Research, Conservation and Utilisation of Plant Genetic Resources and Agro-Biodiversity Enhancement – Contribution of the Research Institute of Crop Production Prague-Ruzyně

LADISLAV DOTLAČIL, ZDENĚK STEHNO, IVA FABEROVÁ and ANNA MICHALOVÁ

Research Institute of Crop Production – Division of Genetics and Plant Breeding, Prague-Ruzyně, Czech Republic

Abstract: Activities on plant genetic resources in the Czech Republic are concentrated in the National Programme on Conservation and Utilisation of Plant Genetic Resources. Eleven institutions maintain 51,000 accessions, of which 17.3% belong to vegetatively propagated species. Research Institute of Crop Production (RICP) Prague has the responsibility for the coordination of the Programme; it holds more than half of all accessions in collections of genetic resources, runs the national information system and provides long-term storage for all seed-propagated species. All Czech collections are fully documented in passport data. Evaluation data (based on National descriptor lists for 29 crops) are available for 33% of the accessions. Much work is currently spent to the description and evaluation of collections, to facilitate their utilisation in breeding and agricultural practice. Also collecting missions on the Czech territory, conservation and monitoring of valuable resources maintained "*in situ*" contribute to the maintenance and evaluation of local resources. Landraces are considered a valuable part of the collections. Suitable ways of "on farm" conservation are investigated for selected accessions, to support their utilisation in agricultural practice and to enrich the existing diversity of crops and cultivars. Cultivars and landraces of neglected crops (buckwheat, millet, hulled wheat species) were successfully used to enrich the agro-biodiversity and for specific purposes of human nutrition. Close collaboration with producers (often organic farms) and processing industry has been established. Selected alternative crops and catch crops were studied as potential new crops.

Keywords: genetic resources; landraces; neglected crops; agro-biodiversity

Genetic diversity of plant species is the unique and irreplaceable source for further genetic improvement of crops and for higher diversity of crops and cultivars in agriculture. Biodiversity is, therefore, considered an essential natural resource, like soil and water. Since 1992, when this value of biodiversity has been internationally recognized by the Convention on Biodiversity (UNCED, Rio de Janeiro, 1992), the work on genetic resources and biodiversity has been substantially strengthened in developed countries as well as in many developing countries. Most countries accepted the responsibility for plant genetic resources on their territory and joined the international collaborative activities on global and regional level to promote the maintenance and sustainable utilisation of biodiversity. The global activities are coordinated by the FAO, mainly through the Global Plan of Action (FAO 1996a), accepted worldwide, and in co-operation with IPGRI (International Institute on Plant Genetic Resources, Rome). The IPGRI is the leading international institute in this field and is involved in both regional and global programmes. Cornerstones of these activities are "National Programmes on Plant Genetic Resources" (GASS *et al*. 1999).

The genetic diversity of agricultural crops is represented by bred cultivars, landraces and other genetic stock (breeders lines, experimental lines) as well as by wild relatives of cultivated plants. All these materials form a gene pool of agricultural crops, which is used to improve important traits, to broaden the genetic base of cultivars and also as a source of new diversity for agriculture (alternative use of crops, utilisation of neglected crops, broadening the spectra of crops grown).

At present, genetic diversity in agriculture as well as in nature is often seriously endangered. In nature, biodiversity has been reduced due to the industrial development, climatic changes and agricultural practices. The biodiversity of crops in agricultural systems also decreased. During the last century – and especially during the last 50 years – the diversity of local and well-adapted landraces has been replaced by a much narrower spectrum of bred cultivars that are often genetically similar. Some valuable original resources were lost in many crops in most countries (FAO 1996b, 1998).

In the Czech Republic, large-scale farming, resulting from collectivisation in the past, has led to significant losses of biodiversity. A broad choice of local cultivars and landraces declined and more narrow spectra of crops and cultivars are presently used in agricultural practice. Some local genetic resources were lost, however, many could be saved and some can still be found in remote areas. Rich diversity still exists in ecotypes of grasses, fodder legumes and other dicots, which can be found in some regions of the country. Selected valuable genotypes can be utilised to increase the diversity of meadows and pastureland or provide new forms of fodder plants. Also some valuable landraces of fruit trees (especially apples, cherries, plums and pears) can be found in several regions of the country (BAREŠ & DOTLAČIL 1998). Large-scale farming has endangered some minor crops used for specific purposes, which were less suited for new technologies and did not provide high yields. However, these crops often are beneficial for soil fertility (improvement of soil characters, increase of organic matter), protect the soil against the erosion. They also can contribute to healthy human nutrition and broaden the crop diversity, which is an important precondition for sustainable development in agriculture.

Biodiversity plays also an important role in the care for landscape and countryside. For this purpose local species and genotypes should be preferably utilised because of their adaptation to the local and regional conditions and their value in the cultural tradition. Therefore, local and traditional species, especially trees and shrubs, should be evaluated in this respect. Selected materials then might become valuable components of care for the landscape.

Research and utilisation of plant genetic resources has a long tradition in this country (BAREŠ & DOTLAČIL 1998). Various research and breeding stations have been gathering cultivars since the beginning of the 20th century. The amount of accessions increased in the former Czechoslovakia from 6 000 in 1951 to 45 500 in 1988 (BAREŠ & STEHNO 1999; BAREŠ *et al.* 1999). Due to revisions of the collections and to the splitting of the former Czechoslovakia, the total number of accessions decreased in the early 1990s. Nevertheless, the amount of nun-duplicated accessions in Czech collections reached 51 000 in 2001.

