More Efficient Conservation and Use of Vegetable Genetic Resources in Europe: ECPGR Achievements and Perspectives

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Abstract

The European Cooperative Programme for Plant Genetic Resources (ECPGR) is a regional network funded by the European countries and coordinated by Bioversity International. The Vegetables Network with representatives of 42 countries, is one of the crop specific ECPGR networks (http://www.ecpgr.cgiar.org/networks/vegetables.html). It consists of six Working Groups (WGs), i.e., on *Allium*, *Brassica*, Cucurbits, Leafy Vegetables, *Solanaceae* and Umbellifer Crops. Sharing responsibilities for the ex situ conservation of European vegetable crops genetic resources is the highest priority of the Vegetables Network. It is foreseen that the rationalization of the collections will lead to higher cost-efficiency, and improvement of plant genetic resources documentation and quality. These efforts will be continued

within the framework of the AEGIS initiative (A European Genebank Integrated System) (http://www.aegis.cgiar.org/). Challenges for the Vegetables Network include the identification of the so-called Most Appropriate Accessions (MAA) for each crop for their inclusion in the decentrally managed European Collection, and the development of agreed crop specific technical standards for conservation.

Achievements of the Network in recent years include the development of European Central Crop Databases (ECCDBs), quality standards for collection management of seed-propagated crops and cryopreserved material, safety duplication improvement and definition of minimum characterization descriptors. Several EU-funded projects have initiated and accelerated the activities of the WGs. Apart from further improvements within the framework of AEGIS, the Network is planning a number of other initiatives, such as improving collaboration at the global level (*Allium*), developing molecular characterization protocols (lettuce), filling the gaps in the conservation of wild relatives (*Brassica* and Umbellifer Crops), and improving the Network's communication with the scientific community and the public at large.

INTRODUCTION

Genetic resources (GR) of cultivated plants are an essential source of diversity to breeders and researchers. Collections of various vegetable crops and their wild relatives are maintained in most European countries, by public institutions such as genebanks and research institutes, as well as by private organizations such as breeding companies and Non Governmental Organizations (NGOs). These collections vary in size and in the extent the accessions are documented, characterized for morphological descriptors, and evaluated for traits of interest. In addition, the available technical facilities differ between the stakeholders. A comparison between the collections of ten vegetable crops (*Allium* spp., *Brassica oleracea*, *Capsicum* spp., *Citrullus* spp., *Cucumis* spp., *Cucurbita* spp., *Daucus* spp., *Lactuca* spp., *Lycopersicon* spp., and *Solanum melongena*) showed that European collections included 28 to 77% of the worldwide accessions recorded in the 2002 VIEWS database of FAO (Maggioni, 2004).

The need for cooperation between European countries to improve the management and use of crop genetic resources was identified more than thirty years ago. Following an intense series of consultative missions and discussions that took place between 1975 and 1979, involving the Food and Agriculture Organization of the United Nations (FAO), the International Board for Plant Genetic Resources (IBPGR)[1], the Genebank Committee of the European Association for Research on Plant Breeding (EUCARPIA) and the European office of the United Nations Development Programme (UNDP) (FAO, 1979), the European Cooperative Programme for the Conservation and Exchange of Genetic Resources for Plant Breeding (ECP/GR, now European Cooperative Programme for Plant Genetic Resources, ECPGR), was created in 1980 (http://www.ecpgr.cgiar.org/homepage.html).

This programme, entirely financed by the member countries (43 as of September 2010) operates through broadly focused networks dealing with groups of crops (vegetables, fruits, cereals, etc.) or general themes related to plant genetic resources (in situ and on farm conservation, documentation, inter-regional cooperation). It is guided by a Steering Committee that meets every two years, and that consists of the coordinators of each National Programme and of representatives of European entities (such as the EUCARPIA, and the European Seed Association, ESA) and worldwide organizations (e.g., FAO). The general coordination is ensured by the ECPGR Secretariat at Bioversity International, Rome, Italy. ECPGR is presently running its eighth Phase (2009-2013), with an overall budget of € 2,759,000 mainly dedicated to coordination and network operations (i.e., meetings, publications, ad hoc actions), with a ratio of 75/25 of funds devoted to meetings versus actions.

[1] IBPGR, later renamed IPGRI, and now Bioversity International.

