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Conservation and domestication of arid-zone plants: Tunisia



BACKGROUND AND JUSTIFICATION

About one third of Tunisia's agricultural land is rangeland, most of which (80 per cent) has an arid or semi-arid climate and mean annual rainfall of less than 350 millimetres. This area used to be home to one of the highest diversities of plant species in northern Africa. By the late 1980s, however, the destruction of natural habitats and the effects of ever-increasing numbers of grazing livestock were leading to a rapid decline in plant species diversity. Overgrazing accelerates the disappearance of species that are grazed and aids the spread of species that are not grazed. In some areas, the result has been desertification of once-fertile areas.

Attempts to introduce exotic species as a way of restoring and improving degraded rangelands have not been particularly successful and attention is now turning to indigenous pastoral plants. In 1986, a gene bank of indigenous arid and desert rangeland plant species was created at the *Institut des régions arides* (IRA, or Arid Regions Institute) in Médenine, Tunisia. This programme is a national priority and has received financial support from the national government as well as from international, regional and national institutions. The gene bank has been included within the frameworks of both the National Strategy to Combat Desertification and the National Programme for

Biodiversity Conservation, and its main objectives are to:

- safeguard and conserve the multiple-use genetic resources of arid and desert zones;
- collect plant material that can be characterized and assessed in order to select the most promising accessions; and
- domesticate the most promising taxa.

These objectives are interrelated: conservation provides the opportunity to domesticate species, while domestication helps to ensure that a species will be conserved. In turn, domestication makes it possible to exploit species commercially and sustainably, while characterization and assessment support the sustainable conservation of species.

DESCRIPTION

A gene bank is a live collection of plant species and ecotypes, in this case including those from the arid and desert regions of southern Tunisia. As the first step in setting up the gene bank of rangeland plants, target species had to be identified, as it would have been impossible to include all 1,300 species reported from the region. Initial studies were limited to perennial species, and especially pastoral species, including some that can be classified as multiple-use plants because of their edible, medical, honey-producing or sand-fixing properties. A few toxic species were also selected

because ongoing biochemical research could lead to medical, industrial or plant-protection uses for them. The project also gave priority to endangered and endemic species and to those with wide intra-specific diversity. As indigenous species, all the selected plants are well adapted to the environment.

Plants were collected from various sites, including Bou Hedma and Sidi Toui national parks, Forest Service areas throughout southern Tunisia and remote, inaccessible sites such as rocky or steep slopes, canyons and mountains. So far, specimens of 220 taxa (species, subspecies and varieties) have been collected from 39 families and 149 genera. These were planted in rows 3 metres long and 1 metre apart and irrigated in the first season to ensure good establishment. The gene bank collection, known as the "pastoretum" (which is to pasture plants what an arboretum is to trees), is located at IRA headquarters in Médenine, where the climate is Mediterranean and soils are shallow and of a calcareous, sandy-loam, sierozem type. In addition, the seeds of some 68 species have been collected from different bioclimatic zones of the arid and desert regions of Tunisia. The collection is dominated by grasses and legumes because of their high value for pastoralism. Other species play an important role in rangeland rehabilitation and there are also some exotic species that have been donated by international institutions. These species come from arid areas in other countries and could be of pastoral value in southern Tunisia. While many of these species self-propagate

from seed and survive easily in the gene-bank fields, others do not persist and need to be regenerated every two to three years.

In addition to the gene bank, in situ conservation is also being established. Three national parks, Sidi Toui, Oued Dekouk and Jbil, provide the setting where natural plant species diversity and plant cover can be monitored and studied. This will make it possible to assess the plants' ability to survive and self-regenerate. The effects of different management techniques on the physical environment will also be assessed.

One function of the gene bank is to donate seeds to various development agencies for use in programmes to improve rangeland and fix sand dunes, etc. Samples are also exchanged with research institutions in Tunisia and other countries. A total of more than 0.7 tons of seeds from 50 species has been distributed over the last 15 years. In some cases, the demand for seeds outstrips the supply and there is a need to establish nurseries for some species. This is particularly the case for the shrub species *Periploca laevigata* and *Rbus tripartium*, which are used extensively to replace introduced species in revegetation programmes.

The gene bank also provides plant material for research on the regrowth potential of transplants, the potential for propagation from seeds, the period of growth and growth rate, plant persistence, etc., and it has also become a valuable educational resource.

Information on the biology and ecology of the target species is stored in a database, which also helps in the management of the various collections contained in the gene bank by keeping track of the different activities carried out, the "plant passport" data of target species, collection sites, the exchange and use of plant materials, and routine maintenance activities.

To date, the main results obtained by the gene-bank project are:

- development of suitable techniques for collecting, cleaning and conditioning the seeds of promising species (a catalogue of this information is being prepared);
- determination of the optimal germination and growing conditions for some species;
- supplying standard plant material from promising species to commercial operators;
- assistance with technical services and capacity-building for specialists;
- exchange of plant material with national and international partners; and
- raising of public awareness of the importance of conserving plant diversity through field research activities, field days with farmers and participation in local cultural activities.

