EUROPEAN COOPERATIVE PROGRAMME FOR CROP GENETIC RESOURCES NETWORKS (ECP/GR)

Maize genetic resources in Europe

ECP/GR

Report of a workshop
28-29 May 1996
Rome, Italy

E. Lipman, R.H. Ellis and T. Gass, *compilers*

International Plant Genetic Resources Institute
IPGRI

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Cover photograph: Maize diversity (courtesy of Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico)

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Part I. Discussion and Recommendations

Introduction

Within the framework of ECP/GR, a meeting on maize genetic resources was organized in Rome 28-29 May 1996. The objectives of the meeting were:

- to discuss the needs and the opportunity to establish a European Maize Database and to consider the offer made by the Maize Research Institute 'Zemun Polje' in Belgrade, Yugoslavia, to host and maintain the database;
- to discuss the project prepared by the Institut National de la Recherche Agronomique (INRA, France) in response to the second call from the European Community on the conservation, characterization and collection of genetic resources in agriculture with the aim "of constituting a European core collection from the different national collections of maize landraces". The project involves seven European countries, all members of ECP/GR (France, Germany, Greece, Italy, The Netherlands, Portugal, Spain);
- to consider other opportunities for collaboration in Europe within the area of maize genetic resources.

The meeting was attended by 21 participants from 16 countries, FAO and IPGRI (see list of participants, Appendix I). Thomas Gass, ECP/GR Coordinator and Director of IPGRI's Regional Office for Europe, welcomed the participants and asked them to introduce themselves briefly. Prof. R.H. Ellis was elected Chair of the meeting. He presented the objectives of the meeting and its agenda, which was adopted by the participants.

The European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR)

Thomas Gass
ECP/GR Coordinator, IPGRI, Rome, Italy

Thomas Gass summarized the historical background of the Programme, underlining its catalytic role in increasing the flow of information among its members. He pointed out the new context of Phase V of the Programme, particularly the importance of the preparatory process for the International Conference on Plant Genetic Resources to be held in Leipzig, Germany, 17-23 June 1996. He described the new structure of ECP/GR as modified at the fifth meeting of the Technical Consultative Committee held in Nitra, Slovak Republic, September 1995. The Programme now consists of ten broadly focused networks within which activities are carried out by standing working groups or through *ad hoc* actions.

Given the absence of a formally established ECP/GR maize working group, the possibility of ensuring the continuity of activities which would be undertaken in the area of maize genetic resources further to the present meeting was discussed. T. Gass explained that this type of meeting illustrated the flexibility granted by *ad hoc* activities, which would allow a satisfactory follow-up of the progress made. He indicated to the participants that the Steering Committee of ECP/GR will decide by the end of Phase V (end of 1998) which Working Groups will be maintained, closed or possibly established.

Maize Genetic Resources in Europe

The delegates presented briefly the status of maize collections in their country (see **Part II. Review of National Collections**).

Austria

Wolfgang Kainz briefly reported on the three national collections, indicating that maize was not a priority crop before the introduction of hybrid varieties in Austria:

- for the Alpine region, the Provincial Institute of Plant Breeding and Seed Testing (Landesanstalt für Pflanzenzucht und Samenprüfung) in Rinn, Tyrol maintains a collection comprising landraces from Austria and northern Italy;
- for the area north of the Alps, material including primitive cultivars from other countries is kept at the Federal Office of Agrobiology (Bundesamt für Agrarbiologie) in Linz;
- the private breeding institute Gleisdorfer Saatzucht maintains landraces and primitive cultivars from southeastern Austria and neighbouring countries, as well as local inbred lines. This collection is not yet freely available for exchange.

Bulgaria

Vesselin Sevov reported on the national maize collection maintained in the genebank of the Institute of Plant Genetic Resources in Sadovo, established in 1977. The collection presently comprises 3868 accessions comprising a majority of inbred lines, Bulgarian populations and cultivars, foreign varieties and synthetics. Computerized data are available for 2515 accessions. Over 1000 landraces have been collected during several expeditions and most of them have been or are being evaluated. Characterization is carried out according to the COMECON descriptors lists.

Czech Republic

Zdenek Stehno outlined the development of the maize collection in relation to the historical context. In former Czechoslovakia, the collection was based in the Slovak part of the country, first in Piestany and later transferred to Trnava where the Research Institute for Maize (RIM) was established in 1962. The genebank of the Research Institute for Crop Production (RICP) in Prague, Czech Republic, became operational in 1989. The documentation system EVIGEZ, based on Fox Pro 2.5, was developed at RICP and data on maize collections were included. After the separation in 1993, maize-related activities were also carried on in the Czech Republic; computer data are still maintained at RICP and 982 seed samples are stored in the Czech genebank. Data concerning the Slovak collection are available from Piestany, Slovak Republic. A safety-duplication system is being established between the Czech and Slovak Republics for the most valuable material.

France

Armand Boyat focused on French research and breeding programmes. Maize is one of the major crops in France with 3.3 million ha for grain and silage production. The national maize collection is maintained by the Institut National de la Recherche Agronomique (INRA) in several locations depending on the type of material. Most of the private seed compagnies also maintain genetic resources (inbred lines, synthetics, populations and research material).

A total of 1236 populations and synthetics were intensively studied between 1983 and 1993 in the framework of the Programme Populations Sources (PPS). This material includes 270 local landraces and 64 synthetics originating from France, the others mostly from European countries. The programme was carried out by Pro-Maïs, an association including both public and private breeders, in collaboration with six INRA laboratories. A high degree of intrapopulation variability was found among temperate accessions for agronomic traits and isoenzymatic polymorphism. A methodology based on RFLP analysis for the development of a core collection is being established, based on the 270 local landraces populations originating from France, which have been fully characterized. All accessions are now regenerated yearly by all partners. A coordination role is played by the INRA laboratory in Montpellier where these resources are stored for medium- and long-term conservation. The collection now comprises 920 landraces from the temperate countries, 100 from the Carribean region and 410 large basic accessions (synthetics, composites).

Additionally, 4600 inbred lines are stored and regenerated by two INRA maize laboratories in Clermont-Ferrand and Saint-Martin-de-Hinx.

Germany

Peter Goertz presented the national situation in relation to the breeders' needs. With 1.5 million ha in cultivated area, maize is an important crop in Germany. Genetic resources are conserved in two major genebanks:

- the largest collection is maintained at the Institute for Plant Genetics and Crop Plant Research (IPK) in Gatersleben (1273 accessions, fully evaluated);
- a small collection of 53 accessions is held by the Institute of Crop Science, Federal Research Center for Agriculture (FAL), in Braunschweig.

Passport data are available from both genebanks.

Additional research or breeding collections are kept by the Institute of Plant Breeding of the University of Höhenheim, in Stuttgart; the Institute for Tropical and Subtropical Agriculture, in Witzenhausen, and the Bayrische Landesanstalt für Pflanzenbau, University of Weihenstephan.

Several national private seed companies have an active maize breeding programme but the accessions kept in the genebanks are scarcely used for applied breeding, owing to a lack of knowledge about their breeding value. More prebreeding work at the level of genebanks and accessibility of data to the current maize breeders are required for better utilization of these collections.

Greece

Georgios Evgenidis stressed that the development of maize cultivation in Greece, at the southern limits of the European 'corn belt', was made possible thanks to modern irrigation techniques and the introduction of hybrids, but the production costs remain high. Because of their low productivity, the traditional landraces were rapidly replaced by the highly productive American dent corn hybrids. Attempts to rescue old landraces started in the mid-1960s. Collections are maintained at the Cereal Institute of Thessaloniki (71 accessions) and at the Gene Bank, which was founded later and established in the same area (184 accessions). Characterization of these landraces is not complete yet and no evaluation has been carried out so far. The collections also include 110 foreign populations from different countries obtained from other international institutes. This material constitutes a source for new hybrids.

Italy

Alberto Verderio presented a report on the Italian collections for maize, which is the most important crop in Italy with an acreage of 1.2 million ha for grain and silage production. Hybrid seed replaced the local varieties in the period 1948-60. During this period many landraces or improved populations were collected.

The major collection is stored at the Experimental Institute for Cereal Research, Maize Station of Bergamo. The Germplasm Institute (Istituto del Germoplasma) of the National Research Council (CNR) in Bari stores some 600 maize landraces from collecting missions in the Mediterranean area. Other minor collections including local varieties, landraces and research materials are maintained by the following institutions:

- Institute of Plant Breeding and Agriculture Research ‘N. Strampelli’, Lonigo;
- Department of Botany and Genetics, University of Piacenza;
- Department of Plant Breeding, University of Bologna;
- Ente di Sviluppo Agricolo per il Friuli-Venezia Giulia.

No documentation data are available.

Mr Verderio stressed the need for establishing a national programme for conservation and management of maize genetic resources in Italy, which presently does not exist. Priorities are the regeneration of all material and the restoration of a working genebank or germplasm collection, according to international recommendations regarding documentation, regeneration, seed conservation and storage. Further development should be user-oriented, including prebreeding activities and germplasm enhancement.

The Netherlands

Loek van Soest reported on the maize collection held by CGN, the Dutch multicrop genebank. The collection includes only material of species *Zea mays* and consists of 488 accessions, with only one landrace from the Netherlands. The original collection of approximately 1000 accessions was rationalized by excluding hybrids (90), inbred lines (140) and material received from other genebanks including CIMMYT, Mexico and the Institute for Agrobotany, Tapiószele, Hungary. The maize collection has the status of a working collection. Nearly 60% of the accessions are landraces, including some unique material collected in Pakistan in 1976 and 1981.

The whole collection is regenerated and available to users. The accessions are characterized for a set of 15 agromorphological traits, according to a minimal descriptors list developed by CGN with the advice of private breeding firms. The passport data and available characterization data are documented in GENIS (**GEN**etic Resources **I**nformation **S**ystem), the data information system of CGN. However, the requests for material are very low; since 1987 only 73 accessions have been distributed.

Poland

Zygmunt Królikowski gave a general report of maize collections in Poland, where it is grown mostly for cattle feed. Part of the local material was lost after World War II owing to population migrations. Collecting in the region of Krakow provided the highest number of landraces.

Maize germplasm collections are kept by two stations of the Plant Breeding and Acclimatization Institute (IHAR): long-term storage in Radzikow and short-term storage at Smolice. The collection is regenerated according to the age, quality and viability of seeds. A number of requests for seed are received from different countries, for purposes ranging from breeding and evaluation to very basic research. At IHAR, the genetic diversity of the germplasm is studied through isoenzyme polymorphism.

Portugal

Silas Pego indicated that since 1975, the Portuguese Plant Germplasm Bank (BPGV) has been carrying out systematic germplasm collecting and was able to save most of the Portuguese landraces of maize, together with the other minor components of the traditional agricultural systems. The conservation activities undertaken by BPGV proved providential given the tremendous genetic erosion which took place during the last 20 years. This erosion, together with the considerable drop in maize area in the same period, is seen as a consequence of the implementation of the Community Agricultural Policy (CAP). Mr Pego stressed the socioeconomic and environmental implications of the change from polycropping to monocropping systems in Portugal, particularly the negative impact on small farmers.

In the framework of its commitment as the IPGRI Maize Base Collection for the Mediterranean Region, the BPGV holds a total of 6632 maize accessions, comprising landraces (1740, out of which 1166 are already characterized); breeding materials and inbred lines (4526) and genepools (366). Three catalogues with the data of 900 accessions already characterized will be published during summer 1996.

Mr Pego stressed the role of breeding as the natural bridge to fill the gap between conservation and utilization, and the urgency of building up a prebreeding programme which should contemplate germplasm enhancement, preliminary evaluation from a breeder’s point of view, and the need for developing new methodologies for a first prebreeding approach.

Romania

Marcel Avramiuc reported on the status of the maize national collection of Romania. The collection comprises 11 239 accessions distributed among the Suceava Genebank (3188 accessions) and six other institutions. The Suceava Genebank is the only institution involved in medium-term conservation. The other institutions keep field collections for research and breeding purposes. The maize germplasm is evaluated using standardized descriptors; however, only Suceava Genebank uses the complete list of *IBPGR Descriptors for Maize*. Since 1989 the genetic resources in Romania are documented in a database using SIRAG, an application of FoxPro. In the national maize collections, half of the accessions are documented for passport data and conservation data, and less than 50% of characterization-evaluation data are computerized.

Spain

Jesus Moreno-Gonzalez described the collections of maize landraces in Spain.

- The Spanish Centre of Genetic Resources (CRF) in Alcalá de Henares (Madrid) and the germplasm bank of the Mision Biológica de Galicia (MBG) in Pontevedra conserve the collection obtained through the first classification of maize races in Spain: 462 accessions were analyzed and recombined to form a collection of 49 races and subraces.
- The germplasm bank of the Mision Biológica de Galicia in Pontevedra was established in 1928. A new collection of 420 accessions was built in the 1970s consisting of new accessions collected mainly in Galicia (220), but also introduced from other parts of Spain and North American Universities.

- The Germplasm bank of the Centro de Investigaciones Agrarias de Mabegondo (CIAM), La Coruña collected maize local varieties from the north of Spain (Galicia, Asturias, Cantabria and the Basque Country) in the 1970s and 1980s. Genetic variability was studied on 86 local varieties using morphological and isoenzyme traits. The collection comprises 750 accessions including 650 local varieties collected in Spain. Regeneration of some populations with low viability is in progress. Additionally, recording of secondary morphological characterization traits has been made in several populations.
- The Centre for Genetic Resources, Alcalá de Henares (Madrid) is the National Gene Bank of Spain. *Zea mays* is the most represented cereal with 1320 accessions including 1020 Spanish local varieties, 45 collected in Portugal and the remainder are from other parts.
- The centre Aula Dei, Zaragoza (800 landraces) out of which 750 were sampled from different regions of Spain over many years.

Mr Moreno-Gonzalez also introduced the National Coordination Project on Maize Genetic Germplasm which involves the abovementioned collections. The objectives are to compile an inventory of all national accessions and to identify duplicates; to regenerate the accessions with low seed viability; to characterize maize samples based on secondary morphological and important agronomic traits; and to establish dissimilarity groups in order to form a core collection in each of the specific collections of CIAM, MBG and Aula Dei.

Slovak Republic

Bozena Ryšavá referred to the presentation of Z. Stehno for the historical background of the maize collection in the Slovak Republic and added that characterization data are recorded according to the *National Descriptor List Species* Zea mays *L.* The list comprises 19 passport descriptors and 115 evaluation descriptors and taxonomic codes are also provided.

