines, this small bird is now rarely observed in Candaba marsh, a small municipality in the Philippines that has gradually been modified for rice production.

In an effort to protect species like the streaked reed-warbler, Candaba City mayor Jerry Pealayo established a 72-hectare bird sanctuary adjacent to the marsh. The sanctuary attracts some 500 local species and foreign visitors each year, boosting the local economy through increased employment and tourism. In addition to preserving biodiversity for bird lovers, there are numerous other human benefits resulting from the maintenance of wetlands. Healthy wetlands protect downstream areas by storing floodwaters during the wet season, recharging underground storage areas for water, and releasing the stored water during the dry season. Wetlands also act as biological filters by retaining and processing nutrients and pollutants.

While humans receive benefits from wetlands, the wetlands must in turn be managed appropriately by humans. “While we must
restore wetland habitat to effectively conserve bird biodiversity,” explained Dr Thomas Brooks, senior director of the Center for Applied Biodiversity Science in Washington D.C., “this alone won’t be effective unless the rice systems in the same landscape are managed in a manner that maintains an appropriate water flow regime into the areas within the system that are important to wildlife.”

This of course raises the question of whether high food production can co-exist with biodiversity.

According to Ruaraidh Sackville Hamilton, leader of the Genetic Resources Center at IRRI, it can. “In theory, judicious selection of the appropriate components of a biodiverse system can actually increase productivity by enhancing beneficial processes like the activity of the natural enemies of diseases and pests, and can increase the stability of production by buffering the impacts of climatic uncertainty.”

Brooks added that “The most authoritative study on this shows that, if the value of all environmental services is considered, conservation areas adjacent to agricultural production areas are generally worth 100 times the opportunity costs of establishing them.”

“When you look at very extensive wetlands,” said Sackville Hamilton, “they are actually quite homogeneous at the landscape level and it’s quite possible that when agriculture is introduced to the landscape in patches, it can actually increase the overall biodiversity of the system. This is because the farmed field is an entirely different ecosystem, providing additional niches for species that are not normally found in wetland ecosystems.”

By Greg Fanslow, IRRI
Edited by Megan Brandeland, Bioversity International

The Maya Nut Programme: safeguarding the forests and empowering women

Native to the rainforests of Central America, Mexico and the Caribbean, the fruit of the Maya Nut tree is a better source of nutrients than many foods grown on farms. And what is more, it has long been available when crops failed. As Jose Lira of Chinandega, Nicaragua, recalled, “When I was a child, there was a terrible famine that lasted five years. We had no food so the families went to the forest to gather Maya Nut to eat. We ate almost nothing but Maya Nut for five years and no one in the village died or even got sick. Maya Nut saved our lives.”

Today, the Maya Nut tree is danger of extinction. Extensive cutting for firewood and agricultural expansion over the last several decades nearly wiped out the tree from the forests of Central America. Fortunately, a chance meeting set off the chain of events that led to the creation of a programme to rescue the Maya Nut tree from extinction in Guatemala, Honduras, El Salvador, Mexico and Nicaragua.
American biologist Erika Vohman was first introduced to the Maya Nut tree while in the forest gathering food for animals at a Guatemalan wildlife rescue organization. Accompanied by a local man whose ancestors had eaten the nuts as a famine food, she was given the opportunity to try them for herself when he offered to prepare a nut soup for her. After this first taste, Vohman was determined to find out more and, upon returning to the USA, where she studied the nut, learned that the nutrient levels found in three of the most widely produced grains worldwide—corn, wheat and rice—paled in comparison with those of the Maya Nut. When she returned to Guatemala as part of a UN rural development programme, Vohman used this knowledge to help the impoverished residents of La Benedición village survive for three months with virtually no food and no crops other than the Maya Nut trees that grew naturally in nearby forests.

The Maya Nut (Brosimum alicastrum) is called variously the Ramón Nut, Breadnut, ujuxte, mojo, ash, ojite, capomo, pisba, masica and guaimaro. Yet while the name may vary from community to community, the uses of the Maya Nut are similar throughout the region. Traditionally prepared by boiling with salt, the Maya Nut has in recent years found its way into a variety of interesting dishes. Today, fresh Maya Nut is stewed and incorporated into tamales, pies, burgers, soup, sauces and more. And the sun-dried or roasted seeds, which taste like a combination of coffee and chocolate, are used in cakes, biscuits, cereal, pancakes, puddings and the like.

Working with local women, Vohman helped create the Equilibrium Fund, a non-profit organization with a mission to improve livelihoods in the region without destroying the environment. The objectives of the Equilibrium Fund are accomplished primarily through the Maya Nut Programme, a unique and highly successful project that focuses on women as caretakers of the family and the environment.

The goals of the Maya Nut Programme are ambitious: they include conservation; personal and community health and well-being, economic growth, and the empowerment of women. The Programme educates women about the potential health benefits and uses of the Maya Nut, while teaching them how to conserve the nuts and to market Maya Nut-based products such as ice cream, biscuits and other sweets.

Hundreds of participants have been motivated to create their own micro-enterprises to raise money for their families and communities. For example, several groups of women have invested their earnings in local Maya Nut tree nurseries in hopes of reforesting their villages with the trees.

