PLANT GENETIC RESOURCES AND AGRI-BIODIVERSITY IN CZECH REPUBLIC

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Abstract

Activities on plant genetic resources in the Czech Republic are concentrated in the National Programme. Eleven institutions hold 51,000 accessions, among them 17,3% vegetatively propagated species. RICP Praha has responsibility for the coordination of the Programme; it runs the national information system and provides long-term storage for all seed -propagated collections. Collections are fully documented and evaluation data (based on National descriptor lists for 29 crops) are available in 33% of accessions. Intensive characterization and evaluation of collections is carried out to enhance their utilization 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 as valuable part of collections and selected accessions are tested with the aim to find convenient forms for "on farm" conservation and for utilization in agricultural practice to enrich the existing diversity of crops and cultivars. Local ecotypes of grasses and fodder legumes were successfully utilized for biodiversity enrichment as well as for specific utilization.. Also local landraces of fruit trees are evaluated, monitored and used in practice. Among field crops some neglected crops (buckwheat, millet, hulled wheat species) and catch crops were studied and they are introduced to growing presently. Crop diversity parameters are discussed as possible biodiversity indicators.

Key words
Genetic resources, crop diversity, biodiversity, indicators

Plants create the basis for life on the Earth. Even when existence of more than 300,000 species of higher plants has been estimated, only about 7,000 species were cultivated by humans and about 30 plant species are of crucial importance for man's nutrition and provide 95 % of dietary energy or protein. This tiny part of the existing biodiversity in species, however, has an extraordinary importance and involves huge intra - specific genetic diversity. This diversity is a unique and irreplaceable source for further genetic improvement of crops and for increasing the diversity of crops and cultivars in agriculture.

The genetic diversity of agricultural crops is represented by bred (registered or restricted) 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 for improvement of important characters, broadening of a genetic base of cultivars and also as a source of new diversity for agriculture (alternative use of crops, utilization of neglected crops, broadening the spectra of crops grown).

Today, the existing genetic diversity 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 has also been decreased. During 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 rather similar. Often valuable original resources of many crops were lost.

In Czech Republic, a large-scale farming, which has arisen as a result of collectivization in agriculture in the time of communist rule, resulted in significant loss of biodiversity. Broad choice of local

cultivars and landraces has been decreased in many crops and the relatively narrow spectra of crops and cultivars are grown in present agricultural practice. Some local genetic resources were lost, however, many of them were saved and some can be still found in remote areas. Still exists rich diversity in ecotypes of grasses, fodder legumes and other dicots, which can be found in some regions of the country and selected valuable genotypes can be utilized to increase the diversity of meadows and pastureland or provide new forms of fodder crops. Also some valuable landraces of fruit trees (especially apples, cherries, plums and pears) can be found in some regions of the country. Large-scale farming has disadvantaged growing of some minor crops used for specific purposes (minor crops, catch crops, alternative crops), which were less suitable for new technologies and did not provide high yields. However, these crops often have positive effect on soil fertility (improvement of soil characters, increase of organic matter), protect soil against the erosion and they contribute to the crop diversity in agricultural practice, which is an important precondition for sustainable development in agriculture.

Biodiversity plays also an important role in landscaping and maintenance of countryside. For this use the local species and genotypes should be preferably utilized because of their adaptation to the local and regional conditions, and their tradition and cultural value. Therefore, local and traditional species and clones of trees and bushes should be assessed from this point of view and selected materials can be evaluated as possible components in landscaping.

Research and utilization of plant genetic resources has a long tradition in this country. Various research and breeding stations have been gathering cultivars since the beginning of the 20th century. The range of 6,000 cultivars gathered in former Czechoslovakia in 1951 was increased to 45,500 accessions in 1988. Due to revisions of the collections and due to splitting off the former Czechoslovakia, the total number of accessions decreased in the early 1990$^{th.}$. However, the present state of Czech collections reached 51,000 accessions without duplications in 2001.

Collecting activities had been carried out by some Czech institutes since 1930s, but systematic collecting of landraces and wild relatives of agricultural crops on our territory begun in the 1960th and continues with different intensity till the present time. A continuous effort was devoted to conservation of collections. First a system of regeneration using sowing of accessions in several years' cycles has been implemented and since 1976, long-term storage under controlled conditions has started. Gene Bank in RICP Praha had been completed in 1988 with total storage capacity for 100,000 accessions. Genetic resources studies were oriented on evaluation of the most important biological characters, with respect to the effective utilization of genetic resources in breeding and agricultural practice.

