

Report of a Working Group on Maize

First Meeting, 2-3 December 2019, Belgrade, Serbia

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The European Cooperative Programme for Plant Genetic Resources (ECPGR) is a collaborative programme among most European countries aimed at contributing to rationally and effectively conserve *ex situ* and *in situ* Plant Genetic Resources for Food and Agriculture, provide access and increase utilization (<http://www.ecpgr.cgiar.org>). The Programme, which is entirely financed by the member countries, is overseen by a Steering Committee composed of National Coordinators nominated by the participating countries. The Coordinating Secretariat is hosted by The Alliance of Bioversity International and CIAT. The Programme operates through Working Groups composed of pools of experts nominated by the National Coordinators. The ECPGR Working Groups deal with either crops or general themes related to plant genetic resources (documentation and information and *in situ* and on-farm conservation). Members of the Working Groups carry out activities based on specific ECPGR objectives, using ECPGR funds and/or their own resources. The geographical designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of The Alliance concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries. Mention of a proprietary name does not constitute endorsement of the product and is given only for information.

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Maize landrace at Storo (Trento), Italy @ L. Maggioni, ECPGR

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CONTENTS

SUMMARY REPORT OF THE MEETING	1
Introduction	1
Importance, rationale and expectations of establishing an ECPGR Maize Working Group	1
Introduction on ECPGR and AEGIS	2
Documentation of European Plant Genetic Resources - The EURISCO information system	2
SWOT analysis of the Maize Genetic Resources in Europe	2
The ECPGR European Evaluation Network (EVA) – opportunities for Maize ..	3
National reports	4
Albania	4
Bosnia and Herzegovina.....	4
France	4
Germany.....	5
Germany.....	5
Italy	5
Montenegro.....	5
Portugal.....	6
Portugal.....	6
Romania.....	7
Serbia	7
Slovenia	7
Spain	8
Switzerland	8
Discussion about future cooperation	9
Conclusion	10
Visit to the National Genebank of Serbia	10
Appendices	11
Appendix I. Workplan.....	11
Appendix II. Proposal to the ECPGR Executive/Steering Committee for the establishment of a Maize Working Group.....	12
Appendix III. Acronyms and abbreviations	14
Appendix IV. Agenda	15
Appendix V. List of participants.....	16

Related presentations are available online ([here](#))

SUMMARY REPORT OF THE MEETING

Introduction

The first meeting of the Working Group (WG) on Maize of the European Cooperative Programme for Plant Genetic Resources (ECPGR) was held 2-3 December 2019 in Belgrade, Serbia. It was organized in collaboration with the Maize Research Institute Zemun Polje, Belgrade and financially supported by the German Federal Ministry of Food and Agriculture.

The intention to establish a Working Group on Maize developed during side meetings held at the EUCARPIA Maize and Sorghum Conference (Montpellier, France, 2015) and at the EUCARPIA Genetic Resources Section Conference (Montpellier, France, 2017). A formal proposal (see Appendix II) was eventually submitted in May 2018 to the ECPGR Steering Committee by Alain Charcosset, Institut National de la Recherche Agronomique (INRA), France, Chairman of the EUCARPIA Maize and Sorghum Section, Violeta Anđelković, Maize Research Institute Zemun Polje, Serbia and Pedro Revilla, Misión Biológica de Galicia (CSIC), Spain. The establishment of a new WG on Maize was favourably commented by the ECPGR Steering Committee during its Fifteenth Meeting in May 2018 (Thessaloniki, Greece). The establishment of a WG on Maize was eventually formalized by the Steering Committee in October 2018, as part of the endorsement to the structure of ECPGR for Phase X.

Based on received 'Expressions of Interest', the ECPGR Executive Committee nominated Violeta Anđelković Chair of the Maize Working Group in February 2019.

V. Anđelković welcomed all the participants (23 WG members and 2 observers) to Belgrade and invited all to self-introduce.

Importance, rationale and expectations of establishing an ECPGR Maize Working Group

Alain Charcosset, INRA

Maize is an important crop in Europe since it was imported from the Americas in 1493. Several landraces were developed and some are still actively used, others have been instrumental in developing inbred lines that proved excellent hybrid parents when crossed to US dent. European collections preserve highly original genetic resources, mostly in the form of landraces and inbred lines. These are of high interest for scientific studies, for direct use and to enrich diversity of elite breeding pools. Increasing interest is devoted to maize as food (functional food, gluten free, etc), to the use of landraces for organic agriculture and to pesticide reduction (early cycle). The value of the collections could be increased for the users through better visibility of the collections' content, improved evaluation and access to information for traits of interest, as well as 'sociocultural' information (past uses, etc).

