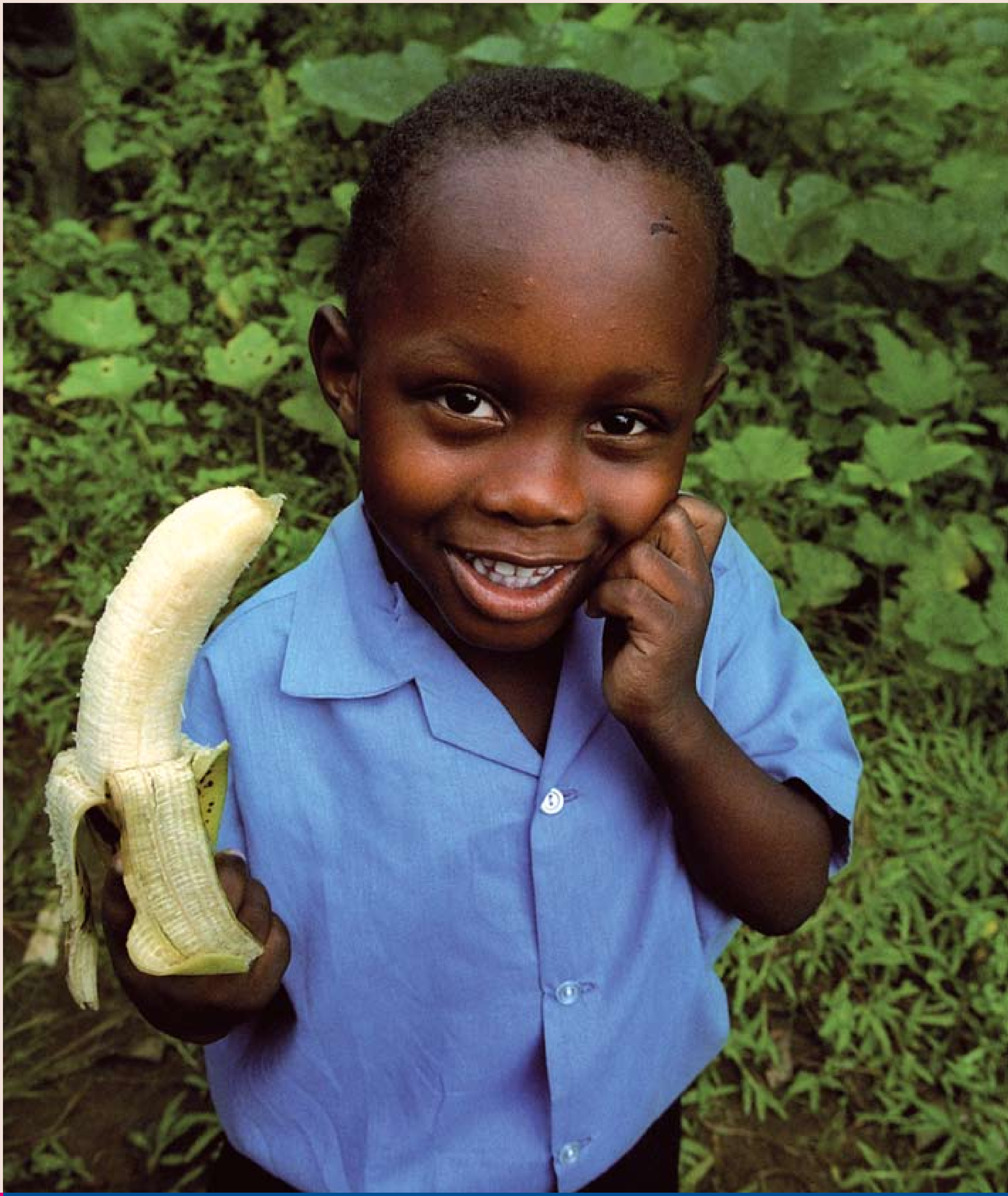
Bioversity International

Crop wild relatives



The Crop Wild Relatives Project

The benefits of foods from the forests

The value of wild relatives

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The wild relatives of banana could provide solutions for improving the crop, which is notoriously difficult to breed.
Karen Robinson/Panos Pictures

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Contents

An introduction to crop wild relatives

Crop wild relatives include crop ancestors as well as other species more or less closely related to crops. They are a critical source of genes for resistance to diseases, pests and stresses such as drought and extreme temperatures. The use of wild relatives has led to improved resistance to wheat curl mite, to late blight in potato and to grassy stunt disease in rice. They have been used to improve tolerance of drought in wheat and acid sulphate soils in rice. Wild relatives have also been used to raise the nutritional value of some crops, including protein content in durum wheat, calcium content in potatoes and provitamin A in tomato.

Crop wild relatives are valuable tools

A. Lane/Bioversity International

Walnuts are one of the target crops for the UNEP/GEF–Bioversity International project on crop wild relatives.

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Protecting crop wild relatives helps to ensure that adequate genetic diversity exists in a particular crop's gene pool. The increasing genetic uniformity of crop varieties, combined with the effects of climate change, makes crops more vulnerable to stress. The devastating losses in the American maize crop caused by the Southern corn blight outbreak in the USA in the 1970s highlighted the real risk of relying on a few high-yielding varieties. While the USA produces about half of the world's maize, production is based on less than 5% of the diversity available worldwide.

Crop wild relatives are valuable tools that we can use to adapt to changing environmental conditions and human needs, but natural populations of wild relatives are increasingly at risk, due to over-exploitation and the loss of habitat. A global project, launched in 2004, addresses these risks. The project, funded by the Global Environment Facility and implemented by the United Nations Environment Programme, involves partners from five countries—Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan—with significant, important and threatened crop wild relatives. For more information about the project, see the story on p. 2.

A. Lane/Bioversity International

Passion fruit, Bolivia. Crop wild relatives are a valuable source of variation that can be used to help crops adapt to changing environmental conditions and human needs.

This special section of Geneflow is sponsored by the Crop Wild Relatives Project as part of its awareness-raising activities.

As understanding and knowledge of crop wild relatives increases, plant breeders will increasingly look to them for solutions to many of the world's unsolved plant disease problems. One such major threat is Ug99, a black-stem rust first found in Ugandan wheat in 1999. This pathogen has been appearing in fields throughout East Africa ever since, where it is reducing grain yields by up to 71%. If not conquered soon, Ug99 could become a global epidemic within the next 15 years. The conservation and use of crop wild relatives could hold the key to meeting the challenge of Ug99 and other threats to agriculture and food security.

By Annie Lane,
Bioversity International

The Crop Wild Relatives Project

The project outcomes will provide the basis for strategies that could be applied in other countries

A. Lane/Bioversity International

Vegetables on display at a bazaar in Tashkent, Uzbekistan. Uzbekistan is one of the five countries involved in the Crop Wild Relatives Project.

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Bringing together five countries—Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan—the Crop Wild Relatives Project aims to protect natural populations of crop wild relatives while setting a precedent for conservation that the rest of the world can follow. These countries contain some of the world's biodiversity hotspots, areas that are also at greatest risk from the loss of diversity.

Crop wild relatives are essential for adapting crops to changing environmental conditions and human needs. Nevertheless, many natural populations of these highly compatible species are increasingly at risk due to climate change, over-exploitation and loss of habitat. The five-year project, which is funded by the Global Environment Facility and implemented by the United Nations Environment Programme, promotes effective *in situ* conservation of crop wild relatives to ensure their availability for improving global food security. Each of the five project countries has a remarkably rich and unique diversity of crop wild relatives, many of which have contributed vital genes for crop improvement in developed and developing countries.

Although most of the partner countries have identified the conservation of crop wild relatives as a strategic national priority, they have had limited resources to invest in conservation programmes in the past.

The project has three broad goals:

- To develop national and international information systems on crop wild relatives that include data on species biology, ecology, conservation status, distribution, crop production potential, uses, existing conservation actions and existing information sources.
- To build the capacity of national partners to use this information to develop and implement rational, cost-effective approaches to conserving crop wild relatives.
- To raise awareness of the potential of crop wild relatives for improving agricultural production among policy-makers, conservation managers, plant breeders, educators and local users.

The project outcomes will provide the basis for strategies that could be applied in other countries with significant populations of crop wild relatives. In this way, these five nations, with little in common beyond the fact that they are located in centres of crop diversity and possess important and endangered crop wild relatives in their mountain systems, will collectively make a major contribution to the conservation of crop wild relatives globally.