The Vegetables Network (VEGNET) is represented by 111 members of 39 countries, who participate to one or several of the six crop Working Groups (WG) (*Allium*, *Brassica*, Cucurbits, Leafy Vegetable*s, Solanaceae* and Umbellifer Crops). It is coordinated by the Chairs and vice Chairs of all WGs. Each WG meets either at separate meetings (see each WG web page, http://www.ecpgr.cgiar.org/networks/vegetables.html) or at combined VEGNET meetings (Maggioni and Spellman, 2001; Thomas et al., 2005; Astley et al., 2009; Maggioni et al., 2010) that are planned for each phase, to develop and update workplans. The goal of this paper is to summarize the achievements of the six crop Working Groups of the ECPGR Vegetables Network, and to illustrate their involvement in the initiative entitled 'A European Genebank Integrated System' (AEGIS).

MODE OF OPERATION OF THE SIX VEGETABLES WORKING GROUPS

The *Allium* WG was established in 1984. It deals with vegetatively and/or seed propagated crop species (Fritsch and Friesen, 2002) such as *Allium cepa* (onion, shallot), *A. sativum* (garlic), *A. fistulosum* (Japanese bunching onion, Welsh onion), *A. ampeloprasum* var. *porrum* (synonym: *A. porrum*) (leek), *A. schoenoprasum* (chives), *A. ramosum* (Chinese chive), as well as with minor crops and wild related taxa. The work of the ECPGR *Allium* WG benefited significantly from the work programme of the EU GENRES[2] *Allium* projects CT95-20 (1996-2000) and AGRI GENRES 050 EURALLIVEG (2007-2011), since several partners of them were also ECPGR members, and the EU research project FAIR (1996-2001) Garlic and Health (1998-2003). A sub-group within the *Allium* WG is devoted to the specific conservation problems of vegetatively propagated *Allium*.

In 1989 a WG on *Brassica* was formed. It benefited from the EU funded research project AIR3 - CT920463 (1993-1997) and GENRES CT99 109-112 project (2000-2003) via partial shared partnership or common meetings. Many species belong to the *Brassica* genus (Gómez-Campo, 1999), including *B. carinata* (Abyssinian mustard), *B. juncea* (Indian mustard), *B. napus* (e.g. ,rapeseed), *B. nigra* (black mustard), *B. oleracea* (e.g., cabbage), *B. rapa* (e.g., turnip rape) and several wild species that the ECPGR WG deals with.

The Umbellifer Crops WG was approved by the ECPGR Steering Committee in 1998. As this botanical family is very rich of taxa (Rubatzky et al., 1999), the group limits its interest and activities to crops and wild *taxa* within nine genera including *Anethum* (dill), *Apium* (celery), *Carum* (caraway), *Chaerophyllum* (chervil), *Coriandrum* (coriander), *Daucus* (carrot), *Foeniculum* (fennel), *Pastinaca* (parsnip) and *Petroselinum* (parsley). Members of the ECPGR Umbellifer Crops WG were full partners in the 5 years EU Carrot project GENRES CT99 - 105 (1999-2004).

The *Solanaceae* WG was established in 2001. It benefited from the EU funded project on eggplant genetic resources (EGGNET) RESGEN PL 98-113 (1999-2004). The group deals with cultivated and wild relatives of *Solanum* species (eggplants), *Capsicum* spp., *Lycopersicon* spp., *Physalis* spp. and *Cyphomandra* spp. All of these species originate from continents other than Europe.

The Cucurbit WG was approved by the ECPGR Steering Committee in October 2003. It attempted to interact with the EU-funded project RESGEN CT99-108 on melon (2000-2002), but with limited success. The group is concerned with *Citrullus* species including *C. lanatus* (watermelon), *Cucumis* species including *C. melo* (melon) and *C. sativus* (cucumber), *Cucurbita* species including *C. maxima*, *C. moschata*, *C. ficifolia*, *C. argyrosperma* and *C. pepo* (squash and pumpkin), *Lagenaria* species (bottle gourd), and many other species that belong to this botanical family (Bates et al., 1990).