Problems in plant genetic resource study and conservation appeared in the early 1990th in connection with cuts in budget for agricultural research, privatization (or the abolishment) of two institutes holding collections, and also due to the division of former Czechoslovakia. These problems have been overcome by the decision of the Ministry of Agriculture of the Czech Republic in 1993 when the "National Programme on Plant Genetic Resources Conservation and Utilization" has been launched. During few years of existence the Programme concentrated all activities on crop genetic resources within this country. The system allowed effective coordination and rationalization of all activities. Also international cooperation has been extended significantly during this period. In this way Czech Republic has joined the countries with safe and effective system of work on plant genetic resources, which meets international standards.

The political changes in Czech Republic in the 1990th lead to the new trends in agriculture, as well. Even when large- scale farming is still a prevailing form of husbandry, family farms and ecologically-oriented farmers and companies started their activities, too. Official agricultural politics accepts also the sharing of responsibilities for countryside maintenance as an important task for agriculture. In addition, an increasing public awareness on biodiversity importance and clean environment stimulates demand on new quality products and interest of farmers in growing neglected crops or landraces and broadening diversity in farming systems.

National Programme on Plant Genetic Resources

National Programme on Plant Genetic Resources Conservation and Utilization deals with gathering (including collecting missions), documentation, characterization, 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 coordinates the Gene Bank in RICP Praha, expertise and consultations are provided by the Czech Board on Plant Genetic Resources.

The institutions holding collections are responsible for maintenance and increase of collections (in co-operation with the gene bank), characterization, documentation, evaluation and regeneration of genetic resources. In vegetatively propagated species, the institutes holding collections are in the position of a gene bank and they are responsible for a long-term conservation of plant genetic resources, too. The Gene Bank in RICP Praha 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 companies have close partnerships with users within the country and also abroad.

Relatively large collections are gathered in cereals, especially wheat (10,542 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 (1,991 accessions), potatoes (1,697 accessions) and hop (303 accessions) belong to important ones in Europe.

Documentation of Plant Genetic Resources

National Information System on Plant Genetic Resources (EVIGEZ) consists of three parts: passport, characterization/evaluation, and storage data. The passport part includes the main characteristics of the genetic resource: accession number, taxonomy, accession name, country of origin, status of sample, year of arrival to collection, breeder and donor institutions etc. Altogether, 33 passport descriptors contain also information on wild material received from collecting missions. Since 1998, passport data base EVIGEZ is on-line searchable on URL http://www.vurv.cz/genetic/resources/.

In the characterization and evaluation part, the results of evaluation of all important characters can be included. In contrary to the passport descriptors, which are used universally, characterization and evaluation descriptors are crop-specific. All characterization and evaluation data are coded in a scale 1 – 9, according to the national descriptor lists (which are available for all important crops in this country).

Storage files describe the accession number, acquisition number, a code for the location of seed sample in the store, germination ability, seed moisture and amount of seeds in a container. The storage date of each sample is entered as well. It is also documented how much, when and to whom the seeds have been distributed.

Increase of collections, collecting missions

The aim of gathering and increasing plant genetic resources collections is to secure existing biodiversity and build up a wide base of genetic diversity to meet demands of present and future users. Primary attention is paid to materials of local origin, which include domestically bred cultivars, old local cultivars, landraces and wild relatives. The sources of new accessions are new cultivars from domestic breeders, foreign cultivars from areas with similar conditions of climate and soil, samples exchanged with other gene banks and finally samples collected by collecting missions. In some cases, it is necessary to reintroduce lost original genetic resources from gene banks abroad.