Some Czech institutes were engaged in collecting since the 1930s, but systematic collecting of landraces and wild relatives of agricultural crops on our territory started in the 1960s and continues with different intensity till the present time (BAREŠ & DOTLAČIL 1998). Much efforts are continuously directed to the conservation of collections. A system of regeneration using cyclic multiplication was originally used. Since 1976 we use long-term storage under controlled conditions. The Gene Bank at the Research Institute of Crop Production (RICP) Prague was completed in 1988 with a total storage capacity for 100 000 accessions. Studies of Genetic resources concentrated mainly on the evaluation of important biological and agronomical traits, that could be effectively utilised in breeding and agricultural practice (BAREŠ & STEHNO 1999; BAREŠ *et al.* 1999).

The Czech National Programme on Plant Genetic Resources Conservation and Utilisation is based on a decision of the Ministry of Agriculture of the Czech Republic in 1993. It has solved the problems, connected with privatisation and restructuring of agricultural research and the split of the former Czechoslovakia. The Programme anabled an effective coordination and rationalisation of all activities (DOTLAČIL & ŠTOLC 1998). International cooperation has also been much extended during this period. In this way the Czech Republic has joined the countries, in which safe and effective work on plant genetic resources is meeting international standards. The care for biodiversity has also been intensified when the Czech Republic legally adopted the Convention on Biodiversity in 1999.

The National Programme on Plant Genetic Resources

The National Programme on Conservation and Utilisation of Plant Genetic Resources deals with gathering (including collecting missions), documentation, characterisation, evaluation and conservation of plant genetic resources and provides also services to users. Presently, 11 institutions in the Czech Republic are involved in this project, among them two state research institutes, one agricultural university and eight private companies. The project is coordinated by the Gene Bank at the RICP Prague. Expertises and consultations are provided by the Czech Board on Plant Genetic Resources (DOTLAČIL & ŠTOLC 1998; DOTLAČIL *et al.* 1998, 1999).

The institutions holding collections are responsible for their maintenance and growth (in co-operation with the gene bank), and for the description, documentation, evaluation and regeneration of the accessions. In vegetatively propagated species, the institutes holding collections are in the position of a gene bank and responsible for long-term conservation of the resources, too. The Gene Bank at the RICP Prague provides long-term storage of seed samples for all seed-propagated species as well as services of the National Information System on Plant Genetic Resources (EVIGEZ) for all co-operating institutions. Institutes and compa-

Table 1. Collections of Genetic resources held by institutions in the Czech Republic (2001)

Institution (company) and its location	Crop collections	Number of accessions
1.1. RICP Prague – Department of Gene Bank Prague-Ruzyně	wheat (including wild species), winter barley, triticale, buckwheat, millet, sorghum, maize, beet, amaranth, other alternative crops	16 017
1.2. RICP – Department of Gene Bank, workplace Olomouc	vegetables; spicy, aromatic and medicinal plants	10 513 (+2 000 acc. collected)
1.3. RICP – Research Station of Viticulture, Karlštejn	grape vine (part of collection)	269
2. Agricultural Research Institute Ltd., Kroměříž	spring barley, oats, rye (working collection of wheat)	5 289
3. AGRITEC, Ltd., Šumperk	pea, vetch, broad bean, lupine and other legumes, flax and other fiber crops	4 620
4.1. OSEVA PRO Ltd., Grassland Research Station, Zubří	grasses including wild ecotypes, phytocenoses of flowering meadows	2 096 (+2 000 acc. collected)
4.2. OSEVA PRO Ltd. Research Institute for Oilseed Crops, Opava	rape seed, mustard, poppy, other oilseed crops	1 293
5. Research and Breeding Institute of Pomology, Ltd., Holovousy	cherries, sour cherries, plums, apples, pears and other fruit trees, berries	2 280
6. Mendel University Brno, Faculty of Horticulture, Lednice na Moravě	apricots, peaches, almonds, grape vine (part of collection); selected perennial vegetables and ornamental plants	1 257
7. Research Institute for Fodder Plants, Ltd., Troubsko	alfalfa, clovers, other fodder plants (including perspective wild forms)	2 186 (+ 500 acc. collected)
8. Research Institute for Potatoes, Ltd., Havlíčkův Brod	potatoes (including wild and related species), "*In vitro*" collection	1 697
9. Hop Institute, Ltd., Žatec	hop	302
10. Research Institute for Ornament. Gard., Průhonice	ornamental plants	1 392
11. AMPELOS, Ltd., Vrbovec	grape vine (part of collection)	286

nies have close partnerships with users within the country and also abroad.

Relatively large collections exist in cereals, especially wheat (10 886 accessions and another 1 449 accessions of primitive and wild *Triticeae*), barley (4 487 accessions) and oat (1 979 accessions). Extensive collections are available in vegetables (8 820 accessions), grasses (2 036 accessions), fodder legumes (2 057), fruit plants (2 897 accessions, among them 1 102 apples). Also collections of flax (1991 accessions), potatoes (1 697 accessions) and hop (303 accessions) belong to important ones in Europe (FABEROVÁ & DOTLAČIL 1996; DOTLAČIL 1998).

The aim of gathering and increasing plant genetic resources collections is to secure existing biodiversity and to build a wide base of genetic diversity, that meets demands of present and future users. Special emphasis is given to resources of local origin, which include domestically bred cultivars, old local cultivars, landraces and wild relatives (STEHNO *et al*. 1996, 1997).

The number of accessions in all Czech collections increased annually by 2 000–2 800 in the last years. The most important sources of new accessions are collecting missions and exchange with partner gene banks and other institutes abroad (DOTLAČIL 1998). In 2000, 732 samples were obtained through international exchange and additional 536 samples were provided by local donors. Collecting missions contributed 1 107 new samples, of which 420 were collected on the Czech territory. Collecting missions are important in order to increase the original diversity in collections and to save resources, that might be endangered in nature or by agricultural practice. Collecting on the Czech territory were intensified especially since 1993, when the project "Gathering, Collection and Conservation of Wild Genetic Resources and Landraces in the Czech Republic" started. Another project, "The Mapping, Collecting and Conserving of Threatened Landraces and Wild Plants Related to Cultivated Crops in the Czech Republic and Bordering European Regions" (1996– 2000), was a continuation of former activities. With the projects valuable resources were found and saved. Also inventories, distribution maps and computer documentation were produced.