Expectations for the WG are to create a community that exchanges knowledge, materials and know-how, harmonizing protocols, developing common minimum descriptors, and optimizing the use of resources. It is also possible to identify short-term cooperation opportunities for scientific purposes and to discuss new actions, such as private/public cooperation for evaluation. The INRA-Promaïs partnership on genetic resources represents an example of a private/public Genetic Resources Network in France. INRA contributes to long-term maintenance and distribution and provides the database SIREGAL. Pro-Maïs members contribute to multiplication and fund research projects on maize genetics, history and breeding.

Introduction on ECPGR and AEGIS

Lorenzo Maggioni, ECPGR

The Objectives for ECPGR Phase X (2019 – 2023), the membership, funding and structure were presented. The new Maize Working Group has so far only 26 members and almost everyone was able to attend this meeting. An ECPGR Maize Database had been created in 1996 at the Maize Research Institute "Zemun Polje", Serbia. It was pointed out that the WG would need to decide whether there were sufficient reasons and resources to continue maintaining the crop specific database, or rather use the European Search Catalogue for Plant Genetic Resources (EURISCO) database, which is funded and supported by ECPGR.

ECPGR's Mode of Operation for Phase X provides for two budget lines of similar amounts. One is for "Meetings", the other for "Other activities". Principles, practices and limitations were explained. The next call for proposals to be submitted to the ECPGR Grant Scheme is limited to 20 000 per Activity, with a deadline for submission of 14 February 2020.

The initiative for A European Genebank Integrated System (AEGIS) has the objective to conserve in a collaborative way and at agreed quality standards, the genetically unique and important accessions for Europe of all crops, and to make them available for breeding and research through the Standard Material Transfer Agreements (SMTA). This system is intended to bring significant benefits to users. The WG should define the crop specific standards for the conservation of the maize accessions, based on the generic FAO genebank standards.

It was pointed out that so far 5,698 maize accessions from Italy, Romania and the Netherlands are part of AEGIS and the expectation is to increase this number.

Documentation of European Plant Genetic Resources - The EURISCO information system

Stephan Weise, IPK, Germany

The European Search Catalogue for Plant Genetic Resources (EURISCO) records data on ex situ collections of all crops at accession level. It is based on a Network of National Focal Points from 43 countries, providing their national inventories' data. It contains data for over two million accessions, including records of those registered as part of the Multilateral System and as part of AEGIS. Examples of online functionalities for the search of passport data were shown. Inclusion of non-standardized phenotypic data is also possible since 2016 and over 84 000 accessions contain this type of data in searchable form. Only the exchange format is standardized and the input of the WG is needed to provide additional data and updated information at accession level. Crop specific databases can receive help to automatically import and update their accession data from EURISCO and evolve towards crop specific portals (see example of the [European Poa Database](#)).

SWOT analysis of the Maize Genetic Resources in Europe

Pedro Revilla, Spain

According to EURISCO, more than 60 000 maize accessions are stored in European genebanks. The actual number is probably higher, because not all countries have sent their data. Many samples are stored in South East Europe and have not been systematically investigated. Most countries have their own collection with many duplicates and redundant accessions at European level, but there was no coordinated action to detect them. Despite this large number of maize accessions, there has been a limited activity in some European countries to collect, conserve and document maize genetic resources and make them available to users. At the same time, a European Maize Landrace Core Collection (EUMLCC) with 96 populations from France, Germany, Italy, Portugal and Spain was defined in the year 2000 through the EU-

funded project GENRES 088. This is representative of the maize genetic diversity existing in the involved countries.

Strengths, Weaknesses, Opportunities and Threats for a European maize germplasm system were presented with a “Plan of action” to address each category. Strengths (high human capacities; intensive sampling of the territory; reliable facilities for conservation; and active breeders’ collections) could be capitalized through better cooperation among countries, optimized use of facilities and valorization of genetic resources for breeding. Weaknesses (limited genetic variation; excessive and irregular sampling; difficult access to collections; doubts about seed quality; and poor coordination) could be addressed by introducing exotic germplasm, defining a complete core collection, sharing genetic resources and information and coordinating genebank curators and breeders. Opportunities exist in high social consciousness on biodiversity value, increasing concern of climate challenges and rising emphasis on food quality and security. Benefits can derive from increased communication to the mass media, international projects and adapting research objectives to social demands. Threats are budget cuts, increasing nationalism and decreasing interest in agriculture. These can be avoided by searching for international and private funding, increasing the number of meetings, exchange of knowledge and again increasing communication to the mass media.

A bottom-up approach could be to use the WG as an open space for participants’ needs, also identifying genebank curators, sharing information and exchanging people for training stages.

A top-down approach could be started by establishing an executive committee for the WG, completing the European Core Collection, promoting participatory breeding for in situ conservation, designing international projects and developing a training programme for sharing PhD students as in the “Marie Curie Programme”.

