Towards a European Plant Germplasm System

The third way

A discussion paper

Lothar Frese[1], Anna Palmé[2], Lorenz Bülow[1], and Chris Kik[3]
to whom responses can be sent

[1]Julius Kühn-Institut (JKI), Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Agricultural Crops, Erwin-Baur-Str. 27, D-06484 Quedlinburg, Germany (e-mail: lothar.frese@jki.bund.de)

[2]Nordic Genetic Resource Center (NordGen), Box 41, SE-230 53 Alnarp, Sweden (e-mail: anna.palme@nordgen.org)

[3]Centre for Genetic Resources, the Netherlands (CGN), Wageningen University and Research Centre, Droevendaalsesteeg 1, NL-6708 PB Wageningen, the Netherlands (e-mail: chris.kik@wur.nl)

Disclaimer: This paper builds on the results of the PGR Secure project funded under the EU Seventh Framework Programme, THEME KBBE.2010.1.1-03, 'Characterization of biodiversity resources for wild crop relatives to improve crops by breeding', Grant agreement no. 266394. The finding have been intensively discussed and further elaborated with the support of experts representing of the stakeholder groups genebanks, public research institutes, breeding companies, non-governmental organisations and policy in Europe. Despite this, the views set out in this discussion paper are those of the authors and do not necessarily reflect the opinion of all representatives of the European plant genetic resources community and the official opinion of the JKI, CGN and NordGen.

Content

Executive summary 2
Towards a European Plant Germplasm System – the third way 3
Recommendations 9
Conclusions 22
Literature 22

Executive summary

An EU/European plant germplasm system that provides European countries with a coherent organisational, technical and information infrastructure for the conservation of plant genetic resources *in situ*, on-farm and *ex situ* does not exist. This is considered a major bottleneck to the efficient and effective conservation of plant genetic resources existing in Europe and a major constraint towards the genetic adaptation of crops by breeding to climate change induced changes of agricultural production conditions.

European countries follow two long-term approaches to meet the challenge of sustainable use of plant genetic resources which includes by definition the need to prevent an exhaustive use (genetic erosion) or even destruction (species extinction) of these resources.

Firstly, the European Cooperative Programme for Plant Genetic Resources (ECPGR) programme is operative since 1980. It was established to facilitate cooperation between countries. Its function was to bring together genebank collection curators, researchers and users of germplasm. The ECPGR was designed to mobilize funds in addition to its very limited core budget which does not allow an active development of a coherent European plant germplasm system similar to the USDA/ARS National Germplasm System (NPGS).

Secondly, the European Union encourage farmers to protect and enhance the environment on their farmland by paying them for the provision of environmental services. The funding mechanism is called agri-environmental measures (AEM) and covers a wide variety of targets amongst which is specific actions for conservation of (botanic) species and their habitats. **42.7 billion** Euro was foreseen for agri-environment payments in the 2007–2013 programming period of the Rural Development Programme of the EU-28 Member States (ECA, 2014). The budget for ECPGR activities donated by the 43 ECPGR member states for a similar programme period was **2.8 million, i.e. 0.007%** of that amount (ECPGR, 2014). There is therefore financial leeway for funding of a European Plant Germplasm System.

Thirdly, we propose organizing a European Plant Germplasm System (EU-PGS) that functions similar to the USDA/ARS NPGS. We call this the third way and put up twelve recommendations for a public debate on and actions and that are necessary to achieve this goal.

1. The remit of a European Plant Germplasm System (EU-PGS) would be much larger than a European network of genebanks. The system would rather be comprised of the stakeholder groups responsible for PGR conservation, for plant genetic and plant breeding research, for plant breeding, as well as agro-NGOs. The system would **organise their relationships** and the flow of information and material (page 9).

2. The establishment of a coherent **technical** EU infrastructure for the **organisation** of conservation of plant genetic resources for food and agriculture measures is urgently needed. National genebanks would be part of the network infrastructure. National genebanks should be supported and backed up by a European Center for Genetic Resources Preservation (EU-CGRP) which would be the central germplasm repository and responsible for the long-term preservation of all accessions maintained by genebanks in Europe (page 11).

3. The establishment of an EU **information infrastructure** for conservation of plant genetic resources for food and agriculture is required to organise the flow of data between national components of an EU-PGS as well as between the EU-PGS, scientific users and the public (page 11).

4. The tasks of genebanks should be disentangled from plant breeding research and plant breeding tasks at the national institutional level as a European network of genebanks functions better if composed of legally independent, equal units with decision-making powers (page 13).

5. The establishment of a legal basis for conservation of plant genetic resources for food and agriculture in the EU similar to Regulation (EC) No 401/2009 of the European Parliament and of the Council of 23 April 2009 on the European Environment Agency and the European Environment Information and Observation Network and by the Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora is of crucial importance. Both legal instruments placed habitat and species conservation on a solid foundation which was the key factor for the great progress made in this domain since 1992 (page 14).

The remaining recommendations concern the need to

- take an inventory of the financial means available to genebanks and to estimate financial means needed for a fully functioning European network of genebanks (page 15)
- increase the visibility of genebanks on the internet (page 16)
- develop a European platform for long-term crop specific pre-breeding programmes (page 17)
- clear uncertainties concerning Access and Benefit Sharing (ABS) rules so that breeding companies can take economic decisions on a save legal basis (page 18)
- strengthen research in order to better understand the amount and geographic distribution of genetic diversity present in priority crop gene pools (page 19)
- strengthen the European agro-NGOs (page 20)
- establish a European Network of Private-Public-Partnership programmes for evaluation of plant genetic resources in Europe (page 20)

The latter seven recommendations address important issues. Weaknesses in these fields do constrain the conservation and sustainable use of European plant genetic resources. However, these weaknesses reflect the effects of a missing regulation for plant genetic resources, insufficient funding at national and European level and a missing joint European organisational, technical and information infrastructure that is needed to conserve plant genetic resource for use today and tomorrow.

Towards a European Plant Germplasm System – the third way

The European region is rich in plant genetic resources, second only to the Middle East in terms of concentration of resources (Vincent *et al.*, 2013). Institutions in Europe engaged in the conservation and use of plant genetic resources altogether maintain and improve a substantial amount of scientific knowledge, technical skills and professional experiences.

- Europe is the cradle of modern plant breeding. Modern plant breeding methods were developed in the second half of the 19th century (Lehmann, 1990).
- One of the most famous European scientists, N.I. Vavilov, founded the first genebank with a worldwide coverage to maintain crop and crop wild relative diversity and to service crop plant research and plant breeding in the 1920s (Kurlovich *et al*., 2000).
- The need to maintain landrace on-farm was stressed by the international plant breeder association in the 1930s (Anonymous, 1931).
- The International Biological Programme emphasized the importance of wild relatives of economic species and called for the organized protection of these species in their natural habitats, i.e. *in situ*. The term genetic reserve was coined in the 1960s (Frankel, 1970).
- The first ontologies for genebank information systems were developed in Europe, and the first computerized genebank information system worldwide became operational in the 1970s in Europe (Seidewitz, 1974, Seidewitz, 1979).
- The European Cooperative Programme for Plant Genetic Resources (ECPGR) became operational in the 1980s (IBPGR, 1984).
- European scientists started to develop the genetic reserve conservation technique in the 1990s (Maxted *et al*., 1997).

Despite this obviously high scientific and technical innovation potential, Europe has failed so far to establish a plant germplasm system that effectively and efficiently prevents genetic erosion in landraces and crop wild relatives and at the same time services research and plant breeding in a way that satisfies users.