Recently, more efforts are directed towards effective utilisation of the genetic resources. Good characterisation and evaluation of the resources under conditions similar to those of their origin can provide breeders with valuable information on an effective utilisation of the genetic resources in breeding (STEHNO *et al.* 1998, 1999). The genetic resources are characterised by morphological traits, electrophoretic protein spectra and/or by suitable molecular techniques of DNA fingerprinting. The evaluation concentrates on data on plant growth and development, characteristics of plant stands, analysis of yield components, response to biotic and abiotic stress and on quality parameters of the products. Accessions with important breeding traits are preferably chosen for systematic evaluation (STEHNO *et al.* 1997). Evaluation in field trials usually lasts for seed propagated accessions 2–3 years, while vegetatively propagated species are evaluated annually. The evaluation is completed by laboratory tests (e.g. quality, specific resistance).

In a number of cases, genetic resources supplied to breeders contributed to the development of new cultivars or breeding materials. Acknowledged co-authorship of collection curators in released cultivars indicates a close and successful cooperation between breeders and researchers (BAREŠ & DOTLAČIL 1998). Some selected materials (especially in neglected crops, minor crops or newly cultivated species) are evaluated and recommended for utilisation in agricultural practice to increase the agro-biodiversity.

Annually, 2–3 thousand samples of genetic resources and relevant information are distributed to users. In 2000 there were 1 665 samples provided to local users (mostly breeders, researchers) and 747 samples were sent abroad.

The collections of vegetatively propagated species are mostly maintained in field collections (fruit-tree or hop gardens, vineyards etc.) or in tissue culture (potatoes). All seed-propagated collections are multiplied and regenerated by institutes (companies) holding the collections. Long-term maintenance of seed samples is provided by the Czech Gene Bank at the RICP Prague.

Activities and responsibilities of the Research Institute of Crop Production Prague-Ruzyně for plant genetic resources

RICP Prague, namely its Division of Genetics and Plant Breeding, has been involved in the study, maintenance and utilisation of plant genetic resources since 1951 when the institute was founded. Prof. Hruška became in 1952 head of the Department of Genetics and Breeding within the new institute, followed by Ing. Holienka from 1953 to 1962. Plant genetic resources, that were maintained in other experimental facilities, such as the Experimental Fields at Uhříněves and the Experimental Base in Doksany, were transferred to the RICP Prague and systematically studied here since 1953. At that time the collections of cereals, legumes, oil crops and maize were held in Prague-Ruzyně. Later, however, some collections were transferred to newly founded specialised commodity institutes. In this way collections of oilseed crops came to the Research Institute of Oil Crops at Opava, the durum wheat collection to the Breeding Station Solary (1954), and the spring barley collection to the Crops Research Institute Kroměříž. Collections of spring barley, oats, rye and legumes were also given to the RICP Piešťany. The work on crop collections was closely linked to breeding efforts during this period and a range of new cultivars was produced. In 1962 Prof. Antonín Kováčik became head of the strengthened Division of Genetic and Plant Breeding. The responsibility for the collections passed to Dr. Ivo Bareš, who became head of the newely established Department of Plant Genetic Resources in 1962. Dr. Ivo Bareš created at that time a sophisticated management system for plant genetic resources, which resulted in the establishment of a National Information System on Plant Genetic Resources (EVIGEZ), in the development of National descriptor lists and seed storage methods, and finally in the establishment of the National Gene Bank at the RICP Prague in 1988. Ing. Ladislav Dotlačil headed the Gene bank department from 1985 to 1990 and participated on the development of Gene bank technologies. Ing. Zdenek Stehno, the present head of the Gene bank department, continued and extended these systematic efforts, contributed significantly to the integration into international collaborative programmes and implemented international standards in all activities on plant genetic resources. During the whole period of its existence the RICP Prague played a key role in the national system of care for genetic resources as well as in international links when the RICP was entrusted as the coordinating institute. In the 1970s and 1980s collaborative efforts were permitted almost exclusively within the COMECON programme of mutual collaboration on plant genetic resources. However, even than the first links to EUCARPIA and IBPGR (today's IPGRI) have been established. An intense cooperation with all European regions begun in the mid-eighties when the former Czechoslovakia became a regular member of the European Cooperative Programme (ECP/GR).

Responsibility for crop collections

Due to the transfer of some collections to specialised research institutes (which have been transformed in the last years to private companies and continue their work on plant genetic resources within the framework of the National Programme – see Table 1) the activities at the RICP Prague concentrated mainly on the collection of wheat in the 1960s and 1970s. When winter barley became an important crop in the 1980s, also this collection was systematically enlarged at the RICP and later supplemented by a triticale collection. The Research Station for Viticulture at Karlštejn was another traditional workplace of the RICP Prague, where a part of the local grape vine collection was and still is held. Some collections at the RICP strongly increased when the Research Institute for Vegetables Growing and Breeding at Olomouc in the early 1990s was closed. Its endangered valuable collections of vegetables, medicinal and aromatic plants could be saved only by passing the responsibility for the collections to the RICP. A practical solution was found by founding at Olomouc a workplace of the RICP Gene Bank, where local experts from the closed institute could be employed and the collections of 10 000 accessions maintained. The RICP Prague took over also collections of genetic resources of beets and fodder carrots from the privatised Research Institute for Beets at Semčice (STEHNO *et al*. 2000).