An annual increase of all Czech collections reached 2,000 – 2,800 samples in last years (2,230 accessions in 2000), the most important sources of new materials are collecting missions and exchange of materials with partner gene banks and other institutes abroad. In 2000, there were 732 samples obtained through international exchange and another 536 samples were provided by local donors. Collecting missions contributed by 1, 107 new samples (among them 420 samples were collected on the Czech territory). Collecting missions are an important tool to increase collections by new original diversity and

save resources, which could be endangered in nature or in agricultural practice. Collecting on the Czech territory extended previous efforts especially since 1993, when project "Gathering, Collection and Conservation of Wild Genetic Resources and Landraces in Czech Republic" has been launched. Project ”The Mapping, Collecting and Conserving of Threatened Landraces and Wild Plants Related to Cultivated Crops in the Czech Republic and Bordering European Region” (1996 – 2000) was a continuation of former activities. As a result, valuable resources were found and saved as well as the inventory, distribution maps and computer documentation were developed.

Characterisation, Evaluation and Utilisation of Plant Genetic Resources

Recently, more attention has been paid to increase the effective utilization of genetic resources. Good characterization and evaluation of genetic resources under conditions similar to those of their origin can provide breeders with valuable information on effective utilization of genetic resources for the breeding programmes. Characterization of genetic resources is aimed at morphological characters, electrophoretic protein spectra or/and suitable molecular techniques of DNA fingerprinting. The evaluation consists of data on plant growth and development, characteristics of plant stand, analysis of yield elements, responses to biotic and abiotic stresses and qualitative characteristics of the products. Importance of characters for breeding is a significant indicator for their systematic evaluation. Evaluation in field trials is usually carried out for 2-3 years (in vegetatively propagated species annually) and it is completed by laboratory tests (e.g. quality, specific resistance).

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

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

Genetic Resources Conservation

The collections of vegetatively propagated species are in most crops 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 such collections, long- term maintenance of seed samples is provided by the Czech Gene Bank in the Research Institute of Crop Production, Praha. Hence only 70% accessions of seed- propagated collections are presently stored in the gene bank, there are still 10,400 accessions to be regenerated in the near future. Prevailing species in the gene bank are cereals (18,084 accessions) and legumes (2,532 accessions). Altogether 31 thousands accessions are presently stored in the Gene Bank.

These seed samples, which meet demanded standards are dried to 4 – 8 % moisture content, filled into glass containers with vapor-proof cover and placed into moving shelves in cooling chambers. Containers are stored under - 18°C (base collection, in selected species active collection as well) and under - 5 °C (active collection), seed viability as well as seed supply are regularly monitored during long- term storage. Regeneration of accession is initiated when seed parameters drops down below standard level. All information on seed samples in the gene bank is recorded and maintained in the information system EVIGEZ.

Cryo-conservation and some other perspective techniques of conservation are being developed. Research project “ Methods and Utilization of Cryopreservation of Field and Garden Crops” (1996 – 2000) was aimed at development and introduction of cryo -methods for maintenance of vegetatively propagated species, (mostly meristems in “*in vitro*” culture). Lately additional research projects on “Cryo-conservation of selected fruit trees” (1999 – 2001) and “New conservation method of genetic resources of fruit trees” (2001 – 2004) have been launched. 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) for application in the gene bank.

Conservation "on farm" is under development and should be applied on 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 few valuable selected localities is planned, on the base of systematic mapping of the Czech territory. Ecotypes of grasses and fodder crops as well as 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 parks Sumava or Krkonose).

Enrichment of crop diversity by local ecotypes and landraces

In accordance with the Convention on Biodiversity the Czech Ministry of Agriculture supports studies on biodiversity, which are carried out within the research programme "Biodiversity Utilization in Agriculture". Also few other research projects supported by the Czech Grant Agency contribute to the knowledge on local valuable landraces and ecotypes and their possible utilization. Some farmers (especially organic farms) and some companies dealing with processing of agricultural products are involved in these activities, as well. Among others following tasks are solved by above mentioned activities :

- Enrichment of biodiversity of meadows and pasturelands
- Mapping and utilization of landraces and old local cultivars of fruit trees
- Utilization of catch crops in agricultural systems
- Study and utilization of neglected crops

Biodiversity of meadows and pastureland

Efforts were aimed at monitoring, study and utilization of local landraces and ecotypes to enrich the diversity in species. Local adapted ecotypes were preferably used, especially in protected areas, rich natural localities and in less favorable areas for agriculture (LFA).