Fans of the Maya Nut have even ventured beyond the immediate boundaries of their villages to instruct and empower their neighbours. incredibly productive, one Maya Nut tree can yield nearly 180 kg of food per year. Combined with the fact that the nuts are easy to process and do not rely on the use of chemicals, fertilizers or pesticides, it perhaps will come as no surprise that, since 2002, more than 150 000 new Maya Nut trees have been planted throughout Guatemala, Nicaragua and Honduras. For her efforts, Vohman was awarded the 2006 St Andrews Prize for the Environment, worth US$50 000.

Although the Maya Nut Programme is certainly having an impact, lack of funding remains a challenge. Until the project is able to scale up in size and achieve legal protection for the Maya Nut tree, this important resource will continue to be threatened throughout its range. Of course, difficulties like these have only served to encourage organizers of the programme to work even harder: 80 000 more trees were set to be planted in 2007 in hopes that this precious source of food and income will become even more difficult to ignore.

By Megan Brandeland, Bioversity International
Nature’s pharmacy: African herbals on the rise

The future of African herbal medicine is in question as the plants on which it is based fall victim to over-harvesting, deforestation and climate change. This spells disaster for the 80% of rural Africans who depend on medicinal plants in times of sickness or injury. Switching to expensive conventional drugs is not an option for poor people. Instead, new initiatives are focusing on protecting and studying traditional African medicinal plants.

The Medicinal Plant Incubator Project was recently launched in South Africa, where it is estimated that more than 350 species of plants are used for medicine. The primary mission of the project is to protect South Africa’s indigenous plants while ensuring that they remain available to the traditional healers and others who use them. Scientists will also study how the healing properties of these plants are affected by different growing conditions. In order to prevent over-harvesting of the plants, well-tended nurseries will be established, from which traditional healers can purchase a regular supply of the plants that they need.

The project is also educating local people in the importance of caring for the areas where plants with medicinal uses grow naturally. Project leader Erica van den Heever observed, “There are 40 000 traditional healers in Guateng. They harvest, harvest, harvest and don’t conserve.” Proper management of traditional herbals would probably lead to better yields and therefore cheaper prices, more variety and more widespread use. In addition, it will stimulate the local economy by increasing the number of job opportunities available through trading and harvesting.

With such a large proportion of Africa’s populations dependent on medicinal plants, the matter of quality and standards is crucial. In response, last year, the Association for African Medicinal Plants Standards unveiled plans for a Pan-African Pharmacopeia—a catalogue of native African plants with medicinal properties. Each entry includes a list of medicinal uses, general taxonomic information, a chemical profile, and safety and toxicity information. The Pharmacopeia will also include information on chemical tests that can be used to identify medicinal plants.

The first phase of the project is already complete and has resulted in the production of 23 profiles of plants, such as African ginger. Widely used in the treatment of coughs, colds and asthma, the rhizomes and roots of the African ginger plant are valued for their natural anti-inflammatory properties.

In addition to increasing the quality and reliability of information about African medicinal plants, the Pan-African Pharmacopeia hopes to enhance cooperation and communication between the academic and industrial sectors. This would make it easier for African communities of all sizes to have a share in a market that has until now been dominated by more familiar Asian herbal products.

Already, efforts to revive traditional African medicinal products have paid off in countries like Mali. With the help of scientists from the University of Oslo, Norway, this West African nation has upgraded its research on medicinal plants and has seen cooperation grow among conventional and traditional medical practitioners. As a result, the mainstream medical

Photo credit: B.S. Paulsen
EVOLTREE, a network of excellence established in April 2006, examines the evolution of biodiversity in forest ecosystems, exploring different levels of diversity—from genes to populations, species, communities and ecosystems—thanks to the cooperation of experts in ecology, evolutionary studies, genetics and genomics. The network is funded by the European Commission and builds on pioneering work of various European research groups, in particular the French National Institute for Agricultural Research (INRA), to understand the path of migration of forest tree species in Europe since the last glacial age. These studies constitute communities to invest more in the species that have greater potential for success. “We see a change coming,” said Professor Smestad Paulsen of Oslo University. “A lot of plants have been verified to have an effect. The World Health Organization acknowledges traditional medicine as vital to improving public health in developing countries.”

The work that is being carried out in Mali has done more than improve the status of traditional healers. It has fostered important links between Malian and European scientists and with the local villages that will benefit from their research. After studying the effectiveness of herbs used to treat everything from malarial parasites to stomach ulcers, scientists give feedback to the healers who first recommended them, thereby helping local communities to invest in species that have greater potential for success.

The future of African herbal medicines is looking much brighter thanks to projects like the Medicinal Plant Incubator Project and the Pan-African Pharmacopeia. As rural communities learn how best to conserve plants with medicinal uses and efforts are made to implement quality standards, millions of African people will gain easier access to the treatments they need. With time, these initiatives could not only improve the economies of rural African communities but also introduce African herbals to the rest of the world.

By Megan Brandeland,
Bioversity International

Based on ‘Hidden in the Herbs,’ Norwegian Centre for International Cooperation in Higher Education (http://www2.siu.no/vev.nsf/o/SIUs+publications-Global+Knowledge-Hidden+in+the+Herbs)
among the largest scale investigations of genetic diversity conducted on living organisms to date. They show that forest trees can survive considerable changes in their environment thanks to their genetic diversity.