The split of the former Czechoslovakia has led to several gaps in the national collections, since collections of some species (e.g. maize, tobacco, some legumes, vegetables and fruit trees) were maintained only in Slovak research institutes. Czech institutions started to build these missing collections in the mid-nineties. The RICP Prague accepted responsibility for the collections of maize, tobacco and some new vegetable species, and also for the reconstruction of the grape vine collection, because only a small part of vine genetic resources was formerly maintained in the present Czechia (BAREŠ & DOTLAČIL 1998; DOTLAČIL *et al*. 1998).

The Gene Bank Prague has also responded to the trends and new needs in the 1990s, aimed at the increasing of crop diversity in agriculture, mainly by utilisation of alternative and new crops and by renascence of neglected (but often original local) crops with specific characters. As a result some new collections were established in the Gene Bank in Prague (e.g. buckwheat, millet, spelt wheat, but also crops of alien origin like amaranth and quinoa). Also genetic resources of some alternative crops and catch crops were studied to find convenient genotypes for practical utilisation (MICHALOVÁ *et al*. 1998a, b).

As a result of these changes the crop spectrum in the collections has been substantially broadened in the last decade and also particular collections have been enlarged. The RICP Prague holds presently with 27 397 accessions the largest collections in the Czech Republic, i.e. 53.7% of all genetic resources maintained. An overview of collections in the RICP Gene Bank at Prague is given in Table 2. Collections maintained at the workplace Olomouc and at the research station Karlštejn are described in Table 3.

The largest collection at the RICP Prague and also in the country is the wheat collection with 6 520 accessions of winter wheat and 4 366 of spring wheat. It contains mostly bred cultivars from European regions, but also landraces (694 accessions) and wild forms (170 accessions). Beside common wheat (*Triticum aestivum)*, also *T. durum, T. spelta, T. dicoccum, T. monococcum, T. polonicum, T. turgidum, T. boeticum* and some other *Triticum* species are included. Another 1 256 accessions of wild *Triticeae* species are maintained in separate subcollection of wild relatives (related species). Among them *Aegilops* species are the most frequent (972 accessions).

The collection of winter barley comprises 1 883 accessions (mostly of *Hordeum vulgare* – 1 818 accessions) and consists mainly of bred cultivars (866 accessions) and breeding materials (902 accessions). The sunflower collection, though with only 91 accessions, is valuable, since it comprises sunflower populations of world-wide origin and has the status of an international collection. Collections of pseudo-cereals are relatively young, but contain some interesting landraces and cultivars with useful properties. Valuable material for breeding and for direct utilisation in agriculture can be found in this group.

The workplace Olomouc of the RICP Gene Bank is responsible for genetic resources of vegetables, medicinal and aromatic plants with 10 179 accessions in total. Due to the mentioned closure of the former Research Institute for Vegetables at Olomouc in the early 1990s an extensive regeneration of the collections was necessary. Therefore, accessions of seed propagated vegetables, medicinal and aromatic plants are systematically multiplied and stored in the RICP Gene Bank at Prague. The greater part of these collections has already been successfully transferred into the standard storage system. The tomato collection is the largest vegetable collection consisting of 1 592 accessions, followed by collections of garden pea (1 032 accessions) and French beans (949 accessions). Among medicinal and aromatic plants, the caraway collection is the largest one (243 accessions).

Vegetatively propagated vegetables, medicinal and aromatic plants are maintained at the workplace Olomouc as field collections. The collection of vegetatively propagated *Allium* species, garlic and shallot, represents one of the most important parts of this subcollection. The Gene Bank, workplace Olomouc has international responsibility for this group of valuable genetic resource.

Both groups of collections (generatively and vegetatively propagated species) are evaluated at regular intervals.

The Research Station for Viticulture at Karštejn maintains a part of *Vitis* genetic resources and coordinates

Table 2. Crop collections studied and held at the RICP Prague (by species and status of accession, October 2001) – I. Field crops (including wild relatives)

Crop (taxon)	Number of acc. in crop collection	Status of genetic resources						Number of accessions
		not known	wild relative	landrace	cultivar	breeders material	special stock	
Beet	**60**	**4**			**22**	**34**		
Beta vulgaris L. var. *altissima* Döll.		2			12	18		32
Beta vulgaris L. var. *rapacea* Koch.		2			10	16		28
Winter wheat	**6 520**	**1**	**90**	**362**	**4 007**	**1 962**	**98**	
Triticum aestivum L.		1		268	3 888	1 890	98	6 145
Triticum durum L.				4	70	48		122
Triticum boeoticum Boiss. em. Schiem			53					53
Triticum spelta L.				26	27	9		62
Other *Triticum* sp. of winter habit		37	64	22	15		138	
Spring wheat	**4 366**	**13**	**80**	**332**	**2 588**	**1 258**	**95**	
Triticum dicoccum Schrank			6	65	11	9		91
Triticum monococcum L.			6	16		6		28
Triticum turgidum L.		1	1	17	4	6		29
Triticum durum Dest.		1	2	92	516	174		785
Triticum polonicum L.			3	11		5		19
Triticum araraticum Jakubz.			41					41
Triticum spelta L.			4	3	2	9		18
Triticum compactum Host			1		12	16		29
Triticum aestivum L.		10	1	102	2039	1013	95	3260
Other *Triticum* sp. of spring habit	1	15	26	4	20		66	
Rye	**78**		**20**				**58**	
Secale sylvestre Host.			2					2
Secale montanum Guss.			18					18
Secale cereale L.							58	58
Winter barley	**1 883**		**66**	**49**	**866**	**902**		
Hordeum bulbosum L.			11					
Hordeum vulgare L.			1	49	866	902		1818
Other *Hordeum* sp. of winter habit			54					54
Triticale	**604**	**27**		**1**	**229**	**347**		
Triticale (winter)		8		1	100	290		399
Triticale (spring)		19			129	57		205
Wild species of the tribe *Triticeae*	**1 256**		**1 256**					
Aegilops sp.			972					972
Other wild species of the tribe *Triticeae*		284					284	
Sunflower	**91**				**58**	**33**		**91**
Maize	731			95	30	606		731
Pseudo-cereals	428	348	1	2	65	12		
Panicum sp.		154	1		12			167
Sorghum sp.		3						3
Setaria sp.		24						24
Fagopyrum sp.		81		2	43	2		128
Amaranthus sp.		86			10	10		106
Total	**16 017**	**397**	**1 515**	**844**	**7 869**	**5 141**	**251**	