The maize collection is held by Zeainvent, the recently privatized research station of Trnava. It includes 134 regional populations of Slovak origin, 32 hybrids from domestic breeding, 102 varieties and 1362 inbred lines of various countries of origin. Further detail on the research work carried out at by Zeainvent can be found in the section **Review of National Collections**.

Turkey

Asuman Oguz reported on the maize genetic resources activities in Turkey. Landraces have been collected since 1964, mainly from the Black Sea and Marmara Region of Turkey. The national maize collection totals 1159 accessions including 1135 populations from Turkey and 24 research materials. Collecting is still a priority to fill gaps, especially in the regions of Turkey which have never been visited for collecting. The documentation system uses dBase (dBase 3+, dBase 4, dBase for Windows) and records passport data, storage data and evaluation data. Characterization of accessions started in 1995. At present 812 accessions are almost completely characterized for 22 agronomic and morphological characters. The characterization of these accessions is expected to be completed by 1997.

United Kingdom

Richard Ellis indicated that there are no conservation activities on maize in the UK. Most information is in the hands of the private sector and thus not easily accessible. Varieties are imported from France and Germany principally. Interest in maize as a forage crop has increased greatly recently.

Yugoslavia

Mr Radovic stressed the importance of maize in Yugoslavia. The maize Gene Bank today maintains 5466 accessions, including 2178 local cultivars and 3298 introduced genotypes from 40 countries. Material is rejuvenated on a regular basis in the experimental fields of the Gene Bank in Zemun Polje, Belgrade. The *IBPGR Descriptors for Maize* are used for characterization, evaluation and documentation. The documentation system is computerized under Access v.2.0. The material is stored under medium-term conditions. Local material is given priority research attention, as being unique and unrecoverable. Now considered as national wealth, this material was collected from 1960 to 1990 from all agro-ecological sites and therefore the collection might be considered complete. The classification of local populations through taxonomic and agronomic analysis identified 16 major agro-ecological groups, confirmed recently by the numerical taxonomy method. Each group (ecotype) has distinctive common characters, which could be used as different donors in the maize breeding programmes.

Utilization of local germplasm by breeders could be enhanced. To reduce a great number of accessions to a manageable proportion, the development of a core collection has been proposed.

Regional Synthesis

The status of maize genetic resources in Europe

D. Jelovac
Maize Research Institute ‘Zemun Polje’, Belgrade, F.R. Yugoslavia

In preparation for the meeting and to provide a rapid appraisal of the status of maize collections in Europe, a questionnaire was sent out to all participants before the meeting by the Maize Research Institute ‘Zemun Polje’. D. Jelovac presented a synthesis of the results. To cover all European countries, the data received in reply to the questionnaire were complemented where necessary with data from the *Directory of European Institutions Holding Crop Genetic Resources Collections* published by FAO/IPGRI in 1995. Results are presented in Table 1 (European Maize collections).

A total of 71 801 maize accessions were recorded for 22 European countries, ranging from material of local and introduced origin to samples that have undergone breeding. They include local populations, populations obtained through exchange, synthetic populations, composites and inbred lines from domestic and foreign sources. A high proportion of duplicates is to be expected between the European collections.

D. Jelovac pointed out that there were more than 20 000 accessions for which the **type of material** was not defined. However, this high number is because only general figures were available for Russia and Ukraine.

When a classification is given, the terminology used is heterogeneous and sometimes inaccurate, e.g. for the notions of synthetic and composite populations, local variety, local population, landrace. The term “research material” may cover any other category. In the perspective of the establishment of a common database, the highest priority would be to identify the material type in a nonambiguous manner and to decide which material should be included in the database.

The **level of documentation** of the collections varies widely from one national collection to another, although it can be assumed that this level is usually higher for small collections and for samples of local origin. The *IBPGR Descriptors for Maize* are widely used. Some countries use lists established at national level (Czech Republic) or regional level (e.g. Bulgaria, using the COMECON descriptors lists). D. Jelovac noted that the molecular descriptor level is not documented presently.

The level of **software compatibility** is satisfactory. Most national collections have computerized data. In spite of the variety of softwares used (dBase III, IV, V, Excel, FoxPro, Access, Oracle, SAS, Widas – see Table 1) they all have compatible export formats (dbf format). Data exchange could be easily performed between the existing systems.

The FAO World Information and Early Warning System on Plant Genetic Resources (WIEWS/PGR)

J. Serwinski
FAO, Rome, Italy

A database report presenting the European collections of maize recorded in WIEWS was distributed to the participants. The database was updated for the publication of the fourth edition of the *Directory of European Institutions Holding Crop Genetic Resources Collections* in 1995. The “metadata” (i.e. not at accession level) contained in the database showed some differences with the results given by the questionnaire, confirming the necessity to define accurately the material considered. It was also noted that the FAO database records all accessions, local or introduced, and that, in the context of a crop-specific database, emphasis is sometimes on local material.

Table 1. European Maize collections.

Country	Population	Varieties	Research material	Inbred lines	Total	Availability of Passport data	Availability of Characterization and evaluation data	Computerization of passport data	Computer programme used
Data from questionnaires									
Austria	29	6	–	–	**35**	Fully	<50%	Fully	dBase, Excel
Bulgaria	632	312	2340	2128	**5412**	<50%	<50%	>50%	dBase III+
Czech Republic	106	30	846	–	**982**	Fully	Fully	Fully	FoxPro 2.5
France	1020	410	1370	4600	**7400**	Fully	>50%	>50%	dBase
Germany	–	–	–	–	**1326**	Fully	Fully	Fully	
Italy	620	797	2903	–	**4320**	No	<50%	No	–
The Netherlands	285	13	19	171	**488**	Fully	>50%	Fully	Oracle
Poland	45	10	580	–	**635**	>50%	>50%	No	–
Romania	754	30	7002	265	**8051**	>50%	<50%	>50%	FoxPro 2.6
Slovakia	134	102	1395	–	**1631**	Fully	Fully	Fully	dBase, FoxPro
Spain	2340	–	350	–	**2690**	Fully	>50%	<50%	Excel, SAS
Switzerland	150	–	223	–	**373**	Fully	No	Fully	Widas (Excel comp.)
Turkey	1135	–	24	–	**1159**	Fully	>50%	>50%	dBase III+, IV, V
Yugoslavia	785	2178	273	2230	**5466**	Fully	Fully	Fully	MS Access 2.0
Total	**8011**	**3888**	**17325**	**9394**	**38756**				
Data from *Directory of European PGR Collections (FAO/IPGRI 1995)*									
Albania	–	190	50	1200	**1440**	*	*	–	
Greece	–	133	113	294	**540**	Fully	Fully	Fully	
Hungary	–	2580	–	–	**2580**	Fully	Fully	Fully	
Israel	–	–	300	–	**300**	*	*	*	
Portugal	1090	2388	395	2500	**6373**	Fully	Fully	Fully	
Russia	*	*	*	*	**18265**	*	*	*	
Ukraine	*	*	*	*	**2290**	*	*	*	
United Kingdom	*	*	*	*	**183**	Fully	Fully	Fully	
Total	**2302**	**5291**	**858**	**3994**	**33183**				
TOTAL	**10313**	**9179**	**18183**	**13388**	**71939**				

(*) data not obtained

Presentation of National Documentation Systems

France

Armand Boyat gave further details about the national programme for the study of source populations or Programme Populations Sources and the related activities undertaken for the establishment of a national core collection.

The **Programme Populations Sources (PPS)** was carried out from 1983 to 1993 to conserve temperate populations and synthetics and to enhance the knowledge of this material and therefore its value for breeders. The total number of 1236 accessions includes 270 local landraces and 64 synthetics from France. For all these populations, evaluation data were documented under dBase and analyzed with SAS.

In complement to the PPS programme and in view of establishing a **national core collection**, the 270 local French populations were more thoroughly studied for different traits and also documented in dBase: passport data, phenological, morphological and ecogeographic traits were recorded. For some populations, further characterization was based on RFLP techniques which proved superior to isoenzymes to discriminate between populations.

Use of the database:

- passport data are freely available, but breeding results are restricted to breeders participating in the programme. They should be made available within a few years. Only the information concerning the French local landraces is freely available;
- most of the descriptors correspond to the *IBPGR Descriptors for Maize;*

Boyat indicated that the data selected for inclusion in the European database could easily be transferred under Access and possibly be loaded on the Internet.

Boyat also outlined a project for the constitution of a European Core Collection, due for submission in June 1996 in response to the second call from the European Programme on the Conservation, Characterization, Collection and Utilization of Genetic Resources in Agriculture (see details in **Review of National Collections**).

Yugoslavia

Drazen Jelovac introduced the documentation system for maize genetic resources developed by the Maize Research Institute 'Zemun Polje' along two different approaches:

- germplasm conservation, covering all classical genebank activities including characterization, evaluation and multiplication, with all stages being documented;
- germplasm utilization, in relation to the existing prebreeding programme on local material.

Jelovac presented the screens of the database system, which was recently transferred under Access. The relational database contains tables for passport data (including photographs of the accession when available), collection data, characterization and primary evaluation, further characterization and evaluation.

The descriptors are recorded over a period of 3-4 years and the average value is entered in the general table. However, it is also possible to look up data on a year by year basis.

Jelovac's presentation raised the following discussion issues:

- the notion of access to data versus availability of the material;
- the need/possibility of providing data recording the experimental conditions for the measurement of each trait;
- the need to specify the difference between characterization data

(independent from agronomical value) and evaluation data (for direct application).

Czech Republic

Zdenek Stehno indicated that the documentation system for plant genetic resources is standardized at the national level. All crop databases use the same software, EVIGEZ, based on FoxPro v. 2.5 for DOS. The maize database comprises three parts: passport data, characterization and evaluation data, genebank management data. Data are linked by a unique national accession number.

Why a European Maize Database?

Further to the regional and national presentations, the motivations for the establishment of a European Maize Database (EMDB) were discussed by the participants. The national reports showed a wide variety in the status of collections and a rather low level of activity by the national programmes. Given this situation, it was necessary to address the basic questions: **why,** and **for whom** to establish a database. Two approaches were considered:

- **"conservation-oriented" database**: established to keep a record of all collections / genebanks with priority given to passport data; in this case, issues such as the uniqueness of the material would be predominant. Characterization and evaluation data could be included to serve further prebreeding activities, further research such as gene mapping or further collection of material;
- **"use-oriented" database**: while maintaining data on all accessions, emphasis is on making valuable maize genetic resources available to the international community (breeders / researchers) directly linked to prebreeding activities. Characteristics such as combining ability and inbreeding status, ecogeographic adaptation, agronomic traits, resistance to biotic and abiotic factors must be well documented.

It was noted that to guarantee their source of funding, genebanks are often bound by political requirements to prove that the conserved material is being used. Thomas Gass also pointed out that the aspect of application to agriculture is an important criterion for approval of projects at the EU level. It was agreed that the usefulness of the database is to be regarded as highest priority.

Specific aspects of maize also were mentioned: the demand for maize genetic resources is very different from that of other crops such as wheat or potato. The interest in wild relatives is not very relevant and their use in breeding systems of maize is low. The experience of the Dutch Genebank, for instance, shows that the number of requests for maize are much lower than for most of the other crops maintained by CGN.

Needs assessment

To help in the assessment of the users' needs, P.G. Goertz gave a general overview of maize in Europe, stressing the economic importance of this crop and highlighting breeders' views of the situation. Maize was introduced into Europe at the beginning of the 16th century, and is now grown in almost all European countries. Regarding cultivation area, Europe comes before the USA with 25 million ha for silage and 15-20 million ha for grain production. Three major environments or 'subregions' can be identified in Europe for the cultivation of maize: northern (silage), central (grain) and southern (grain). Almost all varieties have in common the fact that they are sown annually from hybrid seed, which has high economic implications. Over 600 000 t of seeds are sown per year. The genetic variability of maize in current farmers' fields is narrow.

The immediate economic value of an accession is sometimes very low. For the breeder, the value of a collection lies in the following questions:

- what can the collection contribute toward solving the problems of current maize growing?
- what is the breeding value of each accession?
- are the accessions available and under what conditions?

The information needed at the accession level by a breeder includes ecogeographical data, kernel texture, value for grain or forage, heterotic patterns, quality traits (for food, feed or industrial use), major simple inherited traits (e.g. root lodging), resistance to biotic and abiotic factors (drought, salinity, resistance to pests and diseases).

In conclusion, P.G. Goertz identified four major needs for collaboration on maize genetic resources:

- long-term germplasm conservation, regardless of its current agronomic value or potential application to agriculture;
- identification of accessions that are particularly valuable for their agronomic characteristics (in relation to farmers' needs);
- establishment of a common prebreeding programme (e.g. ProMaïs in France), covering the three major agro-ecological European subregions listed above, and close interaction with worldwide prebreeding activities, particularly the Latin America Maize Project (LAMP)/CIMMYT, which involves 11 Latin American countries and the United States (objective: "evaluation of over 12 000 landrace collections and identification of elite landrace varieties");
- the United States Germplasm Enhancement – Maize Project (US GEM) involving 21 companies and 34 cooperators in the public sector (objective: "introgression of some elite LAMP landrace collections into their source materials").

European Programme for the establishment of a maize core collection

The establishment of the European Maize Database was also discussed in the light of the information given by Armand Boyat on the European project to be submitted by France in June 1996 in response to the second call from the European Programme on the Conservation, Characterization, Collection and Utilization of Genetic Resources in Agriculture.

This project involves seven European countries, all members of ECP/GR: France, Germany, Greece, Italy, the Netherlands, Portugal, Spain. It aims to constitute a **European core collection,** following the model used for the building of the national core collection, with the following steps:

- choice of descriptors in order to build up a **common database** for the 3000 or more European landraces (primary and secondary descriptors to be collected and recorded into the database);
- **definition of a restricted collection** at country level, based on passport, phenological and morphological data. This step would be carried out at national level to make use of the good knowledge of this material by national breeders and because of the high total number of accessions. It would be impossible to study all accessions in the same locations and avoid important genotype x environment interactions. This step should reduce the number of accessions to about one-third and allow the identification of a 'restricted' collection which would be further studied as follows:
  - **molecular characterization of the restricted collection through RFLP techniques:** study of DNA neutral polymorphism to reveal relevant genetic structure among populations and to build the European core collection on allelic richness;
  - **evaluation of the European core collection** according to the criteria needed by the Common Agricultural Policy (CAP), in a common multilocal network.