“We want to identify the genes that control adaptation to environmental changes,” explained the coordinator of EVOLTREE, Antoine Kremer from INRA. Past studies have revealed that oaks have been re-conquering territories in the post-glacial period, moving from a few refuges in the south of Europe and the Balkans, moving outwards at a speed of about 500 m per year.

However, EVOLTREE is not simply trying to cast light on the impacts of major climatic changes on trees in the distant past. “We want to identify the genes that control adaptation to environmental changes,” said Kremer. “These genes are responsible for tree resistance to drought and pests and control the timing of bud bursting, for example. Our ambitious objective is to identify that part of forest tree diversity that distinguishes one individual from another and which is responsible for different responses to external factors.”

Another objective of EVOLTREE is to study the influence of trees on forest biodiversity at the level of an entire system. This will be done by studying other organisms closely associated with trees, such as insect species that feed on tree leaves and fungi that colonize tree roots and absorb nutrients from the soil. The ultimate goal is to understand whether there is a relationship between the genetic diversity of trees and the intraspecific diversity of associated species.

Twenty-five research centres from 15 countries participate in EVOLTREE in an effort to reduce the fragmentation of research efforts across countries and to facilitate the development of joint research infrastructures and standard research methods and databases.

A network of study sites has been established in a number of forest ecosystems, ranging from boreal to Mediterranean forests. A common repository centre is being established in Seibersdorf, Austria, to host DNA samples of selected European tree species. Oaks, pines and poplars are the principle targets of the investigation, serving as models from which the analyses will be extended to other target species.

EVOLTREE plans to actively promote the outcomes of the project, particularly among policy-makers, through a series of round-table discussions and by translating research results into policy briefs. These briefs will emphasize the notion that understanding the distribution of adaptive diversity should be among the criteria guiding the location and establishment of conservation areas. In addition, understanding adaptation should support the formulation of guidelines for transferring forest reproductive material in the face of climate change. Finally, mapping the genetic diversity of tree populations can support the traceability of wood products if verification is needed and can assist in certification schemes.

By Megan Brandeland, Bioversity International
Information technology and the future of Europe’s forests

Forests harbour more biodiversity than any other ecosystem on Earth. Yet today they face an ever-increasing number of challenges as a result of climate change, deforestation and forest fragmentation – the conversion of large areas of forest to other types of vegetation or land use, leaving patches of forest. European forests are no exception to this trend.

In an attempt to improve the conservation and documentation of forest genetic resources in Europe, Bioversity International and six EU partners recently launched a project called EUFGIS (Establishment of a European Information System on Forest Genetic Resources). Set to run until late 2010, the project will create an easily accessible Web-based information system that provides current information on the distribution of forest trees and the status of forest genetic resources conservation sites across Europe.

The project also facilitates the work of the European Forest Genetic Resources Programme (EUFORGEN), a regional collaboration mechanism for promoting the conservation and sustainable use of European forest resources.

EUFGIS partners will first address the lack of common information standards for reporting data on forest genetic resources. Without such standards, efforts to compare the state of forest conservation among countries will be challenging and time consuming, if not impossible.

The project will concentrate its efforts on dynamic gene conservation units of trees. Unlike the ex situ storage of seeds, dynamic gene conservation emphasizes the maintenance of evolutionary processes within tree populations to safeguard their potential for continuous adaptation. This means managing tree populations either in their natural sites or in artificial but dynamically evolving populations elsewhere.

EUFGIS organized a workshop in October 2007 to look at how European countries are currently collecting and managing their forest genetic resources information. As a result, an initiative to develop pan-European information standards for dynamic gene conservation units was launched.

"In addition to wood, forests provide humans with an array of non-wood products, socio-economic benefits and important environmental services. They also work behind the scenes to filter the air, moderate temperatures and water run-off and sequester a large amount of carbon dioxide from the atmosphere, helping to reduce global warming," said Dr Jarkko Koskela, coordinator of EUFGIS and the EUFORGEN network at Bioversity International.

With the creation of EUFGIS, the people and institutions that have taken on the responsibility for safeguarding the future of Europe’s forests will have a valuable tool that not only makes it easier to analyse forest genetic resources information but also harmonizes information from across Europe.

By Megan Brandeland, Bioversity International

For further information, contact Jarkko Koskela j.koskela@cgiar.org or visit the EUFGIS Web site at http://www.bioversityinternational.org/networks/euforgen/EUFGIS/
Communities of farmers living in the Kolli Hills of India, about 300 km south-west of Chennai in the state of Tamil Nadu, are enjoying higher incomes and better nutrition thanks to the efforts of a Bioversity-led project to promote the value of neglected and underused species of grains.

Small-grain cereals such as finger millet, foxtail millet and little millet once formed an important part of the diets of people living in the south of India. However, with the introduction of rice and other high-yielding crops, communities gradually abandoned these traditional grains. Farmers in the Kolli Hills were no exception to this trend. They too abandoned their millets in favour of high-yielding crops that were more popular on the market.

Millets are high in folic acid, minerals, iron and fibre and have higher vitamin levels than crops such as rice. They are also well suited to dry soils and tolerant of drought, providing a source of nutritious food even in the driest, harshest years.