two other cooperating institutions. The Karštejn locality, though being a marginal growing area for vine, is the traditional place where tasty and aromatic wine is produced. The vine sub-collection consists of 269 accessions, among them 141 are cultivars and 109 breeders materials.

Documentation of Plant Genetic Resources: The National Information System EVIGEZ

The system has been developed in the RICP Prague since the 60s and became functional at the end of the 70s. The EVIGEZ consists of three parts: passport, characterisation/evaluation, and storage data (DOTLAČIL & ŠTOLC 1998, STEHNO *et al*. 1997). The national accession number is assigned to each accession as the unique identifier when genetic resource is included into the collection. It consists of a code of the holding institution, crop code and the serial number of the accession within the crop collection. This number is common for all three parts of EVIGEZ.

The passport part includes the basic information on a genetic resource: taxonomy, cultivar name, country of origin, status of sample, year of acquisition, breeder and donor institution etc. Altogether, 33 passport descriptors include also information on wild material received from collecting missions, such as the collector's name, expedition name, collecting number, geographic coordinates and description of the collecting site. All additional passport information is included in the table "Notes". Many passport data are coded and all necessary coding tables are incorporated in the passport part. The passport part is well designed for data input, options and variable outputs. The user can take advantage of creating and printing of various reports, lists and labels.

In the characterisation and evaluation part, the results of evaluation of all important characters can be included. In contrary to the passport descriptors, which are used universally, characterisation and evaluation descriptors are crop-specific. All characterisation and evaluation data are coded in a scale 1–9, according to the national descriptor lists, i.e. specific lists of descriptors for the genus with rules for the scoring of each trait. National descriptor lists are available for 29 species (including all important crops in this country), which enable effective evaluation of genetic resources. The descriptor lists contain up to 110 descriptors including morphological, biological, biochemical, agronomical, quality and yield traits. Only a part of these data has been computerised. However, since significant progress was made in the last years, evaluation data are now documented and available for 17 100 accession, i.e. more than 33%.

The storage part consists of gene bank storage information like accession number, acquisition number, a code determining the location of the seed sample in the store, year of seed harvest, germination ability, seed moisture storage date and amount of seeds in the container. It is also documented how much, when and to whom seeds have been distributed. All other data are available in the passport part via accession number.

Since 1995 all 11 institutions collaborating within the National Programme have used EVIGEZ (DOTLAČIL *et al*. 1998). All institutions use the common user programme and coding tables. Data are exchanged between the collection curators and the central documentation unit. In the seed-propagated collections the storage data of the curator's own materials placed in the gene bank are included as well. All data on the plant genetic resources are available at the central documentation unit of the gene bank in the RICP Prague. The data are updated once or twice a year (depending on the collection type) in the central documentation and in the crop institutions as well. In the near future, the documentation will be extended by data on the cryopreservation and "*in vitro*" maintenance. Selected sets of accessions will be supplemented by image documentation. Also data on the institutions' own conservation efforts should be added to the storage part of documentation. Since 1998, the passport database EVIGEZ is on-line accessible at the web-site http://genbank.vurv.cz/genetic/resources/. In addition to the information stored in EVIGEZ, catalogues of genealogies and gene alleles of wheat cultivars were prepared and published (MARTYNOV *et al*. 1992, 1996a, b). The new updated on-line searchable version of this catalogue including 69 632 cultivated wheat accessions is available at the address http://genbank.vurv.cz/wheat/pedigree/.

Conservation of Genetic Resources

All seed-propagated collections are multiplied and regenerated by institutions holding the collections. Long-term storage of seed samples is provided by the Czech Gene Bank at the RICP Prague. A survey of Czech collections in cooperating institutions is given in Table 1.

Newly arrived seed samples are checked for health and purity. Subsequently the seed viability is tested (if this information is not already declared). Seed samples, which meet the required standards are dried and stored. Seed drying is considered important to assure a long viability of seeds. It is carried out gently using temperatures below 25°C. Seeds are dried to 4–8% moisture, filled into glass containers (in case of large seeds one accession can occupy up to five containers) with vapor-proof cover and placed into moving shelves in cooled chambers. The storage temperature is below –18°C for the base collections (in selected species also for the active collections) and below –5°C for most of the active collections.