The Leafy Vegetables WG, created in 2003 is benefiting from the funding of the EU AGRI-2006-0262 project (2007-2010). The group focuses on four crop groups and their wild relatives, i.e., lettuce (*Lactuca* sp.), spinach (*Spinacia* sp.), chicory (*Cichorium* sp.) and minor leafy vegetables that include, amongst others, artichoke (*Cynara* sp.),

[2] European Union [programme] for Genetic Resources in Agriculture.

asparagus (*Asparagus* sp.), lamb's lettuce (*Valerianella* sp.), rhubarb (*Rheum* sp.) and rocket salad (*Bunias* sp., *Diplotaxis* sp., *Eruca* sp., *Erucaria* sp., *Erucastrum* sp., *Pseuderucaria* sp.).

The country representatives are nominated by their national coordinator (NC). There may be one or several representatives of a given country participating to one or more Vegetables WGs and these representatives may be appointed by the same or different national institutions. Apart from a few exceptions, all country representatives are affiliated to public institutions. Each WG is coordinated by a Chair, generally assisted by a vice Chair. The activity of the WGs is mostly based on (1) planning and managing the activities thanks to meetings financially supported by ECPGR and which are complementary to activities planned as part of the EU funded projects as seen above, and on (2) inputs in kind of each WG member. So far, EU funded projects have greatly facilitated most of the technical achievements of all ECPGR WGs. In Phase VIII, some technical activities are also financed by ECPGR, but to a much smaller extent than EU projects do. The total budget of the Vegetables Network for Phase VIII (5 years) is 201,880 euros.

ECPGR manages and hosts the web site of the Vegetables Network from which all details concerning the activities of each WG are accessible (http://www.ecpgr.cgiar.org/networks/vegetables.html).

MAIN ACHIEVEMENTS OF THE SIX VEGETABLES WORKING GROUPS

All vegetables WGs share common objectives encompassing (1) establishing the European Central Crop Databases for each crop group (ECCDB), (2) defining a list of minimum characterization traits for each crop to be used by all ECPGR members, (3) defining minimum quality standards for collection management operations (e.g., regeneration, conservation) of seed or vegetatively propagated crops as well as cryo-preserved material, and (4) improving safety duplication of the plant genetic resources of all stakeholders. As already mentioned, the synergy established by ECPGR between its WGs and the partners of plant genetic resources projects funded by EU has widely contributed to the achievements presented here.

European Central Crop Databases (ECCDBs)

All WGs have developed their ECCDBs based on the voluntary commitment of database managers of several institutions (Table 1). The backbone of all databases consists of the passport data of the accessions held by the various European stakeholders, based on the Multi Crop Passport Descriptors defined by FAO and IPGRI[3] in 1997 and updated in 2001. Some databases (tomato, eggplant, cucurbits, leafy vegetables) include also characterization and evaluation data. Most databases are searchable online, though the searchable fields (passport data, characterization data, duplicates) and the facilities for downloading the results of the queries differ from one database to another, depending on the progress of each WG.

The fourteen databases are under permanent evolution, given the progressive provision of data by the country members, and given their necessary evolution for being adapted to further uses, such as the inclusion of characterization data or identification of duplicates. The number of accessions presently included in each group of crops or crop databases, including cultivated and wild material is reported in Table 2. A total of 127,193 vegetables accessions are presently entered into the ECPGR ECCDBs, which represents 79.4% of the 160,109 accessions recorded for Europe in the FAO WIEWS database (http://apps3.fao.org/wiews/germplasm_query.htm?i_l=EN).

Full Descriptor Lists

Several WGs have contributed developing IPGRI descriptor lists for several crops, in particular for carrot (1998), *Allium* (2001), Pepino *Solanum muricatum* (2004),

[3] IPGRI: International Plant Genetic Resources Institute, now Bioversity International.

cucumber, melon, watermelon and *Cucurbita* sp. (pumpkins) (2005). Leafy vegetables descriptors agreed by the WG are also available from the WG web site. These descriptors are downloadable from: http://www.bioversityinternational.org/publications/search/results.html.