Due to systematic collecting of ecotypes of grasses and dicots, which started on the Czech territory since 1987 and extended previous occasional collecting activities, there were over 1700 samples of grasses and dicots collected and conserved during this time. Some of these materials were utilized in the projects aimed at the increase of biodiversity. Selected 51 original ecotypes of grasses and dicots were tested in biological and economical characters (including seed production) and evaluated as possible components in species rich meadow mixtures. Convenient ecotypes were multiplied and provided for restoring biological diversity of grasslands, especially in Protected Landscape Areas (PLA Bile Karpaty). Valuable ecotypes of 37 species originating from this localities were multiplied and re-introduced to the regions of their origin. Seed multiplication was carried out on 2,4 ha and regional mixtures were composed on the base of botanical expertise using original composition of meadows and pastureland as a target status. Over 100 ha of species rich grasslands were newly established using multiplied seed (e.g. localities Stitna, Slavkov, Nivnice, Sterkovny, Ostrozska Nova Ves), as well as several small farms in Moravia).

Multiplication of wild grass species for increasing grassland biodiversity

Multiplication of sufficient amount of seeds of wild grass species and their use for regeneration of native, species rich meadow swards has also been used as a possible way of increasing the biodiversity in landscape. Thirteen grass species have been tested at the Grassland Research Station in Zubri to estimate the seed production potential in field conditions. Modified technologies for fodder grasses were used during establishment and treatments of multiplication plots. On the base of five years' results the species were divided to following groups:

Table 1. Species convenient for multiplication in field conditions with high and steady seed production

Name	Latin name	Seed rate ($kg.ha^{-1}$)	Notes
Giant fescue	*Festuca gigantea* (L.) Vill.	25	very late, 3 harvest years only, seed falling, low uniformity of ripening
Fescue	*Festuca rupicola* Heuff.	18	
Yorkshire fog	*Holcus lanatus* L.	12	
Upright Brome	*Bromopsis erecta* (Huds.) Fourr. (syn.: *Bromus erectus* Huds.)	30	
Smooth Brome	*Bromopsis inermis* (Leyss.) Holub (syn.: *Bromus inermis* Leyss.)	20	

Table 2. Species with middle, lower or variable seed production, fitting to the multiplication in field conditions.

Name	Latin name	Seed rate ($kg.ha^{-1}$)	Notes
Narrow-leaved Meadow- grass	*Poa angustifolia* L.	15	low seed productivity
Hairy Oat-grass	*Helictotrichon pubescens* (Huds.) Pilger	30	
June grass	*Koeleria pyramidata* (Lam.) Beauv.	13	seed falling, low uniformity in ripening
Sweet Vernal-grass	*Anthoxanthum odoratum* L.	12	
Common Quaking-grass	*Briza media* L.	15	

3. Wavy hair-grass *(Avenella flexuosa* (L.) Drejer), heath-grass (*Danthonia decumbens* (L.) DC. in Lam. et DC.) and chalk false-brome *(Brachypodium pinnatum* (L.) Beauv) were considered as unconvenient for the multiplication in field conditions, mainly due to very low seed productivity and/or vitality.

Species-rich mixtures for restoring meadows

The different composition of floral mixture containing about 80 % of wild species, mostly herbs,

resulted in significant difference in the price when compared to the standard mixture of *Bromus, Arrhenatherum* and *Trisetum* containing 85 % of commonly traded seed components and 15 % of herbs. All tested variants developed high-density swards without weeds. Higher level of nutrients resulted in prevailing grass species in the swards and the higher green matter production. Even when the lower sowing rate of the floral mixtures were used (when decreased to one half, that is 15 kg.ha^{-1}, sometimes even to 10 kg ha^{-1}) the expenses were still much higher when compared to the standard commercial variants.

The herbs rate is clearly prevailing in plots of floral mixtures in the first and second vegetation period compared to the another variants. But in the third vegetation year the herbs rate is fully comparable with *Bromus, Arrhenatherum and Trisetum* mixtures. Therefore, renovation mixtures containing common species (about 80 - 85 %) and herbs in amount about 15 % could be considered as ecologically acceptable and economically convenient.

Wild species of grasses and herbs for strip seeding into grassland

Strip re-seeding of native species into the grassland is the technology by which demanded species may be introduced into the grassland. The final effect of strip seeding depends on the seeding establishment, which is affected by the weather conditions and by the chosen species resisting to the dry period in the year of establishment. Strip seeding of species with low field germination and poor growing activity after the sowing had often to be repeated during good weather conditions, especially in early spring under sufficient precipitations.