Table 3. Crop collections studied and held at the workplaces Olomouc and Karlštejn of the RICP Prague (arranged by species and status of accession, October 2001) – II. Vegetables, medical and aromatic plants, grape vine

Taxon	Status					Total
	not known	wild	landrace	cultivar	breeders materials	
Medical and aromatic plants	**3**	**759**	**14**	**86**	**38**	**900**
Anethum graveolens L.	3	12	1	6	0	22
Calendula officinalis L.		19	0	7	7	33
Carum carvi L.		216	0	12	15	243
Foeniculum vulgare MILL.		6	4	3	7	20
Lavandula angustifolia MILLER		21	1	9	5	36
Leonurus cardiaca L.		19	1	0	0	20
Mentha sp.		34	0	2	0	36
Ocimum basilicum L.		24	0	19	1	44
Origanum vulgare L.		60	0	0	0	60
Plantago sp.		41	0	0	0	41
Salvia sp.		31	0	0	0	31
Satureja sp.		35	0	1	1	37
Other medicinal and aromatic species		241	7	27	2	277
Vegetables	**2 215**	**452**	**766**	**5 673**	**173**	**9 279**
Beta vulgaris L.		4	3	137	4	148
Allium cepa L.		0	51	130	5	186
Allium sativum L.		0	347	85	4	436
Apium graveolens L.	17	1	1	44	3	66
Brassica carinata A. BRAUN	11	0	16	0	0	27
Brassica oleracea L. em. DC.	4	0	41	233	5	283
Brassica rapa L. em. METZG.	6	0	10	7	0	23
Capsicum annuum L.	10	0	1	463	4	478
Cichorium endivia L.	27	0	0	1	0	28
Cichorium intybus L.	4	0	0	19	0	23
Cucumis melo L.	96	0	0	4	0	100
Cucumis other sp.	55	23	0	0	0	88
Cucumis sativus L.	681	0	0	90	26	797
Cucurbita maxima DUCH.	214	0	0	6	0	220
Cucurbita pepo L.	365	0	1	14	0	380
Cucurbita sp.	50	0	1	27	0	78
Daucus carota L.	16	0	3	413	3	435
Lactuca sativa L.	235	0	26	573	5	839
Lactuca serriola L.	206	114	0	0	0	320
Lactuca sp.	137	71	0	0	0	208
Luffa sp.	27	0	0	1	0	28
Lycopersicon esculentum MILL.	19	13	123	1 389	48	1 592
Lycopersicum sp.		22	0	0	0	22
Petroselinum crispum (MILL.) A.W.HILL		0	2	36	0	38
Physalis sp.		33	1	7	1	42
Raphanus sativus L.		0	5	148	1	154
Solanum sp.		16	2	26	1	45
Faba vulgaris MOENCH		1	6	39	0	46
Phaseolus other sp.		5	15	11	0	31

Table 3 to be continued

Taxon	Status					Total
	not known	wild	landrace	cultivar	breeders materials	
Phaseolus vulgaris L.	5	46	90	794	14	949
Pisum other sp.		4	0	0	0	4
Pisum sativum L.		82	10	891	49	1 032
Other vegetable species	30	17	11	85	0	143
Other species	**16**	**10**	**27**	**199**	**5**	**257**
Nicoctiana sp.	14	3	25	142	5	189
Zea mays L.		0	0	55	0	55
Vitis vinifera L.	18		1	141	109	269
Total	**2 252**	**1 221**	**808**	**6 099**	**325**	**10 705**
International *Allium* collection						**950**

Seed viability as well as seed supply are regularly monitored during long-term storage. Regeneration of accession is initiated when one of these parameters drops below the standard level. All information on seed samples in the Gene bank is recorded and maintained in the information system EVIGEZ. It is used for the gene bank management, some data are provided also to users (DOTLAČIL *et al*. 1998).

Since only 70% of the accessions of seed-propagated collections are presently stored in the Gene bank, there are still 10 400 accessions waiting for regeneration. A fast regeneration of these remaining accessions and their transfer to the gene bank belongs to the priorities of the National Programme. Species of cereals (18 084 accessions) prevail in the Gene bank. The second largest group of accessions are legumes (2 532). Altogether about 29 thousands accessions are presently stored in the Gene bank in active collections. All genetic resources of local origin are duplicated in the base collectionl.

Cryo-conservation and some other prospective techniques of conservation are being developed. The research project "Methods and Utilisation of Cryopreservation of Field and Garden Crops" (1996–2000) was aimed at the development and introduction of cryo-methods for the maintenance of vegetatively propagated species, (mostly meristems in "*in vitro*" culture). Another research projects has dealt with "Cryo-conservation of selected fruit trees" (1999–2001) and a new project "New conservation methods of genetic resources of fruit trees" (2001–2004) was approved. Also advanced seed storage technologies are being developed in the framework of the research projects "Seed viability changes caused by seed aging and storage conditions; improvement of gene bank techniques" (1999–2001) and "Maintenance of biological value of seeds in some species with low seed longevity using combination of effects of physical factors" (2001–2004).

Conservation "on farm" is under development and should be applied to valuable selected local landraces of fruit trees (mainly apples, pears, cherries, and some other species) and few local landraces of neglected crops (millet, buckwheat, emmer wheat, einkorn wheat, spelt wheat). Also "*in situ*" conservation in a few selected suitable localities is planned, based on systematic mapping of the Czech territory. Ecotypes of grasses, fodder crops and some fruit trees will be the target materials. In some cases these genetic resources are located in protected areas and "*in situ*" conservation is actually provided by existing national authorities (e.g. in the National Park Šumava or National Park Krkonoše).

Study and utilisation of neglected and alternative crops

The political changes in the Czech Republic in the 1990s have brought new trends into agriculture. Although large-scale farming is still the prevailing form of farming, family farms and ecologically-oriented farmers and companies are emerging. Official agricultural policy shares responsibilities for countryside maintenance, which is regarded as an important part of agriculture. In addition, an increasing public interest for biodiversity and clean environment stimulates the demand for new quality products. There is growing interest among farmers in neglected crops or landraces and broader diversity in farming systems (MICHALOVÁ *et al*. 2001).