It was commented that there is a need to clarify the origin of samples with better documentation in order to define a complete core collection. The existing core collection was set up 20 years ago based on morphological traits, but it was far from a complete representation of the wider European diversity. Core collection samples are maintained in France in the form of a ‘black box’ and they are also duplicated in Portugal. Including all the core collection accessions in AEGIS should be a good starting point, but it would also be important to extend the core collections to samples from other countries. Sampling of diversity could also be verified and complemented even in those countries where it was already done twenty years ago. It would be useful if each of the core collection countries could multiply its own accessions and include them in AEGIS.

The ECPGR European Evaluation Network (EVA) – opportunities for Maize

Lorenzo Maggioni, ECPGR

The European Evaluation Network (EVA), approved by the ECPGR Steering Committee in Thessaloniki, May 2018, was presented, including its objectives, expected benefits, principles and structure. It is currently promoted through a German-funded project which is helping to establish private/public partnership’s networks for the evaluation of barley, wheat and vegetables’ (carrot, lettuce and pepper) genebank accessions.

Just before the meeting, notification was received from the German Federal Ministry of Food and Agriculture that additional funds might be available for another crop-specific network to be established as part of EVA. This would be a much welcome opportunity to submit a proposal for a new “EVA Maize component” with the involvement and support of the WG.

National reports

Albania

Najada Kadiasi

The operations of the Albanian Gene Bank at the Agricultural University of Tirana were supported by the South East European Development Network (SEEDNet) and are in accordance with international standards. Out of more than 4,350 conserved accessions, 689 are maize, and 144 of these have been regenerated and characterized so far. A weakness remains in the slow rate of regeneration, owing to the lack of isolation cages. The diversity among cereal crops is particularly high in Albania, especially for maize. While for market sale and fodder, farmers produce corn with commercial hybrids, for family consumption they maintain and use local landraces, which are preferred for their specific taste and for the preparation of traditional dishes. Old varieties of maize are promoted in the frame of agri-tourism development as they are also helping small-scale farmers' sustainability in mountain areas.

The University has released a "catalogue of farmer varieties" with 152 varieties to support the development of agri-tourism.

Bosnia and Herzegovina

Danijela Kondić

The National Collection of Maize of the Republic of Srpska, Bosnia and Herzegovina, is stored at the genebank of the Institute of Genetic Resources in Banja Luka. Seventeen percent of the total arable land of Srpska is used for maize production – mainly hybrids. Thanks to the importance of maize in traditional food consumption, local populations can still be found. In the genebank, 101 accessions of maize local populations are stored in long-term conditions. Collecting and documentation activities were described. Morphological characterization of the maize accessions is mainly related to one-year measurements made on 10 traits. Agronomic traits were evaluated for 25% of the total number of maize accessions.

France

Anne Zanetto

The maize diversity in France and the management of the French collection at the Biological Resource Centre (BRC) were presented. The Zea French Network, coordinated by the National Institute for Agronomical Research (INRA), Montpellier, includes public (INRA) and private (Promaïs) partners. The Network maintains an overall collection of 1600 populations and 3,500 inbred lines. Of these, 453 accessions compose the maize French collection registered in EURISCO. The latter consists of populations from the Metropolitan and Caribbean France, synthetics and inbred lines that can be ordered through Siregal, the Plant Genetic Resources Information System of INRA. Identification, conservation and distribution of populations is part of the work of the BRC. The multiplication of populations is carried out within the network.

The quality of the BRC activities has improved with the help of a management diagram, also improving traceability for reception and distribution of accessions with a barcode system and with an overall accreditation ISO 9001. Within the ARCAD project (Agropolis Resource Center for Crop Conservation, Adaptation and Diversity, Montpellier, France), several seed BRCs have joined forces in Montpellier with a multi-institution partnership (GAMèT BRC), enabling purchase of equipment in common and a common platform for access to genetic resources.

Germany

Ulrike Lohwasser

The German Genebank at the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK) in Gatersleben has in total 151 002 accessions, including 1,536 of maize. The seeds are stored at -18 C and partly safety-duplicated at the Svalbard Seed Vault (including 368 maize accessions). The Genebank Information System (GBIS) operates through a barcode system and the management system has an ISO 9001 quality certification. The maize collection is largely composed of landraces (1124) and originates from many countries; 51 accessions have their origin in Germany. Methodologies for the reproduction, characterization, taxonomic determination and photo documentation at IPK were presented. The accessions can be found in EURISCO with their passport data.

Germany

Barbara Eder

The Institute for Crop Science and Plant Breeding in Bavaria (LfL) contacted several genebanks to find landraces which were cultivated in Bavaria or Germany or suitable for growing in Bavaria. About 200 landraces were obtained, with great diversity.

The challenges of finding the truly original variety between many genebank samples were explained with the example of the variety Chiemgauer. Genetic analysis and phenotyping (such as flowering time) were necessary. Twenty varieties cultivated in Germany since a long time were identified, enabling the definition of a “core collection” from Bavaria, Germany and neighbouring regions, with a focus on Bavaria.