The project would contribute to the conservation of genetic resources in the most cost-effective way and allow access to exchangeable resources from other countries. Maize genetic resources would be conserved under the responsibility of each country to manage its own resources rather than by a highly centralized management. This would also help to avoid the duplication now prevailing between collections of the different countries. Efforts would be set on the accessions of the European core collection which would be the primary target for exchanges. This approach could easily be extended to any new country wishing to access the European core collection.

The project raised great interest and it was agreed by the participants that there is no conflict of objectives between the creation of a European Maize Database and this European project, since they address different levels: the latter is restricted to prebreeding activities on local landraces whereas the common database would include all types of maize genetic resources. It was also noted that if the European project were adopted, a good level of coordination would be necessary to ensure its complementarity with the EMDB and an efficient dissemination of information at national and international levels.

Recognizing that the centralization of data would facilitate their management and improve collaboration between the genebanks throughout Europe, the participants agreed that the establishment of a European Maize Database would contribute to meeting the needs listed above.

Guidelines for the Establishment of the European Maize Database (EMDB)

Objectives of the EMDB

The objectives of the EMDB were summarized as follows:

- to identify a unique and complete set of accessions usable in prebreeding activities, including local material and material collected worldwide, when its conservation cannot be guaranteed in its original area;
- to enable rationalization of the collections and so prioritize conservation activities;
- to provide a digest of European collections for worldwide use.

It was unanimously agreed that these data would be made freely available to all interested users.

Host institute

Drazen Jelovac reminded the meeting of the willingness of the Maize Research Institute in Belgrade to host and maintain the EMDB, indicating that the maintenance of the maize database would be a contribution in kind of Yugoslavia to ECP/GR.

The offer of the Maize Research Institute in Yugoslavia to establish and maintain the European Maize Database was formally and gratefully accepted by all delegates and the following session was dedicated to the practical aspects of its implementation.

Definition of the database contents and structure

Accession type

The first step was to define the type of material to be entered in the database in a nonambiguous way to ensure consistency of the data provided. A technical discussion led to the adoption of the following definitions for categories of material inspired and modified from the *IBPGR Descriptors for Maize* (item 2.11: population type, renamed here “accession type” to avoid ambiguity).

2.11 ACCESSION TYPE

1	Inbred line	Pure homozygous line after more than five selfing generations.
2	Landrace	An early, cultivated crop form, evolved from a wild population or grown under traditional agricultural systems, which has not undergone much improvement (synonym: local variety).
3	Advanced cultivar	Open-pollinated varieties, systematically improved (obsolete or currently cultivated).
4	Composite	Deliberate mixture of inbred or segregating materials that have common characteristics.
5	Synthetic	Deliberate mixture of inbred lines for a specific purpose.
6	Wild and related species	Unknown

Remark: genetic stocks or mutants should be included under 1, 4 or 5 and indicated in a “special value” field using a standard symbol.

Other descriptors

Passport data

Reference was made to the list of standard 'multicrop' passport descriptors prepared jointly by FAO and IPGRI in response to the general need for better standardization of crop databases. This list, still in draft form at the time of the meeting, served as a working document. The participants suggested a few modifications to make it more appropriate for maize, resulting in the version given below.

Proposal for Mandatory Descriptors for the European Maize Database†

• Institute code Code of the institute where the accession is maintained (consisting of 3-letter ISO country code plus number) using INST.DBF institute code as provided by FAO/IPGRI	(C 6)
• Accession number This number serves as a unique identifier for accessions and is assigned when an accession is entered into the collection. Once assigned this number should never be re-assigned to another accession in the collection. Even if an accession is lost, its assigned number is still not available for re-use. Letters should be used before the number to identify the genebank or national system (e.g. IDG indicates an accession that comes from the genebank at Bari, Italy; CGN indicates an accession from the genebank at Wageningen, The Netherlands; PI indicates an accession within the USA system)	(C 12)
• Scientific name Full botanical name without authority. Following abbreviations are allowed: sp.; spp.; subsp.; var.; convar. Genus Species Subspecies Botanical variety	(C 180)
• Accession type 1 Inbred line 2 Landrace 3 Advanced cultivar 4 Composite 5 Synthetic 6 Wild and related species 7 Unknown	(N 2)
• Country of origin or collecting Name of the country in which the sample was originally collected or bred. Use the ISO 3166 extended codes, (i.e. current and old ISO codes)	(C 3*)
• Donor institute code Code of the donor institute using INST.DBF institute code as provided by FAO/IPGRI	(C 6 or 10)
• Donor number Number assigned to an accession by the donor	(C 12)
• Acquisition date [DDMMYYYY] Date on which the accession entered the collection in the format DDMMYYYY	(N 8)
• Cultivar name Either a registered or other formal cultivar designation given to the accession	(C80)
• Collecting number Original number assigned by the collector(s) of the sample, normally composed of the name or initials of the collector(s) followed by a number. This item is essential for identifying duplicates held in different collections. It should be unique and always accompany subsamples wherever they are sent	
• Status of accession 1 Collected originally by the institute 2 Received as a second repository	(N1)

3 Unknown	
• Source of collection 1 Wild habitat 1.1 Forest/woodland 1.2 Shrubland 1.3 Grasslands 1.4 Desert/tundra 2 Farm 2.1 field 2.2 orchard 2.3 garden 2.4 fallow 2.5 pasture 2.6 store 3 Market 3.1 Town 3.2 Village 3.3 Urban 3.4 Other exchange system 4 Institute/Research organization 5 Other (specify)	
• Location of collecting site Distance in kilometers and direction from the nearest town, village or map grid reference point (e.g. CURITIBA 7S means 7 km south of Curitiba)	
• Latitude of collecting site Degrees and minutes followed by N (North) or S (South) (e.g. 01030S)	
• Longitude of collecting site Degrees and minutes followed by E (East) or W (West) (e.g. 07625W)	
• Elevation of collecting site [m]	(N 5)
• Location of safety duplicates Location of the institute where a sample has been duplicated using INST.DBF institute code as provided by FAO/IPGRI	(C 6 or 10)
• Availability of additional passport data 0 May be completed in the future 1 Not possible to trace back 2 Limited in descriptors number (XXX) 3 Available	(N 1)
• Availability of characterization data 0 Not characterized 1 No information 2 Limited in descriptors number (XXX) 3 Available	(N 1)
• Type of storage Maintenance type of germplasm. If germplasm is maintained under different types of storage, multiple choices are allowed, separated by a semicolon (e.g. F;I) 1 Short-term 2 Medium-term 3 Long-term 4 *In vitro* 5 Field collection 6 Vegetative 7 Cryopreserved	(C 1)
• Other number(s) associated with the accession Any other identification number known to exist in other collections for this accession (other than Collecting number). Other numbers can be added	

† This list was modified from the draft list of 'multicrop passport descriptors' under elaboration by FAO/IPGRI. At the time of going to press of this report, the draft list used as a reference has been further elaborated and is under review. The final version will be available from the ECP/GR Coordinator, IPGRI, Rome

Minimum characterization data

Bearing in mind the fundamental objectives set for the EMDB, i.e. its usefulness to breeders and the rational management of collections, the choice of relevant descriptors was discussed at length. Final agreement was reached on the following characters:

- earliness (recorded by numbers of days to silking, done at the country level);
- kernel type: colour / texture (cf. *IBPGR Descriptors for Maize*);
- specific traits such as resistance to stress and diseases (cf. *IBPGR Descriptors for Maize*).

It was agreed that coding rules (numeric / alphabetical scales) would be defined and forwarded to all participants by the database manager (see below).

Format

The database manager will accept data sent in any of the following formats: ASCII, .dbf or .xls.

Language of data

The data will be provided in English.

Uniqueness of data

If accessions have already been identified as duplicates, the data sent for inclusion in the EMDB should be restricted to one accession.

Timetable for implementation

The following workplan was accepted:

- **Database structure**: by the end of June 1996, a draft structure of the database will be elaborated by the EMDB manager, D. Jelovac, and sent to all participating members for approval and comments. In case of disagreement between members, the final decision concerning the structure to be adopted remains the responsibility of the database manager. It was also decided that the final definition of the database structure should not be finalized before October 1996, to allow for the integration of any major outcomes of the Joint EGDS-ECP / GR workshop to be held in Budapest, Hungary on the theme 'Central crop database, tools in plant genetic resources management'.
- The official **call for data** will be sent by the database manager in November 1996.
- **Provision of data** (via the national focal point for maize): each country gave a tentative schedule as indicated below:
    - October 1996: Czech Republic, Portugal (complete catalogues will be published very soon and the equivalent set of data can be sent immediately), Slovak Republic;
    - January 1997: Austria, Bulgaria, France, Germany, Italy (existing data), the Netherlands, Poland, Spain, Turkey;
    - February 1997: Romania;
    - March 1997: Greece;
    - January 1998: Italy (new data not processed yet).
- By **March 1997** all data should have been received and merged in the EMDB. No data are to be expected from the United Kingdom where the collections are all of external origin.

Opportunities for Establishing and Extending Collaboration

European Maize Core Collection

If the project is accepted, a meeting of the partners will be followed by a wider meeting including the complete group of the present *ad hoc* meeting, to be organized early 1997. It was noted that the project would provide an excellent model for further and wider collaboration in making maize genetic resources useful.[1]

Follow-up meeting on maize genetic resources

The meeting made recommendations to the Steering Committee of ECP/GR that a second meeting on maize genetic resources be held once the EMDB is implemented. The objectives of this second meeting would be to focus on rationalization for enhancement of utilization and prebreeding issues.

Conclusions

The Recommendations were reviewed and approved by the participants. The group expressed its thanks to the organizers of the meeting and to the Chair, Prof. Richard Ellis.

[1] The project proposal was successful and will be supported within the frame of the EC1467/94 genetic resources programme. Further details are available directly from A. Boyat, INRA, Montpellier, France.

Part II. Review of National Collections

The maize situation in Austria

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In Austria the cultivated area for maize totals 270 000 ha including 170 000 ha for grain and about 100 000 ha for silage production.

The cultivation of maize increased substantially after World War II from west to east, owing to topographic and climatic conditions, and the introduction of short-period varieties resulting from maize breeding.

Since maize is a relatively new crop, Austria is rather poor in maize landraces:

- The genetic resources of maize are stored in several collections depending on their different climatic areas. The collection for the alpine region, which is the oldest, comprises landraces from Austria and northern Italy and is maintained by the Provincial Institute of Plant Breeding and Seed Testing (Landesanstalt für Pflanzenzucht und Samenprüfung) in Rinn, Tyrol.
- The other collection for the area lying north of the Alps is kept at the Federal Office of Agrobiology (Bundesamt für Agrarbiologie) in Linz. It also includes primitive cultivars from other countries.
- Another collection, mainly consisting of landraces and primitive cultivars from southeastern Austria and the neighbouring countries, and of local inbred lines, is maintained at the private breeding institute Gleisdorfer Saatzucht. However the material is not yet freely available for exchange.

The Bulgarian maize collection

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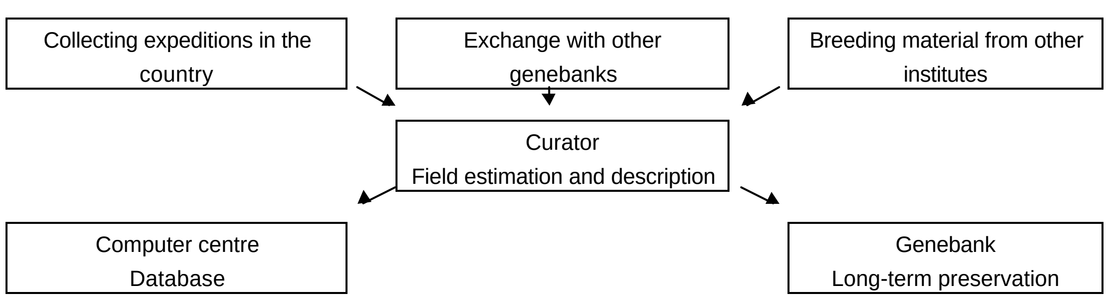
The Institute of Plant Genetic Resources was established in 1977 as the national centre and genebank for long-term preservation. Conditions were created to help grow a considerable number of European landraces, excluding fruit trees and vines.

At present the Genebank maintains plant samples in hermetically sealed glass containers or vacuum packages made of laminated aluminium foils at –18°C and 5-6% grain moisture contents. The active collection is preserved at +6°C and approximately 50% air humidity. Database management of the preserved collections is carried out by a computer centre. The collection is enriched and studied according to the following scheme:



The collection has been constituted in several steps. At the beginning of the existence of the institute as a gene resource centre in 1977, the first step was the gathering of plant collections all over the country (at the former institute of introduction in Sofia and other local breeding centres). The second step was the exchange of material with other genebanks and the third step is illustrated by the collecting expeditions for local varieties and old cultivars in the country.

The collection now includes the following material:

Type of sample	Long-term preservation	Passport data	Full description	Database in the computer centre
Inbred lines	2128	2128	1420	1026
Bulgarian populations and cultivars	944	944	835	835
Foreign varieties	584	584	584	584
Synthetics	212	200	70	70
Total no. accessions	3868	3856	2909	2515

At the time of initial acquisition of the material a single reproduction was carried out, aiming at getting enough seeds for long-term preservation. The descriptions were made according to the international COMECON descriptors (the economic organization of the former socialist countries) during three consecutive years. The data obtained were submitted to the computer centre.

Up to the present, two types of descriptors with different coding systems have been used, which is still a problem for database standardization: until 1985, the descriptors came from the 1977 edition of the COMECON list; since 1985, from the 1984 edition of COMECON list. As a result the information obtained might concern different characteristics.

Collecting and study of the local corn populations is of great importance in Bulgaria. Owing to the great activity of the Institute of Maize in Kneja in 1950-54 and 1956-57, over 1000 samples were collected from 80 regions in the country. Later they were used as the basis for the national corn programme. Since 1979 several expeditions have been carried out and it is now considered that the major part of the corn population present in the country has been collected. This activity is still ongoing but it is getting more and more difficult to find true local landraces, as during the last 30 years the main corn production in Bulgaria was based on hybrids.

At present the collection includes approximately 1000 local varieties and old cultivars, all undergoing thorough testing and studying.

General structure of the collection

Inbred lines: most of them originate from the Bulgarian landraces. Some are recognized foreign lines which have been preserved, such as C103, Mo17, B73. The remaining lines are characterized by valuable breeding parameters and some are approved as possessors of specific genes (Wx, sh, Su, O_2).