In accordance with the Convention on Biodiversity the Czech Ministry of Agriculture supports studies on biodiversity within the research programme "Biodiversity Utilisation in Agriculture". Also a few other research projects supported by the Czech Grant Agency contribute to the knowledge of valuable local landraces and ecotypes and their possible utilisation. Some farmers (especially organic farms) and some companies processing agricultural products are also involved in these activities. Studies of collections at the RICP Prague reflect these efforts, as they cover an increasing number of species and are aimed at increasing agro-biodiversity in practice.

Utilisation of alternative crops in farming systems

In series of experiments at the RICP Prague 239 cultivars and ecotypes of 12 species – *Sinapis alba* L., *Brassica nigra* (L.) Koch, *Brassica carinata* A. Braun, *Brassica juncea* (L.) Czern., *Camelina sativa* (L.) Crantz, *Crambe abyssinica* Hochst. ex R.E.Fr., *Brassica rapa* L., *Eruca sativa* Miller, *Phacelia tanacetifolia* Benth., *Setaria italica* (L.) Beauv., *Panicum miliaceum* L. and *Fagopyrum esculentum* Moench – were evaluated and promising genetic resources were chosen for field tests. In subsequent experiments several economically important traits were evaluated in 24 selected cultivars (ecotypes) of 11 species. Also the growth of biomass (dry matter) during the first seven weeks of vegetation and its dynamics were measured as well as the protein content in the above ground biomass. The data were analyzed and the potential "catch effect" of particular crops of soil nitrogen utilisation has been estimated.

High seed yields were found in *Sinapis alba* L. (2.34 t per ha) and *Setaria italica* (L.) Beauv. (2.22 t/ha). Seed yields above 2 t/ha were recorded also in buckwheat (*Fagopyrum esculentum* Moench) and krambe (*Crambe abyssinica* Hochst. ex R.E.Fr.). Dry biomass production during the first weeks of vegetation has been strongly influenced by climate and soil conditions (years and sites). Under different conditions white mustard (*Sinapis alba* L.) produced high dry biomass within the seven-week period (0.5–0.7 kg/m^2). Also *Phacelia tanacetifolia* Benth, *Setaria italica* (L.) Beauv and *Brassica carinata* A. Braun provided relatively high dry matter production (over 0.5 kg/m^2) in most environments. Especially in *Sinapis alba* L. and *Setaria italica* (L.) Beauv. significant accumulation of nitrogen in dry matter can be expected (about 140–150 kg N /ha in the best cultivars under convenient conditions when they are used as catch crops for green manuring). The highest catch effect was estimated in cv. Nakielska (*Sinapis alba* L.) and in the ecotype SET 621/91 of *Setaria italica* (L.) Beauv. These preliminary results should be verified in large-scale experiments and in agricultural practice. In this way, alternative crops can contribute to the diversity of crops in agricultural systems but they can also help to maintain the soil fertility and prevent leakage of nitrogen to the ground waters.

Evaluation and utilisation of neglected crops

Wheat, barley, ray, oats and recently also triticale are the most important cereals in the Czech Republic. Historically, however, other crops were important at the Czech territory – pseudocereals and cereals, mainly buckwheat, millet and some neglected wheat species (spelt wheat, emmer wheat and einkorn wheat). Although most local landraces were lost in the last century, some valuable local materials still exist and they should be conserved (some of them preferably in "on farm") and effectively utilised to increase the agrobiodiversity in field cropping systems (DOTLAČIL *et al*. 1998, 2000a, b). All above-mentioned species provide specific quality products, which can be utilised in human nutrition. All these species belong also to low-input crops, that can be successfully grown in less favourable environments and with reduced fertiliser and pesticide application. These important properties, together with the special value for human nutrition, predestinate them as a choice for organic agriculture and for the production of bio-food (MICHALOVÁ *et al*. 2001).

The oldest records of buckwheat from the territory of the Czech Republic go back to the 12th century. It was the most favourite food in the 16th and 17th century, then the growing declined due to the expansion of bakery products and growing potato popularity. The maximum retreat of buckwheat occurred during the last century and many local varieties were definitely lost. Therefore domestic materials contribute only by a small part to the present collection.

At present time the growing area of buckwheat is not officially recorded, estimates are about 2 000 ha in conventional farming and about 1 000 ha on organic farms. The 3 000 ha of buckwheat represent about 0.12% of arable farmland. The growing interest for buckwheat in the last ten years comes mainly from organic farming. In the Czech collection are maintained 136 accessions of buckwheat. From the evaluated accessions several promising populations were chosen and tested for potential use in farming.

A set of 20 selected buckwheat cultivars of different origin was tested for 3 years in field trials. 16 selected traits, including 10 quality parameters, some morphological traits, parameters of growth and development phases and yield components were evaluated. The highest variability, expressed as coefficient of variation (CV) was found for yield (51.9%), rutin content in the aboveground mass (46.92%) and rutin content in seeds (33.17%). The lowest variability (CV < 10%) were found for contents of starch, crude protein and some mineral elements (P, K, Mg). The effect of years was significant in all studied traits. The differences in plant height, oil content and K content were significant in all three years. The cultivars were grouped according to yield into higher yielding, medium yielding and lower yielding, relative to the standard cv. Pyra. A cluster analysis using all evaluated traits separated the cultivars into three clusters. By dividing the clusters into yield groupes 6 subgroupes were obtained. The cultivars Sumcanka, Krupinka, Hruszowska, Skorospelaya and Prego formed the group with the highest yield and optimum expressions of other traits.

Experiments were performed, to compare growing practices under organic conditions with conventional farming. The results were important for the development of organic buckwheat production in the Czech Republic.

Two buckwheat cultivars are on the Czech variety list and recommended for growing: Pyra (selected from a local population) and the bred cultivar Jana. Also some not registered Polish cvs. are grown. A landrace, Vychodoslovenska, grown in the former Czechoslovakia, is considered valuable for "on farm" conservation (MICHALOVÁ *et al*. 1998a, b).