It is certainly not a lack of financial resources, a lack of organizational structures or the lack of interest in the subject that prevents the establishment of a European Plant Germplasm System including a network of closely collaborating genebanks. National governments do provide funds for the conservation plant genetic resources and for plant species conservation, however the amount allocated for this purpose is often not adequate. The European Commission operates research and infrastructure programmes endowed with millions of Euro. An average sized research project co-funded by the European Commission costs between 3 and 5 million € and there are many of them.

In 1986, the European Parliament adopted a major resolution which called upon member states and the European Commission to strengthen actions in the field of genetic resources conservation. Since then these bodies produce policy papers stressing the extremely significant role of plant genetic resources for the adaptation of agriculture to changing production conditions whereby plant breeding research and plant breeding plays a pivotal role.

As no analytical study has been carried out to analyse the plant genetic resources conservation and use stakeholder groups in Europe to date, a study was undertaken in the framework of PGR Secure which is a collaborative project funded under the European Union (EU) Seventh Framework Programme (see http://www.pgrsecure.org/). The rationale behind this study is the presence of substantial conservation and use constraints impacting plant genetic resources in Europe. These constraints are currently negatively influencing innovation and hindering attempts to more efficiently meet food security challenges caused for example by a growing human population and a changing climate.

During the study representatives of the five interest groups, genebanks, public research institutes, plant breeders, non-governmental organizations, and governments, were interviewed. In total, twenty countries were visited and 133 semi-structured interviews took place with the various plant genetic resources stakeholders concerned. Also an online questionnaire was carried out which was answered by 226 respondents. The interim results of the study were discussed during a stakeholder conference,

held at Wageningen, The Netherlands, which was attended by more than 80 persons in November 2013. The results of the semi-structured interviews and the online questionnaire were integrated in the final report "On the sustainable use and conservation of plant genetic resources in Europe", which presents the outcome of this conference. The discussion paper presented here capitalizes on the results of the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis presented to the conference participants as well as recommendations agreed upon during the conference.

Today, European institutions pursue two ways of funding plant genetic resources conservation and use activities.

Firstly, the European Cooperative Programme for Plant Genetic Resources (ECPGR) founded in 1980 is financed by the participating countries. Member states provide the ECPGR with funds for the secretariat, the AEGIS process, the operation of EURISCO and small actions of working groups. The technical work is mainly implemented by institutions located in the member countries on an input in kind basis. The programme is guided by the steering committee, composed of representatives from the 43 member states, and assisted by an executive committee and secretariat. The ECPGR is organised into 18 crop specific and three thematic working groups. The member states de facto paid 1,950,286 € for phase VIII (2009-2013). In phase IX the programme allows more flexibility in terms of the composition of working groups and with respect to the planning and implementation of actions. The working groups in the ECPGR compete for very limited amounts of action funds (15,000 € per action and working group) (ECPGR, 2014). As in the past the progress achieved by working groups relies on the interest of individuals in specific subjects and the ability of working groups to attract project funds from sources outside the ECPGR programme.

The ECPGR is above all a voluntary association of individuals with a common goal and the willingness to contribute within the limits of their capabilities and those of their organisations to joint activities. This community spirit is a valuable human resource that should be prudently managed and put to the best possible use.

Many of the working groups succeeded to attract project funds for plant genetic resources conservation and use actions through the European Community Programmes on the Conservation, Characterization, Collection and Utilization of Genetic Resources in Agriculture (Council Regulation (EC) No. 1467/1994 and Council Regulation (EC) No. 870/2004). Both programmes proved beneficial to working groups in that additional financial means became available for the collection, evaluation, documentation and exploitation of genetic resources. The actual amount of EU co-funding of plant genetic resources projects summed up to 6.4 million € for arable crops, fruits, vegetables and spices implemented in the second programme (Council Regulation (EC) No. 870/2004). In the field of plant genetic resources, neither of the programmes helped build a European infrastructure for plant genetic resources conservation and use or strengthening existing components of a future European infrastructure such as EURISCO, the European Plant Genetic Resources Search Catalogue, which was funded using FP5 funding.

A programme such as the ECPGR stands on a vulnerable base. It has to balance the overriding long-term interest of the steering committee in the establishment of a fully functioning European Plant Germplasm System against the interests of individuals which invest work time into the ECPGR and expect to derive some short-term benefit from the participation in working group activities. The appeal of the steering committee to invest work time in the establishment of AEGIS (A European Genebank Integrated System) exemplifies this conflict between overriding and individual interest. AEGIS does not create short-term individual benefit. On the contrary individuals are kindly called upon by the steering committee to provide input in kind to this process at a time when staff and financial resources

available to institutions at the national level are getting less. The individuals are in conflict between personal targets and targets of the steering committee promising the emergence of a fully operative European plant germplasm system, a promise which is given since the establishment of the ECPGR and which so far has not materialized in 2014, i.e. about 30 years after the establishment of the ECPGR. This discussion paper does not question the aims of the ECPGR programme but the funding concept applied to reach the targets.

The infrastructure for a European Plant Germplasm System should meet the requirements of the *ex situ*, *in situ* and on-farm conservation techniques, i.e. it should be based on a complementary plant genetic resources conservation strategy and work plans. The European Plant Germplasm System should be established and be fully operational in sufficient time to be able to mitigate climate change induced damages to agricultural production systems through plant germplasm utilization programmes. The forecasted timing and impacts of climate change on agriculture will not allow us to try for another 30 years to establish an efficient and effective European Plant Germplasm System.

Without doubt, this ambitious goal cannot be achieved with an ECPGR budget of approximately 2.8 million € for a programme phase of five years and an unknown amount invested by institutions into the ECPGR on an input in kind basis.

Secondly, a funding mechanism exists in the European Union which is completely independent from ECPGR activities. It is called agri-environmental measures (AEM) and provides payments to farmers who subscribe, on a voluntary basis, to environmental commitments related to the preservation of the environment. AEM are designed to encourage farmers to protect and enhance the environment on their farmland by paying them for the provision of environmental services. Farmers commit themselves, for a minimum period of at least five years, to adopt environmentally-friendly farming techniques that go beyond legal obligations. In return, farmers receive payments that provide compensation for additional costs and income foregone resulting from applying those environmentally friendly farming practices in line with the stipulations of agri-environment contracts. Agri-environment payments encourage farmers to adopt agricultural activities or levels of production intensity that deliver positive environmental outcomes. The conservation of high-value habitats and their associated biodiversity is an example of commitments covered by national/regional agri-environmental schemes. The costs are part-financed from the EU budget (EC, 2014a). The estimated expenditure for agri-environmental measures amounted according to Whitefield (2006) to 3.5 billion € annually. The EU and member states spend on average the equivalent of USD $7.2 billion per year on payments to farmers that are designed to safeguard environmental benefits (Thorne, 2012). Mathews (2011) speaks of 22 billion payments for agri-environment measures during the 2007-2013 RD programming period. However, it should be noted that these payments are under national control and the payments are applied differently in each EC country.

The measures cover a wide variety of targets amongst which is specific actions for conservation of local breeds or conservation of (botanic) species and their habitats. Whitfield (2006) reported on a study on the effects of agri-environment schemes across Europe, a project called EASY. The authors of the study had difficulties to measure even small benefits arising out of AEM for the environment. They further argued that models to explain the performance of AEM schemes do not exist, and hence effects cannot be measured. Whitefield (2006) cited the European Court of Auditors which wrote in a critical report on the subject, "*If a measure cannot be adequately checked, it should not be the subject of public payment*." This is certainly the case for actions dealing with the conservation of plant genetic resources on-farm through agri-environmental measures. Even if such models for assessing the outcome of measures would exist the conservation of plant genetic resources using agri-environmental measures will still be founded on a vulnerable base as the farmers as main actor contribute on a

voluntary basis. In addition, farmers run companies and the main interest of a company is to generate income under the condition of a competitive market. It is therefore no surprise that the increase of farm revenue was mentioned by 79% of farmers interviewed in Belgium as the first and main motivation for participating in agri-environmental measures while the positive impact on the natural environment was mentioned by 27% of farmers (van Herzele *et al*., 2013).