Bioversity International is the executing agency for the project and five other international organizations are partners in the initiative: the Food and Agriculture Organization of the United Nations, Botanic Gardens Conservation International, the United Nations Environment Programme World Conservation Monitoring Centre, the World Conservation Union, and the Information and Coordination Centre for Biological Diversity (IBV).

By Annie Lane, Bioversity International

Crops whose wild relatives have been given priority by the countries participating in the project

Armenia	Wheat, barley, rye, pulses, pear, beet
Bolivia	Potato, sweet potato, quinoa, cassava, bean, capsicum, pineapple, peanut, cacao, cashew, sugar apple, papaya, palm heart, tree tomato, palmito, blackberry
Madagascar	Rice, banana, coffee, yam, vanilla
Sri Lanka	Rice, cowpea, black pepper, banana, cinnamon
Uzbekistan	Onion, almond, pistachio, walnut, apple, barley

Use crop wild relatives or lose them!

Despite the immense diversity of wild relatives and their potential to resist challenges ranging from disease to drought, wild relatives are little used in crop improvement efforts.

Using crop relatives involves crossing the crop with a wild relative that has the desired character, obtaining the hybrid offspring and then backcrossing this over several generations with the crop parent to obtain a type with the desired new character. However, in order to achieve the desired product, plant breeders often have to overcome some major problems.

Many wild relatives are difficult to cross with the crop

Often the hybrids and subsequent generations of offspring continue to possess undesirable traits derived from the wild relative. They may have poor production or quality characteristics and perform poorly in agricultural production. Efforts to remove these undesirable characteristics through further backcrossing can slow progress and delay the development of new varieties with the desired traits.

Another major factor that has limited the use of wild relatives has been poor interspecific crossability. Many wild relatives are difficult to cross with the crop; even when they can be crossed the hybrid offspring may be sterile. Fortunately, special tissue culture and hybridization techniques can now be used to overcome these problems in order to nurse the progenies of any cross through the first critical generations of crossing and backcrossing.

Yet biological barriers still exist in many crops that block crossbreeding and cause hybrid sterility. For instance, there are difficulties connected with using wild relatives of maize caused by the number of plant generations required to reduce the hybrid genome via backcrossing to maize.

Limited availability of germplasm and lack of knowledge and research are often cited as other reasons why wild species are not used more, but none of these explanations hold water. Since the 1980s, the number of wild species accessions in public genebanks worldwide has been increasing. Most major crops have hundreds, even thousands, of their wild relatives stored in genebanks. Likewise, knowledge and interest in wild species have increased substantially since the 1970s due to the success of crop improvement efforts where wild relatives have been part of the formula.

New molecular genetic techniques provide great potential for increasing the use of wild relatives in breeding. Recent use of DNA markers and sequencing has helped to identify genes responsible for desirable traits, dramatically increasing the precision of selection programmes. However, while techniques for isolating desirable genes have increased greatly in number, the dramatic rate of increase of crossbreeding that has sometimes been predicted is not yet apparent. One important reason for this could be the limited availability of resources for this kind of breeding, which is nearly always carried out by publicly funded breeding programmes.

By Kelly Wagner, Bioversity International

A. Lane/Bioversity International

Wild onion, Italy. Crop wild relatives hold immense potential for helping agriculture meet future challenges.

Wild foods are rich in micronutrients

Most countries plagued with micronutrient deficiencies rely on single-nutrient- based interventions, which are often expensive and unsustainable over the long term. Wild foods from the forests, many of which boast substantial levels of necessary micronutrients, ranging from vitamin A to iron to zinc, are an alternative solution.

The Maasai provide living proof of the impact wild plants can have on health

Policies governing forest management and those dealing with food security and poverty alleviation are not often well coordinated. As a result, people may not be aware of the benefits of the forest foods available to them and thus do not use them to full advantage. And because these resources are not valued or protected, their availability is shrinking as urbanization grows.

The Maasai provide living proof of the impact wild plants can have on health. A group of cattle-herding pastoralists living in Kenya and Tanzania, they have been described as having possibly the worst diet in the world. The Maasai get upwards of two-thirds of their daily calorie intake from animal fat, primarily consuming milk products and meat.

Yet, surprisingly, the Maasai do not suffer from diet-related health problems or diseases associated with high fat consumption. Researchers attribute this to their regular consumption of wild plants. Studies have shown that the Maasai use plants from a variety of vegetation sites, including open and wooded grasslands and closed-canopy forests.

S. Mann/ ILRI

The Maasai consume a diet rich in animal fats and yet they do not suffer from diet-related health problems or diseases associated with high fat consumption. Researchers attribute this to the fact that they regularly eat wild plants.

The Maasai prepare healthful soups with plant extracts. Roots, bark or parts of stems are added to improve the taste and to prevent or treat diseases. The Maasai also use wild plants to brew tea, to chew as a sort of gum and as an ingredient in traditional medicines. The biochemicals present in the wild plants effectively remove cholesterol from the body and reduce its impact by acting as an antioxidant.

Unfortunately, the Maasai's tradition of incorporating wild plants into their diets is being eroded by increasing urbanization and the subsequent loss of their knowledge about the uses of wild foods. Studies of the benefits of wild foods used by the Maasai and others are needed to provide the basis for promoting their use more generally. Only then will we realize the full benefits of a diet enriched by foods from the forest.

By Kelly Wagner, Bioversity International

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Common nutritional deficiencies, the related health problems and the potential role of wild foods

(adapted from the 'Report of the International Expert Consultation on Non-Wood Forest Products. Non-wood Forest Products,' FAO 1995)

Nutrient deficiency	Related health problems	Wild food sources to combat deficiency
Protein–energy malnutrition	Reduced growth, susceptibility to infections, changes in skin, hair and mental ability	Energy-rich food, such as nuts, seeds, oil-rich fruit and tubers and wild animals such as snails
Vitamin A deficiency	Impaired vision and immune function, blindness and death in extreme cases	Forest leaves and fruits, palm oil, bee larvae and other animal foods
Zinc deficiency	Slowed growth and development, suppressed immunity, increased complications in pregnancy	Animal-sourced foods, particularly red meat, along with certain types of nuts, including pine nuts, pecans and brazil nuts
Iron deficiency	Anaemia, weakness and increased susceptibility to disease	Wild animals, including insects such as the tree ant, mushrooms, forest leaves, baobab fruit pulp
Folate deficiency	Anaemia, neural tube defects	Leafy and other vegetables and many fruits
Vitamin C deficiency	Increased susceptibility to disease and impaired iron status	Forest fruits and leaves

The benefits of foods from the forests

A study of eating habits in north-east Thailand reveals that wild foods gathered from forests and field margins make up half of the food intake of rural communities during the rainy season. The study, which took place in three communities, found that villagers collect 126 kinds of forest foods from trees, ponds and streams. The foods include 49 species of animals, 16 species of mushrooms, 6 species of bamboo and 43 species of other vegetables.

Forest resources are essential for local communities

Communities in rural Thailand know a great deal about the benefits of forest foods. Unfortunately this knowledge is often overlooked by the policy-makers and scientists whose help is needed to protect the forests, which, ironically, are being put at risk by the villagers' dependence on them as well as by unsustainable logging practices and growing urbanization.

From tropical moist forests to mangroves and dry woodlands, forests provide many benefits to the neighbouring communities. The forests can prevent soil erosion and filter the flow of fresh water, reducing the spread of water-borne diseases by controlling pests and contaminants. Forest cover also reduces the impact of climate change and provides shelter for people and useful organisms. Even when local agricultural production is secure, forest foods can supplement staple foods and provide essential micronutrients often lacking in the diets of rural people.

Forest resources are essential for local communities and, during certain seasonal food shortages or emergencies, such as drought or war, they become critical for survival. Forest foods provide an alternative to domesticated crops during seasonal stresses, creating a buffer during periods of poor crop yields. Food from forest ecosystems often commands a premium price over equivalent domesticated foods.

L. Thomson/Bioversity International

A villager in north-east Thailand returns from the forest with a harvest of wild tubers.