PARTNERSHIPS

Among the national partners involved in the various stages of the project were universities, development agencies and local communities. In addition, international partners included the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), based in Damascus, Syria; the *Administration générale de la coopération au développement* (AGCD), Belgium; the European Union; the Food and Agriculture Organization of the United Nations (FAO); the Global Environment Facility (GEF); the International Center for Agricultural Research in the Dry Areas (ICARDA), based in Aleppo, Syrian Arab Republic; the International Plant Genetic Resources Institute (IPGRI), Maccaresse, Italy; the Royal Botanic Gardens, Kew, United Kingdom; the United Nations Development Programme (UNDP); the United Nations Environment Programme (UNEP); and the United States Department of Agriculture (USDA).

REPLICABILITY

The Tunisian national centre for the conservation, domestication and evaluation of indigenous plants can serve as a model for centres in other countries that face similar ecological problems. A number of North African and Middle Eastern countries have already expressed interest in establishing similar projects. The various scientific and technical publications generated by the project as well as the

experience gained by its coordinators and the staff involved are valuable assets for the success of future projects.

IMPACT

This project helped to strengthen relationships between research and development institutions on the one hand and development agencies, producers, local organizations and the general public on the other. It raised public awareness of the value of plant genetic resources and induced several non-governmental organizations, local communities and public organizations to establish botanical gardens to protect and promote local plants. These plants can be used to combat desertification, improve the value of pastureland, produce honey, improve water and land resources, and even to beautify cities. The project has also encouraged a number of producers to introduce plants with medicinal uses onto their farms. Other species are gaining popularity for their aromatic or ornamental value.

LESSONS LEARNED

Very few of the spontaneous species that occur in arid zones have ever been domesticated. The conservation and domestication of such indigenous plants, therefore, require a long-term effort. Given the large number of species with traits worthy of study, it is essential that priority species be carefully identified

before projects are implemented. To begin with at least, only the most valuable and interesting species should be considered. In arid zones, priority should be given to those plants with characteristics that make them suitable for harsh local conditions. Plants with wide intra-species diversity are also preferable as they are more likely to be able to adapt to the range of soils and climates encountered in such zones.

Even so, during the project, scientists found that some species were not well suited to *ex situ* conservation in the IRA fields. The preservation of plant genetic resources is therefore best achieved through a combination of *ex situ* and *in situ* conservation methods.

During the implementation period of the "pastureum", a framework for the selection and propagation of plant material targeted for domestication was devised based on a number of overlapping steps as follows:

- prospect for and collect plant material;
- install the basic collections, setting a maximum number of accessions and lines for each target species;
- characterize and evaluate the lines in terms of resistance to stress and disturbances, and production and adaptation capabilities;
- study the floral biology and reproduction of the target species;

- develop appropriate selection strategies based on the two criteria mentioned above and selection of performing genotypes;
- produce seeds from selected genotypes;
- conduct large-scale tests on selected genotypes; and
- master the cultivation of these species or how to reintroduce them to degraded sites (depending on the primary use of the species).

The handling of seeds is an integral part of any programme of conservation and domestication of indigenous plants. Given the large numbers of samples and seeds involved, threshing and cleaning operations need to be mechanized. However, the IRA project found that all the machines for doing this needed to be imported and were not well suited to the seeds being collected and processed in southern Tunisia. It is therefore necessary to develop local machines or to adapt existing machines to the specific requirements of the seeds concerned.

The large distributions of many of the target species, coupled with the need to collect genetically diverse specimens of each species, demonstrate the importance of making conservation programmes regional rather than national in scope. However, the target market for the commercial production of improved plant material needs to be as large as possible, which usually means expanding beyond the borders of a single country to encompass a whole region.

Improving the genetic potential of plant material and exploring traditional and novel uses for it will not guarantee the economic profitability of conservation efforts, at least in the short and medium terms. These activities, therefore, need to be integrated into the larger agricultural production system and the sustainable use of resources must be supplemented by other measures including: strengthening research structures; diversifying the sources of revenue (other than agriculture) in marginal areas; mastering the distribution networks for agricultural products; and raising the awareness of local populations.

Other priorities for the future include integrating the project activities into the national network for biological diversity conservation and developing more international partnerships.

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FUTURE PLANS

The IRA project is currently exploring the ornamental or medicinal potential of various plant resources. It is also collaborating with laboratories in Tunisia in order to identify the active compounds in indigenous species that are used by traditional healers.

In addition, the existing collection will be expanded until it includes all of the naturally occurring perennial species of southern Tunisia. As the collection grows, more methodical management systems need to be developed, as do appropriate equipment for processing seeds, improved long-term storage facilities and seed multiplication techniques. In the meantime, the evaluation of target species will continue in order to select new taxa with suitable characteristics.