In September 2014, the European Court of Auditors renewed the criticism and wrote that the European Commission and member states must ensure better use of the European Regional Development Fund (ERDF) for halting biodiversity loss. It is strange to see that **42.7 billion** Euro was foreseen for agri-environment payments in the 2007–2013 programming period of the Rural Development Programme of the EU-28 Member States (ECA, 2014) and that this amount was spent without much measurable effects, while the ECPGR, once founded by European countries with the objective of conserving one of the most important resources of agriculture, the plant genetic resources, is supported by the 43 ECPGR member states with **2–3 million** Euro for a similar programme period.

We think therefore that it is time to discuss **a third way** towards the conservation and sustainable use of plant genetic resources in Europe. We suggest establishing a European Plant Germplasm System similar to the National Plant Germplasm System (NPGS) operated by the USDA/ARS. This goal is attainable as components of a European Plant Germplasm System exist already. We are convinced that such system can only function as efficient and effectively as the NPGS if it is reasonably funded. As a rule of thumb the *ex situ* conservation including related research costs approximately 60 € / accession and year (personal communication of Dr. U. Lohwasser of 23 May, 2014 and Dr. P. Bretting of 22 May 2014). 1,725,315 accessions are kept in European genebanks resulting in an assumed total annual costs for *ex situ* conservation of 103,518,900 € per year for the whole of Europe. In view of the 34 billion € spent for agri-environmental measures within the EU-28 a budget of 100 million € / year is not unreasonable. The question rather is whether the stakeholder groups and policy makers feel that having a European Plant Germplasm System is worth this amount.

During the final session of the stakeholder conference participants agreed on a set of weaknesses and threats that are given next. These are the most important constraints of conservation and use of plant genetic resources (PGR) in Europe.

Stakeholder group Genebank

- Most gene banks are not independent with respect to their program, funds or staff. Crop experts are thus forced to prioritise research work at the expense of conservation work.
- *Ex situ* management of PGR of many EU gene banks is not based on defined, written quality management standards. Limited funding exists for basic tasks of maintaining and regenerating PGR.
- Gene banks are seldom leading the development of national *in situ* management and on-farm management strategies. Many different governmental authorities are responsible and national strategies for in situ/on-farm management are often missing.
- Insufficient support of germplasm conservation activities at all governmental levels.

Stakeholder group Public Research Institutes

- Financial means for research are decreasing and financial resources are unevenly distributed between the EU member states, leading to a loss of expertise and of long-term breeding research programmes.
- Instability of research institute policies concerning PGR and pre-breeding research programs.

- Several institutes operate their own collections. This may unnecessarily hinder accessibility of germplasm.
- Short-term project funding for breeding research and instabilities of policies (i.e. target crops / products) in reaction to the development of global markets.
- Insufficient visibility of PGR collections (passport, characterisation and evaluation data) on internet is a problem for selecting the appropriate accessions, which limits the use severely.
- Lack of implementation of PGR conservation and use policies in Europe are limiting access to and potential use of PGR resources. As a consequence, crop wild relatives are not well represented in gene banks and landraces conservation is not systematically performed.

Stakeholder group Breeders

- Smaller companies have limited capacities for scientific cooperation and for conducting their own pre-breeding programs or developing breeding tools.
- Limited breeding in some fruit trees, edible fungi, grain legumes and neglected crops as well as crops for marginal areas in Europe.
- Limited knowledge on international ABS (Access and Benefit Sharing) arrangements at smaller companies.
- International ABS and MLS (Multilateral System) arrangements should facilitate the exchange of PGR, but it is not working efficiently and therefore limits the exchange.
- Lack of characterization and evaluation data in (inter)national databases limits targeted choice of accessions from gene bank holdings.
- Limited public funds for breeding research and maintenance of gene banks is causing considerable problems.

Stakeholder group agro-NGO

- Lack of or insufficient national landrace inventories in some countries.
- Limited involvement in the national PGR circuit with other stakeholders.
- Shortage of (employed) staff and annual budgets of agro-NGOs.
- Future EU seed directives may limit the livelihood of agro-NGOs.
- Strengthening of intellectual property rights (UPOV 91, patents, copy rights) may cause conflicts of interest between the governmental and non-governmental sector.
- The insufficient information systems operated by the governmental sector do not allow recording, documentation and dissemination of farmer's knowledge.

Stakeholder group Governments

- In some countries PGR issues have low priority within the Ministry(ies) responsible and the complexities of GR issues are not well perceived by people in a position of responsibility at the national or European level.
- If Ministries share responsibilities they do not always cooperate in a systematic and structured manner on PGR issues, which is a strong disadvantage in particular in the case of *in situ* conservation approaches.
- The PGR community and the commercial plant breeding sector in Europe as a whole has so far failed to link the issue of biodiversity/PGR protection to the aspect of climate change mitigation.

- The food processing sector is the greatest industrial branch in the EU. Despite this the economic importance and the number of enterprises and employees in the agricultural sector is declining in many European countries. In addition, a critical view of the public on agricultural policies and its consequences will not create a favourable condition for a strong support of agro-biodiversity issues. Taken together this could lead to an insufficient budget for agricultural research, including breeding research and PGR conservation measures.
- Fear of increased administrative burdens and distrust of existing legal frame result in industries/breeders establishing private gene banks that might undermine public funding of existing gene banks.

Recommendations

We here put up for discussion the twelve recommendations published in the final report. The recommendations are presented in a different structure and sequence compared to the report to facilitate and stimulate discussions on our vision of a European Plant Germplasm System.

Recommendation 1. We suggest the establishment of a European Plant Germplasm System

Why is this important?

The remit of a European Plant Germplasm System (EU-PGS) would be much larger than a European network of genebanks. The system would rather be comprised of the stakeholder groups responsible for PGR conservation, for plant genetic and plant breeding research, for plant breeding, as well as agro-NGOs. The system would **organise their relationships** and the flow of information and material as to achieve the best possible conservation and use of plant genetic resources in Europe, thus avoiding overlap and maximizing cooperative benefits. *Progress towards the target:*

A European Plant Germplasm System (EU-PGS, Figure 1) has elements corresponding to the USDA/ARS NPGS as described by White *et al*. (1989). The reason why we chose this figure simply is that we Europeans have already created several of the elements of an EU-PGS; they are however not well connected and often far from sufficiently funded.

(a) There are institutions specialised on plant taxonomy such as Royal Botanic Gardens, Kew and more specifically in the PGRFA context the Vavilov Institute in St. Petersburg.

(b) The ECPGR programme provides a platform for curators of *ex situ* collections, mainly.

(c) In particular EU countries with a strong seed industry operate crop specific networks such as in France. Some countries established associations composed of experts from genebanks, the research sector, and plant breeders which screen, evaluate und utilise genetic resources such as in Germany.

(d) A European plant genetic resources information infrastructure (e.g. EURISCO, national inventories) is emerging.

(e) The ECPGR steering committee, the ECPGR Executive Committee and Secretariat as well as the Committee on the conservation, characterisation, collection and utilisation of genetic resources in agriculture established to assist the European Commission in the implementation of COUNCIL REGULATION (EC) No 870/2004) called the "EU genetic resources committee", exist. Some of the experts are involved in the ECPGR and the EU genetic resources committee as well.