The role of forests in people's lives is not a new phenomenon. Archaeological studies have found that forests were an integral part of the success of the Mayan civilization. The fruit of the Mayan breadnut tree served as a dietary staple. Breadnut seeds, which contain protein, iron, vitamin A and other nutrients, could be boiled, mashed and eaten as a substitute for root crops.

A better understanding of the benefits of forest foods is needed to motivate the protection of the forests. Highly nutritious species must be protected through sustainable use and conservation practices in these forest ecosystems and woodlands. With the current trends towards deforestation in many countries, we must ask ourselves what will happen to entire communities, like those in north-east Thailand, if we don't take better care of the forests.

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The value of wild relatives

It is estimated that between 1976 and 1980 wild relatives contributed approximately US$340 million per year in yield and disease resistance to the farm economy of the USA alone

A wild tomato has allowed plant breeders to boost the level of solids in commercial varieties by 2.4%, an increase worth US$250 million annually to farmers in California (USA) alone. Meanwhile, three different wild peanuts have been used to breed commercial varieties resistant to root knot nematodes. This development is helping to save peanut growers around the world an estimated US$100 million a year.

Crop wild relatives make a huge contribution to plant breeding. Wild relatives have provided traits such as disease resistance, tolerance of extreme temperatures, tolerance of salinity and resistance to drought.

A.Lane/Bioversity International

A wild relative of rice provided resistance to grassy stunt virus, a disease that caused devastating losses to farmers across South and South-East Asia in the 1970s. Sri Lanka.

In the 1970s an outbreak of grassy stunt virus devastated the rice fields of millions of farmers in South and South-East Asia. The virus, transmitted by the brown plant hopper, prevents the rice plant from producing flowers and grain.

Scientists from the International Rice Research Institute (IRRI) screened more than 17 000 samples of cultivated and wild rices for resistance to the disease. A wild relative of rice growing in Uttar Pradesh, India was found to have a gene for resistance to the grassy stunt virus. This gene is now routinely incorporated in all new varieties of rice grown across more than 100 000 km^2 of Asian rice fields.

Breeders have also used wild relatives to boost the nutritional value of foods. By crossing cultivated broccoli with a wild Sicilian relative, scientists are breeding a variety that contains higher levels of the cancer-fighting chemical, sulphoraphane, an antioxidant that destroys compounds that can damage DNA. The new variety of broccoli contains 100 times more sulphoraphane. Wild relatives have also helped increase the nutritional value of the cultivated tomato by providing more vitamin C and beta-carotene.

Wheat is the staple food for approximately one in three of the world's population. But diets based solely on cereals lack important nutrients such as iron, zinc and vitamin A. A wild relative of wheat from the eastern Mediterranean was used to increase the protein content of bread and durum wheat. The International Maize and Wheat Improvement Center (CIMMYT) has shown that wild relatives of wheat have up to 1.8 times more zinc and 1.5 times more iron in their grains than ordinary wheat and could be used to increase levels of these minerals in wheat varieties.

The growing recognition of the value of wild relatives in crop improvement comes at a time of increasing concern over the loss of these genetic resources. For example more than one in 20 of the species of Poaceae, the botanical family that includes cereal crops such as wheat, maize, barley and millet, are threatened with extinction from deforestation, habitat loss and intensive agriculture. Forests are rich in wild plants that may be new sources of novel genetic traits for improved crops including coffee, mango and rubber. Yet during the 1990s, 94 million hectares, or 2.4% of total forest cover, was lost.

Recent experience shows that using crop wild relatives to improve production and the nutritional contents of crops can improve people's livelihoods and their health. Taking action now to rescue endangered crop wild relatives is the only way to ensure that this value will continue to be available to future generations.

By Ruth Raymond, Bioversity International

Bringing crop relatives to the public

The Sri Lankan Department of Agriculture is taking advantage of its beautiful setting to bring the story of agriculture—including the role played by wild relatives—directly to the public.

A. Wijesekara

The entrance to Sri Lanka's Agriculture Information Park.

The Department of Agriculture is the only government department whose headquarters are located outside the capital city of Colombo. The Department was first established at the Royal Botanic Gardens during the colonial era and it can still be found in an enchanting environment in the central hills of Sri Lanka along both banks of the Mahaweli, the longest river in the country.

Inspired by its attractive location, Rohan Wijekoon of the Department of Agriculture came up with the idea of giving the public the opportunity to see the new agricultural technologies used on the Department's research and farming fields. Today, the Department's Agriculture Information Park welcomes about 30 000 people annually.

Visitors to the park are guided by trained agricultural instructors through its main attractions, which include fields of vegetables, root and tuber crops, fruit orchards, a home garden, paddy cultivation fields, traditional farming systems, the national genebank and an agriculture museum. Along the way, colourful signboards explain the exhibits to visitors. The genebank tour guide explains the importance of crop diversity conservation, while the home garden and the traditional agriculture and leafy vegetable exhibits display Sri Lanka's own crop diversity. The paddy cultivation section features traditional rice varieties that are rarely cultivated today.

The Department's Agriculture Information Park welcomes about 30 000 people each year

The Department of Agriculture, which is a collaborator in a global project on crop wild relatives, funded by the Global Environment Facility and implemented by the United Nations Environment Programme, is using the Agriculture Information Park to increase public awareness about the potential role of wild relatives in crop improvement. So far, wild relatives of pepper, bean, okra, banana and rice have been established along the banks of the Mahaweli river. The Department is in the process of establishing a second information park in southern Sri Lanka, which will also feature a section devoted to crop wild relatives.

The success of the park has prompted plans by the Department of National Botanic Gardens to establish similar exhibits throughout the country. And the idea has caught on beyond the crop sector. Using a similar concept, the Forest Department has established a Forest Education Park at Kande Ela, in the central hills of Sri Lanka near Horton Plains, a popular national park.

By Anura Wijesekara, Horticulture Crops Development and Research Institute, Sri Lanka

A. Wijesekara

Visitors to Sri Lanka's Department of Agriculture Information Park are given a tour through a variety of exhibits including fields of vegetables, home gardens, the national genebank and an agriculture museum.

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Spicy wild relatives get some respect

Cinnamon is big business in Sri Lanka, with the potential to get even bigger if efforts to safeguard the wild relatives of the spice succeed. More than 100 000 Sri Lankans depend on cinnamon for their livelihoods. An important ingredient in many Sri Lankan dishes, cinnamon earns the nation US$60 million annually.

Although Sri Lanka's most important modern export is tea, cinnamon historically held this place of honour. The Portuguese invaded the island in the 16th century to gain easy access to lucrative spices such as cinnamon and the Dutch fought the Portuguese over Sri Lanka in the 17th century for the same reason.

Today, cinnamon is commercially cultivated in many countries, including Brazil, Egypt, India, Indonesia, Madagascar and Vietnam, as well as on several Caribbean islands. However, the best cinnamon still comes from Sri Lanka, which accounts for about 75% of the world's supply.

The spice is obtained from the cinnamon plant by drying the central part of the bark, which is then sold in either stick or powdered form.

A. Wijesekara

A cinnamon plantation in Sri Lanka.

Over-exploitation by local herbal industries continues to threaten the survival of these crop wild relatives

A. Wijesekara

Bundles of cinnamon sticks ready to be sold at markets in Sri Lanka. Cinnamon earns the nation US$60 million annually.

Interestingly, two of the seven wild relatives of cinnamon endemic to Sri Lanka lack the spice's characteristic smell. *Cinnamomum citriodorum* has the aroma of lemon grass, while *C. capparu-coronde* smells a bit like camphor mixed with cinnamon. While *C. citriodorum* is not commonly used, *C. capparu-coronde* is a popular medicine for treating a wide range of ailments, including toothache, bronchitis and rheumatism.

Despite legislation enacted in 1993 to protect wild fauna and flora such as *C. citriodorum* and *C. capparu-coronde*, habitat destruction and, in the case of *C. capparu-coronde*, over-exploitation by local herbal industries continue to threaten the survival of these crop wild relatives.

Today, an international project funded by the Global Environment Facility and implemented by the United Nations Environment Programme (see 'The Crop Wild Relatives Project', p. 2) is striving to safeguard these and the other wild relatives of cinnamon to ensure that they will be available to provide genes for future crop development. The project brings together growers, agronomists, researchers and vendors in an effort to strike an appropriate balance between conservation and use—an important strategy for protecting Sri Lanka's historical edge in the spice trade.