Minimum Descriptors and Vegetable Crops Genetic Resources Characterization

In Europe, most vegetable stakeholders characterize their genetic resources morphologically. However, the descriptors used may differ, being either self-developed or adapted from IPGRI or COMECON[4], UPOV[5] or OCVV[6] descriptors lists. Furthermore, the descriptors are rarely included in the institutional databases which predominantly consist of passport data. As plant description is important information in particular for end users such as breeders, the ECPGR Vegetable Network decided to define for each crop a minimum list of descriptors to be used by each stakeholder, in addition to its own descriptors. The final aim is of course to enter these minimum descriptors into each ECCDB. A set of minimum descriptors has been so far defined for several species of *Brassica* (*B. napus*, *B. oleracea*, *B. rapa*), *Solanaceae* (eggplant, pepper, tomato), cucurbits (*Cucurbita* sp., cucumber, melon, watermelon), and leafy vegetables (cultivated lettuce, wild *Lactuca*, spinach, leaf chicory, witloof, endive, root chicory, *Eruca* and *Valerianella*). For *Cyphomandra*, *Physalis* and pepino (minor *Solanaceae*), a first draft of minimum descriptors has been completed. For the other crops, work is ongoing. Some characterization data are already entered into and downloadable from the *Brassica*, the tomato, the eggplant, the cucurbits (cucumber, watermelon, pumpkin) and leafy vegetables databases. However, as gathering such data is time consuming and costly, there is a need for special funding via common projects to carry out this task efficiently and including the data in the ECCDBs.

Detection of Duplicates

Duplicates exist within and between vegetables collections. For a more efficient management of the collections within and between European institutions, there is a need to decrease the intra and inter collection duplication rate. However, the concept of plant genetic resources duplication is quite complex (Engels and Visser, 2003) and duplicates detection can be based on different types of data, in particular passport, morphological, agronomic and molecular data. The concept of duplicates has been outlined (e.g., van Hintum and Knüpffer, 1995; van Hintum, 2000; Germeier et al., 2003) within the general framework of genebank management, and has allowed the definition of different categories of duplicated material. A possibly more appropriate alternative to the identification of duplicates, discussed in the section AEGIS in this paper, may be the identification of Most Original Samples (Accessions), or Most Appropriate Accessions (MAAs), or Unique Accessions within each collection.

Several ECPGR members, in particular genebanks, have made substantial efforts for identifying the level of redundancy within their collections and appropriate algorithms are being developed at the Centre for Genetic Resources (CGN), The Netherlands, for screening passport data of the European vegetable crops genetic resources. First results obtained from the *Brassica* and Tomato DBs have respectively yielded a total of 1698 accessions out of 3622, assigned to 545 duplication groups within the *Brassica rapa* collection (32% probable duplicates), and a total of 7892 tomato accessions out of 21,327, assigned to 2491 duplication groups (i.e., 25% probable duplicates). In a study based on passport data of four main lettuce collections, only 33 to 54% of the accessions appeared unique to single collections (van Hintum, 2000). Within CGNs[7] collection of cultivated

[4] COMECON: English acronym for the former 1949-1991 economic organization comprising the countries of the Eastern Bloc along with a number of communist states.

[5] UPOV: Union pour la Protection des Obtentions Végétales.

[6] OCVV: Office Communautaire des Variétés Végétales.

[7] CGN: Centre for Genetic Resources, Wageningen, the Netherlands.

lettuce, a percentage of 13% of redundancy was calculated on the basis of passport, morphological and molecular data (van Treuren et al., 2010). These examples illustrate the importance of identifying redundancy within and between collections, and emphasize the need to rationalize the collections for reducing the regeneration, characterization, evaluation and conservation costs. There is a general agreement within all WGs for having the duplicates, at least for cultivated material, being also identified within each national programme. Hence, strong interaction between ECCDBs managers and country representatives is needed.

Minimum Quality Standards for Collection Management Operations

Inquiries made by the six WGs have revealed that the different European stakeholders use a variety of storage conditions (e.g., short term or long term conservation approaches) and a variety of different protocols for seed regeneration and conservation, or for conservation of vegetatively propagated crops (e.g., field conservation, in vitro, or cryopreservation). In order to upgrade the general level of the quality standards used in Europe, minimum standards have been defined for several seed propagated crops that were distributed among stakeholders. These standards are on line available at the web page of most WGs or within their meetings reports, also accessible from their web page.

Safety Duplication

Safety duplication of genetic resources is a common concern to all WGs, and is organized within each WG via a memorandum of understanding (MoU) or an alternative form of agreement between the provider of the safety duplicates, and the hosting institution, under black box arrangements. Safety duplication has been improved for *Allium*, *Brassica*, cucurbits and leafy vegetables and work is ongoing for the other WGs.

Collecting Material

So far, this activity was carried out on national initiatives. The major actions concerned *Allium* and Umbellifer Crops.