Storyline (Recent trends, current status and projections)

Engels *et al.* (2012) published a strategy paper on the ECPGR relationship with the European Union/European Commission. Ad hoc working groups were asked by the ECPGR steering committee to write concepts for a European *in situ* and on-farm conservation strategy as well as strategy for evaluation of plant genetic resources. The *in situ* and on-farm strategy papers were delivered and circulated within the ECPGR member states for discussion, amendment and completion. At the end of the consultation process it is to be discussed whether the ECPGR programme could be developed further towards a programme agency that manages EU funds for plant genetic resource conservation and use. A positive outcome of the anticipated consultation process would allow realising the vision of a European Plant Germplasm System.

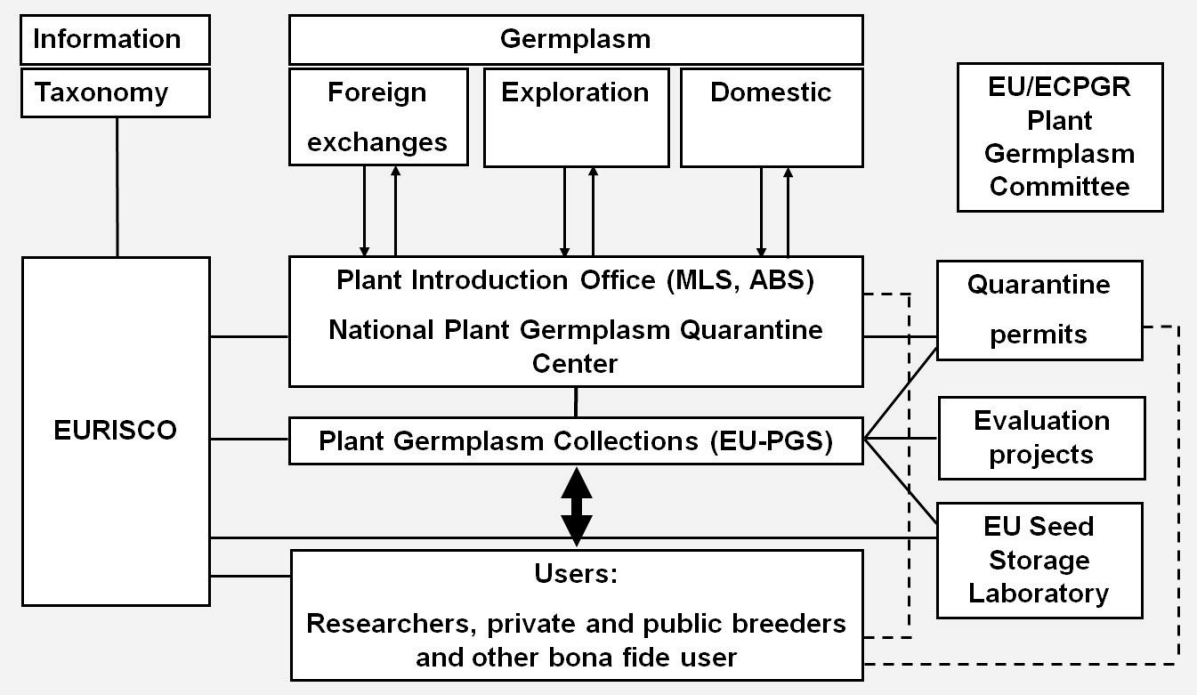

Fig. 1. Schema of an EU Plant Germplasm System.

Information and germplasm is exchanged with European counterparts and partners outside of Europe. A central Plant Introduction Office supervises germplasm exchange, advises and guides plant explorations and collecting missions outside of Europe, and is kept informed on domestic explorations and collecting missions. A central taxonomy unit advises and supports collectors, collection and database managers. The central seed storage laboratory stores backup samples of germplasm collections held within the EU Plant Germplasm System. National Plant Germplasm Systems run quarantine centres and issue quarantine permits according to EU rules. EURISCO is imbedded in a European Plant Genetic Resources Information Infrastructure. It functions as central access point within a network of national information systems that keep and manage data on plant genetic resources. Data from evaluation projects are recorded and managed by these information infrastructure components and made available to the user community via EURISCO. The EU Plant Germplasm System is supervised by a Plant Germplasm Committee.

Actions to enhance progress towards the target:

The process has been started by the ECPGR steering committee. After the approval of a complementary plant genetic resources conservation and use strategy by the ECPGR community and steering committee, the ECPGR secretariat should contact the European Commission and consult on

the paper of Engels *et al.* (2012) and the complementary conservation strategy to explore options for a European Plant Germplasm System.

Recommendation 2. Establish a legal basis for conservation of plant genetic resources for food and agriculture in the EU.

Why is this important?

A coherent European Union policy based on EU law is a pre-condition for an EU plant genetic resources programme and Plant Germplasm System that sufficiently services the global user community in a way which is adequate for an economically strong region such as Europe.

Progress towards the target:

This issue has not been discussed, yet.

Storyline (Recent trends, current status and projections):

The CBD and IT-PGRFA are binding according to international law. The signatory parties shall in accordance with its particular conditions and capabilities and as far as possible and as appropriate perform measures within the country of the signatory parties. It means that the CBD and IT-PGRFA allow an interpretation of the range and intensity of actions unless national laws do not specify and quantify mandatory actions in implementing laws. Such laws do not exist within EU member states. The legal basis for plant genetic resources conservation is thus very weak as compared to habitat and species conservation. The latter are ruled by Regulation (EC) No 401/2009 of the European Parliament and of the Council of 23 April 2009 on the European Environment Agency and the European Environment Information and Observation Network and by the Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Both legal instruments place habitat and species conservation on a solid foundation which was the key factor for the great progress made in this domain since 1992.

Actions to enhance progress towards the target:

There is enormous plethora of EU directives and regulations ruling our economies and daily lives. Strikingly, a discussion on the possible effects of a directive and regulation for plant genetic resources has not even started. The CBD and IT-PGRFA as well as derived policy papers should be used to establish a legal basis for conservation plant genetic resources for food and agriculture in the EU. A sound legal basis would initiate a formalised process leading to an EU conservation and sustainable use strategy, an EU action plan and corresponding national strategies and plans.

Recommendation 3. Establishment of a **technical** EU infrastructure for the **organisation** of conservation of plant genetic resources for food and agriculture measures.

Why is this important?

Plant genetic resources are considered one of the most important assets for adapting agricultural production to the climate change. Plant breeding must be able to keep pace with these rapid changes. It is therefore of utmost importance to establish a technical European infrastructure that supports *ex situ, in situ* and on-farm conservation and allows straightforward access to information and germplasm.

Progress towards the target:

Almost all European countries have established and are operating one or several plant genetic resources collections. Plant genetic resources in Europe are thus maintained in a decentralized genebank network.

The development of A European Genetic Resources Integrated System (AEGIS, called the virtual European Genebank) goes along with the development of the AEGIS Quality Management System (AQUAS) (ECPGR, 2014). The intended management of germplasm collections at a high quality level is a very important step towards the organisation a European Plant Germplasm System as it harmonises management procedures across genebanks in Europe. Comparable management procedures create trust which is precondition for the organisation and implementation of task-sharing within a network of decentralised genetic resources holdings.

Storyline (Recent trends, current status and projections):

The ECPGR programme has been revised lately. The new mode of operation allows more flexibility in terms of nomination of experts and the forming of working groups for specific actions. An assessment of the new mode of operation is likely possible in 2–3 years when first actions have been implemented, closed and evaluated. An organisational infrastructure for plant genetic resources exists and is well developed. Actions of the new ECPGR programme will be focussed on four main outputs, i.e. AEGIS, EURISCO, agreement on a European *in situ* and on-farm concept, strengthening of relations between genebanks and users of germplasm.