By Siril Wijesundara, National Botanic Gardens, Sri Lanka

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The importance of wild bananas in Sri Lanka

Local demand for banana is high, as is the potential for export, making the crop a priority for development

Banana has been a favourite fruit in Sri Lanka from time immemorial. The remains of a wild banana species, *Musa balbisiana* (locally known as 'ati kehel'), have been found at prehistoric cave sites. The finding indicates that wild bananas were enjoyed in Sri Lanka over 12 000 years ago.

Many ancient documents, including the great Singhalese chronicle, 'Mahavanasa', refer to bananas. Dating back to 341 CE, 'Saratha Sangrahaya', the oldest book of medicine in Sri Lanka, describes the medicinal properties of various parts of the banana plant.

Today, banana is the most important fruit crop in Sri Lanka. Local demand for banana is high, as is the potential for export, making the crop a priority for development.

Two wild species of banana, *Musa acuminata* Colla and *M. balbisiana* Colla, grow in Sri Lanka. The traits exhibited by Sri Lankan races of cultivated bananas show that most of them are the result of hybridization between the two wild types.

Present-day banana cultivars rarely produce seeds because they have little or no pollen and exhibit female sterility, making them very difficult to breed. But wild types are fertile and produce viable seeds. The wild accessions held in Sri Lanka's national genebank could thus be used in breeding. The development of new varieties will also make use of somatic mutations: mutations of body cells that are not passed on in sexual reproduction.

A number of cultivars and wild species show a variable degree of resistance to a range of diseases that threaten banana around the world, including Panama disease, Black Sigatoka, banana bract mosaic disease, bunchy top, cucumber mosaic virus and banana streak virus. However, the once widely distributed wild species and native cultivars are beginning to disappear from Sri Lanka, due to habitat destruction and a move away from traditional farming. Although significant banana diversity is being conserved at the Plant Genetic Resources Centre and at other research stations in Sri Lanka, no conscious effort has been made so far to protect bananas in the wild.

By Gamini Samarasinghe, Plant Genetic Resources Centre, Sri Lanka

D. Yakandawela

Close-up of a banana flower, Sri Lanka. Banana is the most important fruit crop in Sri Lanka.

A.Wijesekara

A market stall in Sri Lanka displays the country's rich banana diversity. Banana is the most important fruit crop in Sri Lanka

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Wild relatives offer new lease on life to an ancient grain

The Armenian highlands are home to a rich diversity of crop wild relatives. Some are ancestors of cultivated varieties; others cross freely with their related cultigens and can be used in breeding or to study the relationship between wild and cultivated plants.

Armenia is a centre of origin for cereals. Here, the use of wheat dates back more than two millennia. Archaeological excavations have revealed well-preserved granaries and clay vessels filled with a grain identified as *Triticum urartu*, a wheat species named after the ancient kingdom of Urartu whose inhabitants were skilled agriculturists. It is believed that the ancestors of *T. urartu* played a role in the origin of wheat varieties cultivated today. Another ancient type, known as *korkot*, is used in modern-day Armenian kitchens. Wheat grains discovered in the storehouses of the ancient Urartu fortress still grow in the Ararat valley. Today, about 13 species and more than 360 varieties of cultivated and wild wheat can be found in Armenia. Three out of the four known wild wheat species can be found in Armenia.

The wild wheats of Armenia have a high potential for use in improving cultivated wheat varieties. Some of the wild species are drought-resistant, which is particularly important in Armenia due to the dry climate and frequent water shortages. The wild species *Triticum boeoticum* Bois is resistant to fungal diseases and has high variability, which makes it a valuable subject for research. *Triticum araraticum* Jakubz could be used to breed protein-rich wheat varieties.

The use of wild relatives to improve Armenian wheat is an important strategy: wheat is absolutely central to the country's culture and customs. Traditionally, the mother of the groom puts *lavash*—a type of flat bread—on the shoulders of the bride and the groom when they are about to enter their new home for the first time. It is believed that this will keep the new family productive, affluent and fertile. In other words, as an Armenian saying would have it, "there will always be bread on the table."

By Armen Danielian, Ministry of Nature Protection, Armenia

The use of wild relatives to improve Armenian wheat is an important strategy

A. Danielian

Lavash, traditional Armenian bread.

A. Danielian

Women preparing *lavash*.

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Global conference maps out future for wild relatives

Wild pea vine found in central and southern Europe.

L. Udvardy

Although the wild relatives of crop plants have been used by farmers for millennia and by plant breeders for over a century, remarkably, efforts to ensure the continued availability of these valuable resources are very recent. Addressing a problem—the disappearance of wild relatives from nature due mostly to human influence—that has been largely ignored over time brings with it special challenges. The nature of these challenges set the context for the first-ever International Conference on Crop Wild Relative Conservation and Use, held in September 2005 in Sicily, Italy.

The Conference, which was organized by the University of Birmingham (UK), IPGRI (now Bioversity International) and the Istituto Sperimentale per la Frutticoltura (Italy), brought together about 150 scientists, policy-makers, private- sector participants and non-governmental organizations from 45 countries.

"Crop wild relatives are plant species that are closely related to cultivated crops," said Jozef Turok, Bioversity International's Regional Director for Europe and one of the organizers of the conference. "Their closeness means that they can contribute beneficial heritable traits for pest or disease resistance or yield improvement to crop varieties."

In Europe and the Mediterranean, a start has already been made to better assess and document the status of wild relatives through the three-year European Union-funded project, PGR Forum, whose findings were presented at the conference (see 'Regional catalogue supports national strategies,' p.12). For example, two-thirds of an estimated 30 000 plant species in the region are considered useful to society. Major crop plants such as oats, sugar beet, apple, annual meadow grass and white clover have wild relatives in Europe. Many minor crops have also been developed and domesticated from crop wild relatives in the region, such as arnica (which is used in homeopathic remedies), asparagus, lettuce and sage. These and other findings are documented in PGR Forum's chief product, the Crop Wild Relatives Catalogue for Europe and the Mediterranean, which provides easy access to information on wild relatives in Europe.

The conference highlighted the threats to crop wild relatives worldwide as a result of changes in land use, such as the growth of housing developments, large-scale farming and tourism. Climate change is also an important factor affecting the wild relatives of crop plants.

Participants described their experiences in studying and managing wild relatives around the world. They agreed on the need to identify and locate wild species with socio-economic value. Conservationists need guidelines for maintaining wild relatives in their natural habitats.

The conference considered elements of a global strategy on crop wild relatives. All agreed that the development of supportive policies, *in situ* conservation, sustainable use of wild relatives and raising public awareness of their value were major areas for action. Involving many different sectors, including farmers, in the further development and implementation of the strategy will be critical, as will be exploring the use of a variety of techniques, such as satellite imagery, to produce maps showing changes in vegetation patterns, land use and individual species over time.

It is no coincidence that the first conference on wild relatives happened in Sicily. The island has 1741 species of crop wild relatives, 11% of the total found in Europe. Thirty-five of these species are found only in Sicily.

The conference proceedings will be published by CAB International in 2007.

By Kelly Wagner, Bioversity International

Conservationists need guidelines for maintaining wild relatives in their natural habitats

For further information, visit http://www.pgrforum.org

Parco Archeologico e Paesaggistico della Valle dei Templi

The beautiful temples of the Valle dei Templi in Agrigento, Sicily, Italy, formed the backdrop for the first ever conference on crop wild relatives, which took place in September 2005.

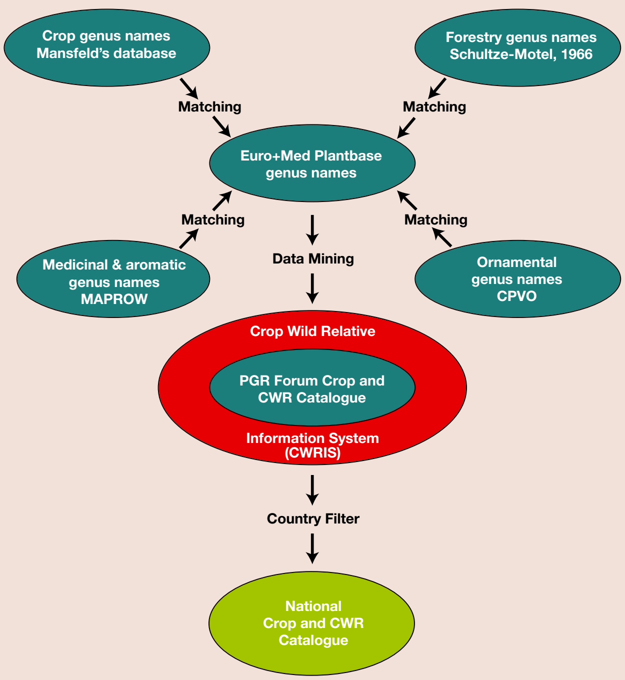
Regional catalogue supports national strategies

Researchers can use the catalogue to generate national inventories

Recently, 21 European countries worked together to catalogue the full range of cultivated and wild plants of socio-economic importance in the European and Mediterranean regions.