However, lack of demand for millets and the laborious processing that millet grains demand eventually pushed the Kolli Hills communities to instead start growing cash crops such as cassava for sale to local processing factories. With the extra income, the farmers were able to buy other foods that were less nutritious but much easier to prepare.

“The communities of the Kolli Hills had become seriously malnourished,” explained Stefano Padulosi, the global coordinator of the project, which was implemented in India through the M.S. Swaminathan Research Foundation. “Millet diversity was vanishing because it was no longer being grown and the sustainability of farming systems was also at risk because cassava and other cash crops are harder to grow.”

One of the main reasons for the millets’ fall from grace was the long and laborious processing that was required before they could be consumed, a job invariably carried out by the women of the community. The growing availability of pre-processed or more-easily processed foods made them more attractive to the over-burdened women.

To address the problem, the project introduced mini-mills to the farmers’ self-help groups. “The mills do in ten minutes what used to take the women two or three hours,” said Padulosi.

Reducing the drudgery involved in the preparation of the millets and promoting their nutritional value made them more attractive to grow. The project worked with the community to build capacity by organizing courses on topics such as cultivation practices and marketing. Access to micro-credit schemes allowed the community to buy additional machines, further reducing the burden of the women.

Family incomes increased, not only from the sale of millet grains but also because people ate more millet at home, which saved money that they had previously been spending on food.

The health of children in the Kolli Hills villages is improving as their parents return to growing more nutritious crops.

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By Cassandra Moore, Bioversity International

P. Bordoni/Bioversity International

Electrical mini-mills allow women to prepare the millet for a day’s meals in 10 minutes instead of 2 hours.
Since the beginning of the last century, nearly three-quarters of the genetic diversity of agricultural crops is thought to have been lost. This means that for every four species that existed at the beginning of the 20th century, only one remains today. This dramatic decline in crop diversity is largely a result of the replacement of traditional varieties with high-yielding, modern cultivars.

It has been said that a species is only as safe as its habitat. As climate change threatens to raise temperatures and increase the frequency of catastrophic events such as droughts and floods, the habitats to which traditional cultivated varieties have spent centuries adapting will face serious changes. This is likely to speed the loss of crop diversity even further, with catastrophic consequences for agriculture. Conserving the genetic material of traditional crops is the best way to ensure that irreplaceable traits are not lost along with diversity in the field.

One of the most effective ways of conserving plant genetic resources is in genebanks, like the one established by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), a CGIAR centre dedicated to using agricultural science to serve the poor in semi-arid regions throughout the developing world.

The semi-arid tropics cover 48 developing countries and are home to more than one-sixth of the world’s population. Yet prior to the development of ICRISAT’s Rajendra S. Paroda Genebank, in Patancheru, India, the diversity of crops native to this area was at serious risk. “Most of the world’s centres of diversity of native crops are in areas where productivity levels are relatively low and where farmers are willing to abandon genetically broad-based landraces for newly bred, more uniform, high-yielding cultivars,” explained Hari Upadhyaya of the ICRISAT Genetic Resources Team.

Since its creation in 1972, the ICRISAT genebank has grown to house one of the largest crop diversity collections in the world. Over 118 000 accessions of sorghum, millets, chickpea, pigeon pea and groundnut from 144 countries are currently conserved in the genebank. “The collection represents both insurance against genetic erosion and a source of tolerance to diseases and pests, climatic and other environmental stresses, as well as improved quality and yield traits for crop improvement,” said Upadhyaya.

The materials in the ICRISAT genebank come from donations as well as from rescue missions launched in response to emergency situations such as drought and desertification. “ICRISAT scientists have conducted over 200 expeditions to collect landraces on the verge of extinction, braving difficult terrain, hostile environments and harsh conditions,” said Upadhyaya. Several of the traditional crop varieties conserved at ICRISAT have now disappeared from their natural habitats in Africa and Asia. The collection does not belong to ICRISAT but is held by the centre in-trust for the world community.

The crop accessions maintained in the ICRISAT and other genebanks around the world are not only important for ensuring the long-term security of agricultural biodiversity in response to challenges such as climate change. They can also help to restore collections that are lost or damaged on account of unsatisfactory storage facilities, natural calamities or civil unrest, as well as providing the basis for crop improvement research. More than 685 000 samples from the ICRISAT genebank have been supplied to scientists in 144 different countries for such purposes.

By Megan Brandeland, Bioversity International
The coconut has been at the heart of many controversies over the years. Should it be classified as a fruit, a nut, a vegetable or a seed? Should its rich saturated fat content be likened to the artery-clogging fats found in meat and dairy products? Has anyone ever really been injured by a falling coconut? Rather than pondering modern-day questions like these, the early Spanish explorers who encountered the coconut simply observed the three indentations on this hairy sphere, dubbed it 'coco', meaning 'monkey face', and spent their time enjoying its sweet, creamy taste.

Although the exact origin of the coconut is still debatable, the general consensus is that it came from one of three places: South Asia, north-western South America or the islands of the western Pacific. With the help of both human and marine transport, the coconut has since traveled far from its origin, typically establishing itself in sunny climates that receive regular rainfall. Some of the best places to find the salt-tolerant coconut are in the sandy soils along tropical shorelines. It is here that many of these trees, often planted in a deliberate effort to prevent coastal erosion, provide a habitat and food source for local animals like the coconut crab.