Synthetics: all synthetics established in Bulgaria, and others from USA, Europe, Asia.

Foreign landraces: exotic germplasm.

Bulgarian landraces and populations.

Maize genetic resources in the Czech Republic

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In the history of the Czech maize genetic resources collection, two periods can be distinguished

Period 1

- In the framework of former Czechoslovakia the gathering of maize genetic resources started at the Research Institute of Crop Production (RICP) in Piešťany. Different accessions were collected including accessions from places in the Czech part of the country, for example from the Laboratory of Genetics in Lednice.
- In 1962, the Research Institute of Maize (RIM) was launched in Trnava, in the Slovak region suitable for maize growing. The collection was transferred to this institute and has developed intensively since then.
- During the 1970s and 1980s, the documentation system on plant genetic resources was developed at RICP Prague. After its completion, the data on maize collection were included in the system for a high percentage of accessions.
- In 1989, construction of the genebank in RICP Prague was completed and the genebank started its activity. Since then a large part of the maize collection has been transferred to the medium-term storage facility.

Period 2

- Since 1993 the above activities have continued in the Czech Republic.
- The data are maintained with the documentation system EVIGEZ in RICP Prague. The system and data for Slovak collections are available also from RICP Piešťany. Seed samples are still stored in the genebank in Prague. They will be kept there until the opening of the Slovak Gene Bank in RICP Piešťany.
- For the future we intend to prepare a 'safety-duplication system' between the Czech and Slovak maize collections, as for other groups of genetic resources. The base for the Czech maize collection will be the original material from the Czech part of the former Czechoslovakia and the most valuable parts of the collection gathered by the RIM Trnava. The Czech genebank will be responsible for the Czech maize collection.

A collection of maize genetic resources should be re-established in the Czech Republic in view of the safety-duplication programme and also because maize breeding takes place in the country. The growing area of maize in the Czech Republic is not negligible. Within the last five years, maize was cultivated for silage on 275 000-340 000 ha and grain maize occupied 26 000-34 000 ha.

Composition of the maize genetic resources collection

The seed samples maintained in the Czech genebank consist of 106 populations and local cultivars, 30 cultivars and 846 research materials (mostly lines). In total 982 samples are stored in the Czech genebank. Among them 627 accessions represent material of local origin. The accessions are kept as a part of the active collection. Seeds are dried down to 6-7% moisture content and maintained under a permanent temperature of $-5^{\circ}C$. The containers are glass jars with vapour-proof lids containing silica gel.

The maize database

The database is managed by our own user software – EVIGEZ, based on FoxPro 2.5 (DOS) – and is divided into three parts:

- passport data: up to 33 descriptors can be registered;
- characterization and evaluation data can be recorded for up to 110 descriptors using a 1 to 9 scale, according to the national descriptor list published in 1986;
- genebank management represents the third part of the database.

All three parts are linked mutually by the national accession number, the unique identification of the accession.

Passport data are available for 1402 accessions (1165 lines, 102 cultivars and 135 populations). All data are available from the database and selected passport descriptors were published in the *Catalogue of Crop Genetic Resources in Czech and Slovak Collections* - *Volume II* - *Other Crops* -*Prague, 1995*.

Evaluation data have been registered for 1352 accessions, but only selected characters have been evaluated according to the national maize descriptor list.

Maize genetic resources management in France

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Maize is one of the major crops in France with 3.3 million ha for grain and silage production. Its success is mainly due to the introduction of early hybrids at the beginning of the 1960s into new areas. Extension toward northern European regions is due to the very good forage value of maize silage and the high productivity of this crop. INRA played a very important role with the creation of the first early flint inbred lines from local populations: F2 and F7 originate from the Lacaune landrace. Private and cooperative breeding companies have developed this activity, and more than 25 of them are presently working to create the future new inbred lines and hybrids. Pro-Maïs is the major association of public and private maize breeders, where scientific exchanges are numerous and lead to collaboration in research programmes.

Local populations are no longer grown in France but were collected before extinction and stored as genetic resources to preserve genetic diversity and genetic progress for future agriculture. A cooperative programme focusing on these populations was developed, starting in 1983, between six INRA laboratories and most of the Pro-Maïs members, with the financial support of French ministries. This programme illustrates the importance of these resources for breeders, even if their utilization may be the result of a very long process. Two types of material can constitute genetic resources: populations (heterozygous status) managed by an INRA laboratory in Montpellier, and inbred lines (homozygous status) managed by several laboratories and institutions. Maize is not of European origin, so only *ex situ* conservation will be considered.

In the same time and as for other species of economic importance, a 'Charte Nationale des Ressources génétiques' is being elaborated in France to define the commitment of all partners – public institutions, private companies and associations – for the conservation of genetic resources. This charter intends to give a general and coherent framework, to help the research work on genetic resources and to develop the economical aspects and value of these materials. A specific charter will be specially dedicated to maize.

Population management

Temperate material

The programme carried out in France from 1983 to 1993 under the name Programme Populations Sources (PPS) is intended to conserve temperate populations and synthetics, to gain a better knowledge of this material and to enhance its value for breeders (Gallais *et al.* 1992). Out of 1236 accessions, 270 local landraces and 64 synthetics originated from France, others mainly from European countries.

Conservation. All populations are regenerated on the basis of 200 full-sib ears per population, in an annual programme. The participation of INRA laboratories and Pro-Maïs members allows the high total cost to be acceptable to everyone. J. Dallard (INRA, Montpellier) is the coordinator of this network. All accessions are kept in *ex situ* conditions. For long-term storage, a sample of 600 kernels is stored in a freezer at the INRA Station in Mauguio. For security, a second sample is stored elsewhere. For utilization, 10 samples are kept in a cold room at the INRA Station in Mauguio (5°C, about 40% RH). Recently, we improved the conditions of seed conservation to extend the term of conservation to 20-25 years and to reduce the cost of genetic resource conservation. Seeds are dehydrated to a relative humidity of the maize kernel close to 7% in special dehumidification equipment for 2 months. Seeds are stored in laminated aluminium foil packets containing 600 kernels.

The variability of temperate local populations and synthetics was studied on both the *per se* evaluation of agronomic traits and the analysis of isoenzymatic polymorphism. This study showed a large intrapopulation variability for these characters (Lavergne 1988; Lefort-Buson *et al.* 1991; Garnier-Géré 1992). However, the analysis of their hybrid combining ability on three complementary testers for grain production and on two complementary testers for silage production showed that these populations could not be easily classified into groups of specific combining ability (Lavergne *et al.* 1991; Garnier-Géré 1992; DGAP-INRA Groupe Maïs et Pro-Maïs 1994). Results and data collected on these populations for *per se* and combining ability have been recorded in a database only accessible to the members of the evaluation network.

To optimize the use of combining ability results on populations, 32 pools with a very large basis were developed on utilization criteria (earliness, combining ability, grain or silage utilization). Some pools contain only populations, other have been crossed with elite hybrids to improve their agronomic value, mainly for a better tolerance to lodging at harvest. Pools were evaluated for *per se* and combining ability values in a multilocal net. Eight pools were selected on both S_1 family and topcross progenies value during a recurrent cycle of selection and can be used as a new source of genetic variability by breeders. Results showed that a large intrapopulation variability may be difficult to use for the identification of some specific traits. Within the framework of a European programme, two pools were developed from populations having high ability value to produce semolinas of great size (hominy) and were crossed with inbred lines (Boyat *et al.* 1994).

Exotic material

Some exotic material has been studied for its usefulness to broaden the genetic variability of temperate maize germplasm in northwest Europe. Dosage effect between exotic and temperate material was studied. Even if estimates of genetic variance for earliness, height and yield traits were higher in a pool than in the pool x elite germplasm, the latter has a higher breeding value based on the predicted genotypic mean of the selected population. Estimation of the proportion of exotic material in the exotic x adapted crosses using isoenzymatic allele indicates no significant deviation due to the mild selection (Gouesnard *et al.* 1996). Nearly 100 populations from the Caribbean countries are also managed and stored in the cold room in Montpellier. Some of these materials are used to improve insect tolerance.

Core collection strategy

The PPS programme showed that management of a great number of accessions is an expensive and demanding task. Moreover, it is difficult to evaluate all these accessions each time a new problem is submitted to the breeders. So it becomes important to have a new strategy to manage genetic resources in several steps by means of a core collection**.** Such a collection is comprised of a limited number of accessions representative of the whole variability existing in the complete collection. For a researched new trait, the evaluation can first be done on the core collection. In a second step, the group from which one favourable identified accession is representative can be more deeply investigated. In the same way, regular regeneration of populations can be done only on the accessions of the core collection; the other accessions would be submitted to a long-term and low-cost conservation system.

A methodology for the development of a core collection is going to be developed based on local landrace populations originating from France. These 270 populations have been more precisely described than during the PPS programme with all the populations in two locations. Phenological, morphological and ecogeographic traits have been recorded to constitute a database to be used during the structuring and sampling phases of the constitution of the core collection. In the same time a new methodology has been developed to apply the RFLP technique of neutral nuclear polymorphism analysis to populations. The first results show a higher total diversity for RFLP in comparison with isoenzymes, and the similar population differentiation for isoenzymes and RFLP. However, RFLP proved clearly superior to isoenzymes to reveal a relevant genetic structure among populations (Dubreuil and Charcosset 1996). Using such a tool to evaluate genetic diversity would be a powerful way to use the strategy of maximization of allelic richness for the constitution of a core collection (Bataillon 1994; Brown and Schoen 1993).

Future developments

The situation observed in France on 270 local landraces can be easily extended to the 3000 populations of European Union countries. There is a general agreement to preserve genetic resources in the cheapest way and to have access to exchangeable resources from other countries. A European core collection would be a useful way to meet this general request. First, maize genetic resources would be preserved under the responsibility of each country to manage its own resources and not by a highly centralized management. This would also avoid the redundancy presently existing between the collections of the different countries. Efforts would focus on the accessions of the European core collections and exchanges would primarily deal with the core collection for a very specific demand. This approach could be extended easily to any new country wishing for access to the European core collection.

The major steps of such a European programme would be:

- To have descriptors of the populations in order to build up a common database for the 3000 or more European landraces; primary and secondary descriptors would have to be collected and recorded in the base.
- Passport, phenological and morphological data would be used by each country to define a restricted collection in the same way as a true core collection. This step can be done by each country on its own resources because of the good knowledge of this material by national breeders and because of the high total number of accessions. Indeed, it would be impossible to study all accessions in the same locations and avoid (genotype x environment) interaction. This restricted collection is necessary to reduce the number of accessions to about one-third, for the next step.
- A restricted collection would be studied for DNA neutral polymorphism by RFLP technique to reveal relevant genetic structure among populations and to build the European core collection on allelic richness.
- The European core collection would be evaluated for the criteria needed by the Common Agricultural Policy, in a common multilocal network.

Such a programme is being outlined by J. Dallard and will be submitted next month to the European Programme on the Conservation, Characterization, Collection and Utilization of Genetic Resources in Agriculture (RESGEN).

Inbred lines management

Numerous inbred lines are described in several databases in France:

- inbred lines produced and maintained by INRA laboratories;
- inbred lines exchanged with public research institutes all over the world;
- inbred lines from private breeders and foundation seed companies.

Out of the 4600 inbred lines described in French databases, only a few (about 20) are really accessible without restriction and can be considered as true genetic resources. For the others, an agreement on limited use is needed. For INRA inbred lines, Agri-Obtentions requires that the users acknowledge INRA as rights owner and that they agree:

- to use the material exclusively for research programmes;
- not to release it to anyone in France or abroad;
- not to reproduce it for commercial purposes.

Descriptors used for French populations

PASSPORT DATA

Accession number
Local/vernacular name
Country of collection
Location of collection site (*village*)
Latitude of collection site (*lambert coordinates*)
Longitude of collection site (*lambert coordinates*)
Altitude of collection
Date of last regeneration
Number of times accession regenerated
Number of plants used in regeneration

CHARACTERIZATION AND PRELIMINARY EVALUATION

Kernel colour *(specific code)*
Kernel type (*specific code*)
Number of kernel rows
1000-kernel weight
Days to silking
Ear height

FURTHER CHARACTERIZATION DATA

Cob colour (*specific code*)
Ear length
Ear diameter
Ear conicity
Tassel length
Tassel branching space
Number of primary branches
Number of secondary branches
Kernel length
Kernel width
Grain weight/ one ear
Cob weight
Ear weight
Tassel weight

If not otherwise specified, these decriptors use the standards recommended in the document *Descriptors for Maize* published by CIMMYT/IBPGR.

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The present situation of maize germplasm collections in Germany

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Two genebanks are established for germplasm conservation of maize in Germany, together holding 1300 accessions:

- The Genebank of the Institute for Plant Genetics and Crop Plant Research (IPK) in Gatersleben: 1273 accessions;
- The Genebank of the Institute of Crop Science, Federal Research Centre for Agriculture (FAL) in Braunschweig: 53 accessions.

These two genebanks keep mainly original or duplicate collections of landraces (local varieties) or advanced cultivars/hybrids from different countries. Passport data are available from both genebanks.

Besides these two centres the following organizations maintain maize germplasm:

- Institute of Plant Breeding, University of Höhenheim, Stuttgart;
- Institute for Tropical and Subtropical Agriculture, Witzenhausen;
- Bayrische Landesanstalt für Pflanzenbau, Universität Weihenstephan.

These institutions use their collections mainly for research or applied breeding. The germplasm conserved consists mostly of populations, composites, synthetics or inbred lines.

Several German landraces of maize were cultivated by farmers until hybrid seed was introduced, such as Chimgauer, Gelber Badischer Landmais, Pfarrkirchner or Schindelmeiser. The Gelber Badischer Landmais (GBL) is still on the national list of varieties and is also sold to farmers.

Although maize is a major crop in Germany (1.5 million ha), few activities have been undertaken so far to utilize the genebank accessions for applied breeding.

Besides the state institutes mentioned above, several national private seed companies have an active maize breeding programme where a wide range of breeding material is undergoing systematic improvement with the objective to create new competitive maize hybrids for the European maize-growing areas. Through these operations a wide range of the genetic variability in maize is planted annually in the breeding nurseries, but up to now very few collections from the German genebanks have been used for this breeding work because very little is known about their breeding value for modern breeding. This can only be corrected if much more prebreeding work is undertaken with the genebank collections and such data are made accessible to the current maize breeders.