Only well-developed swards in reseeding strips with wild species can significantly affect the final green matter production. Rapid growth, competition ability and persistence are the most important characters for developing re-seeded components in meadow swards.

Among the suitable wild grass species as components for the strip seeding *Holcus lanatus, Bromus erectus, Bromus inermis* and particularly *Festuca rupicola* can be recommended.

Utilization of fodder legumes and other forage crops

Beside grasses also use of forage crops and other species in farming and landscaping has been studied in last five years. Forage crops can play an important role not only in fertile growing regions but predominantly also in marginal areas, in areas damaged by industrial activities, in flowering meadows, when creating a biological balance in extreme conditions of orchards and vineyards and also by increasing an ecological stability on hunting grounds and consequently by reducing damages caused by browsing game to crop stands and forests. Combined with other plant species they can contribute to the restoration of rich plant communities on the localities in protected landscape areas and nature reserves.

Cultivars of many fodder crops were often bred from local ecotypes, which had been usually collected in localities near former breeding stations. Some of the cultivars of such origin are still released for growing in Czech Republic. Brief review of such landraces is given in following summary:

Species	Landrace
Melilotus albus Medic.	Krajova
Lotus corniculatus L.	Malejovsky
Anthyllis vulneraria L.	Trebicsky
Onobrychis viciifolia Scop.	Visnovsky vicesecny
Trifolium repens L.	Viglassky
Trifolium pratense L.	Chlumecky, Jicinsky
Daucus carota L. *(fodder)*	Taborska zluta

Beside old released landraces, newly collected ecotypes are tested and best promising materials are used in breeding or directly examined as candidate cultivars. In addition to main fodder species (alfalfa, red clover and Dutch clover) also neglected species and some wild species are collected and studied to

extend the spectra of fodder species and meet specific demands arising e.g. from needs to increase the diversity of dicots in meadows and pasture land, to meet needs on fodder crops for specific conditions or purposes. Some of these species are also used as components to mixtures which are used for maintenance of "set aside" arable lands.

Neglected fodder species (where local cultivars are still available) were evaluated and their utilization was recommended for use as convenient components in mixtures with grasses and /or other legumes. Following species and cultivars were recommended for growing: *Onobrychis viciifolia* cv. Visnovsky vicesecny, *Trifolium incarnatum* cv. Kardinal, *Anthyllis vulneraria* cv. Trebicsky, *Trifolium hybridum* cv. Taborsky, *Lotus corniculatus* cvs. Lotar and Malejovsky and *Melilotus albus* cvs. Krajova and Adela.

Some fodder crops were grown historically on the territory of the Czech Republic but the cultivars disappeared after the World War II. and the crops have to be newly introduced in the last decade. In this way the new cultivars of following species have been released:

Carthamus tinctorius L. cv. Sabina is grown on about 3000 ha, usually as oil crop, but also as fodder or catch crop.

Medicago lupulina L. can be used as a fodder crop, catch crop or a component in mixtures with grasses and other legumes. New cultivar Ecola can compete with alfalfa in biomass quality and due its self-reproduction it is a valuable component in mixtures (occupying lower layer in mixtures).

Kribice (*Secale cereale* var. *multicaule)* was traditionally grown in northeast Moravia (Valassko) for pasture and for baking bread with special flavor. This form of rye was usually sown in June; it was used for grazing in autumn and for grain harvest in the next year. The rescued materials are multiplied and tested. Results indicate that kribice could be used as a fodder crop (in pure stand or in mixture with legumes) and provide grain harvest in consequent year. Also utilization of this crop for green maturing and as a fodder for game in forests was successfully tested.

Among grasses, *Phalaris canariensis* L. cv. Judita (released in 2000) is being reintroduced as fodder crop (for growing in monoculture or in a mixture with annual legumes) and its seeds can be used for feeding (e.g. they are popular with birds´ breeders).

In addition to traditional forage species, some new species were evaluated and selected among native wild plants, with the aim to introduce new crop diversity and some of them were released as cultivars. In this group *Coronilla varia* L. cv. Eroza can be used as fodder crop as well as a cover plant preventing erosion. Among grasses, *Bromus secalinus* L.(which is on the list of endangered species) has been examined and recommended as annual fodder crop or in mixtures with annual legumes. Also *Astragalus cicer* L. has been tested and recommended as a component to pasture mixtures and for protection against soil erosion.