Throughout South Asia and the South Pacific, the coconut tree has been referred to as the 'tree of life' or the 'tree that grants all wishes' thanks to its endless assortment of culinary and non-culinary uses. The coconut is perhaps most famous for its role as a delicious and nutritious food source, whether eaten fresh or in cooked dishes. All across the globe, the sweet, refreshing liquid found inside the coconut (known as coconut water) is enjoyed fresh, while the rich, white meat is often dried and added to baked goods. Meanwhile, in Pohnpei—one of the Federated States of Micronesia, located north-east of Papua New Guinea—many people enjoy the edible husk of the 'adohi' variety of coconut as a syrupy snack. The fibrous husk, or outer covering, of other coconut varieties provides coir fibres and coir dust (cocopeat) for environmentally friendly geotextiles and potting composts respectively.

Today, the most nutritional resource obtained from the coconut may be its oil. Long-valued by the soap and cosmetic industries of western countries it was shunned by dieticians and doctors for decades due to its high saturated fat content. With better extraction techniques, coconut oil has in recent years begun to make a comeback in the food world. Ironically, many scientists and medical professionals are beginning to endorse it for the same fats that originally limited its appeal. All fats and oils are made up of molecules called fatty acids, which can be categorized in two ways: saturation and length. The fats found in coconuts are saturated as are the fats in meat and dairy products. Unlike those found in meat, dairy products and the great majority of dietary fat sources however, the fatty acid chains in coconut are of medium length rather than being long. These medium-chain fatty acids (MCFA) are more easily digested and metabolized than the more abundant long-chain fatty acids (LCFA) and for this reason they have been promoted as a quick source of energy. Coconuts are also promoted for their antimicrobial activity, thanks to a saturated MCFA known as lauric acid. Found in human breast milk, lauric acid is thought to be responsible for protecting a baby’s digestive tract from viruses and infections until it is strong enough to take care of itself.
New ways to combat aflatoxin

Scientists at the International Institute for Tropical Agriculture (IITA) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) have recently made two major breakthroughs in the fight against the deadly crop contaminant aflatoxin, offering new hope to millions of people in sub-Saharan Africa.

Aflatoxins are a category of toxins that threaten some of the most important staple crops in sub-Saharan Africa, and are a serious threat to livestock and human health. At high levels, the toxins can severely affect the liver and they are a known human carcinogen.

Aflatoxins are produced primarily by two fungi—Aspergillus flavus and A. parasiticus—that infect crops such as maize, groundnut, sorghum and cassava, both before harvest and in storage. Contamination of maize causes particular concern, because it is sub-Saharan Africa’s most important cereal. In recent years, rapidly rising levels of aflatoxin have resulted in widespread crop losses and a growing threat to human well-being. In Benin and Togo, for example, the levels of aflatoxin are five times the safe limit in nearly one-third of the maize grain. According to a study carried out in those countries and Nigeria, 99% of blood samples collected randomly from children contained aflatoxins. In 2004, aflatoxin...
Aflatoxins are believed to affect the human immune system, making people more vulnerable to diseases like HIV and malaria. When it occurs in conjunction with Hepatitis B, aflatoxin contamination can lead to liver cancer. Even more disturbing is the threat aflatoxin contamination poses to its youngest victims. It has already been blamed for impairing the growth and development of millions of children in West Africa. Because the susceptibility of Africa’s staple crops to contamination by aflatoxin rises with increasing temperature and humidity, researchers worry that the already widespread distribution of aflatoxin will continue to expand at a dramatic pace as climate change warms the globe.

In an effort to halt the spread of aflatoxin, scientists at IITA have been testing different approaches to drying, storing and preparing grain, and experimenting with a method called ‘competitive exclusion’. This method is based on the presence in nature of both toxigenic and atoxigenic strains of the A. flavus fungus—only the former of which produces aflatoxin. For the strategy to succeed, researchers must identify and successfully introduce harmless strains that show a large competitive advantage over the dangerous ones.

IITA plant pathologist Ranajit Bandyopadhyay explained, “The competition between strains occur in nature. We are just trying to tip the scale in favour of the atoxigenic strains by identifying the more competitive strains and then releasing them in farmers’ fields. The good strains virtually eliminate their highly toxic relatives and ensure that the ‘bad guys’ cannot re-emerge.”

After carefully testing thousands of strains collected from stores of mouldy maize in Nigeria, IITA scientists narrowed the pool down to eight strains of A. flavus that do not produce aflatoxin; these were then evaluated further in the lab and the field. Results of subsequent trials could not have been more encouraging. “The atoxigenic strains were able to reduce aflatoxin contamination by up to 99.8% in field trials,” said Ranajit. Scientists have already begun large-scale biocontrol experiments in Nigeria, where multiple strains are being released.

Although these biological control approaches are certainly encouraging, it will take some time to implement them on a large scale across rural Africa. However, even small-scale farmers in the most remote regions of the continent stand to benefit from a new aflatoxin testing kit designed by scientists at ICRISAT. This simple and affordable kit is able to detect the invisible contaminant in stored grain.

When African products are refused by major markets due to unacceptable levels of aflatoxin or other contaminants, farmers’ incomes are greatly affected. In the past, few farmers could afford to test for aflatoxin, but the aflatoxin kit has brought the price of testing down from US$25 to only US$1. “We have put a powerful weapon in the hands of poor farmers to fight a problem that was making it particularly hard for African agricultural products to get fair treatment in international markets,” said Dr William Dar, Director General of ICRISAT.