The low yield of landraces is a challenge for their maintenance in cultivation and needs to be improved without losing the typical traits. In situ conservation can be implemented via marketing products for human consumption, such as chips and ‘polenta’.

Italy

Carlotta Balconi

The mission of the Council for Agricultural Research and Economics, Research Centre for Cereal and Industrial Crops (CREA) in Bergamo, Italy is mostly focused on maize breeding. CREA, Bergamo’s scientific expertise is orientated towards basic as well as applied research related to maize genetic improvement and biodiversity preservation in the framework of finalized projects of national and international interest. Strategies include genetic, biochemical, physiological, molecular and phytopathological methods for the valorization of the local maize genetic resources. CREA has the largest maize ex situ collection in Italy with over 1200 landraces, of which 500 are Italian, and over 3000 inbred lines, of which 600 are Italian. Collection of Italian landraces goes back to the year 1950. Genotyping by sequencing (GbS) has been performed for 400 Italian inbred lines and 100 derived from American background. The large number of populations and ecotypes and their genetic variability provide interesting material for the identification of genotypes with nutraceutical value (high levels of carotenoids, proteins and lipids) and low mycotoxin content. Italian landraces are also used for human consumption, mainly for ‘polenta’.

Montenegro

Zoran Jovović

Maize was introduced in Montenegro in the middle of the 16th century, mainly with flint corn varieties and was cultivated from the sea level up to 1000 m of altitude, and even higher (very early maize varieties were grown at 1300 m). As the result of mutations, recombination and selection, many local populations were developed. The first organized collection of local maize

populations from the territory of the former Yugoslavia was done in the early 1960s by the USA Department of Agriculture. All local populations from the former Yugoslavian area were classified in 16 main and two derived groups. With the help of a SEEDnet project in 2009-10, 68 local maize populations were collected from 20 municipalities in Montenegro. A majority of these accessions belong to Montenegrin flint corn types. Full passport data for all Montenegrin accessions were made available in EURISCO. Samples of seeds are stored at the Montenegrin Plant Gene Bank at -20°C. Montenegrin flint maize, with promising traits such as early maturing, good adaptability to local agro-climatic conditions and day length and high content of proteins, has been included in breeding programs of the Maize Research Institute "Zemun Polje", Belgrade, a long time ago. "Zemun Polje" conserves 320 maize accessions collected in Montenegro in the sixties and seventies of last century. All these samples have been morphologically characterized. Classification of Montenegrin maize populations and their comparison with Montenegrin samples stored in "Zemun Polje" is ongoing. The next step is the DNA evaluation of the characteristic group representatives in order to determine if Montenegrin maize samples originate from populations already collected in previous times by the Maize Research Institute. Due to lack of human and technical resources, no studies on morphological and molecular identification of maize local populations have been done in Montenegro until now.

Portugal

Ana Maria Barata

The Portuguese maize collection conserved at the Banco Português de Germoplasma Vegetal (BPGV) in Braga consists of 2,710 accessions, of which 1,470 have been characterized and 1,610 multiplied. Seventeen accessions are part of the European Maize Landrace Core Collection. The genebank activities include collection, conservation, evaluation and documentation. The ex situ collection is divided into an active collection and a base collection. The software GRIN Global has been adopted for documentation. So far 217 maize accessions have been sent to the Svalbard Seed Vault for safety duplication. Valorization of local maize includes Slow Food products, such as the maize bread Broa de milho from Arcos de Valdevez. An ongoing project has the goal to compile data and explore the genetic wealth of local origin of the maize landraces conserved in BPGV by selecting landraces resistant to climate change (heat and drought stress), as well as communicate and disseminate useful information to be used by the agri-food sector.

Portugal

Pedro Mendes Moreira

Existing use, constraints and valorization of maize in Portugal were presented. It is a challenge to improve production traits, maintaining diverse and rare qualities. Through participatory agronomic and quality data integration, it is possible to develop innovative and more resilient diverse maize populations, suitable for bread making. Escola Superior Agraria, Politecnico de Coimbra, coordinates the "VASO-Vale do Sousa" programme, focused on on-farm long-term management and valorization of maize landraces for human use through participatory breeding. Specifically, the VASO programme seeks to improve germplasm and its use so that varieties are attractive to consumers, the processing industry and farmers, responding to public concerns related to health and the environment, increasing the sustainability of agricultural systems and contributing to the short chain and well-being of farmers.

There is still the need to improve the connection between actors such as the farmer and the consumer. Pre-breeding is very important, as well as screening in different locations, use of heterotic groups and molecular associations. Economic models must be created and adapted

and there is need for innovation projects and their national and international connection, with greater involvement of national and local actors.