In Situ Conservation

So far, the *Brassica* WG is the most involved, with the intent of implementing a strategy for in situ conservation of wild species of Mediterranean relatives of cultivated *Brassica*, in particular in Sicily. The role of the WG is seen as a contribution to highlighting the usefulness of the wild genetic resources for breeding purposes, but protection in genetic reserves is considered the responsibility of local authorities.

Miscellaneous Achievements

1. Taxonomic Information. Given the number of cultivated species and wild relatives some WGs deal with, it is essential they help their stakeholders to correctly identify their material. The *Allium*, Umbellifer Crops, and *Solanaceae* WGs have provided online access to various useful and reliable sources of taxonomic information.

2. Regional Cooperation. This is useful at various levels. For instance, the Umbellifer Crops WG was responsible for the emergency rescue of carrot accessions of the Vavilov Institute, St. Petersburg. Another example addresses the strong disparity between facilities such that several genebanks provide long term conservation of safety duplicates to countries in need of such facilities.

3. Capacity Building. The best example is that of the *Allium* WG, subgroup vegetative *Allium*, providing expertise for cryopreservation of the genetic resources for any crop WG dealing with vegetatively propagated crops (e.g., fruits).

4. Private Breeders Involved in Regeneration of Public Genetic Resources. In some countries such as The Netherlands and France, several private breeders assist with regenerating genetic resources held in public institutions. An example is the regeneration

of 25 French lettuce cultivars from the GEVES[8] collection by a consortium of Dutch and French breeders in 2007. Via the ECPGR secretariat and its Vegetables WGs, this input from the private sector is increasingly requested by institutions of other countries.

5. Scientific and Public Relationships. The ECPGR Vegetable Network is aware of the importance of having its genetic resources and related information well known and easily accessible by the scientific community. The *Solanaceae* and the cucurbits WGs have made significant efforts in strengthening communication via appropriate routes (scientific leaflets, crop congresses) (Daunay et al., 2001, 2004, 2006; van Dooijeweert, 2007; Diez et al., 2007; van der Weerden, 2010). These need to be adopted by all WGs to their respective scientific community. Further, plant genetic resources are not the sole responsibility of the stakeholders, but of society as a whole, being the heritage of mankind, ensuring food and nutritional security. As maintenance and characterization of genetic resources need funding, the better publicly known these genetic resources the easier the potential funding. An outstanding and successful example of communication focusing on the general public was done in 2009 by an Austrian institute[9], with teaching people, artistic and culinary use of *Solanaceae* diversity. An illustrated summary of the event is available at: http://www.ecpgr.cgiar.org/networks/vegetables/solanaceae.html.

TOWARDS A EUROPEAN GENEBANK INTEGRATED SYSTEM (AEGIS)

AEGIS: Why, What and How?

As mentioned in the previous section, the achievements realized so far by the ECPGR vegetables WGs, mostly obtained during the last 15 years, are numerous, diverse, successful and useful for the community of plant genetic resources managers, breeders, NGOs, scientists and other end users. Most activities are still ongoing because of the high number of member countries involved, their heterogeneous commitments, and generally limited resources. Apart from historical bilateral collaborations between some genebanks, the initial situation (1) of isolation from each other of the European vegetables genetic resources stakeholders, (2) of dispersed information, (3) of unknown redundancy between collections, has developed over 30 years to the present network of over one hundred people knowing and working with each other, sharing common objectives, in particular upgrading genetic resources management quality, security, documentation, and rendering material more accessible to end users. However, the present system strongly relies on inputs in kind by each member. There are increasingly structural limitations to this mode of cooperation, because of the very heterogeneous national policies on plant genetic resources among European countries with subsequent financial and technical consequences imposed on national institutions in charge of genetic resources.

A higher European integration level, based on a formal contractual commitment of the participating countries, was initiated by ECPGR in 2004 via an initiative entitled 'A European Genebank Integrated System' (AEGIS) (http://www.aegis.cgiar.org/). This initiative, which was endorsed by the Vegetables Network in 2009, defines the routes to be taken in the near future, and aims in particular at (i) improving the collaboration among European countries, the cost-efficiency of conservation activities and the quality standards across Europe; (ii) reducing redundancy in collections maintained by European institutions; (iii) facilitating access to all the genetic resources included in AEGIS, and (iv) strengthening linkages between ex situ and in situ conservation.