The National Small Farmer Association of Malawi has already used the aflatoxin kit to revive the groundnut export industry, which had gradually eroded as a result of repeated aflatoxin outbreaks throughout the 1970s. “We’ve seen a very positive impact,” noted Moses Siambi, an ICRISAT scientist based in Lilongwe. “Malawian groundnuts are now available on the Fair Trade market and also in some of the biggest supermarkets in the UK.”

Each day, billions of people in developing countries are unknowingly exposed to aflatoxins in contaminated foods. Thanks to the efforts of IITA and ICRISAT however, weapons against the dreaded toxins have become a reality, and their gradual elimination is on the horizon. The result will be safer products for consumers and better incomes for farmers.
Loroco: a pre-Columbian crop with a bright future

As a result of increasing demand, farmers are now trying to establish commercial loroco plantations.

Few people have probably ever heard of loroco (*Fernaldia pandurata*), yet this herbaceous plant, also known as quelite (which means edible herb in the pre-Columbian Nahuatl language), is a culinary delicacy for millions of people in Central America, particularly in El Salvador, Guatemala and Honduras. Increasing demand in the local and foreign markets, farmers are now trying to establish commercial loroco plantations. Unfortunately, they are facing many challenges. Firstly, loroco has not been fully domesticated and the planting material obtained from seed is not genetically homogeneous. Secondly, increasing plant density in large loroco plots or commercial fields exposes the plants to pests and diseases seldom observed in the wild. In El Salvador, for example, viral diseases and insect pests, such as whiteflies and aphids, are the main constraints in commercial fields and even in small backyard plots, forcing farmers to use toxic insecticides to fight them. This is most unfortunate, given the potential that loroco has to become a high-value crop for small- and medium-scale farmers in Central America. Consumers increasingly express concerns about the health implications of applying toxic agrochemicals to food products consumed raw or lightly cooked, such as loroco buds. Indeed, the USA bans pesticide residues in imported products consumed raw or lightly cooked, such as loroco buds. The strategy is tailor-made for loroco. In the wild, the plant normally grows in the shade of trees, benefiting from reduced light exposure.

Loroco buds and flowers are typically eaten with meat, tamales, in filled maize tortillas called pupusas and mixed with eggs. More recently, loroco has become a popular ingredient in pizzas. It is also exported to the USA, where over three million Central American immigrants are willing to pay up to US$10 for a pound (US$22 per kilogram) of loroco buds.

Until recently, loroco was primarily harvested from the wild or grown in home gardens. As a result of increasing demand in the local and foreign markets, farmers are now trying to establish commercial loroco plantations. Unfortunately, they are facing many challenges. Firstly, loroco has not been fully domesticated and the planting material obtained from seed is not genetically homogeneous. Secondly, increasing plant density in large loroco plots or commercial fields exposes the plants to pests and diseases seldom observed in the wild. In El Salvador, for example, viral diseases and insect pests, such as whiteflies and aphids, are the main constraints in commercial fields and even in small backyard plots, forcing farmers to use toxic insecticides to fight them. This is most unfortunate, given the potential that loroco has to become a high-value crop for small- and medium-scale farmers in Central America. Consumers increasingly express concerns about the health implications of applying toxic agrochemicals to food products consumed raw or lightly cooked, such as loroco buds. Indeed, the USA bans pesticide residues in imported food crops.

Most experts agree that the best way to combat insect-transmitted viruses is by using virus-resistant plant varieties. Loroco, however, is still at an early stage of genetic improvement. This is why loroco farmers in Central America are being shown how to avoid viral diseases by adopting a simple but effective practice: the use of partial shade to camouflage loroco plants from airborne aphids. The strategy is tailor-made for loroco. In the wild, the plant normally grows in the shade of trees, benefiting from reduced light exposure.

Field experiments have shown that large-scale implementation of this method can be accomplished fairly easily by placing dry coconut-palm leaves over the wire trellises used to support the climbing loroco plants in commercial plantations. Results of trials conducted in El Salvador showed that 50–85% of the uncovered plants became infected with aphid-borne viruses, compared with 5–20% of those grown under shade. The shaded plots produced an average of 43.5% more buds and flowers than the non-shaded ones.

These experimental results are good news for loroco farmers, who stand to benefit significantly from increased yields. It has been estimated that a single hectare of loroco in full production can produce a net economic benefit of over US$10 000/year. And in rural areas where women usually grow loroco in home gardens, the crop could bring an important additional source of income. Even a very small backyard plot of loroco can make a substantial contribution to improving the well-being of resource-poor households in Central America.

By Megan Brandeland and Margarita Baena, Bioversity International

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Studies conducted by Dr Francisco Morales, Virologist at the International Center for Tropical Agriculture (CIAT) in Colombia and scientists from the Centro Nacional de Tecnología Agropecuaria (CENTA) in El Salvador showed how two different viruses affect loroco. These viruses can be transmitted in seconds by sap-sucking aphids from virus-infected plants to healthy plants. Insecticides have no time to act before the aphids set into motion a process that can cause significant yield and quality losses.