An important task is to increase and maintain the biodiversity in protected areas. Therefore, mutual cooperation of agricultural research institutes (especially Research Institute of Fodder Crops Ltd., Troubsko near Brno and OSEVA PRO, Ltd., Grassland Research Station, Zubri) has been initiated. The partners in cooperation are Protected Landscape Areas Bile Karpaty, Moravian Karst and the National Park Podyji. Botanical explorations were performed and evaluations of botanical composition have been carried out in selected areas. The aim of these studies is to recommend measures for management improvements. Seed samples of some fodder plant species are collected in the National Park Podyji and geobotanical survey is carried out on the base of permission for botanical exploration given by Administration of the National Park. The collected seed samples are regenerated and used for creation of regional meadow mixtures for restoration of some areas in the National Park.

Some newly introduced species were tested for a possible use in marginal areas as industrial or energetic crops and for land reclamation in areas damaged by industrial activities. The experiments were aimed at selection of convenient species and ecotypes, development of growing technologies and verification of their value for practical utilization in marginal areas and extreme conditions (coal mining areas, extremely dry conditions of the Southern Moravia). With respect to the diversity of possible growing conditions a broad spectrum of annual and perennial species is being tested.

Monitoring and utilization of landraces and old local cultivars of fruit trees

The territory of Czech Republic is rich in landraces and local cultivars of fruit trees, especially apples, pears, cherries and plums. These original resources have an important role in the breeding and they are still grown in some areas. They can be often used as sources of resistance to diseases (e.g. resistance to *Erwinia amylovora* has been found in one local cultivar of pear 'Libovicka maslovka'. Also adaptation to the local condition of climate is an important character utilized in breeding, especially in breeding cultivars for marginal growing areas. Some landraces have been recommended for growing on ecological farms (e.g. apple landrace 'Chodske' due to its resistance to fungi diseases and tolerance to less convenient climatic conditions).

Since 1994 several collecting missions have been undertaken on the territories of the National Parks (NP) and Protected Landscape Regions (PLR) in the Czech Republic (namely NP Sumava, NP Krkonose, PLR Orlicke hory., PLR Beskydy, NP Podyji and PLR Jeseniky) as well as in western part of the mountains Krusne hory and Doupovske vrchy. The distribution of fruit woody plants was found to be larger in the lower altitudes of the Sumava Mts., in the vicinity of former or existing villages and along melioration gullies, mainly along the Schwarzenberg Channel. Solitary trees and former alleys were predominating. In the most cases we have found wild forms of cherries, apple and pear trees. In NP Krkonose the collecting was mainly oriented to interesting frost-resistant individuals. Altogether 39 items were chosen for in situ conservation. Bird cherries (*Prunus avium* L.) from the altitudes of 800 to 1,000 m formed the major part. They were characterized by a good health and were not damaged by frost; their age was estimated ranging between 100 and 200 years. From the pomological point of view the region of the mountains Orlicke hory is poor for original landraces. Nearly all old fruit trees were cut down during the last 50 years. Nevertheless, we succeeded to discover several original apple landraces ('Vinne', 'Kralicke', 'Studnicne', 'Medove' and 'Louzne'). The western part of the mountains Krusne hory is relatively rich in the fruit trees, especially in apple and pear trees. The regional cultivar collection includes cultivars planted after 1st World War. Surprisingly, there is a very often appearance of apple and especially pear seedlings which do not occur in the other localities. Two seedlings of pears with red fruits and good economic traits were found.

The region of the mountains Krusne hory is relatively rich in historical fruit plantations, especially in apples and pears. The cultivar spectrum includes accessions planted after the World War I. A very often occurrence of apple, and even more pear seedlings is surprising and it was not noticed in other West Bohemian localities. In the region of the Mts. Krusne hory 26 apple landraces and obsolete cultivars were recorded as well as 10 landraces and cultivars of pears. Altogether 25 sites were visited, shortly described and localized by GPS. Available cultivars/landraces were determined and their characters and health state were recorded.

The notes taken and monitoring data serve for the mapping initiative of Czech native historical genetic resources and for decision-making and proposals for *in situ* or on farm conservation. Selected landraces were recommended for growing in extensive conditions.