The ECPGR community is currently debating and reviewing two concept papers, the *in situ* concept "Preserving Diversity: a concept for *in situ* conservation of crop wild relatives in Europe" (Maxted *et al.*, 2013) and the on-farm concept "The ECPGR concept for *in situ* (on-farm) conservation in Europe" (Negri *et al*., 2014). The genetic reserve conservation technique has been developed to promote *in situ* conservation of the wild relatives of domesticated species. It is planned to maintain genetic diversity *in situ* by a European network of individual genetic reserves. The network of *ex situ* holdings would complement and backup these *in situ* conservation activities.

The older idea of establishing a network of crop specific centres of excellences across European countries has been set aside. Instead, the AEGIS process was started which is a way of task-sharing accession-wise. The concept included the idea of disentangling and streamlining multi-species collections and to create crop specific genebanks within centres of excellences to allow for a better integration of *ex situ*, *in situ* and on-farm conservation actions with genetic diversity, characterisation, evaluation, and pre-breeding research. This concept was launched by CGN in the 1990s and may come up again as it is for scientific and pragmatic reasons still a valid concept. CGN obviously adheres to the concept as indicated by the statement "*CGN aspires to be the vegetable genebank of Europe*" on its homepage.

Actions to enhance progress towards the target:

A process should be initiated that leads to the establishment of a sufficiently funded organisational and technical EU infrastructure for conservation of plant genetic resources for food and agriculture that integrates existing national components and assists in the enhancement of these national components. This process should be guided by the ECPGR and the EU genetic resources committee.

The strategy paper of Engels *et al.* (2012) and the development of specific conservation strategies for the *ex situ*, *in situ* and on-farm domain are important steps. Once the ECPGR steering committee has discussed the domain specific strategies and agreed to an overall strategy, the ECPGR and the

European Commission should in particular debate how to organise and finance a European Plant Germplasm System.

Recommendation 4. Establishment of an EU **information infrastructure** for conservation of plant genetic resources for food and agriculture.

Why is this important?

Users are currently confronted with a plethora of information systems with different user-interfaces and search tools. Compared to the Genetic Resources Information System (GRIN) managed by the USDA/ARS it is very difficult and time-consuming for users without intimate knowledge of the European genebank community to find and order material. This is a major constraint towards the use of genetic resources kept in European genebanks in plant breeding and crop production.

Progress towards the target:

Almost all European countries have established and are operating a plant genetic resources information system. Steinbach *et al.* (2013) describe the development of modern plant genetic resources information systems that also integrate genetic and genomic data. With the support of research and development funds provided by the European Commission and other agencies ECPGR working groups established a large variety of crop specific data bases (ECCDB), the European Plant Genetic Resources Search Catalogue (EURISCO) and since short the Plant Genetic Resources Diversity Gateway for the conservation and use of crop wild relative and landrace traits. In particular the establishment of EURISCO has fostered the standardisation of documentation and information management procedures.

Storyline (Recent trends, current status and projections):

EURISCO and the Diversity Gateway are two cross-functional systems that provide information on plant genetic resources but do not yet function as a central access point and one-stop-shop for users wishing to order genetic resources accession from European genebanks.

EURISCO is currently managed by a single IT-scientists, the Diversity Gateway was established during the lifetime of the PGR Secure project which ended on 31 August 2014. Even though the development of the latter is planned to be taken forward in other projects, under these financial conditions a consistent work progress resulting in a European GRIN-like structure within the next 5-10 years is not very likely. The development of a EURISCO towards an information system that can additionally cope with the data documentation and management requirements of the *in situ* and on-farm conservation sector, as is currently been discussed within the ECPGR, would be a challenge on top.

Actions to enhance progress towards the target:

A process should be initiated that leads to the establishment of a sufficiently funded EU information infrastructure for conservation of plant genetic resources for food and agriculture that integrates existing national components and assists in the enhancement of these national components. This process should be guided by the ECPGR and the EU genetic resources committee. As EURISCO is an important infrastructure element of a European Plant Germplasm System, the ECPGR and the European Commission should in particular debate how to finance the improvement and long-term operation of EURISCO. April (1979) described the concept and state of development of the later GRIN and noted that *practical financial aspects also play an important role in developing the system*

so that the eventual operation will realistically reflect the available funds. The USDA/ARS evidently follow this recommendation and brought tasks and funds into balance which explains the high performance of the GRIN today. GRIN is currently operated by 10 persons. Unlike the USDA/ARS we Europeans seem to avoid addressing the real costs related to the development and operation of plant genetic resources information systems. As EURISCO is an important infrastructure element of a European Plant Germplasm System, funds required for the improvement and long-term operation of EURISCO and its extension towards a GRIN-like system should be a first and central discussion point.

Recommendation 5. Disentangle juridically and financially genebank tasks from plant breeding research and plant breeding tasks at the national level

Why is this important?

A network of reliable genebanks, i.e. genebanks with a comparable mandate and juridical status, would be a central component of a European Plant Germplasm System. Today, genebanks are often an integral part of a research institute and seldom independent in terms of mandate, programme, staff and budget. As the operation of a genebank entails long-term routine service tasks, in times of financial pressure on the institution managing the genebank, resources tend to be shifted from the service tasks to research tasks. The latter generate short-term scientific outcome and thus are thought better suited to justify the existence of a research institution.

Progress towards the target:

There is only one juridically independent genebank in Europe, namely the regional Nordic genebank (the Nordic Genetic Resources Centre, NordGen). The Centre for Genetic Resources, the Netherlands (CGN) and the Genebank of the Institute for Plant Genetics and Crop Plant Research are not juridically independent, however they all have an earmarked budget.

Storyline (Recent trends, current status and projections):

When asked about funding of *ex situ* genebank work during personal interviews (Annex I to the Report "On the conservation and sustainable use of plant genetic resources") the self-validation of genebanks ranged between "reasonable but decreasing funds" and "poor" funding. When the same stakeholder group was asked anonymously with the help of an online questionnaire 83% of the genebank representatives considered instability of funding and the shift from permanent funding to project funding as the major constraint to their work. This concerns the *ex situ* conservation technique.

The juridical and financial independency is even more important if genebanks are mandated to facilitate *in situ* and on-farm conservation strategies. Ideally the application and control of conservation management measures should be a joint activity of the PGRFA sector and the nature conservation sector. The tasks of a genebank comprise responsibility for *ex situ* conservation activities and the advice on and guidance of *in situ* and on-farm activities. While the *ex situ* conservation of genetic resources in genebanks has a long history in Europe the development of conservation strategies and techniques that should actually be complemented by the *ex situ* conservation technique is lagging behind.

As long as there is no common agreement on how and who should organise and control complementary conservation measure a discussion on funding would be premature.

Actions to enhance progress towards the target:

A European Plant Germplasm System should be based on national partner genebanks that are juridically and economically independent from the host institute as to ensure their full and long-term functioning. A scientific or geographical separation from research institutes is not recommended, as it would complicate the cooperation between the genebank with breeding researchers in the field of evaluation and pre-breeding. The genebank should have at least an earmarked budget, programme and staff that are not intermingled with the rest of the institute. Such organisational solution requires an independent genebank board whose members are to be nominated by the Ministry responsible for the genebank. The board would foster and overview the genebank's work plan, budget and human resources issues.

We respectfully ask Ministries responsible for the functioning of the national genebank(s) to take our recommendation into consideration.

Recommendation 6. Inventory of financial means available to genebanks and estimation of financial means needed for a fully functioning European network of genetic resource collections (*ex situ, in situ* and on-farm)

Why is this important?

Only if the current expenditures related to the *ex situ* conservation of plant genetic resources in Europe are known and the costs for a fully functioning network of European genebanks are estimated a public debate on the societal value and costs of genebanks can be started. Similarly, the costs of *in situ* and on-farm conservation should be evaluated at a later stage when it has become clear how such a complementary conservation system should be organised.

A public debate can help clarifying to what extend policy and the public is prepared to pay for the conservation of plant genetic resources.