The concept of the European Collection is at the very heart of AEGIS. This European Collection will, in essence, operate as a virtual European genebank, consisting of the genetically unique accessions that are important for Europe, held in European genebanks and registered as "European Accessions", i.e., accessions that are free from any third party obligations or restrictions, selected according to agreed criteria, organized

[8] GEVES: Groupe d'Etudes et de Contrôle des Variétés et des Semences, France.

[9] Höhere Bundeslehr- und Forschungsanstalt für Gartenbau, Abteilung Gemüsebau, Schönbrunn, Wien, Austria.

on a crop genepool specific basis, maintained according to agreed standards, and freely available in accordance with the terms and conditions set out in the International Treaty on Plant Genetic Resources for Food and Agriculture (http://www.planttreaty.org/). *Asparagus*, *Brassica* complex, carrot, and eggplant are the vegetable crops included in Annex I of the Treaty, i.e., benefiting facilitated access via the use of the Multilateral System (MLS) formalized with a standard MTA (http://www.planttreaty.org/smta_en.htm), However, AEGIS has decided to extend in Europe the MLS to non-Annex I crops, i.e., those that would not require the SMTA as they fall under the CBD[10] access and benefit-sharing system, based on bilateral agreement between donor of genetic resources and recipients.

The participation in AEGIS is based on the signature of countries of a Memorandum of Understanding (MoU) that includes the rights and obligations of the AEGIS member countries. The MoU was entered into force in July 2009 when the first ten MoUs were signed. At present, 22 countries (Albania, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, Georgia, Germany, Ireland, The Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Switzerland, Ukraine and United Kingdom) have signed the MoU.

Identification of Most Appropriate Accessions (MAAs)

The first step of creating the European Collection is to identify the unique accessions from those proposed by the countries and respective WGs that, according to the ECPGR Steering Committee, agreed selection requirements. A guideline for the selection of the Most Appropriate Accessions (MAAs) was established by ECPGR and possible selection criteria proposed by ECPGR pilot groups during the AEGIS feasibility study. This guideline is available on the AEGIS web site. Accordingly, crop specific selection criteria must be agreed upon by the WGs for selecting the MAAs among possible duplicates. The *Allium* and *Brassica* WGs were selected as model crops for developing the MAA system. Discussions have been ongoing for the last four years or so and the respective results are accessible online at: http://aegis.cgiar.org/documents/crop_specific_documents.html.

The *Brassica* WG carried out a pilot study on passport data of the 3622 accessions of *B. rapa* in the *Brassica* DB. The most relevant descriptors for determining genetic uniqueness were found to be 'accession name', 'country of origin', 'donor number', 'donor code', 'sample status', 'collection number' ,'collection site' and 'other number'. However, the task of identifying MAAs was found to be complex, (i) because of incompleteness of passport data in the DB, in particular for 'accession name', and (ii) because a given accession of an outbreeding species such as *B. rapa*, when regenerated in different places, might undergo a genetic shift at each regeneration, depending in particular on local conditions and number of plants cultivated. A provisional workflow chart for the selection of MAAs has been set up by the *Brassica* WG.

The *Allium* WG concentrated its effort on vegetative alliums (garlic and shallot), within the frame of the EU funded project EURALLIVEG. After consideration of various passport data and of their meaning as regards to accessions uniqueness, molecular fingerprinting was considered essential for the final decision to exclude duplicates from the European collection of MAAs.

Improving and Searching Plant Genetic Resources Documentation

For detecting "probable duplicates" the tomato DB managers at CGN developed a search facility prototype based on an algorithm screening of the passport data. They found 25% of duplicates and 75% of unique accessions. However, the lack of data was a constraint for effective identification of duplicates as well as the need to improve the quality of the data in the DB. The recourse to algorithms to help the identification of potential duplicates within the ECCDBs was acknowledged as a valuable tool by all WGs

[10] CBD: Convention on Biological Diversity, Rio, 1992.

dealing with seed propagated crops, but automated software tools, usable by all WGs are required.

A Quality System

To ensure the high quality of the European Collection, it is necessary that AEGIS participants publish their genebank operation procedures in the form of a genebank manual. Generic and crop specific technical minimum standards should also be adopted and a monitoring and reporting system agreed upon and established. A template for the preparation of the genebank manual and the technical standards are presently being discussed by the ECPGR Secretariat with the Vegetables (and other) Network(s), on the basis of the recent experience of the *Allium* and the *Brassica* WGs.