Europe may not be the first region to come to mind when thinking of crop diversity; after all, most of the world's most important plant genetic resources are to be found in the developing world. Nevertheless, Europe does have globally significant diversity of crops such as oats, sugar beet, carrot, apple, asparagus, lettuce, raspberries and blackberries, as well as many forage, medicinal and aromatic species.

A recent European Union-funded project, PGR Forum, brought together partners from across Europe to assess the taxonomic and genetic diversity of European crop wild relatives and to make plans to conserve them. The central product was the first comprehensive Crop Wild Relatives Catalogue for Europe and the Mediterranean.



The Crop Wild Relatives Catalogue for Europe and the Mediterranean was created by matching the regional flora (held in the Euro+Med Plantbase: www.euromed.org.uk) with specialist socio-economic plant databases. Individual country catalogues can be extracted by filtering the regional database.

Researchers can use the catalogue to generate national inventories by downloading a list of crops and crop wild relative taxa for their countries. Such inventories are important because they provide the baseline data needed for setting priorities and developing long-term conservation and sustainable-use strategies. Ireland, Portugal and the UK have already used the catalogue to create national inventories; these will serve as the basis for making decisions on conservation strategies in the three countries.

The catalogue references over 24 000 species—around 80% of the total Euro-Mediterranean flora. It is available at http://cwris.ecpgr.org, the Web site of the Crop Wild Relative Information System. This information platform contains a wide range of data on both wild relatives in Europe and the Mediterranean and the cultivated species to which they are related.

By Nigel Maxted, Shelagh Kell and Brian Ford-Lloyd, University of Birmingham

Once individual country catalogues are established, the sites with the greatest diversity can be identified. Here the five sites in the British Isles that contain the greatest overall species diversity are shown with the number of priority crop wild relative species present at each site.

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Putting diversity back into wheat

Wheat is the staple food for a third of the world

Researchers are using wild relatives to create wheat varieties containing valuable traits that were thought to have been lost forever, watered down by thousands of years of wheat breeding.

When farmers started to domesticate wheat thousands of years ago, they were given a great head start by nature. The original primitive wheats were the results of spontaneous crossings of wild grasses, the wild relatives of wheat. Those grasses had been exposed to cold, drought, heat, waterlogging and all kinds of diseases and pests. The grass species alive today resisted those scourges and carried resistance in their seeds as part of their genetic heritage. They also brought those characteristics to the first wheats planted by farmers.

CIMMYT

Three synthetic wheats (right) derived from crosses of durum wheat (left) with wild grass species.

Wheat today comes in two broad categories. Durum wheat resulted from the crossing of two wild grasses and today is best known as the wheat used for pasta, couscous and semolina products. Bread wheat, a cross between durum and another grass, is thought to have arisen about 10 000 years ago, in the Caspian area of Iran.

Wheat is the staple food for a third of the world, providing more calories and protein in people's diets than any other crop. Nine-tenths of the world's wheat is bread wheat. The rise of wheat as an important food crop came at a cost to its genetic diversity, especially when landraces were replaced over large areas by fewer varieties.

The adoption of 'Green Revolution' wheats starting in the 1960s had spectacular results, bringing self-sufficiency in wheat to India, Pakistan, Turkey and other countries. The new, semi-dwarf varieties had higher yields and were resistant to production-limiting diseases, in particular rusts. Farmers grew the best-performing varieties selected by scientists from national agricultural research programmes. The breeding efforts of national programmes, the International Maize and Wheat Improvement Center (CIMMYT) and other centres continued to build on the strength of those varieties and the valuable traits they exhibited. In fact today varieties based on CIMMYT-derived germplasm are grown on more than 60% of wheat fields of the developing world and in much of the developed world as well.

One result of this selection process by farmers and breeders has been a decline in the inherent diversity of wheat being grown in farmers' fields. If wheat varieties are genetically uniform, the vulnerability of global wheat production to a devastating new disease or insect pest outbreak is high. Increased genetic diversity provides a buffer against such risks and reduces vulnerabilities.

CIMMYT recognized this risk and designed novel breeding strategies to put diversity back into the wheat germplasm it provides to farmers. Wheat cytogeneticist Abdul Mujeeb-Kazi decided to recreate the events that resulted in the creation of the original bread wheats. Mujeeb-Kazi crossed one of wheat's wild relatives with a modern durum wheat. Wild relatives may have traits that have been lost in the domesticated crop over thousands of years of farmer selection and the last century of more intense breeding.

"In places where there's a good bit of rainfall, wheats face diseases such as rust, septoria, leaf and spot blotch, fusarium scab and powdery mildew," said Mujeeb-Kazi. "The wheats we've developed show genetic resistance to six or seven diseases at the same time, plus tolerance of such problems as salinity, waterlogging and drought. This gives them a huge advantage in most environments where wheat is grown."

CIMMYT began incorporating materials from wild relatives into its wheat breeding 15 years ago. The first varieties are now reaching farmers fields, but until recently CIMMYT could not say quantitatively whether there had been a true impact on genetic diversity in the seeds.

By examining the DNA of the landraces of wheat grown by farmers before

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modern breeding started and comparing it with DNA from the most popular modern varieties and with the newest materials from CIMMYT, a team led by molecular geneticist Marilyn Warburton was able to confirm the decline in diversity in popular current wheats while at the same time demonstrating that the new wheats from CIMMYT had genetic diversity similar to that in the pre-Green Revolution landraces. “The study confirms what we had hoped would happen,” said Warburton. “It means that in the future, wheat will carry its historic heritage back into farmers’ fields.”

“The successful incorporation and re-mixing of genetic diversity from wheat’s wild relatives has created wheats containing more variation than has ever been available to farmers and breeders, possibly since hexaploid (the complex genetic structure of wheat that arose from the accidental crossing of wild relatives and grasses in the distant past) wheat first appeared 10 000 years ago,” the study concluded.

Today, as a result of the work by Mujeeb-Kazi, there are a thousand new wheats created from crossing different wild relatives with modern wheats, far more than the original bread wheat that might have originated with just a few plants and a couple of wild crosses.

By David Mowbray, CIMMYT

Protecting the wild relatives of walnut

Close to 200 species of Persian walnut grow in Central Asia

The Persian or common walnut (*Juglans regia*) is native to Central Asia. This species has been widely cultivated for many thousands of years, but its wild relatives have been sadly neglected, putting them at risk of disappearing.

The story has it that Alexander of Macedonia ordered the importation of the Persian walnut to Greece, ascribing to it the power to protect his soldiers against disease. Numerous ancient historians, such as Arrianos, Teofrast and others, claim that Alexander’s army was saved from certain death by the large numbers of walnuts they ingested during his campaign in Turkistan.

Apparently, this is not far fetched. Walnuts are an excellent source of omega-3 fatty acids and have been shown to be helpful in lowering cholesterol, both of which characteristics help guard against heart disease. In addition, walnuts contain a host of other important vitamins, minerals, protein and antioxidants. Walnuts are cited as the second richest source of antioxidants, next to rose hips, according to a study by the University of Minnesota, USA, and the University of Oslo, Norway.

Close to 200 species of Persian walnut grow in Central Asia. Long prized for its beautiful wood, as well as for its fruit, the dangers faced by walnut diversity in the region are very real. To protect walnut trees in their native lands, the Crop Wild Relatives Project, funded by the Global Environment Facility and implemented by the United Nations Environment Programme, is working with partners throughout the region to set up modern walnut plantations. If successful, the project should reduce the exploitation of natural stands of walnut trees, allowing diversity to flourish while establishing a sustainable approach to enriching the livelihoods of people in the region.