Progress towards the target:

In all European countries the responsible Ministries or institutions hosting a genebank have allocated a budget to a genebank, genebank department or working group. The data are presented either in internal or public annual reports.

Storyline (Recent trends, current status and projections):

Engels *et al.* (2012) suggest in chapter 3.4 "Ex situ conservation, characterization and evaluation of PGRFA" increasing the funding volume of a new programme on conservation, characterisation, collection and utilisation of genetic resources in agriculture to succeed Council Regulation 870/2004 (GENRES) to 10 million € / year and to extend the duration of the programme to 10 years. The sum of 100 million € of additional funding of plant genetic resources work in the EU does not seem a disproportionate demand considering the sub-optimal functioning of national genebanks in Europe. This amount would have to be shared by the animal and forest genetic resources sector.

As explained under recommendation 2, a discussion on funding of *in situ* and on-farm measures would be premature currently. Nevertheless a few thoughts are described next.

If a GENRES programme emerges again, the financial means should not be spread over a series of more or less crop specific projects but invested into the improvement of national genebanks though the EU co-funding mechanism, i.e. into the building of the European plant genetic resources conservation infrastructure. On the long run, a well developed infrastructure will be more beneficial to users than a series of time-bound and crop specific projects.

Within the HORIZON 2020 – WORK PROGRAMME 2014-2015 Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy, the European Commission allocated 28 million € to projects aiming at the enhanced conservation of livestock and crop genetic resources in ex situ and in situ/on-farm conditions (SFS-07a and SFS-7b) . The projects will likly resemble those funded under Council Regulation 870/2004 and contribute to on-going initiatives seeking to improve the management of existing collections and databases and use of genetic resources in breeding and agricultural production (EC, 2014b). Due to their properties (short-term funding, continuity depends on the skills of project teams to aquire funds for follow-up projects), research project can assist improving on-going activities but they are not suited to build a reliable infrastructure for the conservation of genetic resources that meets the requirements of users.

The application of the genetic reserve technique for *in situ* conservation of plant genetic resources would require the formal involvement of local nature conservation agencies. The only species and their populations that are actively managed *in situ* are crop wild relatives that happen to be listed in the annexes of the Council Directive 92/43/EEC of May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive). As the capacities of the nature conservation sector are also limited any actions beyond the legally binding, such as the establishment of a European network of genetic reserves, would require additional or a redirection of existing means.

The conservation of crop genetic diversity within the agricultural production system is an even more complex matter than *in situ* conservation. On-farm conservation activities have spatial and temporal dimensions which are superimposed by cultural, social, economic and political trends. It is not yet clear what on-farm conservation activities in Europe should look like and how they can be supported and steered so that they add to the conservation of plant genetic resources in a complementary and predictable manner. When the on-farm conservation strategy reaches the operative state, the European Agricultural Fund for Rural Development (EAFRD) can be used to support on-farm conservation actions.

Actions to enhance progress towards the target:

To identify the financial needs for the establishment of European infrastructure, national genebanks should make available information on the annual budget to the ECPGR secretariat and EU genetic resources committee. They should explain why additional funds are needed and how funds would be invested to develop genebanks towards a component of an EU Plant Germplasm System. The *ex situ* conservation technique is established since long and costs can be estimated fairly quickly. As the implementation of the *in situ* and on-farm conservation in practice is still at the beginning, the estimation of costs for *in situ* and on-farm should follow later.

Recommendation 7. Increase the visibility of plant genetic resources collections on the internet

Why is this important?

The lack of visibility of genebank collections as well as inventories of plant genetic resources managed *in situ* and on-farm on the internet along with the sub-optimal functioning of national genebank information systems is a serious problem impeding the flow of genetic resources into research and breeding.

Progress towards the target:

EURISCO was established and can be developed towards a central access point to Europe's plant genetic resources collections.

Storyline (Recent trends, current status and projections):

EURISCO, as the potential central access point to Europe's plant genetic resources in *ex situ* holdings provides information on national inventories. ECPGR presents a list of national multi-crop database on the website (ECPGR, 2014). PGR-COMNET visualises the location of all institutions physically holding genetic resources collections and guides users to the respective websites (Frese *et al*., 2014). Despite this, national genebanks in Europe cannot be readily found with the help of a search engine.

Actions to enhance progress towards the target:

A specific website at a prominent position of the ECPGR homepage that leads users to genebanks' hompage in the ECPGR member states (and not to the so-called implementing agencies!) would be simple manner of increasing the visibility of European genebanks on the web.

Accession numbers filed in EURISCO could be linked with the genebanks' websites managing the holding or with the online ordering system of a genebank. For that purpose all national information systems should be technically enabled. This action is technically more demanding and is thus depending on the implementation of recommendation 4.

Recommendation 8. Develop a European platform for long-term crop specific pre-breeding programmes

Why is this important?

Without pre-breeding plant genetic resources stay unused on the shelves of genebanks. In particular long-term pre-breeding programmes constitute an infrastructure element of a European Plant Germplasm System. They are needed to maintain and broaden the genetic base of highly productive and adaptable breeding material and form a bridge between wild/exotic genetic resources and advanced breeding pools. Knowledge and material is seldom exchanged as individual programmes and projects are not systematically linked with each other.

Progress towards the target:

In wheat (e.g.: Goldringer *et al*., 2001) and spring oat (Howarth *et al*., 2014) pre-breeding programmes exists or have been started recently. Although such programmes were launched for two reasons (scientific and maintenance of genetic diversity in evolving populations), they are operated by public research institutes for scientific purposes, mainly. Importantly, there are also pre-breeding projects that are partnerships between public research and commercial breeding companies, for example the ongoing Nordic Public-Private-Partnership projects on barley, rye grass and apple. Such PPP projects assure the relevance of the pre-breeding activities for the commercial breeding sector and are a good way to directly channel exotic material as well as new breeding tools into commercial breeding.

Storyline (Recent trends, current status and projections):

There is a trend in Europe to close long-term pre-breeding programmes despite the pivotal role of plant breeding in improving food security. This trend needs to be reversed to ensure that valuable breeding pools are continuously adapted to changing climatic conditions.

Pre-breeding refers to all activities designed to identify desirable characteristics and/or genes from unadapted material that cannot be used directly in breeding populations and to transfer these traits to an intermediate set of material that breeders can use further in producing new varieties for farmers. It is a necessary first step in the use of diversity arising from wild relatives and other unimproved

material (GIPB, 2014, Hausmann *et al.*, 2004). In the context of this discussion paper pre-breeding shall be understood as breeding activity designated "incorporation" by Spoor and Simmonds (2001). It describes the development and long-term management of genetically broad, adapted populations with large variation and acceptable performance level. Bosemark (1990) described these populations as feeder populations assimilating unadapted material. Through several cycles of recurrent selection the feeder population is upgraded until its performance approaches that of commercial varieties.

Actions to enhance progress towards the target:

The rolling negotiations on public funding of EU breeding research and innovation programs provide an opportunity to intensify the communication between the plant breeding research sector, plant breeders and policy makers on this issue. European Commission's Directorate General for Agriculture and Rural Development recently established the European Innovation Partnership (EIP) Service Point within the EIP Network to enhance communication and cooperation between all innovation actors, including farmers, advisors, agri-business, civil society, and researchers, working at EU, national and regional level. EIP would be a suitable platform to discuss how activities and competences could be brought together and how existing infrastructures required for such long-term activity could be maintained and expanded. National crop or crop group specific networks like the Pulse Crop Genetic Improvement Network (PCGIN, 2014) that are connected with similar networks at the EU/European level could be a way forwards towards the establishment of such platforms.

Recommendation 9. Clear uncertainties concerning Access and Benefit Sharing (ABS) rules so that breeding companies can take economic decisions on a safe legal basis

Why is this important?