Romania

Danela Murariu

The mission of the Suceava Genebank includes exploration, inventorying, collecting and studying of plant genetic resources for conservation, as a precondition for food security, poverty eradication and environmental protection. The maize collection includes 3,591 accessions of local landraces, 1,955 inbred lines, 113 synthetics and 32 obsolete cultivars. In summary 5,691 accessions, 88% of which are of Romanian origin. The active collection has 5,105 accessions stored at +4 C. The base collection has 2,094 accessions stored at -20 C. The documentation system includes a national collection database with passport data, and a genebank collection database with passport, characterization and conservation data. On-farm conservation of maize takes place in Bucovina, Maramures and Apuseni Mountains, which are considered the last refuges of the Romanian traditional agriculture.

Constraints to efficient conservation include lack of support for local people who maintain maize landraces in small farms. There is also lack of financial resources and technical staff for multiplication and regeneration of maize accessions and for their secondary evaluation. Agricultural research institutions conserving maize accessions are not contributing to update online accessible information for the national database and also do not practice safety duplication. The Suceava Genebank carried out evaluation for cold resistance for 220 accessions, high protein content for 70 accessions and resistance to Fusarium for 85 accessions. About 1,200 inbred lines accessions have been genotyped.

Serbia

Natalija Kravić

The Maize Research Institute "Zemun Polje" in Belgrade conserves 5,806 maize accessions from the former Yugoslavia, 2,217 of which are local landraces, 2,254 are inbred lines and 1,335 are introduced heterozygous populations, composites or synthetics. The Maize genebank collection is an active collection with medium-term storage conditions. Material is regenerated, multiplied, exchanged and distributed. The collection of local landraces has been fully characterized, including passport, characterization and preliminary evaluation data.

The collection of local landraces is classified into 16 main and two derived agro-ecological groups, based on morphological traits, origin and evolution.

Constraints to efficient conservation are related to the medium-term storage of many accessions which require frequent regeneration and multiplication. Financial support from the government and the Ministry of Agriculture is insufficient.

The high diversity of maize ecotypes represents a good potential for improvement of elite breeding material. Maize landraces are not directly used in breeding, but for the development of synthetic populations or core collections for the traits of interest. The development of core collections allows the integration of the most valuable traits (adaptability, variability, divergence and heterotic potential) of underutilized gene bank germplasm into breeding programmes.

Slovenia

Igor Šantavec

The Slovenian Plant Gene Bank is financially supported by the Ministry of Agriculture, Forestry and Food and is coordinated by the Agricultural Institute of Slovenia, Ljubljana. Maize is mainly conserved at the Biotechnical Faculty, Ljubljana (78 foreign and 615 local accessions, of which 241 are inbreds with different levels of homozygosity, originated from

Slovenia and 374 are local populations collected since 1955). The Agricultural Institute of Slovenia also conserves 20 accessions, of which 14 are local populations collected after 2006.

All the accessions of the Slovenian Plant Gene Bank have full passport data, but data in EURISCO need updating and so far no accessions are flagged as part of AEGIS.

Constraint to efficient conservation is the medium-term storage condition (at 4-6 C, with up to 8 % moisture in the seeds), which maintains good germination for about 20 years. In order to maintain viability and enough seeds, there is need for permanent multiplication in the field, based on hand isolation and pollination. Characterization and evaluation take place during the multiplication process.

Spain

Rosa Ana Malvar

The Spanish genetic resources of maize are maintained at the Plant Genetic Resources Centre (CRF), Madrid, aiming to contribute to the conservation and sustainable use of the genetic diversity of native plant genetic resources, particularly underutilized landraces and crop wild relatives and other species with potential value for food and agriculture. The Centre maintains a base collection, with a safety-duplicate of all the Spanish plant genetic resources for food and agriculture with seed reproduction, and an active collection.

Collections of Spanish maize populations are maintained at the Mision Biologica de Galicia (MBG-CSIC) in Pontevedra (93 landraces from Galicia and 55 landraces from the rest of Spain). CIAM-Xunta de Galicia, A Coruña, conserves 697 accessions from northern Spain (529 from Galicia, 77 from Asturias, 52 from Basque Country and 24 from Cantabria). EEAD-CSIC, Zaragoza, maintains 404 varieties from Spain. NEIKER, Vitoria has over 100 varieties from the north and many accessions from one province. Other 120 accessions are maintained by CCBAT-Cabildo de Tenerife.

The Plant Genetic Resources Centre (CRF) maintains 2,936 Spanish and ca. 3,000 foreign maize populations. The sampling of the Spanish populations is not homogeneous across regions. As there is a lot of variability and duplications across the collections, the national genebank will implement a plan to rationalize this situation.

All collections, except from the Canary Islands, have been extensively studied. A national collection of 90 varieties was defined, based on morphological, agronomic and molecular characterization as well as on previous knowledge of breeders. Twenty-four varieties of the Spanish collection belong to European Union Maize Landrace Core Collection (EUMLCC), created during the project RESGEN 088 in the year 2000.