By E.A. Butkov, R.A. Sultanov, G.M. Chernova and L.V. Nikolyai, Republican Scientific Production Center of Decorative Horticulture and Forestry, Uzbekistan

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E. Butkov

Walnuts are a good source of omega-3 fatty acids and can help lower cholesterol.

Saving Central Asia's pistachio diversity

Considered a delicacy since the beginning of recorded time, the pistachio has been cultivated for centuries throughout Central Asia, where it originated. Pistachio nuts are eaten fresh or roasted and are also used in ice cream and desserts such as baklava.

While there is a huge potential for expanding the commercial production of pistachio in the region, it has not been well exploited. Today, of the countries in the region only Iran holds a large market share, at 38% of the world market. The USA has the second largest share of the market with 28%. As the global commercial production of pistachio amounts to 500 million tonnes per year, efforts to create markets for pistachio varieties native to other Central Asia countries could bring major benefits to the region.

An important first step is to shore up existing pistachio diversity in the region. For three millennia, pistachio trees were used in metallurgy and mining in Central Asia due to their accessibility and the highly calorific charcoal they produce. The result was a major depopulation of wild pistachio in the region. During the Stone Age, pistachio trees in Central Asia covered approximately 2 million hectares, compared with only 300 000 hectares today.

The loss of wild pistachio diversity in Central Asia has major implications for pistachio growers in the region and beyond. Most of the pistachio gene pool is to be found here, where it is needed to underpin the continued availability of the tasty nut. The wild relatives of pistachio also play an important role in holding back the region's fragile soils. Their loss further threatens an already threatened environment.

Two projects are currently addressing the challenges facing the pistachio in Central Asia. The Crop Wild Relative Project, funded by the Global Environment Facility, implemented by the United Nations Environment Programme and coordinated by Bioversity International, is overseeing the planning of ecogeographic surveys and germplasm collecting missions in Central Asia to learn more about the diversity, distribution and uses of pistachio and to strengthen conservation efforts. The project's activities in the region are being managed by Bioversity's office in Tashkent, Uzbekistan.

"Pistachio plays a vital role in the nutrition, economy and culture of many poor countries in the region" — Basha

A grant provided by the International Fund for Agricultural Research will enable pistachio expert Amer Ibrahim Basha to assess the amount and distribution of wild and cultivated pistachio diversity in his native Syria and more widely in Central Asia using molecular techniques. This information will help to develop effective strategies to conserve and make use of pistachio diversity in the region.

"Pistachio plays a vital role in the nutrition, economy and culture of many poor countries in the region," said Ibrahim Basha. "This study, and complementary work through the Crop Wild Relatives Project, will help the countries make the most of their pistachio diversity for the benefit of people in the region."

By Galina Chernova, Republican Scientific Production Center of Decorative Horticulture and Forestry, Uzbekistan

L. Nikolyai

Pistachio plays an important role in the culture and culinary traditions of Central Asia.

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Ask the old women
the search for hardy survivors

"We are going back through time, backwards through human-induced evolution" —Street

Scientists are on a hunt for genes in the land where farming began, searching for lost genetic resources that scientists say will be crucial for the world to keep feeding itself as climate change and deteriorating agricultural landscapes begin to bite.

High in the mountains of southern Armenia, the farmer's tanned, furrowed face is thoughtful. "You should ask the old women," he said after a pause. From village to village, others agree. "Ask the old women." They are helpful and nostalgic and, after an obligatory vodka or two, melancholy.

The old women emerge from lightless kitchens and farm buildings and the scientists explain their quest to find places where ancestral plants might still grow on high plains that have been overgrazed or mined. The women hurry away and with extraordinary generosity re-emerge with tins, jars and knotted cloth containing biological treasures—the seeds of bygone crops.

Grains of wheat, barley, beans and peas disappear into small yellow envelopes. Some of the old women cry, because these visiting scientists seem to understand what they have known intuitively all along—that the traditional varieties were special.

The scientists are led by a Syria-based Australian, Ken Street, an agricultural ecologist with the International Center for Agricultural Research in the Dry Areas (ICARDA). The team comprises Russian and Armenian plant researchers, as well as another Australian, Perth-based Clive Francis from the Centre for Legumes in Mediterranean Agriculture (CLIMA). Their work is partly funded by the Australian Centre for International Agricultural Research (ACIAR), a development agency, and the Grains Research and Development Corporation (GRDC).

The team scours the birthplace of agriculture, the Caucasus—Armenia, Azerbaijan, Georgia and parts of Russia—for remnant on-farm seed stocks and for the ancestral wild grasses from which modern crops like wheat and barley were first bred some 5000 or so years ago. They are focused on the two or three degree increase in average temperatures that the globe is likely to face due to global warming. A fraction of a degree change can be enough to stop many food plants from flowering and delivering grains and fruits.

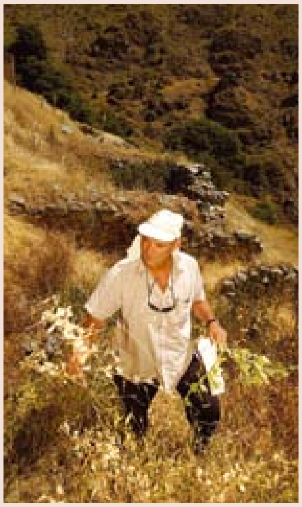
© Brad Collis/Coretext

Clive Francis, CLIMA, collecting seed in Armenia, July 2005.

It is the genes that allow the old relatives of modern crops to flourish in frozen or arid landscapes that need to be found and reintroduced. "We are going back through time, backwards through human-induced evolution," explained Street. "We are looking for the grasses that were used for bread-making thousands of years ago. We are searching for what our far-distant ancestors were using, because these plants have a wider genetic base. A modern wheat plant might have a few hundred parents from a breeding programme, but the ancient wild varieties had hundreds of thousands, perhaps millions, of parents.

"The world is losing irreplaceable seeds. This is frightening, because the genetic origins for a very large proportion of the world's food crops do not exist anywhere else. So we are desperately trying to collect, store, document and manage as much diversity from old varieties and wild relatives as we can before they are gone forever. It's a survival issue," Street said.

By Brad Collis, Coretext Pty Ltd



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Ken Street looking for old crop varieties in the ruins of a long-abandoned village in Armenia.

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Tapping the potential of medicinal and aromatic plants in northern Europe

In northern Europe, biodiversity programmes are looking to wild species as a new source of commercial products and, in so doing, are creating an economic motive for their conservation.

The inhabitants of Nordic and Baltic countries once valued their ancestors' expertise in using wild plants. The knowledge arising from this expertise was passed down over many generations, allowing the continued use of medicinal plants in accordance with old traditions. However, growing urbanization in the region and the lack of supportive policies and technical support has led to a dramatic decline in the use of traditional medicines, putting the wild plants at risk.

One sure way to convince decision-makers of the importance of conserving wild plants is to demonstrate their economic potential. Creating a commercial value for the plants is a great incentive to keep them safe. Norway and Finland had already had some experience of this with the commercial production of roseroot, a wild plant used to stimulate the nervous system, decreasing depression, enhancing work performance and eliminating fatigue.

A four-year project to identify potential commercial uses of wild plants in the Nordic and Balkan countries wound up in 2005. The project, funded by the Nordic Gene Bank, investigated eight wild species with market prospects. These included wild thyme, shrubby St. John's wort, sweet flag root and wild oregano. The plants were collected and deposited in national collections for conservation and further study. In addition, the project catalogued over 130 wild plants with medicinal and aromatic uses, some of which are under threat in the region due to changing agricultural practices, habitat loss, over-exploitation and other factors. It would not be good business to let these species disappear before their market potential can be realized.

Creating a commercial value for the plants is a great incentive to keep them safe

Follow-up to the project will involve additional collecting and evaluation of the promising plants, as well as the development of methods for commercial production in order to ensure against over-harvesting from the wild populations of vulnerable species.

By Kelly Wagner,
Bioversity International

Roseroot, a wild plant used to combat depression, has gone into commercial production in Norway and Finland.

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Climate change threatens wild relatives with extinction

As global temperatures continue to rise, crop wild relatives are threatened with extinction at the very time they are needed the most.