Commercial loroco plantation in the Valle de Zapotitlan, El Salvador. Planting loroco in the shade helps avoid plant contamination.
Microfossils help scientists trace the domestication of the chilli pepper

Scientists in Central and South America have discovered a way to trace the history and domestication of one of the most popular foods native to the region: the chilli pepper. Archaeological sites throughout the Caribbean, Venezuela and the Andes have been found to contain tiny fossils of starch grains—so-called ‘microfossils’—that are similar in shape and general appearance to the five domesticated varieties of chilli pepper that exist today.

Limited archaeological evidence for many crops has made it difficult to deduce exactly when, where and from what species modern-day crop varieties developed. For example, while few people would argue that the chilli pepper originated somewhere in Mexico or Mesoamerica, no one is sure how long it had been cultivated by indigenous populations prior to its ‘discovery’ by Christopher Columbus in the fifteenth century.

With the findings made by Dr Linda Perry, a post-doctoral fellow in the archaeobiology department at the Smithsonian National Museum of Natural History, and colleagues, however, that date has been set at several thousand years ago. An analysis of microfossils taken from sediment samples, milling stones, cooking vessels and other artefacts at two sites in south-western Ecuador revealed that ancient civilizations were actively cultivating chilli peppers on a large scale more than six millennia ago. The ancient peoples of the coastal and highland areas of Peru, meanwhile, were found to have been chilli eaters as far back as 4000 years ago.

Both wild and domesticated chilli peppers come in many varieties, each with a unique colour, flavour, shape and level of heat. Jalapeño and cayenne peppers tend to be the hottest, while bell and cherry peppers are significantly milder. The rule of thumb is that the smaller and thinner the pepper, the hotter the taste. In addition to being used in popular dishes like enchiladas, salsa and tamales, chilli peppers have recently been lauded for their potential health benefits. Rich in vitamins A and C, they contain a compound called capsaicin that, besides giving peppers their ‘kick’, may help fight cancer and inflammation and provide pain relief.

Because all of the microfossils uncovered from the seven sites across the Americas were characteristic of fully domesticated (as opposed to wild or semi-domesticated) varieties of chilli pepper, the question still remains as to exactly where and when the chilli pepper was first brought under the management of humans. Nonetheless, at least two conclusions can safely be drawn from the research of Perry and her colleagues. First, domestication must have occurred before the development of any of the ancient societies examined in the study, i.e. at least 6000 or more years ago, and, second, chilli peppers were often cultivated alongside crops such as maize as part of a plant food complex that may, in some areas, predate pottery. “All of the components of the modern Mexican diet were there,” said Perry. “Whether or not the food was exactly the same, the main ingredients were there.”

Thanks to a perpetual interest in exotic foods, humans have greatly influenced the distribution and trajectory of the chilli pepper across the globe. But, just as humans are responsible for the expansion in the range of the chilli pepper, so too are we responsible for continuing to investigate its origins. The microfossils uncovered by Perry are just one means by which we have begun to unravel the evolution of the chilli pepper. Delving even deeper into its history may reveal traits that were lost in the process of domestication—traits like resistance to pests or diseases that may one day help modern farmers improve their own chilli crops.

By Megan Brandeland, Bioversity International

Wild relatives of banana under threat

According to the IUCN Red List criteria, *Musa beccarii* var. *beccari* is endangered. 

Like the forests they inhabit, wild bananas are feared to be disappearing at an alarming rate. 

According to the IUCN Red List criteria, *Musa beccarii* var. *beccari* is endangered. 

Bananas (*Musa species*) originated in the tropical and subtropical forests of South-east Asia and the Pacific. Wild bananas are easily distinguished from the cultivated forms by their seedy fruits. The capacity to reproduce sexually not only means that wild bananas are more genetically diverse than their vegetatively-propagated, cultivated relatives but also that breeders have little choice but to use them in improvement schemes. The parentage of FHIA-03, one of the first banana hybrids to be released to farmers, includes several wild *Musa* relatives, from which it derived pest and disease resistance.

Despite the obvious value of the wild relatives of banana, the large majority of them—taxonomists have recognized up to 90 wild types—are not to be found in genebanks. As a result, like the forests they inhabit, wild bananas are feared to be disappearing at an alarming rate. Yet until now nobody had examined the data for evidence that this is actually the case.

Working with Markku Häkkinen, a banana expert from the University of Helsinki, and focusing on the section *Callimusa*, which contains some 14 species, Justine Carré, an MSc intern based at Bioversity International’s office in Montpellier, France, has identified and documented some eight taxa as endangered or critically endangered according to the criteria established by the World Conservation Union (IUCN). One of them is *Musa lawitiensis* var. *suratti*, a variety endemic to Sabah in Malaysia. Häkkinen, who visited the area in 2002, is concerned about the survival of this variety. “Twenty years ago, *Musa lawitiensis* var. *suratti* was observed in three locations in open forest. Today, it is found in one location. The surviving population contains only eight plants occupying a few square metres,” she said. The loss has potentially significant consequences. Because this variety occurs at relatively high altitudes, it could harbour genes of resistance to drought and cold, traits that might become in high demand as climate changes.