Utilization of alternative crops in farming system as a source of organic matter, as catch crops and for the increase of biodiversity

Twenty-seven commonly grown as well as non-traditional plant species were tested in field experiments (Research Institute of Fodder Plants, Troubsko near Brno) in different conditions as catch crops. Experiments were sown in August, after the harvest of the main crop. Following characteristics were estimated: over-ground biomass, root biomass, root/shoot ratio and rate of biomass decomposition in soil. The yield of next crop in rotation, the influence of catch crops and subsequent crops on soil structure and the nitrogen content were also investigated as well as the influence of catch crops on humus content and quality. Cultivars of *Sinapis alba* L , *Malva verticilata* L., *Phacelia tanacetifolia* Benth. and several other species were selected for further evaluation.

In another series of experiments (Research Institute of Crop Production, Praha), 239 cultivars and ecotypes of 12 species (*Sinapis alba* L., *Brassica nigra* (L.) Koch , *Brassica carinat* 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 the subsequent experiments several economically important characters were evaluated in 24 selected cultivars (ecotypes) of 11 species. Also the growth of biomass (dry matter) during first seven weeks of vegetation and its dynamics was measured as well as the protein content in above ground biomass. The data were analyzed and potential "catch effect" of particular crops by keeping soil nitrogen has been estimated.

Higher mean seed yields were found in *Sinapis alba* L. (2,34 t/ha) and *Setaria italica* (L.) Beauv (2,22 t/ha). Seed production over 2t/ha provided also buckwheat (*Fagopyrum esculentum* Moench*)* and krambe *(Crambe abyssinica* Hochst.ex R.E.Fr.*).* Dry biomass production during 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 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 wider diversity of crops in agricultural systems but they can also help to maintain the soil fertility and prevent the leakage of nitrogen to the ground waters.

Evaluation and utilization of neglected crops on arable land

Wheat, barley, ray, oats and lately also triticale are most important cereals in the Czech Republic. However, historically there were grown on the Czech territory other important crops - pseudocereals and cereals, mainly buckwheat, millet and some neglected wheat species (spelt wheat, emmer wheat and einkorn wheat). Even when most of local landraces were lost in last century still some valuable local materials exist, which should be conserved (some of them preferably in "on farm" conservation) and effectively utilized for increasing agri-biodiversity in field cropping systems. All above-mentioned species provide specific quality products, which can be utilized in human nutrition. All these species belong also to the crops with relatively lower demands on fertilizers and pesticides which can be successfully grown in low- input systems and less favourable areas. These important characters, stressed by specific nutritious value, predestinate them as convenient crops for organic agriculture and stuff for bio-food production.

The oldest records of buckwheat on 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 decreased due to expansion of bakery products and potato popularity. The maximum falling-off of interest in buckwheat was during last century. Later, the irreversible loss of local varieties took place, and therefore the domestic materials contribute only by a small part to the present collection.

At present time the growing area of buckwheat is not officially registered, estimations are about 2.000 ha. in conventional systems and about 1,000 ha in organic systems; altogether 3.000 ha of buckwheat is grown (0,12 % of total crop area). The interest in buckwheat growing has arisen in the last decade, mainly in organic systems of agriculture, where the interest in buckwheat is continuously increasing.

There are 136 accessions of buckwheat maintained in the Czech collection. On the base of evaluation, several promising populations were chosen and tested for utilization in practical growing. Beside agronomics characters also rutin content has been tested as well as a complex nutritive value and significant variability within varieties in quality characters was determined. The experimental results on growing practices in ecological conditions and their comparison with conventional ones were important for the development of organic buckwheat production.

Two buckwheat cultivars are registered and recommended for growing in Czech Republic - 'Pyra' (selection from local population) and bred cultivar – 'Jana'; but also some Polish cvs. are grown. Landrace

from former Czechoslovakia 'Vychodoslovenska' (which was grown on the Czech territory, as well) is considered as valuable material for "on farm" conservation.

Also millet has been grown in the Middle Europe for centuries but in modern agriculture its growing has been strongly reduced to present areas of about 400 ha (with presently small, but fast increasing share of organic farming). Czech collection of millet genetic resources reached 171 accessions, but only few local landraces were maintained. Local cultivar Hanacka mana and bred cultivar Unicum are recommended for growing. Landrace 'Slovenske cervene' (grown historically also in Czechia) is considered as convenient valuable material for "on farm" conservation.