Searching Efficiency

To speed up the establishment of AEGIS, a project named 'EUROGENBANK', an avatar of AEGIS, was submitted by Bioversity International in 2009 to the EU call within the 7th Framework Programme FP INFRA - 2010 - 1.1.7. This project proposal, not approved so far, will be submitted again. Additional funding is indispensable to facilitate and speed-up the establishment of AEGIS and thus, the establishment of the European Collection.

CONCLUSIONS

Ex situ vegetable genetic resources conserved in European collections are estimated to represent, on average, 43% of the world's accessions of ten crops (Maggioni, 2004). Cooperation between the many public institutions of the 39 countries which manage these resources started in the 1980s with the establishment of an *Allium* Crops WG, thanks to the impetus provided by ECPGR. Today, six WGs, assembled within the Vegetables Network, cooperate and rationalize the management of the genetic resources held in Europe for *Allium*, *Brassica*, cucurbits, leafy vegetables, *Solanaceae* and umbellifer crops. All WGs activities are ongoing and include progressively the various contributions of each member country.

The creation of on line crop specific European Central Databases, containing passport, characterization and evaluation data, is a major achievement of all groups and was technically facilitated as a result of the strong involvement of several national genebank database managers and several EU funded projects. The many other achievements include the finalization of full IPGRI descriptor lists for several crops, the definition of minimum descriptors for several crops to be used by all member countries, the definition of minimum quality standards for collection management (regeneration and conservation), and the safety duplication of many collections. The information contained in the central crop databases for several crops is currently more complete than the information contained in the European EURISCO database[11], which is based on a compilation of the national inventories provided by the countries national coordinators.

Despite the ratification by most European countries of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the integration of the Treaty obligations into national legislations, and the effectiveness of the national coordination vary significantly from one country to another. This hampers the impetus of the European cooperation for the management of plant genetic resources. For this reason, a new initiative, the European Genebank Integrated System (AEGIS) was developed by ECPGR to its community and the six vegetables WGs are eagerly supporting and implementing AEGIS. This initiative is based (i) on the contractual commitment of the participating countries via the official signature of a memorandum of understanding, and (ii) on the creation of a decentrally managed European Collection (as a virtual genebank),

[11] EURISCO (http://eurisco.ecpgr.org/static/about_eurisco.html) is the European equivalent of the System-wide Information Network for Genetic Resources (SINGER) of the Consultative Group on International Agricultural Research (CGIAR) and its partners (http://www.singer.cgiar.org/).

including the most appropriate accessions (MAAs) of the collections held by all member countries. For upgrading the quality of this plant material and of its documentation, the initiative will comprise a quality management system that includes in particular standardized protocols for genebank management and crop specific technical standards. The AEGIS initiative is henceforth the new framework within which the vegetables WGs will operate.

Improved communication on the part of the vegetables WGs is necessary to enhance political and public awareness about the strategic importance of vegetables genetic resources, in particular for present and future food security. The ECPGR Vegetables Network has also recognized the importance to extend its collaboration to NGOs and breeders who maintain and regenerate plant genetic resources, as well as with the ECPGR Network dealing with in situ conservation of cultivated and wild material. Last and not the least, the Vegetables Network aims at strengthening its relationships with scientific and university circles, for an extended use of vegetable crops genetic resources as well as for warning on actual deficiencies, such as the disappearing training of botanists and taxonomists.

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Tables

Table 1. The European Central Crop Databases (ECCDBs) of the ECPGR Vegetable Network.

Crops	Hosting institute and web site
Allium	HRI, Wellesbourne, UK
	http://www2.warwick.ac.uk/fac/sci/lifesci/wcc/gru/ecpallium/
Brassica	CGN, Wageningen, The Netherlands
	http://documents.plant.wur.nl/cgn/pgr/brasedb/
Umbellifers	HRI, Wellesbourne, UK
	http://www2.warwick.ac.uk/fac/sci/lifesci/wcc/gru/ecpumbel//
Solanaceae	
Eggplant	Botanical and Experimental Garden, Nijmegen, The Netherlands
	http://www.ecpgr.cgiar.org/index.php?id=3295#7449
Pepper	Botanical and Experimental Garden, Nijmegen, The Netherlands
	http://www.etae.gov.tr/Default.aspx?ID=capsicum
Tomato	CGN, Wageningen, The Netherlands
	http://documents.plant.wur.nl/cgn/pgr/tomato/
Cyphomandra	COMAV, Valencia, Spain
	http://www.comav.upv.es/Cyphomandra.html
Physalis	COMAV, Valencia, Spain
	http://www.comav.upv.es/Physalis.html
Pepino	COMAV, Valencia, Spain
	http://www.comav.upv.es/muricatum.html
Cucurbits	COMAV, Valencia, Spain
	http://www.comav.upv.es/eccudb.html
Leafy vegetables	
Lettuce	CGN, the Netherlands
	http://documents.plant.wur.nl/cgn/pgr/ildb/
Chicory	GEVES, Brion, France
	http://documents.plant.wur.nl/cgn/pgr/chicory/
Spinach	CGN, The Netherlands
	http://documents.plant.wur.nl/cgn/pgr/spinach/
Minor species	IPK, Gatersleben, Germany
	http://documents.plant.wur.nl/cgn/pgr/minorlv/