In particular plant breeding companies consider legal uncertainties concerning Access and Benefit Sharing (ABS) rules as a major constraint to the use of plant genetic resources. It is not the intended payment itself but rather the uncertainty concerning the scope, i.e. the range of species and other types of materials, costs for administrative procedures, and liabilities which makes the calculation of costs related to the use of a plant genetic resources collected after the coming into force of the Nagoya protocol for the development of a new variety impossible.

Progress towards the target:

The proposed Regulation of the European Parliament and of the Council on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in the Union (EC, 2014), in particular the establishment of a Union register of trusted collections (paragraph 28), may be a way forward.

Storyline (Recent trends, current status and projections):

Access to plant genetic resources is regulated by the International Treaty (FAO, 2004) for a limited number of crops that are essential for the global food security. The Nagogya Protocol of the CBD defines rules for access and benefit sharing with respect to the majority of species including plant species. The Nagoya Protocol may come into force in the European Union in 2014 and shall be implemented by the member states as stipulated in Regulation of the European Parliament and of the Council on Compliance Measures for Users from the Nagoya Protocol Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in the Union (EU, 2014). However, the regulation is currently challenged by a group of German plant breeding companies filing a complaint against this regulation to the European Court of Justice in July, 2014.

Actions to enhance progress towards the target:

Actions, i.e. a revision of version 2 of the regulation, should be taken to clear the legal uncertainties regarding ABS rules after the European Court of Justice has taken a decision.

Recommendation 10. Research should be strengthened to better understand the amount and geographic distribution of genetic diversity present in priority crop gene pools.

Why is this important?

The operation of genebanks, the management of networks of genetic reserves and on-farm conservation activities are to be financed by the tax payer who has a right to know whether public funds are being spent effectively and efficiently. Therefore, decisions concerning the conservation of genetic diversity are to be based on the SMARTER (**S**pecific, **M**easurable, **A**chievable, **R**ealistic, **T**erminated, **E**valuable, **R**evisable) goal setting technique. The identification of genetic conservation goals is central for policy makers who have to assess the effects of policy decisions concerning the conservation and sustainable use of plant genetic resources and to revise research policy when indicated. Without an understanding of the structure and amount of genetic variation in a target crop or species, it is not possible to make scientifically sound conservation decisions or design monitoring activities.

Progress towards the target:

The science of biological conservation can define these goals. The term conservation biology was introduced by Soulé and Wilcox (Douglas, 1978) and describes a new multidisciplinary domain which marries ecology and population biology on the one hand and conservation policy and practice on the other. The inherent multidisciplinary basis for conservation biology has led to the development of several new sub-disciplines including conservation genetics and conservation informatics.

As financial resources are always finite, there is a need for prioritisation of crops for which research should be intensified. Kell *et al.* 2012a. cited in Bilz *et al.* (2011) used the average value (millions of Euro) of crops produced in Europe to select 25 crop genepools / crop groups for a threat assessment study of crop wild relative species. Within each crop genepool the 4-step-methodology developed by Kell *et al.* (2012b) to identify genetic reserve sites can be applied to focus research on specific species within a crop genepool or crop group.

Storyline (Recent trends, current status and projections):

The vast array of methods and techniques developed by molecular biology (Tuberosa *et al.*, 2014) information science and geosciences is not iterated here. It is available, becoming increasingly affordable and can be applied in conservation science to provide the data and information required to implement crop specific conservation strategies. Among the 18 global crop conservation and utilization strategies published by the Global Crop Diversity Trust (Anonymous, 2014) and reviewed by Khoury *et al.* (2010) eight deal with economically important crops produced in Europe.

Actions to enhance progress towards the target:

Crop specific *ex situ* conservation strategies should be developed for all 25 priority crop genepools / crop groups listed by Kell *et al.* (2012a) and complemented by crop specific *in situ* and on-farm conservation strategies. European as well as national funding agencies should prioritize genetic diversity research of species within these 25 groups to ensure sufficient scientific data to base the strategies on.

Recommendation 11. The European agro-NGOs and their influence should be strengthened.

Why is this important?

Agro-NGOs are the voice of the civil society interested and engaged in the conservation and sustainable use of plant genetic resources. Agro-NGOs are in close contact with consumers and are experienced in passing on knowledge on plant genetic resources issues to the general public. This and other activities of the agro-NGO sector complement governmental activities. Public support for plant genetic resources activities is very important as it strengthens this domain.

Progress towards the target:

Four agro-NGOs with an impressively high number of members exist in Europe (Arche Noah, ProSpezieRara, Garden Organic and Save Foundation) and co-operate with the governmental sector. The web-based information system Arca-Net was further developed in the context of the EU project European Livestock Breeds Ark and Rescue Net (ELBARN) and is operated by the organization Safeguard for Agricultural Varieties (SAVE, 2014). Arca-Net allows the search for actors provides the address of actors and visualizes their locations on a map.

Storyline (Recent trends, current status and projections):

Across the EU, agro-NGOs are the weakest component of an EU Plant Germplasm System. Efforts should therefore be made to strengthen the agro-NGO sector in Europe. Agro-NGOs stand for organic farming which is a small but increasing sector in European agriculture.

Plant breeders are often engaged in national plant genetic resources advisory boards and speak for conventional farmers.

Actions to enhance progress towards the target:

Governments within European countries, if applicable, should appoint agro-NGO representatives as national board members supervising national plant genetic resources for food and agriculture work programmes. Governments should seek also the political support of conventional farmers for plant genetic resources measures as our landscapes, species diversity, crop diversity and varietal diversity is mainly determined by decisions of conventional farmers.

Recommendation 12. Establishment of a European Network of Private-Public-Partnership programmes for evaluation of plant genetic resources in Europe

Why is this important?

There are two important reasons. Firstly, phenotyping is considered a bottleneck with respect to the exploitation of data generated by high-throughput genotyping. The identification of linked genetic markers and the application of marker assisted selection procedures in plant breeding programmes are only possible if phenotypic data can be combined with genotypic.

Secondly, if the assumptions of experts apply it may not be sufficient to adapt crop production by solely improving the varieties of currently grown crops by exploiting intraspecific diversity. Agriculture will also need to harness interspecific diversity to adapt production to new climatic conditions. From the risk insurance point of view the portfolio of crop species should be diversified. The task of PPP programmes would be to explore the production potential of crop species not yet adapted to European production conditions and to describe the genetic diversity contained in these

crop genepools as to understand their genetic adaptive potential and to facilitate the introduction of these genetic resources into commercial gene pools.

Evaluation of plant genetic resources is costly, often requires specific knowledge and is often time-consuming. A network of European PPP programmes as an infrastructure component of a European Plant Germplasm System would allow generating evaluation data on plant genetic resources that are systematically documented and made public and accessible via EURISCO. A network guided by an EU/ECPGR plant germplasm committee would avoid overlapping of individual efforts and facilitate cooperation.

Progress towards the target:

The European Community Programmes on the conservation, characterisation, collection and utilisation of genetic resources in agriculture (GENRES, Council Regulations 1467/94 and 870/2004) facilitated the joint and systematic evaluation of plant genetic resources. The data and valuable material was shared with the stakeholders, made public and accessible via European Central Crop Databases and further used in research and pre-breeding projects. If the evaluation of plant genetic resources would be implemented as a European-wide network activity on an ongoing basis the uptake of promising materials in pre-breeding programmes will increase. PPP projects were operative during the lifetime of the GENRES programmes. Projects were often organised by ECPGR crop specific working groups which can serve today and in future as a platform for the organisation and implementation of crop specific European PPP programmes for plant genetic resources evaluation.