Climate change is making major new demands on crop diversity as well as creating new opportunities for using diversity to mitigate its adverse impacts on agricultural systems. Crop wild relatives can help adapt cultivated crops to changing climactic conditions, but their very survival has been placed in jeopardy by climate change. A study conducted by Bioversity International and the International Rice Research Institute (IRRI) estimated the current and future geographical distribution of the wild relatives of three of the world's important food crops—potato, peanut and cowpea—based on 19 climate variables. The results show that within the next 50 years climate change is likely to dramatically affect all three crops. Strikingly, the study predicts that by 2055, 18–25% of all potato, peanut and cowpea species could become extinct and that most species could lose over 50% of the land area that is currently suited to them.

A. Lane/Bioversity International

A vegetable stall in Cochabamba, Bolivia, boasts a striking display of potato diversity. A recent study by IRRI and Bioversity International estimates that up to 13 of 107 wild species of potato being studied could become extinct by 2055.

Wild peanuts are predicted to be the hardest hit, with as many as 31 of the 51 wild species studied likely to become extinct and the distribution area of the remainder to be reduced by more than 90%. In addition, up to 13 of 107 wild species of potato studied could become extinct by 2055, with the potential distribution area of the remaining species reduced by over 70%. Up to three of 48 species of cowpea are likely to disappear, and the distribution area could be reduced by 65%, with 41 out of 48 species losing more than 50% of their current ranges.

The study also estimates that the average patch size of populations will diminish by as much as 75%, indicating greater fragmentation of populations and reduced viability for survival. Moreover, habitat fragmentation will create spatial barriers to species migration, effectively isolating populations and narrowing genetic diversity.

The findings demonstrate that climate change will drive many wild relatives of important crops to extinction through habitat reduction and fragmentation, without even considering other continuing drivers of habitat loss such as deforestation and over-exploitation. The wild relatives of peanut, potato and cowpea have already proven to be important sources of genes for improving agricultural production. For example, wild relatives of the potato have provided resistance to late blight, Colorado potato beetle and various viruses, and wild relatives of cultivated peanut have been used to breed resistance to root-knot nematode.

Unfortunately, it is rare for crop wild relatives to be targeted for conservation actions. Equally rare is their use in adapting modern crops to the impacts of climate change, although they are a promising source of genes for hardiness, often growing off the beaten track in already challenged environments. The selection of *in situ* conservation areas for crop wild relatives and species-specific management strategies need to factor in climate change as a significant driver of species distribution and conservation status. Climate modellers, plant breeders and conservationists also need to work together to identify vulnerable areas and species, evaluate the species that are important to crop improvement and develop integrated climate-change conservation and breeding strategies. Threatened species will require targeted monitoring and conservation measures in order to ensure their survival in the face of climate change. The more threatened species will require targeted *ex situ* conservation interventions.

Climate change is making major new demands on crop diversity

By Annie Lane and Andy Jarvis, Bioversity International, and Robert Hijmans, IRRI

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Wild potato relative may blunt late blight

Late blight, the disease that laid waste to Ireland's potato fields in the 1840s, continues to cut a deadly swath through agriculture over a century and a half later. But tomorrow's tubers may have protection against this disease, thanks to research by the United States Department of Agriculture's Agricultural Research Service (USDA–ARS). Scientists at USDA–ARS are developing hardy, highly productive potato plants that not only produce top-quality potatoes but also shrug off attack by the fungus-like microbe that causes late blight. The disease costs about US$400 million in losses each year in the USA alone.

V. Heywood

Antonio Rivera Pena, researcher in Mexico, examines a wild potato. Researchers have identified and isolated a gene in a wild potato that could confer resistance to late blight.

For further information, visit www.nps.ars.usda.gov

The assault on the resilient microbe started when a USDA–ARS team at the Western Regional Research Center in Albany, California, identified and isolated the gene in *Solanum bulbocastanum*—a wild relative of the potato originating in Mexico—that could be introduced directly into potatoes to work in concert with other genes to fend off late blight.

This discovery grew from research over the past decade by plant physiologist John P. Helgeson, formerly with USDA–ARS in Madison, Wisconsin. He fused *S. bulbocastanum* with the familiar domesticated potato, creating unique hybrids. Then, scientists from USDA–ARS worked to isolate and clone the resistance gene from the crop wild relative. They transferred the gene into domesticated potatoes to test the effectiveness of the gene in countering late blight.

L. Cooke/ Agri-Food and Biosciences Institute

Leaves of a potato plant in Northern Ireland infested with blight, the deadly disease that laid waste to Ireland's potato fields in the 1840s.

When grown out in plant pathologist Kenneth L. Deahl's greenhouse, the test plants from Albany showed resistance to the disease. Additional tests will reveal how well the potatoes perform outdoors when exposed to the microbe. These field experiments should bring scientists a step closer to determining whether genes from a wild, south-of-the-border potato can protect its northern cousins from being battered by late blight.

By Marcia Wood, USDA–ARS

Late blight causes losses of about US$400 million each year in the USA alone

On the rocks

While much attention is given to the benefits to be obtained from the use of crop wild relatives in breeding, it is worth sparing a thought for the problems of collecting these plants from the wild.

Crop wild relatives occupy a very wide range of habitats throughout the world, some of which

V. Heywood

Cliffs in Trapani, western Sicily, Italy, home to various species of brassica wild relatives.

pose serious difficulties for the plant collector. Some grow in inaccessible rocky habitats. The plants that grow on rock faces or cliffs often have a highly specialized ecology and may even be niche-specific—they will grow only on overhangs or on vertical faces, for example. As a consequence, their populations are very scattered and difficult to measure or study.

The close relatives of the widely cultivated vegetables such as cabbage, cauliflower, kohlrabi and Brussels sprouts that are derived from *Brassica oleracea* L. are bushy wild cabbages native to the Atlantic coast of Europe, the Mediterranean basin and the Canary Islands. These form a group of wild taxa, including some that are narrow endemics restricted to cliff habitats in several Mediterranean islands, including Corsica, Sardinia, Sicily, Crete and Cyprus.

Sometimes the plants are within reach (or nearly so) but all too often they grow on cliffs well out of reach except to goats or the most intrepid plant collectors, who may have to seek recourse to long-arm pruners (not the most convenient contraption to carry with one in the field), or even to throwing stones at the plant in the hope of dislodging some branches with fruits.

During a recent trip to Sicily, Professor Cesar Gómez-Campo from the Polytechnic University of Madrid, Spain, and Professor Vernon Heywood of the University of Reading, UK, sought out seeds of *Brassica villosa*. To reach the vertical rock faces where the plants were growing, they had to climb up the side of the cliffs from shore level, passing through the living room of a farm cottage (with the owner's permission!) on the way. Under such circumstances when there are only a few isolated plants on the cliffs, any attempt to undertake a proper sampling of the population as recommended in the manuals becomes irrelevant. Some seed in the bag is better than none.

By Vernon Heywood, University of Reading

The plants that grow on rock faces or cliffs often have a highly specialized ecology and may even be niche-specific

V. Heywood

Professor Cesar Gomez Campo collecting seed of *Brassica villosa* growing on rocks in Trapani.

For further information, contact Vernon Heywood, University of Reading v.h.heywood@reading.ac.uk

Spreading the word about wild relatives

The extensive loss of agrobiodiversity and the threat that it poses to human well-being is a global problem that requires a global solution. Important initiatives have been launched to stem the haemorrhage of crop diversity, including action by the Convention on Biological Diversity, the Food and Agriculture Organization of the United Nations and the centres supported by the Consultative Group on International Agricultural Research (CGIAR).

Examples of wild relatives at risk

Crop	Situation
Tomato	Across South America, populations of wild tomato are being severely reduced due to goat herding in the highlands and habitat loss.
Coffee	A wild species of coffee that once grew in Côte d'Ivoire is known to be extinct. Ten others are either endangered or vulnerable in the wild.
Pistachio	Pistachio's broad genetic base is being lost as a few high-yielding commercial types replace ancient varieties and human activity destroys wild species.

But crop wild relatives, although they have an important role to play in crop improvement, tend to fall between the cracks of such conservation initiatives. Now, a group of specialists have banded together, with support from the World Conservation Union, to ensure that wild relatives get the respect they deserve.