Switzerland

Beate Schierscher

The first mention of maize in Switzerland goes back to 1571 in the Rhine Valley. Historically, the utilization for human consumption includes polenta in the south, the porridge ribel in the Rhine Valley and bread, in mixture with rye flour. The Swiss Genebank currently maintains 209 local varieties. Important natural selection factors for the development of local varieties were the duration of the growing season, drought, disease and pest tolerance. Human selection focused on preferences for certain forms and colours or culinary characteristics.

A success story for a local variety of maize is the 'Rheintaler Ribel' which is used for human consumption (bier, tortilla chips, etc) with a protected geographical indication. Local varieties are facing challenges for climate change (new diseases and higher disease pressure), lodging and low yield, food legislation limits for mycotoxins. Local varieties show in general a good early vigour under cool conditions.

The Swiss Genebank has its own database for documentation (www.bdn.ch) and the evaluation data are available online. The genebank breeding programme has developed 229

inbred lines out of the Linthmais, but also from the Rhine Valley and Graubünden varieties. However, the maize breeding programme has been privatised as of 1994. All the maize accessions have been safety-duplicated in the Svalbard Seed Vault.

Discussion about future cooperation

The group discussed opportunities and priorities for collaboration.

It was suggested that a new round of presentations could be prepared next year, to compare the status of the different programmes in a more homogeneous way.

Regarding genebank management, a collective effort could be made adapting the FAO Genebank standards to maize crop-specific standards; a definition of a minimum set of descriptors to focus on would also be useful, considering that IBPGR and UPOV descriptors are too many. However, "[key access and utilization descriptors for maize genetic resources](#)" have already been developed by Bioversity International and an international advisory group in 2009.

Another issue to be clarified in the coming years is whether it is reasonable to maintain the same accessions in additional locations or would it be better to further rationalize access to material. Flagging of accessions as part of AEGIS would go in the direction of such rationalization. Criteria for flagging according to the German approach (see presentation) were proposed. Developing genebank operational manuals to increase the transparency of operation of the partner genebanks is also recommended (template and examples are available).

A short discussion focused on possible different methodologies to genotype landraces. At INRA, the choice was made to pool DNA, bulking samples to reduce the cost; data analysis is tricky, but something meaningful can be obtained using 50K SNP chips and the cost is about 57 Euros per accession. It does not matter too much how many plants are used. Assuming the 'infinity' starts at 30, they work well with 15 plants (= 30 gametes). At Lfl, Bavaria, 25 plants are used. Other people use just one individual, but considering that there are several possible alleles, if you choose the wrong individual, it is a problem.

Regarding the European core collection, generated through the GENRES 88 project in the early 2000 with accession from France, Italy, Greece, Spain and Portugal, the first suggested step was the expansion to additional geographic areas, selecting representative accessions based on geographic and other criteria.

The core collection could then be used to address climate change issues, for example defining a common trait, such as drought tolerance, that could be tested in different countries.

Attention could also be dedicated to the diversity represented by the inbred lines. The fact they are homogeneous helps a lot in assessing the value. Genotyping allows comparing the diversity of existing inbred lines with new ones.

The value of the collections could also be better valued by increasing knowledge with an inventory of the different uses for human consumption.

During the discussion, the Workplan table (see Appendix I) was agreed, including assignment of responsibilities and proposed deadlines.

A small group organized a session to advance the preparation of a public/private partnership project for the creation of a maize component of the EVA Network, to be submitted to the German Federal Ministry of Food and Agriculture for funding. The scope focused on field testing in multiple sites, looking at various phenotypic and agronomic traits, specifically disease resistance (*Aspergillus*, *Fusarium*, *Helminthosporium*), and abiotic stresses, such as drought and cold tolerance¹.

¹ In December 2019 the German Federal Ministry of Food and Agriculture granted an additional contribution of ca. € 300 000 to add a component on maize to the project 'Implementation of the ECPGR EVA Network'.

Conclusion

Special thanks were given to the staff of the Maize Research Institute Zemun Polje, Belgrade and specifically Violeta Anđelković, for the support and hospitality during the organization of this workshop. Particular thanks were also extended to the German Federal Ministry of Food and Agriculture for financial support, to the ECPGR Secretariat and all the participants for their constructive contribution.

Visit to the National Genebank of Serbia

After the closure of the meeting, some participants went to visit the National Gene Bank of Serbia. Milena Savić Ivanov, Head of the Plant Gene Bank, gave a presentation on the history and status of the National Genebank. Afterwards, staff of the Genebank showed the participants around the facility.