It is clear that once research addresses other sections of the genus, additional seriously-threatened species will be identified. Recent expeditions in north-eastern India have failed to find *Musa acuminate* subsp. *burmannicoides*, better known as ‘Calcutta 4’, a subspecies used in breeding programmes as a source of resistance to Black Sigatoka, a devastating fungal disease. Even though it is represented in *Musa* working collections, the specimens, donated by the Calcutta Botanic Garden, are probably too few to represent the genetic diversity of the subspecies. A comprehensive conservation assessment of the genus will be published sometime in the next two years and information about the threatened species submitted for review and publishing in the IUCN Red Data Books.

This work is part of the continuing *Musa* conservation strategy coordinated by Bioversity within the framework of the Global Crop Diversity Trust, an organization working to support the conservation in perpetuity of the world’s major crops. While the strategy focuses on investing in existing *Musa* collections, it has become clear from the consultation process involved in its development that attention is urgently needed to address the loss of species and cultivars that are poorly represented in or totally absent from formal collections. Bioversity has launched an attempt, with the support of the community of *Musa* taxonomists and experts, to appraise the conservation status of the entire genus, a challenging feat given the lack of data and the confused taxonomy.

It is hoped that these efforts will contribute to securing the conservation of wild bananas and ensure that their genetic diversity can be used to improve the lives of the millions of people who depend on bananas as a source of food and income.

By Justine Carré and Charlotte Lusty, Bioversity International

For further information, visit http://www.bananas.bioversityinternational.org/
Cacao: from the farms of Nicaragua to the mouths of gourmet connoisseurs everywhere

A new project from Bioversity International will use high-quality chocolate to link poor farmers in Nicaragua to gourmets in Europe and North America. The farmers will gain income and independence, the gourmets will enjoy complex-flavoured chocolates based on new varieties of cacao, and the environment will benefit from organic and sustainable farming. All of this while preserving the diversity of cacao for future generations.

Funded by the Austrian Development Agency, with additional contributions from local and international partners, this project will serve as a complement to the CacaoNet initiative, also coordinated by Bioversity, whose work is to promote the conservation and use of cacao genetic resources across the globe.

Rather than try to increase the yields and value of these trees, the new cacao project will instead focus on a small number of older trees, called criollo, that remain in the reserve. The criollo trees produce much better cocoa—superior in terms of flavour—but are nonetheless vanishing as a result of neglect. This is because they tend to be low-yielding. In the past, because of poor communication between farmers and consumers of chocolate, farmers placed priority on producing high yields rather than high quality cacao.

Working with local partners and foreign chocolate companies and scientists, Bioversity hopes to boost the yields of the criollo and to increase the quality of the beans they produce by improving processing methods. As a result of increases in product quality using organic standards, trade links will be strengthened with farmers getting a fair price for their produce.

Bioversity and its partners in the project plan to focus on training and empowering women, because they are vital in the processing of cocoa beans.

“We will work with our partners at all steps in the chain from cacao farmer to chocolate eater to give everyone a taste of the benefits of cacao diversity,” said Bioversity scientist Michael Hermann, who manages the project. “Better chocolate is just one of the many spin-off benefits of improving the lives of poor cacao farmers.”

By Jeremy Cherfas, Bioversity International

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Accession: A sample of a crop variety or wild relative collected at a specific location and time.

Agrobiodiversity (or agricultural biodiversity): Biodiversity that contributes to food and agricultural production.

Agro-ecosystems: Ecosystems that produce food via farming under human guidance.

Biodiversity: The total variability within and among species of all living organisms and their habitats.

Climate change: A change of climate that can be directly or indirectly attributed to human activity and that is in addition to natural climate variability over comparable time periods.

Cultivar: Shorthand for cultivated variety.

CGIAR: The Consultative Group on International Agricultural Research, a strategic alliance of countries, international and regional organizations and private foundations supporting 15 international agricultural research centres.

Desertification: Land degradation in arid, semi-arid and dry subhumid areas resulting from various factors including climatic variability and human actions.

Ecosystem: An ecological system formed by the interaction of a community of organisms with their physical environment.

Ex situ conservation: Conservation of a plant, animal or other organism outside of its original or natural habitat.

Genebank: Facility where crop diversity is stored in the form of seeds, pollen, in vitro culture or DNA, or in the case of a field genebank, as plants growing in the field. Genebanks can also be used to store the genetic resources of animals, microbes and other elements of biodiversity.

Genetic diversity: The genetic variation present in a population or species.

Genetic resources: Genetic material of plants, animals and other organisms that is of value for present and future generations of people.

Genotypes: 1. The genetic constitution of an organism. 2. A group of organisms with similar genetic constitutions.

Germplasm: A set of genotypes that can be conserved or used.

In situ conservation: Conservation of plants, animals or other organisms in the areas where they developed their distinctive properties, i.e. in the wild or in farmer’s fields.

Landrace: Farmer-developed variety of a crop plant or animal that is adapted to local environmental conditions.

Micronutrient: A dietary element, such as a vitamin or mineral, that is required in minute amounts for the proper growth and metabolism of a living organism.

Taxon: A group or category, at any level, in a system for classifying plants or animals.

GEF: A joint programme between the United Nations Development Programme, the World Bank and the United Nations Environment Programme, the Global Environment Facility was established in 1991 to provide funds for environmental problems. UNEP is the administrator of grants relating to agricultural biodiversity.

Wild relative: A non-cultivated species that is more or less closely related to a crop or livestock species (usually in the same genus).