Wheat is considered to be one of the most important crops for human nutrition. Wheat species *Triticum aestivum* L. and *T. durum* Desf. are widely grown round the world. In addition to these major species, some another ones have special properties and characters important for their potential utilisation as crops. Collection of wheat genetic resources at the Czech Gene Bank contains at present 10 481 accessions. Among them there are 104 emmer (*T. dicoccum* Schűbl.), 74 spelt (*T. spelta* L.) and 38 einkorn (*T. monococcum* L.) obsolete cultivars and landraces of these hulled wheat species. Standard evaluation of the accessions takes place regularly and also detailed evaluation of valuable cultivars has been done in the last decade.

Spelt wheat belongs to old cultivated crops with specific characters. Percentage of glumes in harvested spikelets was about 25%, TKW was 48 –57 g with high protein content (close to 18%) and good bread making properties of spelt flour were certified. Growing areas are continuously increasing during last decade and reached over 500 ha in the last year. Two cultivars are available, cv. Franckenkorn and lately local cultivar 'Rubiota', which was selected as the best material among local landraces. Several other ladraces could be recommended for "on farm" conservation, mainly due to their superior quality characters.

Glum proportion in emmer wheat (*T. diccocum* Schűbl.*)* spikelet harvest was 25 – 27 %, TKW was lower then in spelt and reached 35 – 37 g. Yield of naked kernels was 2.2 – 2.5 t/ha and crude protein content reached the level nearly by one third higher than in bread wheat and it was close to 20%. On the other hand lower SDS sedimentation values show worse suitability for breadmaking .

Proportion of glumes in einkorn (*T. monoccocum* L.) spikelets was higher (28 %) and kernels are relatively small (TKW was 27 – 29 g). Yield of de-hulled kernels in einkorn accessions was nearly the same as in emmer (2,5 t/ha in 1999 and 2.1 t/ha in 2000). Einkorn also did not differ from emmer in crude protein content (20,7 resp. 18.6 %). Einkorn similarly as emmer seems to be more suitable for other utilisation (porridges, műsli etc.) than for breadmaking.

Hulled wheat species are more resistant to unsuitable growing conditions. For instance, it was very hot and dry period in spring 2000 at Praha -Ruzyně locality. Under such conditions some emmer and einkorn accessions overcame check bread wheat cultivar in crude protein production per hectare. Recently organic farmers in the Czech Republic are interested in addition to other crops also in growing of neglected wheat species as spelt, emmer and einkorn. In both, emmer and einkorn wheat, there are presently no registered cultivars. However, most of local populations (landraces) were maintained and some valuable materials were found in both species, which can be recommended for "on farm" conservation as well as practical utilization. Their quality parameters and agronomic characters allow to recommend them for growing in limited extent in low- input systems, especially in organic farming.

Crop diversity in agriculture and indicators of biological diversity

Crop diversity (diversity within crops as well as within grown cultivars of a crop) is one of important means influencing a range of biological, economical and social outcomes of agricultural systems. On the other hand an optimal structure of crops and cultivars is to some extent determined by regional natural conditions (climate, soil) and also by traditions, market demands etc. Even when crop diversity in agricultural systems does not determine the biodiversity directly, it is obviously one of factors with significant impact on many biodiversity indicators and the biodiversity as a whole. Therefore, some indicators describing the crop diversity in farming systems should be involved as a means for biodiversity measurement, as well. Because of linkage of crop diversity to natural (regional) conditions, these

conditions should be taken in account when constructing relevant indicators. Specific approach will probably be useful for different groups of crops, namely:

- crops on arable land
- meadows and pasture
- orchards and other perennial cultures

In our opinion following parameters should be considered when creating and selecting indicators of biodiversity based on the crop diversity in farming systems:

- number of crops in crop rotation(s), (farming system)
- share of crops in rotation (farming system) convenient for low input systems
- proportion of "neglected" or "minor" crops
- incidence of local cultivars and landraces in growing systems.

Because all crop diversity parameters are closely related to the intensity of production, it should be also discussed whether indicators based on agro-ecosystems should be related to this intensity (for instance to LFA and other regions separately).

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