It is not known how many wild relatives of crop plants exist around the world, but in Europe and the Mediterranean region more than 20 000 out of an estimated 30 000 species are considered crop wild relatives. Many of these are related to major European crops such as oats, sugar beet and apple. Numerous minor crops such as asparagus, lettuce and sage have wild relatives in the region as well.

According to Ehsan Dulloo, senior scientist at Bioversity International and co-chair of the expert group, "They may look scruffy and worthless, but wild relatives are a goldmine of genes for helping farmers to combat challenges such as pests and diseases, climate change, water stress and salinity."

Although agricultural scientists identified crop wild relatives as a conservation target over 30 years ago, it was not until the 1990s that the *in situ* conservation of wild relatives began to be taken seriously.

Ex situ conservation of wild relatives, while a desirable back-up to *in situ* conservation, can be tricky because the wild relatives tend to contain fewer seeds than their cultivated counterparts. Only about 5% of the crop diversity conserved in European and CGIAR genebanks is from crop wild relatives; the rest is from domesticated crops.

It was not until the 1990s that the in situ conservation of wild relatives began to be taken seriously

R. Khalil /Bioversity International

Pistachio's broad genetic base is being lost as a few high-yielding commercial types replace ancient varieties, and human activity destroys wild species.

One of the first actions of the specialist group, currently in its formative days, will be to establish a global database on crop wild relatives. The group plans a major effort to raise the profile of wild relatives and stimulate their conservation. Dulloo believes that the future of wild relatives is safe in the hands of the group. "The Crop Wild Relatives Specialist Group will become the global authority on the conservation of wild relatives," he said.

By Kelly Wagner,
Bioversity International

For further information, contact the co-chairs of the specialist group: Ehsan Dulloo, Bioversity International
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Wild relatives could help boost berry market

Wild relatives provide a valuable source of variation that can be used to improve the quality of many cultivated species. In the past, wild relatives have been used to improve the flavour of tomatoes, the disease resistance of potatoes and the drought tolerance of chickpeas. Now, studies are being conducted to see if wild relatives can boost the marketability of pepino (*Solanum muricatum*).

Golden yellow or purplish green and covered with darker stripes, the pepino is a juicy, mildly sweet and aromatic berry that is also referred to as pepino melon or melon pear. The fruit is native to the temperate Andean region that includes Chile, Colombia, Ecuador and Peru. Today, it is grown commercially in Chile, New Zealand and Western Australia. The introduction of pepino as a new fruit on European markets has potential for increasing the incomes of poor farmers in Latin America. However, existing pepino varieties are not sweet enough and do not have enough solid mass to be marketed in Europe in their present state.

Environmental conditions influence the fruit quality of pepino. For example, high temperature during ripening reduces the sugar content, making the fruit less sweet. On the other hand, when the crop grows in a cooler environment, the soluble solids concentration levels—sugar and organic acid content in fruit—increase, although they still are normally too low to meet European consumer demands.

J. Prohens

Researchers are looking to wild relatives of pepino for ways to increase the fruit's sweetness.

Now, research is underway to improve the sweetness of pepinos by crossbreeding them with their wild relatives.

Difficulties often arise when breeding cultivated crops with their wild relatives due to crossability barriers between species. Fortunately, pepino crosses easily with two wild species that are its accepted ancestors, *S. caripense* and *S. tabanoense.* These species are harvested and eaten by rural people in the Andean region and have high acidity and mass. Although the wild species have smaller fruit, this undesirable trait can be reduced in a few backcrossing generations.

The Institute for Conservation and Improvement of Agrobiodiversity of Valencia, Spain, has been doing research on pepino improvement. Recent progress indicates that the two wild species are promising sources of variation for improving pepino fruit quality. If market access can be assured, Europeans may soon grow accustomed to seeing purple striped yellow berries alongside the familiar blue, black and red ones at their local fruit stands.

By Kelly Wagner, Bioversity International

The introduction of pepino as a new fruit on European markets has potential for increasing the incomes of poor farmers in Latin America

For further information, visit the Web site of the Institute for Conservation and Improvement of Agrobiodiversity of Valencia, Spain, at http://www.comav.upv.es/index2.html

Groundnut relatives hit the spot

For years, groundnut fields have been laid waste by devastating fungal diseases. Now, thanks to the wild relatives of the groundnut, farmers around the world can breathe easier.

A few spots on the leaves of the groundnut plant are enough to strike fear into the hearts of farmers around the world. Two fungal diseases—early leaf spot and late leaf spot—can seriously damage the plant and have a major impact on crop yields.

Groundnut is the thirteenth most important food crop in the world, the fourth most important source of edible oil and the third most important source of vegetable protein. It is grown on 26.4 million hectares worldwide with a total production of 36.1 million tonnes. Developing countries account for 96% of the land planted to groundnut and for 92% of global production. Clearly, coming to grips with leaf spot could have major implications for the livelihoods of poor countries.

Early leaf spot is caused by the fungus *Cercospora arachidicola.* Reports indicate that yield losses due to this pathogen can be as high as 50%. Late leaf spot is caused by *Phaeoisariopsis personata,* which has caused economic losses totalling US$599 million in the groundnut growing areas of the world, including Asia and Africa.

Now, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is developing groundnuts with resistance to the two dread diseases. Fortunately, many wild relatives of groundnut are good sources of resistance to both leaf spot diseases. By crossing wild groundnut with the cultivated type, ICRISAT scientists have already managed to produce resistant types.

Given the dynamic and ever-evolving character of diseases, ICRISAT scientists are constantly on the hunt for new sources of resistance to leaf spot. Recently, crosses of four wild peanut varieties—*Arachis stenosperma*, *A. kempff-mercadoi*, *A. diogoi* and *A. cardenasii*—yielded progeny with resistance to late leaf spot. Thanks to its nutty relatives, it looks like groundnut is here to stay.

By N. Mallikarjuna, ICRISAT

A few spots on the leaves of the groundnut plant are enough to strike fear into the hearts of farmers around the world

ICRISAT

Arachis diogoi, a wild relative of groundnut.

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Glossary

Agrobiodiversity: The elements of biodiversity—including plants, animals and micro-organisms—that benefit people.

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

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

Cultigen: Cultivated plant, such as the banana, not known to have a wild or uncultivated counterpart.

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 its physical environment.

***Ex situ* conservation**: Conservation of a plant outside of its original or natural habitat.

Genebank: A 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 agricultural 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.

Genotype: 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 domesticated 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, animals or other organisms.

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 species (usually in the same genus).

Our organization has a new name: Bioversity International (Bioversity for short)

We didn't change our name simply for the sake of change. Our organization has evolved over the years and the old name, the International Plant Genetic Resources Institute, respected as it was, no longer adequately reflected the work we do.

We are a research organization dedicated to conserving and using biodiversity, but the scope of our work extends far beyond plant genetic resources. We are working with our research collaborators to conserve all types of biodiversity, including animal, aquatic and even microbial genetic resources.

What's more, our research is about much more than genetic resources and genetics. It's about people. People are at the centre of everything we do.

We don't measure our success by calculating the number of varieties and species conserved in genebanks. It is measured in the tangible benefits our research brings to the people of the world, especially those living in poverty and hunger in developing countries. We are committed to working with an international network of partners to conserve and harness biodiversity to secure dignified and sustainable livelihoods for the poor, provide better nutrition to the undernourished and protect threatened ecosystems.

So to better reflect the scope and nature of our work we chose a new name, Bioversity International.

In fact, more than selecting a new name, we have coined a whole new word. We believe 'Bioversity' evokes a constellation of ideas that unites biodiversity with other concepts that are central to our work. The name suggests 'universe' and 'universality', which evoke the immensity of the natural world and our belief in the value of working together for common good of humanity. Also, our new name conjures up the idea of a university. Like a university, we are a 'collegial' organization, one that derives it strength from collaborative activities among many different types of groups with expertise in many different disciplines and with research as an important component.

Although you will often see the organization referred to simply as Bioversity, we have retained 'International' as part of our official name. This is not simply because our research activities are carried out all over the world and our members, donors and research partners come from many countries, but because we are committed to ensuring that our research contributes to international efforts to establish effective policies and plans of action for the conservation and sustainable use of agricultural biodiversity.

We would like to welcome you to the world of Bioversity International.

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Bioversity International.

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