Also millet, common in Middle Europe for centuries, the growing area of which has strongly declined to now about 400 ha, experiences a renaissance in organic farming. The Czech collection of millet genetic resources reached 171 accessions, but only a few local landraces are maintained. The local cultivar Hanacka Mana and the bred cultivar Unicum are recommended for growing. The Slovak landrace "Slovenske cervene", grown historically also in Czechia, is considered valuable for "on farm" conservation.

Wheat is considered one of the most important crops for human nutrition. The wheat species *Triticum aestivum* L. and *T. durum* Desf. are widely grown worldwide. Also some another species have special properties important for their potential utilisation as crops. Our collection of wheat genetic resources with 10 481 accessions includes also outdated cultivars and landraces of other hulled wheat species: 104 emmer (*T. dicoccum* [Schrank] Schübl.), 74 spelt (*T. spelta* L.) and 38 einkorn (*T. monococcum* L.) wheats. Standard evaluation of these accessions is done regularly and also valuable cultivars were evaluated in detailed in the last years (STEHNO *et al*. 1998; DOTLAČIL *et al*. 2000b).

Spelt wheat is an old cultivated crop and has specific properties. The accessions showed 25% of glumes in the harvested spikelets, TKW between 48 and 57 g, high protein content close to 18% and good bread making quality. The cultivation area of spelt wheat is recently increasing and reached more than 500 ha in the last year. Two cultivars are presently on the Czech variety list, cv. Franckenkorn and the recently released Czech cv. Rubiota, which was selected as the best among local landraces. Several other ladraces were recommended for "on farm" conservation, mainly due to their superior quality.

The accessions of emmer wheat (*T. dicoccum* [Schrank] Schübl.) showed 25–27% glumes in the harvested spikelets, a TKW of only 35–37 g and a yield of naked kernels between 2.2–2.5 t/ha. The crude protein content was close to 20%, i.e. by nearly one third higher than in bread wheat. In contrast, the SDS sedimentation values were low, indicating lower suitability for breadmaking purposes.

The accessions of einkorn wheat (*T. monococcum* L.) showed 28% glumes in the harvested spikelets and the TKW was with 27–29 g relatively low. The yield of naked kernels was nearly the same as in emmer wheat (2.5 t/ha in 1999 and 2.1 t/ha in 2000). Einkorn also did not differ from emmer in the crude protein content (20.7 and 18.6%, respectively). Einkorn similarly as emmer seems to be more suited for other use than breadmaking (porridges, müsli etc.).

Hulled wheat species are more resistant to unfavourable growing conditions. For instance, after a very hot and dry spring in 2000 at Prague-Ruzyně, some emmer and einkorn accessions yielded more protein per hectare than the standard bread wheat cultivar. Recently the interest in neglected wheat species as spelt, emmer and einkorn is growing among organic farmers in the Czech Republic. No cultivars of emmer or einkorn wheat are presently on the Czech variety list. However, most local populations (landraces) are maintained and in both species valuable accessions have been found, that can be recommended for "on farm" conservation as well as for practical utilisation. Their quality parameters and agronomic properties permit to recommend them for growing at limited extent under low-input conditions, especially in organic farming.

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Abstrakt

DOTLAČIL L., STEHNO Z., FABEROVÁ I., MICHALOVÁ A. (2002): **Výzkum, konzervace a využití genetických zdrojů rostlin a hodnocení agro-biodiverzity – příspěvek Výzkumného ústavu rostlinné výroby Praha-Ruzyně**. Czech J. Genet. Plant Breed., **38**: 3–15.

Práce s genetickými zdroji je v České republice soustředěna v Národním programu konzervace a využití genetických zdrojů rostlin. Jedenáct institucí uchovává v kolekcích 51 000 vzorků genetických zdrojů, mezi nimiž patří 17,3 % k vegetativně množeným druhům. VÚRV Praha-Ruzyně je odpovědný za koordinaci programu, v kolekcích, za něž odpovídá, uchovává více než polovinu všech genetických zdrojů, zajišťuje činnost národního informačního systému a dlouhodobé uchování všech semenných kolekcí. Všechny české kolekce mají zdokumentovány pasportní údaje a u 33 % položek jsou k dispozici popisná data (kódovaná podle národních klasifikátorů pro 29 plodin). Probíhá intenzivní charakterizace a hodnocení kolekcí zaměřené na lepší využívání genetických zdrojů ve šlechtění a v zemědělské praxi. K uchování a monitorování cenných genetických zdrojů na území České republiky přispívají sběrové expedice a konzervace cenných materiálů *in situ*. Krajové odrůdy jsou považovány za cennou část kolekcí a vybrané materiály jsou hodnoceny s ohledem na využití v zemědělské praxi pro rozšíření současné diverzity druhů a odrůd. Šlechtěné a krajové odrůdy opomíjených plodin (pluchaté pšenice, proso, pohanka) jsou úspěšně využívány pro rozšíření agro-biodiverzity a pro specifické uplatnění v lidské výživě. Přitom byla navázána úspěšná spolupráce s producenty (často to jsou organické farmy) a zpracovatelským průmyslem. Hodnoceny byly rovněž vybrané alternativní plodiny a meziplodiny s ohledem na jejich praktické využití.

Klíčová slova: genetické zdroje; krajové odrůdy; opomíjené plodiny; agro-biodiverzita

Corresponding Author:

Ing. LADISLAV DOTLAČIL, CSc., Výzkumný ústav rostlinné výroby, odbor genetiky a šlechtění rostlin,
161 06 Praha 6-Ruzyně, Česká republika
tel.: + 420 2 33 02 23 74, fax: + 420 2 33 02 22 86, e-mail: dotlacil@vurv.cz