Appendices

Appendix I. Workplan

Activities	Responsibility	Deadline
Expansion of the Maize core collection created in the framework of the EU-funded project GENRES 088	Summary of how the first core collection was prepared (phenotypic + genotypic data)	Done at the meeting
	Each member identifies an expert of maize genetic resources in each country. The Chair will be informed	As soon as possible
	Each country expert lists the landraces (LRs) (and possibly inbred lines extracted from LRs) available in the country	31.03.2020
	P. Revilla to draft guidelines for each country representative to identify representative landraces for inclusion in the expanded core collection.	31.03.2020
	to be further discussed: Identification of the representative LR	
Adaptation of FAO Genebank standards for the AEGIS crop-specific standards	A.M.Barata to prepare first draft and circulate to all genebanks	First draft by March 2020
As IBPGR and UPOV descriptors are too long, define minimum descriptors	Recommended to use existing key descriptors (to be further discussed)	
AEGIS flagging of accessions with the AEGIS suggested procedure	Curators to apply AEGIS suggested procedure and recommend to National Coordinator for flagging	
To address problem of duplicates: create overview of situation	S. Weise to prepare a table from EURISCO	31.12.2020
Monographies about variety (inspired by Albanian example) could be prepared in local language and English	N. Kadiasi, Albania, translates one example into English and circulates it to the group	March 2020
	Romania (D. Muraru), Italy (C. Balconi), Bosnia and Herzegovina (D. Kondić) to be the first to follow	End of 2021
Inventory of uses for human consumption	Montenegro (Z. Jovović), Portugal (P. Moreira), Italy (C. Balconi)	
Genotyping inbred lines and landraces	Idea for ECPGR Grant Scheme, to be refined by Chair and WG members	In time for one of the next Calls for Proposal of the ECPGR Grant Scheme

Appendix II. Proposal to the ECPGR Executive/Steering Committee for the establishment of a Maize Working Group

6 May 2018

Maize genetic resources in Europe

More than 60 000 accessions of maize are currently stored in European genebanks. They all belong to the *Zea* genus and with very few exceptions (some teosintes) to the *Zea mays* species. Most of them are held in Institutions, located in Azerbaijan, Bulgaria, France Germany, Hungary, Italy, Portugal, Romania, Serbia, Spain, and Ukraine. A partial view, to be updated, can be viewed at:

https://eurisco.ipk-gatersleben.de/apex/f?p=103:56:::::P56_INCLUDE_SYNONYMS,P56_GENUS,P56_SPECIES,P56_SPECIES_AUTHORITY,P56_USE_C_EXAMPLES;ZEA,MAYS,,

In spite of this large number of maize accessions there has been no coordinated activities involving all concerned European countries to collect, conserve, document and make available to users the genetic resources of this crop.

Background

Within the framework of ECPGR, a meeting on maize genetic resources was organized in Rome 28-29 May 1996. The objectives of the meeting were to establish a European Maize Database (hosted by Maize Research Institute 'Zemun Polje') and to consider the 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.

Given the absence of a formally established ECPGR maize working group, in the EUCARPIA Maize and Sorghum Conference, held in Montpellier (France) in May 2015, the establishment of a maize working group, in the context of ECPGR, was initiated. Also, the importance of extending collaborative action between curators of maize genebanks was considered.

Reasons/ Expectations

In agenda of the EUCARPIA Maize and Sorghum Conference held in Montpellier (France), on May 12th, 2015, about 30 participants from different countries (Croatia, France, Germany, Italy, Portugal, Serbia, Slovenia, Spain) took part in the session:

“Working group of Maize genetic Resources and Diversity in Europe (history, conservation, description and utilization)”, organized by: A. Charcosset, B. Gouesnard, A. Zanetto.

The objective of this meeting was to update reciprocal knowledge between main actors involved in the conservation and use of maize genetic resources in the different European countries, which have been home to diversification of Maize varieties for centuries. A wealth of traditional varieties is still cultivated in some regions or maintained in genebanks, representing an invaluable cultural patrimony and a source of diversity for breeding. The possibility of ensuring the continuity of activities which would be undertaken in the area of maize genetic resources in future was discussed considered the importance of extending collaborative action.

A follow-up meeting was organized on 8 May 2017 by P. Revilla, V. Anđelković and A. Charcosset as a workshop of the Eucarpia Genetic Resources section meeting. It involved the participation of Bill Tracy (University of Wisconsin), Chair of the International Maize Genetic Resources Advisory Committee (IMCRAG). This meeting confirmed the willingness of participants to build a regular concertation framework to improve the current status of maize genetic resources conservation, evaluation and use in Europe.

Objectives

- Coordinate the efforts of the managers of national collections.