HRI, Wellesbourne, UK: Genetic Resources Unit, Warwick HRI, Wellesbourne, UK.
CGN, Wageningen, The Netherlands: Centre for Genetic Resources (CGN), Wageningen, the Netherlands.
Botanical and Experimental Garden, Nijmegen, the Netherlands: Botanical and Experimental Garden, Radboud University Nijmegen, the Netherlands.
AARI, Izmir, Turkey: Aegean Agricultural Research Institute (AARI), Izmir, Turkey.
COMAV Valencia, Spain: Center for the Conservation and Breeding of Agrodiversity, COMAV Genebank, Universidad Politécnica de Valencia, Spain.
GEVES, Brion, France: Groupe d'Etudes et de Contrôle des Variétés et des Semences (GEVES), Brion, France.
IPK, Gatersleben, Germany: Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Gatersleben, Germany.

Table 2. Total number of accessions of vegetable crops and related species included in the European Central Crop Databases (2010) and comparison with the number of accessions recorded in FAO WIEWS (query for region = "ECPGR", http://apps3.fao.org/wiews/germplasm_query.htm?i_l=EN). The crop groups and crops are listed in order to reflect the structures of the existing vegetables ECCDBs.

Crop groups	Crops	No. of acc. in the ECCDBs	No. of acc. in WIEWS	Ratio (%) ECCDBs/WIEWS
Allium		14,194	16,442	86.3
Brassica		23,752	31,061	76.5
Umbellifers crops[1]		9,396	13,006	72.2
Solanaceae	Eggplant	5,896[2a]	3,395[2b]	
	Pepper	9,075	16,679	
	Tomato	21,327	24,280[3]	
	Cyphomandra	84	59	
	Physalis	294	336	
	Pepino	144	5	
	Total	36,820	44,754	82.3
Cucurbits[4]		25,501	34,813	73.3
Leafy vegetables	Lettuce	11,643	13,038	
	Chicory	1,716	2,141	
	Spinach	2,017	2,027	
	Minor spp.[5]	2,154	2,827	
	Total	17,530	20,033	87.5
Grand total		127,193	160,109	79.4

[1] All species listed in the ECCDB, i.e. belonging to the genera *Anethum*, *Apium*, *Carum*, *Chaerophyllum*, *Coriandrum*, *Daucus*, *Foeniculum*, *Pastinaca* and *Petroselinum*.

[2a] *Solanum melongena*, *S. aethiopicum* and *S. macrocarpon* and related species.

[2b] *Solanum melongena*, *S. aethiopicum* and *S. macrocarpon.*

[3] Query of WIEWS made for "*Lycopersicon*" and also for "*Solanum lycopersicum*".

[4] All species listed in the ECCDB, i.e., belonging to the genera *Acanthosicyos*, *Benincasa*, *Bryonia*, *Citrullus*, *Coccinia*, *Cucumis*, *Cucurbita*, *Cyclanthera*, *Diplocyclos*, *Ecballium*, *Echinocystis*, *Gynostemma*, *Kedrostis*, *Lagenaria*, *Luffa*, *Melothria*, *Momordica*, *Praecitrullus*, *Sechium*, *Thladiantha*, *Trichosanthes*.

[5] All species listed in the ECCDB, i.e., belonging to the genera *Asparagus*, *Bunias*, *Cynara*, *Diplotaxis*, *Eruca*, *Erucaria*, *Erucastrum*, *Pseuderucaria*, *Rheum*, *Valerianella*.