Maize genetic resources in Greece

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In 1966 Professor Fasoulas stated that the Greek environment is not ideal for the cultivation of maize (Fasoulas and Senloglou 1966). Summer temperatures reach the upper limit and the rainfall is extremely insufficient. He concluded that irrigation was the only possibility for serious maize production in Greece. Around the same time double-cross hybrids became familiar to growers and the mean yield of the crop rose significantly for the first time, reaching about 4000 kg/ha in 1973 compared with the 800-2000 kg/ha for all accumulated years since 1930 (Fig. 1). The introduction of single-cross hybrids and the rapid development of irrigation systems in the Greek plains, together with modern cultivation practices, gave a second large impulse to maize culture about 10 years later. Grain maize production increased four times by doubling yields and acreage within 5 years (1978-83).

For the next few years grain maize production in Greece was about 2 million t, with a high mean national yield slightly under 10 000 kg/ha. The production of forage maize of recent years is also notable. But Greece is still at the southern limits of the European 'corn belt' and the cost of corn production is high. Statistics of the last 2-3 years indicate that maize might meet problems in the future, due to high costs. Greek growers now prefer to cultivate cotton or sugarbeet in the plains instead of corn.

The need for high production and the *ex officio* action of the farmers resulted in the rapid replacement of the old landraces traditionally cultivated in Greece by the highly productive American dent corn hybrids. This material is full-season (130-150 days from planting to physiological maturity) and exploits effectively the long growing season. The old races were dropped because of their low productivity (most of them were of flint type) and shorter growth period. Attempts to rescue this material started in the mid-1960s. Collections were made by the Cereal Institute of Thessaloniki and by the Gene Bank which was founded later and established at the same location. The major part of the collections of both institutes because it constitutes a source for new hybrids.

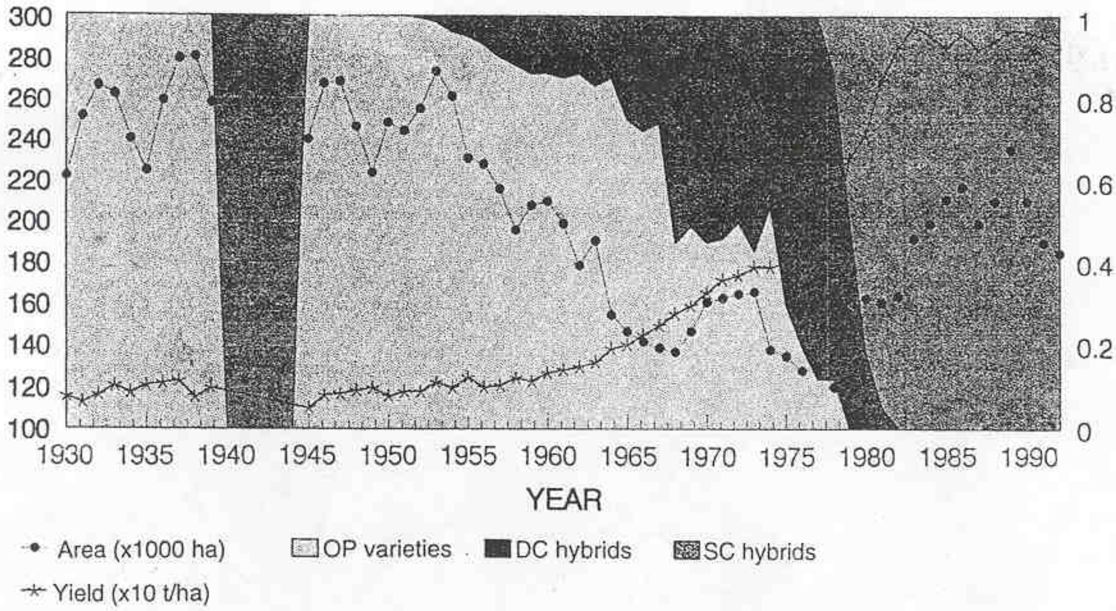

Fig. 1. Trends in production area and mean yield/ha, 1930-92.

Fig. 1. Trends in production area and mean yield/ha, 1930-92.

Table 1. Maize landraces in storage.

	Gene Bank	Cereal Institute	Total
Greek landraces	184	71	255
Foreign landraces	110	73	183
Total	294	144	438

Information about Greek landraces is lacking. According to Trifunovic (1978) corn was first cultivated in the year 1576 in the Ionian Islands and from there spread to the Balkan Peninsula. We can be sure that in the following centuries many races were imported from different countries, mainly by seamen. For example the name *arabositos,* which predominates today for corn, means “wheat from the Arabs” and perhaps indicates some importation from the Near East (Syria, Egypt, etc.). Of course the importation of corn from America came first. Therefore we can assume that interracial hybridization must have taken place in the Balkans.

Mangelsdorf (1952) says that interracial hybridization has been an important factor in the evolution of maize. This is because natural selection operating in a man-made environment tended to preserve the heterozygote and to eliminate the segregates which approach homozygosity. Thus maize under domestication is potentially, and no doubt actually, a self-improving plant. He concluded that distinct, more or less stable varieties or races evolve in the isolation of separated regions. Taking into account that these landraces were grown for many years under various stresses, such as drought conditions, low nitrogen input, weed and insect competition, we may find in that kind of collection an abundant source for tolerance to environmental stresses. This will be particularly useful now, because of the trend for sustainable agriculture.

The way to achieve this aim is not so easy. First these materials must be characterized; then the known (or new?) race to which they belong must be identified. This work is important for reducing collections as much as possible and making the procedure easier for the following stages of evaluation and exploitation of materials. A lot of work has to be done in Greece and it will take many years, but we are sure that it is worth trying.

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Current status of maize collections and genetic resources in Italy

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Maize is the most important crop in Italy with an acreage of 1.2 million ha for grain and silage production. The largest corn area (80% of the total) is located in the Po Valley, in alluvial soils and irrigated lands. The environmental conditions of this area are very favourable to maize growth: 45° latitude N; 2800°F GDD (growing degree-days); growing season from April to October; average rainfall 600-1200 mm; excellent or good irrigation water availability; excellent or good soil fertility; high air humidity. Drought stress and virus pressure are the main factors controlling yield stability.

High-input crop management is adopted for soil tillage, irrigation, fertilizer, herbicides, mechanical equipment and drying machines. The average yield is currently about 10 t/ha and is still improving. The modern single-cross hybrids, their fast replacement and genetic improvement play the most important role in this scenario.

The 6/700 FAO maturity class hybrids (70% of the total acreage) are the full-season materials for Italian environment. Medium season 5-400 FAO class hybrids (25% of the market share) are adopted in areas subject to drought stress and in cool pre-alpine high plains; early materials find some use in second crop or in marginal soils.

The basic germplasm of the hybrids currently grown in Italy does not differ from US Corn Belt hybrids and US ancestral varieties; genetic contribution from local-European or 'exotic' germplasm is very limited.

Hybrid seed replaced the local varieties between 1948 and 1960. During this period a lot of landraces or improved populations were collected before extinction.

Italian collections

There is no coordinated programme for maize genetic resources in Italy. The main maize germplasm collection is stored at the Experimental Institute for Cereal Research, Maize Station of Bergamo.

The Germplasm Institute (Istituto del Germoplasma) of the National Research Council (Consiglio Nazionale del Germoplasma, CNR) located in Bari, with specific responsibilities and mission for *Triticum* spp. and plant germplasm of interest to Mediterranean agriculture, stores some 600 maize landraces from collecting missions in the Mediterranean area.

The following institutions belonging to the University or to the district government also hold small collections including local varieties, landraces and research materials:

- Institute of Plant Breeding and Agriculture Research "N. Strampelli"- Lonigo;
- Department of Botany and Genetics, University of Piacenza;
- Department of Plant Breeding, University of Bologna;
- Ente di Sviluppo Agricolo per il Friuli-Venezia Giulia.

Summary of the accessions.

Type	Origin	No. of accessions
Inbreds	Italian from Bergamo	
	recent	207
	from open-pollinated varieties	346
	from other crosses	276
	Italian from other institutes	125
	From USA and others	
	yellow	1400
	white	190
	sweet corn	17
	popcorn	25
	waxy	4
	o2 converted	114
	fl2 converted	19
	ms converted	107
	bm3 converted	10
	Rp converted	5
	Ht converted	52
	su2 converted	6
Synthetics and genepools	Italian from Bergamo	61
	Italian from other institutes	19
	Other introduced	178
Varieties and populations	Italian	620
	Other European and Mediteranean	422
	USA and others	117

Establishment of a new programme for maize genetic resources in Italy

Currently Italy does not have a specific project, properly funded, for maize genetic resources conservation and management. Therefore it is now imperative:

- in a first step, to establish a specific mission, and to regenerate all materials urgently, setting a short-term workplan (2 years) and using summer and winter generations;
- in a second step, to restore the basic conditions of a working genebank or germplasm collection, according to international networks recommendations regarding passport and primary characterization, database and exchange format, regeneration routine and procedures, proper seed conservation and storage;
- for the next steps, we believe that a more user-oriented (i.e. breeder-oriented) profile of germplasm management must be considered. Efforts could focus on:
  - secondary characterization for agronomic traits;
  - variability structure and core collection;
  - prebreeding profile, such as combining ability, genetic distance, relevant traits or genes as sources for breeding purposes.

Besides looking at the practical experience in plant breeding, we believe that a specific activity called **germplasm enhancement** will be encouraged with the mission to create intermediate products (first-cycle material) between germplasm and the elite adapted material currently in the fields.

Current status of the CGN maize collection

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The collection

Status

Zea mays (maize): working collection priority 2

Curators: Loek J.M. van Soest and Harm Dijkstra

The collection originated from the former Foundation for Agricultural Plant Breeding (SVP). The original collection of approximately 1000 accessions was rationalized excluding hybrids (90), inbred lines (140) and material received from other genebanks including CIMMYT, Mexico and the Institute for Agrobotany, Tapiószele, Hungary. The maize collection has the status of a working collection in the CGN system and receives less emphasis in the genetic resources activities. Detailed information on the collection has been published by van Soest and Boukema (1995).

Composition of the collection

The collection includes only material of species *Zea mays* and consists of 488 accessions. The origins and number of accessions according to population type are presented in Table 1. Nearly 60% of the accessions are landraces including the 179 accessions collected during the Pakistan expeditions in 1976 and 1981 (Hashmi *et al.* 1981). This material is rather unique and probably only duplicated in the genebank at Islamabad, Pakistan. The value of this material for maize cultivation in northwest Europe is limited, because of its late flowering and subsequent late maturity. The number of cultivars and research material is rather low (Table 1).

Maize was an important crop in the Netherlands before the last world war, but only two Dutch cultivars; Baanbreker (1941) and Noordlander (1938), are found in the collection. VC 150 is the only Dutch landrace in the collection. Most likely it originated from an old landrace of the province, Gelderland. Goudster (1952) and Foliant (1953) are developed from inbred lines from the old landrace Van Platte Mais. The 42 landraces from Portugal have been collected in the mountains and were previously used in a breeding programme for cold tolerance. The French landraces are from different localities, mainly in the southern parts of France including the Pyrénées.

Regeneration and characterization

In general each accession is rejuvenated by collecting ears of at least 100 plants. Seeds are directly drilled in April in the field. During April and May, the maize seedlings are covered with a plastic layer to stimulate early growth. The distance between the rows is 75 cm and after thinning, the between-plant distance is 25 cm. Pollination is conducted by hand, in general crossings between neighbouring plants. The crossing system used results in at least 100 crosses within each accession. After pollination the ears are wrapped in paper bags. Around October, 100 ears of each population are collected and threshed during the winter. All 488 accessions have been regenerated and are available to potential users.

During the growing season and after the harvest the accessions are characterized for a set of 15 agromorphological traits. For this purpose CGN developed its own minimal descriptor list with the advice of private breeding firms in the Netherlands. A list with the set of characters and the number of accessions characterized is presented in Table 2. The collection has not yet been evaluated for pests and diseases or quality traits.

Table 1. Origin of the *Zea mays* accessions according to population type.

Origin[†]	**Landraces**	**Cultivars**	**Research material**	**Unknown**	**Total**
Europe	**83**	**10**	**3**	**46**	**142**
The Netherlands	1	5	–	10	16
Portugal	42	–	–	1	43
Russia	18	–	–	8	26
France	9	–	2	5	16
West + South Europe (DEU, ESP, GRC, ITA, YUG)	12	3	1	17	33
Central + East Europe (AUT, CSK, HUN, ROM)	1	2	–	5	8
North America	**21**	**1**	**8**	**55**	**85**
USA	11	1	5	23	40
Canada	8	–	3	7	18
Mexico	2	–	–	25	27
South America (BLV, PER)	**1**	**–**	–	**3**	**4**
Africa (ETH)	**1**	–	–	–	**1**
Asia	**179**	–	–	**14**	**193**
Pakistan	179	–	–	9	188
Rest (JPN, ISR, TUR)	–	–	–	5	5
Unknown		**2**	**8**	**53**	**63**
Total	**285**	**13**	**19**	**171**	**488**

[†] Country codes according to FAO.

Table 2. Characterization of maize collection.

Character	**Number**	**Scale**
100-kernel weight	443	numeric
Root lodging susceptibility	153	1-3-5-7-9
Kernel rows per ear	414	numeric
Plant height	379	numeric
Endosperm colour	415	1-2-3-4-5-6
Ear: day to silk (50% of plants)	326	numeric
Ear height	378	numeric
Number of ears per plant	13	numeric
Ear length	414	numeric
Kernel type	415	symbols
Tillering per plant	262	numeric
Ear: shape	415	1-2-3
Kernel-pericarp colour	415	1-2-3
Ear: diameter	415	numeric
Silks: anthocyanin colouration of	93	1-3-5-7-9
Total number of characterized traits	5075	

Documentation

The accessions are documented for passport data in GENIS (**GE**netic Resources **I**nformation **S**ystem), the data information system of CGN (van Hintum 1989). As shown in Table 1 the country of origin of 63 accessions and the population type of 171 accessions is not known.

The 5075 characterization data of the 15 agromorphological traits (Table 2) are included in GENIS and can be made available to potential users.

Seed storage management

All seed-processing and storage facilities meet internationally recognized standards. The collection is stored in a cooler compartment at 4°C (medium-term storage) and in a deep-freeze compartment at –20°C (long-term storage). Dried seeds are stored in laminated aluminium foil bags.

Utilization

Since 1987 only 73 accessions have been distributed to a limited number of users. CGN supplies 100 seeds of each accession.