- Coordinate our efforts with the USA and CIMMYT (The IMGRAC is already established). We might also think about a cooperative plan with countries that have most of the maize genetic resources and lack expertise and resources to take care of them.
- Improve the information contained in the European Maize Database at the Maize Research Institute Zemun Polje, Serbia. Initially, database was created with passport data stored in the FAO/IPGRI *Multi-crop Passport Descriptors* format.
- Establish suitable links between this database, Eurisco and national information systems.
- Re-examination of passport descriptor lists and characterization protocols in order to improve standardization and to develop minimum descriptors.
- To obtain information about the status of regeneration in each country, improve and harmonize protocols for seed regeneration and seed storage.
- To obtain information about the current status of safety-duplication in all collections, long-term storage facilities, and availability to host black boxes for genetic resources of maize. Partners will be encouraged to make plans for safety-duplication.
- The group expressed interest for a better collaboration and application for EU project(s) focused on maize genetic resources in Europe. Main priorities identified are:
 - To use genetic markers with a unified protocol to (i) identify duplicates and describe the organization of the maize genetic resources, (ii) make a core collection, thereby extending what was done in the context of the RESGEN88 project, which involved only six countries.
 - To evaluate the core collection and other resources of interest for specific traits to facilitate the use of maize genetic resources by breeders and other possible users. Strong attention will be paid to establish the link with the Private Public Partnership framework being implemented by ECPGR.

Proposal

Following the very positive feedback of participants to the meetings mentioned above, we submit for consideration and approval by the Executive/ Steering Committee of ECPGR a request for the formal establishment of a Maize Working Group within the ECPGR. We believe that the formalization of this ECPGR Working Group on Maize would be a major step to establish and strengthen collaboration to the entire European region who are highly motivated to act as a steering committee for its establishment.

On behalf of members of EUCARPIA Maize and Sorghum Section, we very much appreciate the encouragement and support of the ECPGR Steering Committee.

Sincerely yours,

Alain Charcosset,
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 Chairman of the EUCARPIA Maize and Sorghum Section

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Appendix III. Acronyms and abbreviations

AEGIS	A European Genebank Integrated System
ARCAD	Agropolis Resource Centre for Crop Conservation, Adaptation and Diversity
BRC	Biological Resource Centre
COST	European Cooperation in Science and Technology
CREA	Council for Agricultural Research and Economics, Research Centre for Cereal and Industrial Crops
CRF	Plant Genetic Resources Centre
ECPGR	European Cooperative Programme for Plant Genetic Resources
EUCARPIA	European Association for Research on Plant Breeding
EURISCO	European Search Catalogue for Plant Genetic Resources
EVA	European Evaluation Network
GBIS	Genebank Information System
GbS	genotyping by sequencing
H2020/HOR2020	Horizon 2020
IBPGR	Former name for Bioversity International
INRA	Institut national de la recherche agronomique
IPK	Leibniz-Institut für Pflanzengenetik und Kulturpflanzenforschung
LfL	Institute for Crop Science and Plant Breeding in Bavaria
MEB2015	Maize for EXPO for Bergamo
MoU	Memorandum of Understanding
MRIZP	Maize Research Institute, Zemun Polje
PGR	Plant Genetic Resources
SEEDNet	South East European Development Network
SIREGAL	Plant Genetic Resources Information System of the National Institut for Agronomical Research (INRA)
SMTA	Standard Material Transfer Agreement
WG	Working Group

Appendix IV. Agenda

First Meeting of the ECPGR Maize Working Group 2-3 December 2019, Belgrade, Serbia

Monday, 2 December 2019

Arrival of participants

14:00-14:15	Welcome (<i>Violeta Anđelković</i> , Maize Research Institute Zemun Polje)
14:15-14:30	Short self-introduction of participants
14:30-15:00	Importance, rationale and expectations of establishing an ECPGR Maize Working Group (Alain Charcosset, INRA)
15:00-15:30	Introduction on ECPGR and AEGIS (Lorenzo Maggioni, ECPGR)
15:30-16:00	Coffee/Tea break
16:00-16:30	EURISCO (Stephan Weise, IPK, Germany)
16:30-17:00	SWOT analysis of the Maize Genetic Resources in Europe (Pedro Revilla, Spain)
19:00	Social dinner

Tuesday, 3 December 2019

09:00-09:30	The ECPGR European Evaluation Network (EVA) – opportunities for Maize to implement a maize component (Lorenzo Maggioni, ECPGR)
09:30-10:30	Presentations of WG members (12 min each country): size, status and availability of the national collection; documentation level of the collection; constraints to efficient conservation; existing use and its valorization; Ongoing projects (national and international level); legislation; expectations from WG <ul style="list-style-type: none">- Albania- Bosnia and Herzegovina- France- Germany
10:30-11:00	Coffee/Tea break
11:00-13:00	Presentations of WG members, continued (12 min each country) <ul style="list-style-type: none">- Italy- Montenegro- Portugal- Romania- Serbia- Slovenia- Spain- Switzerland
13:00-14:00	Lunch
14:00-16:00	Discussion about the future cooperation
16:00	Visit to the National Genebank of Serbia (optional) / Discussion about the implementation of the ECPGR EVA network – maize component for interested WG members

Departure of participants on the afternoon/evening of 3 December or morning of 4 December.

Appendix V. List of participants**First Meeting of the ECPGR Maize Working Group
2-3 December 2019, Belgrade, Serbia****Working Group members**

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