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General report on maize collections in Poland

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Maize is a crop with great adaptability and variability. This plant is an important crop in Poland as a grain and silage for cattle feeding, although the country is not typical for maize growing.

Maize was introduced to Poland in the 18th century from the Balkans. Before the Second World War it was grown in the southeastern part of the country where climatic conditions were suitable.

After the Second World War when part of the Nation was moved from east to west, farmers also moved local maize populations to the new regions. Part of that material was lost under the circumstances. Only a small part of it was collected in a proper way by breeders. The biggest amount of local populations was found in the village Wawrzenczyce near Krakow. This material was described and used as a source of genes for breeding.

In the breeding programme we use different germplasm and divide maize resources into the following categories:

- native open-pollinated populations, flint and dent type;
- improved open-pollinated populations introduced in the early 1930s from the USA;
- direct introduction and adaptation of US germplasm after the Second World War;
- hybrids containing some US and European germplasm;
- synthetics developed by breeders;
- material developed from programme Early by Late.

More than 85% of the hybrids released by the Polish national programme in the last decade contain our germplasm.

Our collection contains hundreds of accessions. The number of accessions held in short- and long-term storage is presented in Table 1. During the last decade we replied to a number of seed requests for these accessions, distributing a number of samples to different countries (Table 2). This germplasm was requested for numerous purposes ranging from breeding and evaluation to very basic research.

This germplasm is kept in two storage chambers: one for long-term storage in IHAR Radzików and the other for short-term storage at Smolice.

Table 1. Sources of accessions of maize germplasm (Maize collection, Smolice 1986-96).

Country	No. of accessions	Country	No. of accessions
Albania	25	Poland	280
Canada	46	Romania	2
Germany	28	Spain	1
France	43	Switzerland	10
Hungary	16	Czechoslovakia	53
Great Britain	1	USSR	50
China	1	USA	58
Japan	5		
The Netherlands	16	**Total**	**635**

Table 2. Distribution of maize accessions (Maize collection, Smolice 1986-96).

Country	Populations	Inbreds	Total
Bulgaria	15	35	50
Czechoslovakia	3	25	28
Germany	–	36	36
France	3	12	15
Hungary	4	10	14
India	–	20	20
Iraq	27	128	155
Japan	–	16	16
Thailand	4	6	10
The Netherlands	–	16	16
North Korea	30	160	190
USA	12	33	45
USSR	10	145	155
Yugoslavia	–	4	4
Total	**108**	**646**	**754**

It is necessary to regenerate the accessions to meet the seed requests because of the relatively low number of seeds kept in storage and the poor germination of seed after long-term storage. The accessions to be regenerated are chosen according to the age, quality and viability of seeds.

Several approaches are taken in this work including early vigour, resistance to lodging, *Fusarium* sp. and estimation of yielding ability (Tables 3, 4, 5).

Table 3. Frequency of resistance to root lodging among 451 maize accessions (Maize collection, Smolice 1986-96).

Resistance rating 1-9[†]	No. of accessions	Percentage of resistant accessions
9	5	1.1
8	0	0
7	1	0.2
6	8	1.8
5	16	3.5
4	28	6.2
3	31	6.9
2	81	18.0
1	281	62.3
Total	**451**	**100.0**

[†] 9 = highly susceptible, 1 = highly resistant.

Table 4. Number and percentage of accessions resistant to *Fusarium* sp. (Maize collection, Smolice 1986-96).

Resistance rating 1-9[†]	No. of accessions	Percentage of resistant accessions
9	33	7.3
8	39	8.7
7	40	8.7
6	64	14.2
5	91	20.2
4	70	15.5
3	49	10.9
2	35	7.8
1	30	6.7

Table 5. Evaluation of yielding ability of maize accessions: testers and number of accessions in particular groups (Maize collection, Smolice 1986-96).

Yield (% of standard LG 5)	S 152	S 205	S 206	F2	Co 255	Total
< 70	–	1	2	8	3	14
71 -80	1	–	1	9	3	14
81 -90	6	7	4	7	6	30
91 - 100	4	6	3	5	6	24
101 - 110	–	4	3	7	7	21
111 - 120	2	5	1	4	3	15
121 - 130	1	–	–	5	12	18
> 130	–	1	–	–	1	2
Total	**14**	**24**	**14**	**45**	**41**	**138**

One of our important tasks is the estimation of genetic diversity and relationships by isoenzyme polymorphism studies. Each species could be unambiguously distinguished by the number of isoenzymes present in the set of the enzyme system analyzed. Since the isoenzyme number is generally believed to be highly conserved in plant, we were surprised to find so much variation within a small group of maize lines (Figs. 1, 2). Therefore we were particularly interested in determining isoenzymes in different inbred lines and we tried to obtain additional information regarding the origin and similarity and/or diversity of maize lines. The main task is to build a detailed catalogue of inbred lines developed at IHAR. The following enzymes were included in the analysis: Alcohol-dehydrogenase (ADH), Malate-dehydrogenase (MDH), Isocitrate-dehydrogenase (IDH), Glutaminate-dehydrogenase (GDH), Acid-phosphate (ACPH), Esterase (EST) and proteins (P).

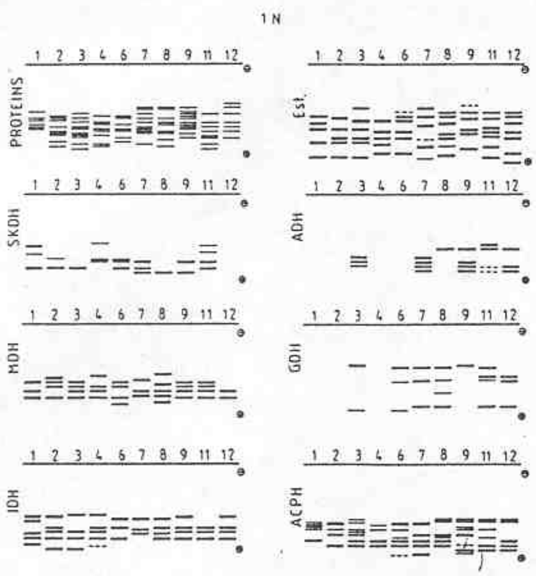

Fig. 1. Comparison of isoenzymes of maize inbred lines in pollen grain. The sequence of accessions: 1-F2, 2-Co255, 3-F113, 4-S151, 5-S152, 6-S195, 7-S210, 8-S215, 9-S132, 10-S146, 11-S247, 12-S311.

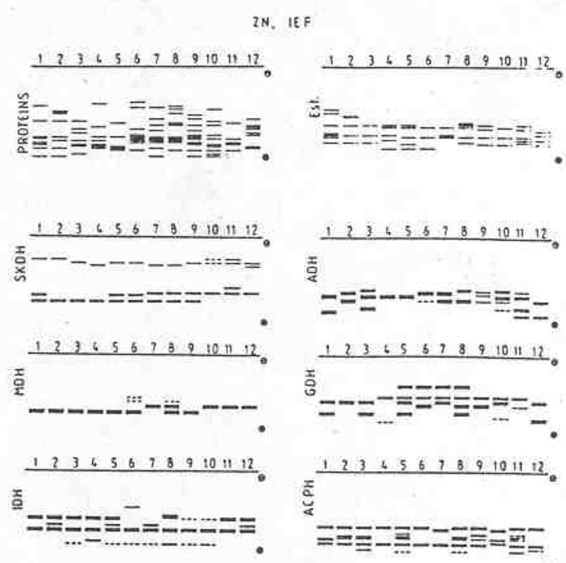

Fig. 2. Comparison of isoenzymes of maize inbred lines in seedling. The sequence of accessions: 1-F2, 2-Co255, 3-F113, 4-S151, 5-S152, 6-S195, 7-S210, 8-S215, 9-S132, 10-S146, 11-S247, 12-S311.

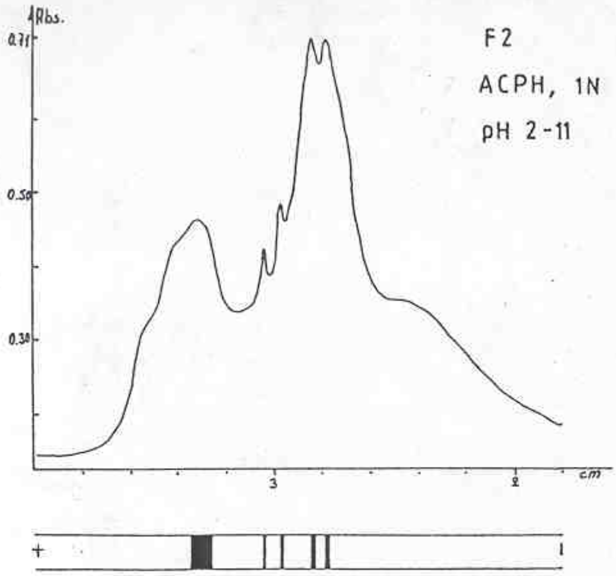

Fig. 3. Laser densitogram of an ACPH (1n) inbred F2.

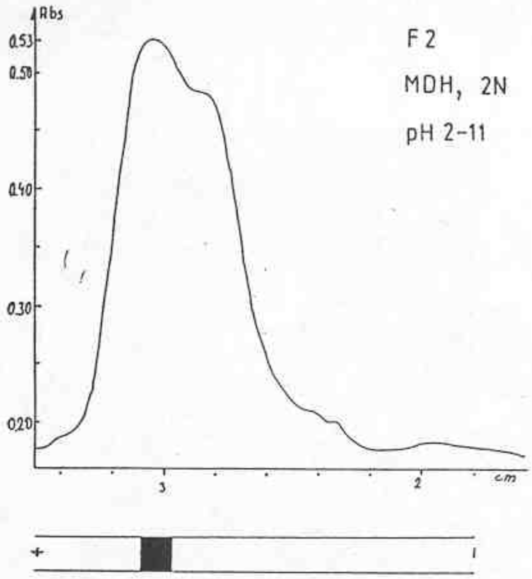

Fig. 4. Laser densitogram of an ACPH (2n) inbred F2.

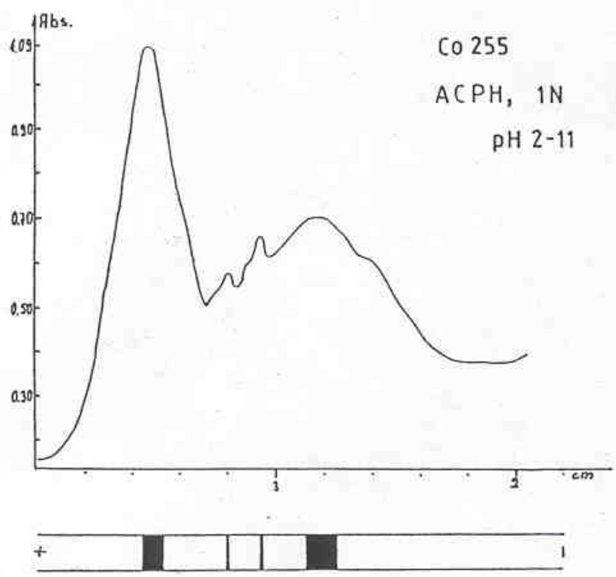

Fig. 5. Laser densitogram of an ACPH (1n) inbred Co255.

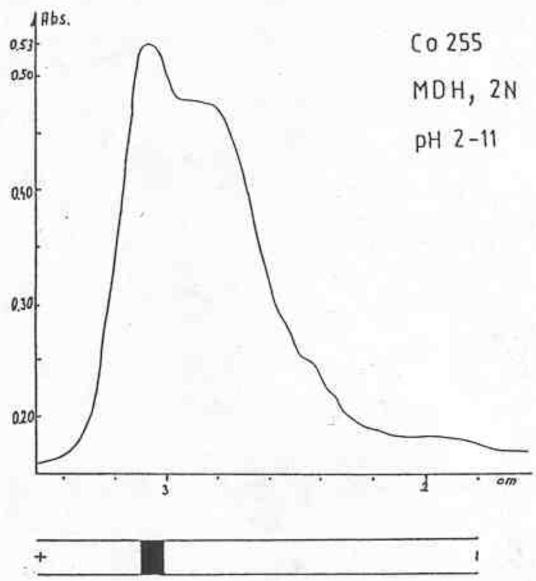

Fig. 6. Laser densitogram of an ACPH (2n) inbred Co255.

As an example I would like to present the results obtained for the standard line F2 and another line. Some important isoenzymes were included in the analysis. All comparisons were made within the samples run on the same gel. Indistinguishable bands were scored as identical.

The intensities of isoenzyme bands were evaluated by LKB Ultrascan laser densitometer. The comparison of densitogram curves (Figs. 3, 4, 5, 6) shows significant differences among accessions. This method is suitable for developing a true catalogue of inbred lines.

One- and two-dimensional analyses of proteins are frequently used for the determination of genetic diversity of accessions. This method was applied for analysis in pollen grains and seedlings of maize accessions. In inbred lines the characteristic spectra of soluble proteins for pollen and for seedling were observed. Each line has its own specific spots picture and its number was different from particular lines.

Maize genetic resources in Portugal

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Introduction

Maize was introduced in Portugal after Columbus and became a traditional crop responsible for the agricultural revolution of the 16th and 17th centuries in the Portuguese northwest. This region is particularly mountainous, with some good pieces of flat land along the valleys, but most of the farmlands follow the sources of water. For centuries farmers selected the best adapted landraces and built up an agricultural polycropping system which, besides a set of minor crops, was composed of two major components: maize (bread) and vineyards (wine).

Since 1975, the Portuguese Plant Germplasm Bank (BPGV) has been carrying out systematic germplasm collecting and was able to save most of the Portuguese landraces of maize, together with the other minor components of the traditional agricultural systems. This proved to be providential. In fact, during the last 20 years, a tremendous genetic erosion took place that can be summarized in the following table:

Evolution of maize germplasm utilization during the last 20 years in Portugal.

Year	% of landraces used by farmers	% of hybrids used by farmers
1975	90	10
1985	80	20
1995	30	70

Together with this genetic erosion, both in maize and other related crops, a considerable drop in maize area has occurred: from 350 000 ha in 1975 to 250 000 ha in 1996. In this same time, we went from a position of producing 50% of our food needs in 1975 to only 25% in 1996.

The reason for this big transformation is found in the Community Agricultural Policy (CAP) which has been focusing in a productivist model of monocropping, highly mechanized agriculture. In fact this political strategy almost destroyed the traditional Portuguese agricultural polycropping systems and put out of business 500 000 small farmers in these past 10 years. This transformation in a small country with 10 million people gave rise to a set of hard consequences:

- a strong genetic erosion, not only in maize, but also in all related crops, as well as a set of diversified horticultural plants;
- a serious social problem with the movement of rural families to the sea border, looking for jobs and shelter in the big cities and thus creating a national housing problem;
- an environmental disruption, since the farmer was himself a component of the ecological equilibrium making the balance between the forest and the farming fields;
- a national problem of forest fires each summer with growing financial support going to the building up of a small army of firemen, together with their physical structures and professional means.

It is our opinion that the CAP policy suffers from a philosophical handicap of not understanding the role of small farmers in a place like the Portuguese northwest. It does not recognize that this type of farmer combines four activities, all of them in favour of general society: food producer, genetic resources curator, environmental protector and forest fireman. And since the CAP and the society in general do not recognize this specificity, the farmer has been paid only as a food producer and as such, cannot compete with the best arable soils down in the valley. So he has been pushed into bankruptcy.

The genetic resources issue in Portugal

Portugal still does not have a formal national programme for genetic resources. Its resources are evenly distributed by an array of public and private institutions. However, most of its *ex situ* genetic resources are located at Braga, stored in the Portuguese Plant Germplasm Bank (BPGV) which is a public institution belonging to the regional services (DRAEDM) of the Ministry of Agriculture.

The BPGV was born in the 1970s within the maize breeding station (NUMI) and since then grew to its present status of major germplasm bank of the country. Together with maize, BPGV brought to its attention all cultivated crops, aromatic and medicinal plants and is still expanding the range of crops with total accessions of 11 212 covering 80 species. Regarding maize and in its duty of ‘IPGRI Maize Germplasm Bank for the Mediterranean Region’, the BPGV holds the following collection:

Landraces	1740 (1166 landraces already have been characterized)
From Morocco	172
From Yemen	43
From Portugal	1525
Breeding materials and inbred lines	4526
Genepools	366
Total	6632

It is expected that early this summer the new building facilities of the BPGV will be inaugurated and among a set of laboratories equipped with modern technologies for both conservation and evaluation, it will house:

- a 120 m^3 cold-storage room for long storage conservation at –20ºC, and
- a 60 m^3 cold-storage room for medium-term conservation ranging from –2 to 10ºC.

The same building will house, in independent structures, the maize breeding station (NUMI) which will have for its own service two extra cold storage rooms of 60 m^3 each, for medium-term conservation at 4ºC.

Three catalogues with the data of 900 accessions already characterized will be issued and distributed this summer.

Our collaborative experience

Since its very beginning BPGV has been working side by side with the maize breeding programme. All the collaborative experience of NUMI/BPGV supports the idea that conservation and breeding should work together, if possible side by side in a place where breeders and curators can continuously discuss their own specific problems and tasks.

From this experience, some populations received as accessions at the BPGV were immediately chosen by the breeders to undergo population improvement and were put at the farmers’ disposal for production under the form of improved pollinated varieties. In the same way, the discussion of the descriptors has been a permanent issue stressing the two main descriptors breeders want most and that are still missing: inbreeding depression and combining ability.

To fill this gap between conservation and utilization, that is to say between curators and breeders, we want to stress the urgency of building up a prebreeding programme which should consider:

- germplasm enhancement
- preliminary evaluation under a breeder's point of view
- the need for developing a new and, if possible, easily implemented methodology for a first prebreeding approach.

It is our aim to keep going in the direction of filling up this gap between **conservation** and **utilization**, keeping in mind that **breeding** is the natural bridge between them and that the real utilization is that by farmers and / or industry.

We consider that this effort is not only useful and necessary for the economic use of genetic resources, but also for the support of the germplasm banks themselves.

The Romanian maize collection

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The national maize collection of Romania comprises a total of 11 239 accessions distributed as follows:

- 3188 accessions held by the Suceava Genebank;
- 8051 accessions held by six other institutions.

The composition of the maize germplasm collection is: for indigenous cultivars, a total of 8079 accessions consisting of 3550 landraces, 1587 hybrids, 2759 inbred lines, 26 breeds, 80 mutants and 77 synthetics.

The introduced cultivars consist of 3160 accessions including 103 old forms, 40 hybrids, 2790 inbred lines, 4 breeds, 35 mutants, 50 synthetics and 138 other forms.

Although several institutions in Romania hold a large amount of maize germplasm, only the Suceava Genebank assures the conservation of germplasm up to the recommended standard, namely in medium-term storage (for the time being). The other institutions have mainly field collections.

The main purpose of these collections is to preserve material for breeding use.

The maize germplasm, as part of these collections, is evaluated using standardized descriptors. Being breeders, many maize collections holders are interested only in certain characters and then they do not use some of these descriptors. The Suceava Genebank is the only institution in Romania which has as objectives the collecting, evaluation and conservation of plant genetic resources. For maize germplasm evaluation the whole descriptors system provided by IPGRI is used at Suceava.

Since 1989 the Romanian agricultural research institutes and stations have computerized the documentation of their collections using microcomputers and adequate softwares.

At Suceava Genebank the information system is grafted onto the old system keeping the documentation specific to each activity in the bank. The new information system was designed to coexist with the traditions of the old system, that cannot be ignored. Since 1992 the Genebank Computing Office is equipped with an AT286 microcomputer and a matrix printer. The data of our collection are stored in a database using a programme package SIRAG, created with FoxPro.

The information concerning the preserved genetic material is divided into three groups: passport data, conservation data and characterization / evaluation data.

In Romania, at the national level, 50% of maize accessions are entered into the database with passport and conservation data. For Suceava Genebank, more than 90% of this work is complete. While the material is being studied characterization / evaluation data are entered. Completion of these data, both for the Genebank and for the other institutions, is below 50%.

Collections of maize landraces in Spain

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Maize was first cultivated in Spain immediately after the second trip of Columbus (Brandolini 1969). Following that time, several maize types from different locations in America were introduced into many different regions in Europe. Nevertheless, a unique species, *Zea mays* L., has been widely cultivated throughout Europe. Diversification of maize has become very large in the world during the long period of cultivation. The diversification likely occurred because of (a) the different origin of the introductions, (b) the selective pressure of environments where maize has been cultivated, (c) the growing conditions and techniques utilized in the different regions of Europe, (d) the screening criteria of farmers to choose maize types for distinct purposes and (e) the active trade and exchange of maize seed, which favoured intercrossing and recombination.

Although maize has been cultivated in Spain from the beginning of the 16th century, the crop was not spread over all regions until some years later. For example, maize was not regularly grown in Galicia, the northwest of Spain, until the second half of the 17th century (Perez-Garcia 1982). From that time onwards, the traditional summer cereal crop of the region, millet (*Panicum miliaceum* L.), and also other winter cereals were progressively replaced as maize cultivation extended from the coast to the inland and highland areas, following the rivers. The speed with which maize was extended was fastest in the coastal areas and slower as it moved to areas 400 m asl (Perez-Garcia 1982). Table 1 gives cultivation data based on records of rural churches and monasteries.

Maize hybrids have been adopted extensively in South and Central Spain since the 1950s, but their adoption occurred in the north much later. Even now, about 30% of the maize-growing area of Galicia is still cultivated with local varieties. The limitations of cold temperatures in the area and the small holdings fragmented into many smaller plots might be responsible for the delay in adopting new technology and extending the area of cultivation for maize hybrids. The progressive substitution of the local varieties risks their definitive extinction. Therefore, it is necessary to carry out actions for conserving the old landraces with the double purpose of (a) avoiding the loss of a rich and variable germplasm which otherwise might cause the so-called 'genetic erosion', and (b) being able to incorporate this germplasm into active breeding programmes as sources of specific traits, e.g. early vigour, cold, drought and pest tolerance, disease resistance, specific fatty acid and starch components.

Table 1. Distribution (%) of the cropping area of cereals in northwest Spain (Galicia) before and after the introduction of the maize crop (adapted from Perez-Garcia 1982).

	Before maize introduction				**After maize introduction**				
Region	**Years**	**Wheat**	**Rye**	**Millet**	**Years**	**Wheat**	**Rye**	**Millet**	**Maize**
Coast	1600-29	17	49	34	1660-69	9	21	14	55
Midland	1600-29	12	41	45	1650-59	15	23	16	45
Highland	1630-69	10	78	12	1780-97	16	62	12	9

Surveys and collections of maize for breeding purposes started in northern Spain in the late 1920s. Collections for conservation and variability studies started later, in the 1950s.

The following collections are worth mentioning:

First classification of maize races in Spain

The work carried out by Professor Sanchez-Monge (1962) is a very complete and accurate study in which 462 accessions from all over Spain were analyzed. Seventeen races of maize for grain and three for popcorn were identified. In addition, 32 more groups that included intermediate characteristics between the main races also were identified as subraces. Characterization was based on some morphological traits of the plant, ear, cob, kernel and tassel, and on counting the number of chromosome knobs.

Accessions belonging to the same group were recombined to form a collection of 49 races and subraces. This collection is conserved in the Spanish Centre of Genetic Resources (CRF), Alcalá (Madrid) and in the germplasm bank of the Mision Bilógica de Galicia (MBG) at Pontevedra. The method of conservation was hand-pollination with at least 200 plants. Some inbred lines were derived from this material (e.g. EC21 from the Gallego race).

Germplasm bank of the MBG at Pontevedra

The MBG is a breeding station which has been working on maize since the late 1920s. Two periods can be distinguished in this station: (1) since its creation until the early 1960s, when the introduction of maize accessions came mainly from North Spain, but also from North America, e.g. the Longfellow landrace. Reputed early inbreds such as the EP1 were derived from northern Spanish early material. Part of the material from this time was lost; (2) the second period extends since the early 1970s until now. New accessions have been collected mainly in Galicia, but also have been introduced from other parts of Spain and North American Universities.

Some 420 accessions are presently conserved in cold storage at 0-4ºC and 45-55% relative humidity; 220 out of the 420 were collected in Galicia. Characterization of part of this material based on morphological data of plants and ears was carried out by Ron and Ordas (1987) and Ordas *et al.* (1994).

Germplasm bank of the CIAM at La Coruña

The Centro de Investigaciones Agrarias de Mabegondo (CIAM) collected maize local varieties from the north of Spain (Galicia, Asturias, Cantabria and the Basque Country) in the 1970s and 1980s. More than 95% of the accessions were of the flint endosperm type. Several inbred lines have been developed from this material and are presently used in an active breeding programme. Crossing of the flint germplasm from North Spain by dent endosperm types from the US Corn Belt has shown a high level of heterosis (Moreno-González 1988a, 1988b). Two expeditions (1977 and 1982) to collect accessions in the region were partially funded by the IBPGR/FAO. Duplicated accessions collected in these expeditions were sent to the germplasm bank in Bari and the CRF at Madrid. A representative sample of the CIAM collection composed of 86 local varieties was studied to (1) assess the genetic variability, (2) define a morphological system of classification and (3) establish relationships between the classification groups and the climatic conditions of the area from which the varieties were collected. Morphological and isoenzyme traits were used for the characterization and grouping of the varieties (Llauradó and Moreno-González 1993; Llauradó *et al.* 1993). Populations were grouped by the degree of dissimilarity into four distinct subracial groups related to four geographically and climatically defined areas. Three levels of discrimination based on morphological traits were found to separate the populations. Level 1 included earliness and plant size, level 2 ear traits and level 3 tassel traits.

Some 750 accessions are conserved in cold storage at 0-4ºC and 45-55% relative humidity. Out of the 750, 650 are local varieties collected in Spain. Regeneration of some populations with low viability is in progress. Additionally, recording of secondary morphological characterization traits has been made in several populations.

Centre of Genetic Resources

The Centre of Genetic Resources (CRF) located at Alcalá de Henares (Madrid) is the National Gene Bank of Spain. More than 21 000 accessions from 83 different species are conserved in the Bank. The cereal group includes 8600 accessions belonging to 19 species, *Zea mays* being the cereal with the highest number of accessions (1320). Out of these 1320 samples, 1020 are Spanish local varieties, 45 were collected in Portugal, and the remainder came from other parts. Regeneration of these samples is carried out when seed viability is low. The active collection is kept in a cold chamber at –2 to –4ºC and 45% relative humidity. Some of the samples are duplicates from those stored in the regional seed banks, especially from the CIAM bank and the Servicio de Investigaciones Agrarias de la Comunidad de Madrid (SIACM).

Centre of 'Aula Dei'

This Centre is located at Zaragoza and stores in cold chamber about 800 landraces, out of which 750 were sampled from different regions of Spain along many years. Characterization studies based on morphological data have been carried out in the group of populations from Cantabria (Alvarez and Lasa 1990a, 1990b) and the Basque Country (Ruiz de Galarreta and Alvarez 1990). Presently, landraces with low seed viability are being multiplied.

National Coordination Project on Maize Genetic Germplasm

A National Coordination Project which includes the abovementioned collections is presently being carried out in Spain. The main objectives are (1) to inventory all national accessions and to introduce the passport and primary characterization descriptors in a database, such as Excel, in order to identify duplicates, (2) to regenerate those accessions with low seed viability, (3) to characterize maize samples based on secondary morphological and important agronomic traits, and (4) to establish dissimilarity groups in order to form a core collection in each of the specific collections of CIAM, MBG and AD.

Table 2. Situation of the maize collections in Spain conserved in cold chambers at –4 to 4ºC.

Collection	Accessions	Local varieties	Passport†	Primary characterization	Secondary characterization
Races	49	49	49 (0)	49	0
MBG	420	220	420 (200)	220	100
CIAM	750	650	650 (180)	650	250
CRF	1320	1020	1020 (1020)	0	0
AD	800	750	750 (200)	750	100

† Number in parenthesis refers to computerized data.

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Genetic resources of maize (*Zea mays* L.) in Slovakia

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Introduction

The history of the collection of genetic resources of maize in Czechoslovakia (regional populations and varieties) started in the Plant Production Research Institute (PPRI) at Pieštany. A group of PPRI workers had collected regional populations with the help of agricultural schools and training centres.

After the foundation of the Maize Research Institute in Trnava in 1962, the seed material of regional populations was transferred there. Each sample was registered, numbered and the grower's precise address recorded. The study of the collected seed material of regional populations was carried out in a research programme. After a 3-year evaluation in trial plots, the results were elaborated by Husárová (1967).

In 1969, varieties were taken over from the Laboratory of Genetics in Lednice where up to then the assortment had been only collected and partially used by Mostovoj. The remaining part of the assortment of the varieties was acquired by the institute through importation or personal contacts. The varieties were described by Javorek (1964). As from the mid-1960s, both homozygotic and heterozygotic genetic resources were studied by Polerecký and Piovarèi. Their work on genetic resources is documented by a considerable number of samples. The less fertile regional populations with specific characteristics, long used for growing in certain agro-ecological conditions, were exchanged for higher-yielding varieties and hybrids, leading to unrecoverable loss of suitable genes. The aim of maintaining genetic populations is to preserve them for the future in a genetically unchanged form. Therefore, after a thorough study, the sample is stored. The task of conservation is to restore the germination of the stored sample. This part of the work is technically most demanding and brings along the highest risk of damaging the stored sample of genetic resources.

Materials and methods

The genetic resources are evaluated according to the "National descriptors list, species *Zea mays* L." (Ryšava and Nešticky 1986) and the "Methodology for the national descriptors list species *Zea mays* L." (Ryšava *et al.* 1987). The descriptor list has been conceived for the filing of data resulting from genetic resources studies during many years. The basic data are expressed directly or alphanumerically. In the descriptive part, the one-digit value expresses the state of the descriptor of a morphological trait according to the legend or the level of a biological trait ranging from 1 to 9. The overall description consists of a passport part (19 descriptors) and a characterization part (115 descriptors). A part of the descriptor list consists of codes of the corresponding taxonomical names.

The genetic resources of Zeainvent are as follows:

Homozygotic genetic resources

After a 3-year evaluation, samples are selected in the genebank and are multiplied in 2-row plots with a row length of 5.6 m and an inter- and intrarow distance of 0.7 and 0.2 m respectively. In the plots, the seeds are produced by technical isolation. Both male and female inflorescences are isolated. Female inflorescences are pollinated with a pollen mixture. After drying and evaluation, the seeds are kept in long-term storage.

Heterozygotic genetic resources

For the multiplication of heterogenetic resources (varieties, regional populations), an effective size of a population is to be taken into account:

$$Ne = 4Nf \cdot Nm / Nf \cdot Nm$$

where Nf = number of female plants
Nm = number of male plants.

The effective size of a population affects two important processes: self-pollination and drift. For the maintenance and restoration of germination, 200 plants sown in 10 rows are used. In the time of pollination, they are technically isolated: tassels in even rows and silks in odd rows. It is important that each genotype be equally represented in a population. For the multiplication of hybrids, both male and female components are used. Upon flowering, female sexual organs are isolated on the female components, and they are pollinated with pollen from female plants.

Results

In Zeainvent, the genetic resources have been studied from the viewpoint of both morphologically and economically important traits and characteristics, and some of them also have been evaluated from the breeding point of view.

Homozygotic genetic resources:

- Inbred lines from Slovakia, used in breeding for quality. The assortment is constantly completed.
- Inbred lines of foreign origin, used in breeding for quantity. The given material has been obtained from multilateral cooperation and is constantly completed.
- Inbred lines used in breeding for quality. Zeainvent has at its disposal special genetic resources:
  - genetic resources for the change of architecture / geometry of plants
    - dwarfing mutant for lowering of plant height: br_2, rd, ct
    - mutant with an altered leaf angle: lg_1, lg_2, lg_3
  - genetic resources with an altered chemical composition of vegetative matter
    - gene mutant bm_3 (brown midrib) for a lowered lignin content and a higher content of nitrogenous matter in green matter
  - genetic resources with an altered chemical composition of kernels
    - high protein
    - endosperm mutants: opaque-2, floury-2 (increased lysine and tryptophane content)
    - gene mutants wx (waxy endosperm) and ae (amylose extender) - quantitative changes of starch in the kernel endosperm
  - genetic resources used in the food and canning industry
    - sweet corn mutants with genes su_1 and su_2 (sugary endosperm) and sh (shrunken)

Heterozygotic genetic resources:

Regional populations and varieties were collected and evaluated in 1964-67. The harvest was carried out with the help of agricultural schools. The assortment is constantly completed and is described on the cards of genetic resources. The seeds are kept in long-term storage.

After registration, a hybrid and its components are included in the genebank; passport and descriptive cards are produced and the seeds are kept in long-term storage.

Synthetic populations are resources with certain characteristics (content, etc.).

Discussion and conclusion

Recently, scientists and breeders of the world have given more attention to extensive materials. If suitable gene donors are not found in the present collections of present cultivars, it is necessary to look for them in the older materials and in the wild relative species. Breeders do not collect these materials themselves; rather, they rely upon the existing collections. But the material collected in small collections cannot sufficiently represent the variability of a species. Therefore for a successful choice of a starting material it is desirable that large collections with materials from the total area of the species expansion be created (Ladizinski 1989).

Genetic resources would be only items if no information were available about them to breeders and scientists in research institutes and other users (van Soest 1985). The required characteristics of genetic resources must be evaluated and documented is a way that enables breeders to use them in breeding programmes (Srivastaya and Damania 1989). The International Board for Plant Genetic Resources (IBPGR, now International Plant Genetic Resources Institute, IPGRI) has stressed the importance of both passport data and individual identifiers and basic data concerning the sample origin for a long time. Well-organized databases are indispensable if they contain data covering the needs of curators, breeders and researchers (Williams 1989).

Work on genetic resources of maize in Zeainvent is part of the work on genetic resources in Slovakia. This work is coordinated by the Plant Production Research Institute at Pieštany. The passportization and description of the genetic resources of maize have been made according to the national Descriptor List (Ryšava *et al.* 1986).

At present, the following materials can be found in Zeainvent:

- 134 regional populations of Slovak origin;
- 32 hybrids resulting from domestic breeding;
- 102 varieties;
- 1362 inbred lines of various countries of origin.

The characteristics studied can be reclassified according to other descriptor lists, e.g. CIMMYT, IBPGR (1991) or UPOV.

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Maize genetic resources activities in Turkey

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Turkey has many crop species which originated in either the Mediterranean or Near Eastern gene centres. For some crops, such as maize, Turkey is a micro-gene centre (Harlan 1951). Therefore, there are many maize landraces. They have been collected since 1964, mainly from the Black Sea and Marmara Regions of Turkey. The Turkish maize collection has reached a total of 1159, comprising 1135 populations from Turkey and 24 research materials from various origins. Collecting is still a priority in order to fill the gaps in landraces found in Turkey, particularly in the regions of Turkey which were never visited by collecting missions. Collections are kept in long-term storage for the base collection and medium-term for the active collection, respectively, at –18ºC and 0ºC.

The national plant genetic resources database system is dBase (dBase 3+, dBase 4, dBase for Windows). The genetic resources information in the database consist of passport data file, storage data file and evaluation data file (Fig. 1). The passport data file includes all basic information about collections. The storage data file includes information on storage behaviour of accessions, viability, multiplication/regeneration, location in the storage and size of accessions for base, active and excess collections. The characterization of accessions started in 1995 and is almost completed for 812 accessions. Each accession is being characterized for 22 characters on the basis of agronomic and morphological characters as shown below. By the end of 1997, the characterization of these accessions should be completed.

Vegetative characters	Ear characters	Kernel characters
Days to tasseling	Husk cover	Kernel type
Days to silking	Ear damage	Kernel colour
Days to ear leaf senescence	Ear length	1000-kernel weight
Plant height	Cob colour	
Ear height	Ear weight	
Foliage	Ear yield	
Tillering Index	Plant yield	
Stem colour	Kernel row arrangement	
Tassel type	Number of kernel rows	

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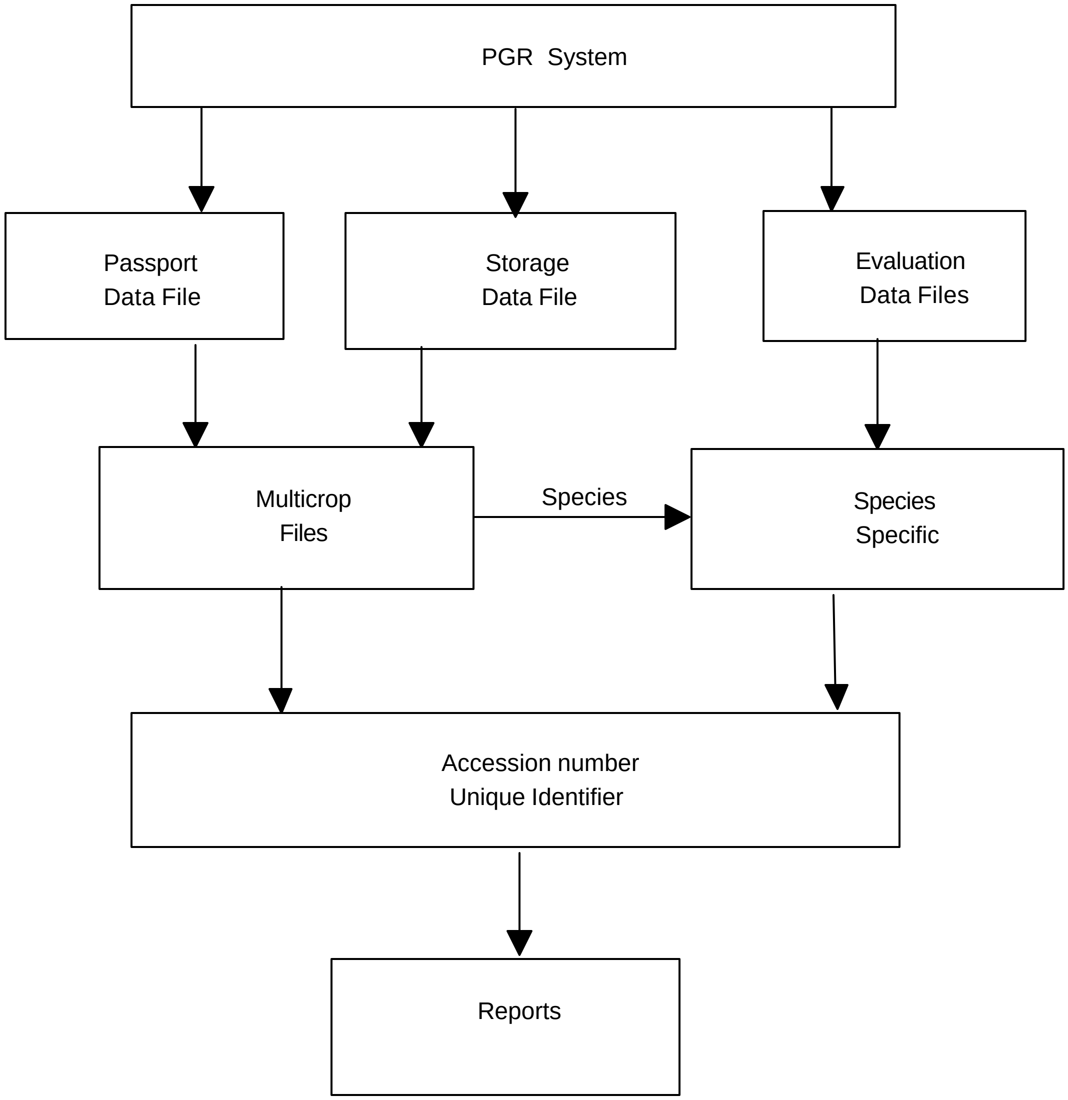

Fig. 1. PGR data management system of Turkey.

Maize genetic resources management in Yugoslavia

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Maize is the most important crop for Yugoslavia, considering the growing area, the yields obtained, the successful breeding programme and the well-organized Gene Bank. The Maize Gene Bank was established as a part of the Breeding Department at the Maize Research Institute, but in the course of time it has developed its own programme. The Maize Gene Bank today maintains 5466 accessions, including 2178 local cultivars and 3298 introduced genotypes originating from 40 countries. The structure of the introduced material is as follows:

- Breeder P2s lines: 67%
- Foreign local cultivars: 24%
- Synthetics: 9%.

The material is rejuvenated on a regular basis in the experimental fields of the Gene Bank in Zemun Polje, Belgrade. The IBPGR/CIMMYT descriptors list (1991) is used as the basis for characterization, evaluation and documentation. The documentation system is computerized under MS Access v2.0. The material is stored under medium-term conditions of the cold storage room at a temperature from 0 to 4ºC with a relative humidity of 50-60%.

Local material is given priority research attention, as being unique and unrecoverable. Now considered as national wealth, this material has been collected from 1960 to 1990 with the majority of accessions collected at the beginning of this 30-year period. The accessions were collected widely from all agro-ecological sites and therefore the collection might be considered a complete one. The largest number has been acquired from the regions with optimal conditions for maize growing (Vojvodina and Slavonija), then from Montenegro, Bosnia, Slovenia and Macedonia. Most accessions come from areas located at altitudes of 100-300 m, with an upper limit at 1270 m asl.

From historical data on the evolution of local material, and the geographic distribution, it has been found that an outstanding variability has been developed in this relatively small area. This variability is best illustrated by the classification of local populations. Using the method of natural classification (Anderson and Cutler 1942), sixteen major agro-ecological groups have been identified (Pavlicic and Trifunovic 1966).

Recently, the numerical taxonomy method proved the existence of these groups, and made clearer the relation between groups while at the same time pointing out at the evolutionary path of maize development in Yugoslavia.

Each classified group (ecotype) has some distinctive common characters, geographic origin, genetic constitution and phenotypic expression. These characteristics could be used as different donors in the maize breeding programmes.

So far, only a limited part of local populations is being used for commercial breeding. To increase the utilization of local germplasm, combining abilities of 900 local populations of FAO maturity groups 500-700 have recently been evaluated. Three divergent testers were used (Mo17, B73, V395) and three groups of populations with a high heterosis effect were selected.

These groups are the source for the creation of synthetic populations, which have a heterotic pattern and can be used for inbred line development.

To reduce a great number of accessions to a manageable proportion, the development of a core collection has been proposed. This activity has two approaches. The first one is based on the classification of the agro-ecological groups; the sixteen main groups could be considered as sixteen core collections. The second is a breeding approach, i.e. a creation of core collections on the basis of combining ability of populations. For instance, by testing 900 populations with three different testers, three groups of populations with a high heterotic expression have been acquired, which could be considered as three core collections. If this approach is justified in practice then the complete variability could be classified into several core collections.

Future work should be based on studies of genetic diversity at cellular or molecular level, accompanied by the identification of gene alleles useful to maize breeding.

The first step to solving these problems is to create the database system recording the maize germplasm as it will provide better communication and cooperation among European countries.

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