Storyline (Recent trends, current status and projections):

In some countries national crop specific networks (e.g. France) or crop specific PPP programmes (e.g. Germany, Nordic Countries, UK) operate on the basis of cooperation agreements but the data generated are often difficult to access either because access is limited to network members or data are kept in off-line database.

Evaluation of plant genetic resources collections is generally performed on a project basis, focussed on a specific, currently emerging problem; projects are time-bound and discontinuous. Themes that were thought to be important 30 years ago are re-addressed today such as the domestication of wild species for the production of industrial raw materials or the domestic production of grain legumes as a means of diversification of crop rotation systems and alternative for soy bean imports. These projects are initiated by scientists and/or stakeholder groups that seek and get policy support.

Agricultural policy reacts on suggestions rather than manages actively a crop diversity portfolio. Figge (2001) addressed this issue. He compared the stock management principles with the biodiversity management procedures and concluded that biodiversity management decisions rely on the analysts, only. Conservation biologists or plant genetic resources experts determine the value of a specific species or population. Their function is similar to stock analysts.

Portfolio manager forecast yields and risks related to stock portfolios and diversify portfolios to maximize yield while minimizing risks. The biodiversity management ignores the important role of the portfolio manager. To put it pointedly: By ignoring the portfolio theory the most important and greatest asset of mankind, the biodiversity, is managed according to the state of scientific knowledge applied to stock management in the early 1950s (Figge, 2001).

Actions to enhance progress towards the target:

Firstly, an inventory and description of national Public-Private-Partnership (PPP) programmes will be a valuable first step. Secondly, the best approach for a European PPP network should be investigated. Thirdly, a European PPP network co-funded by the European Union and focused on a portfolio of crops and related species should be created.

Conclusions

Gass and Thormann (1999) implemented a survey of plant genetic resources activities in 42 European countries. They concluded that a number of improvements have been made between 1995 and 1998 but that progress in conservation and sustainable use of crop genetic resources is still very uneven across the region. Despite the additional progress achieved in the field of conservation and sustainable use of plant genetic resources since that time, Europe still lacks an integrated plant genetic resource program already called for by Hardon (1999), who stressed the mutual interdependency between countries and the need to maximize access and use of genetic diversity in the interest of world agriculture and food production. In view of the globally increasing social and economic instabilities resulting from the anticipated rapid climate changes we may not have another two decades time to develop and deploy national complementary conservation strategies and to debate the integration of national plant germplasm programmes with the objective of increasing the overall efficiency and effectiveness of PGRFA conservation and sustainable use in Europe. Engels *et al*. (2012) suggested to work on the development of a common European strategy which is pre-condition for an EU and pan-European plant genetic resources programme and plant germplasm system that sufficiently services users within Europe and can provide services to the international user community in a way which is adequate for an economically strong region such as Europe is.

Europe can capitalize on valuable assets of plant genetic resources either occurring in the landscape or kept in genebanks, on a diverse and innovative research sector, on engaged people and policy makers and on a favourable public opinion concerning biodiversity issues. Europe is distinguished by a diversity of a nations, cultures, and people as well as scientific approaches and political views on how to best conserve and promote our common heritage: the diversity of wild plant species and crop species, landraces, and breeding pools. This diversity is our strength.

Diversity can be a weakness at the same time when a coherent European plant genetic resources policy, strategy and programme is to be organized that balances the benefits and costs related to such programme between nations in a fair and equitable way.

It is our impression that, compared to the past decade, Europe and the European Countries are prepared to invest more thoughts and means into the conservation of Europe's genetic resources. This discussion paper may plant some helpful ideas. It is our hope that these ideas fall on fertile grounds and grow.

Literature

Anonymous, 1931. Kleine Mitteilungen. Z. Pflanzenzüchtung 14, 697.

Anonymous, 2014. Crop Strategies. http://www.croptrust.org/content/crop-strategies (Last visited on 2nd October, 2014).

April, J., 1979. An information system to service the US National Plant Germplasm System. In: Technical Aspects of Information Management and Means of Communication in Plant Genetic Resources Work for a Future Utilization of Genetic Material in Plant Breeding. Proc. of a Colloquium held in Braunschweig on 7th and 8th November 1978. Institut für Pflanzenbau und Saatgutforschung, Bundesforschungsanstalt für Landwirtschaft Braunschweig-Völkenrode (FAL), pp. 77–38.

Bilz, M., Kell, S., Maxted, N., Lansdown, R. V., 2011. European Red List of Vascular Plants. – Pub. Office of the European Union, Luxembourg.

Bosemark, N. O., 1989. Prospect for beet breeding and use of genetic resources. In: Report of an International Workshop on Beta Genetic Resources. International Crop Network Series. 3. International Board for Plant Genetic Resources, Rome, pp. 89–97.

Douglas, J., 1978. Biologists urge US endowment for conservation. Nature Vol. 275, 14 September 1978.

EC [European Commission], 2013. Report from the Commission to the European Parliament, the Council and the European Economic and Social Committee "Agricultural Genetic Resources – from conservation to sustainable use", COM(2013) 838.

EC, 2014a. Agri-environment measures. http://ec.europa.eu/agriculture/envir/measures/index_en.htm (Last updated on 10 February, 2014).

EC, 2014b. Horizon 2020 Work Programme 2014 – 2015. 9. Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy. Revised. European Commission Decision C (2014)4995 of 22 July 2014.

EU [European Union], 2014. Regulation of the European Parliament and of the Council on Compliance Measures for Users from the Nagoya Protocol Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in the Union. 2012/0278 (COD) LEX 1504 of 16 April, 2014.

ECA [European Court of Auditors], 2014. Special Report, No. 12. Is the ERDF effectively funding projects that directly promote biodiversity under the EU biodiversity strategy to 2020?

ECPGR [European Cooperative Programme for Plant Genetic Resources], 2014. http://www.ecpgr.-cgiar.org/about_ecpgr.html (Last visited on 05 August, 2014).

Engels, J., Freudenthaler, P., Landbo, L., Latorre, F., 2012. Strategy Paper on the ECPGR Relationship with the European Union/European Commission. Rome, Italy, ECPGR.

FAO [Food and Agriculture Organization], 2004. International Treaty on Plant Genetic Resources for Food and Agriculture.

Figge, F., 2001. Biodiversität richtig managen – Effizientes Portfoliomanagement als effektiver Artenschutz. Centrum für Nachhaltigkeitsmanagement, Lehrstuhl für Betriebswirtschaftlehre, Universität Lüneburg.

Frankel, O. H., 1970. Genetic conservation of plants useful to man. Biol. Conserv., 2, 162–169.

Frese, L., Palmé, A., Bülow, L., Neuhaus, G., Kik, C., 2014 (in press). On the sustainable use and conservation of plant genetic resources in Europe. Crop Wild Relative, issue 10.

Gass, T., Thormann, I., 1999. Implementation in Europe of the Global Plan of Action for Food and Agriculture. In: Gass, T. Frese, L. Begemann, F. Lipmann, E. (Comp.): Implementation of the global plan of action in Europe - Conservation and sustainable utilization of plant genetic resources for food and agriculture. Proc. Eur. Symp. 30 June – 3 July 1998 Braunschweig, Germany, Rom, IPGRI, pp. 22-34.

GIPB [Global Partnership Initiative for Plant Breeding Capacity Building], 2014. http://www.fao.org/-fileadmin/templates/agphome/documents/PGR/Announcements/PB-elearningcourse_GIPB_en.pdf (Last visited on 05 August, 2014).

Goldringer, I., Enjalbert, J., David, J., Oaillard, S., Pham, J. L., Brabant, P., 2001. Dynamic management of genetic resources: a 13-year experiment on wheat. In: Cooper, H. D., Spillane, C., Hodgkin, T. (eds.) Broadening the genetic base of crop production. IPGRI/FAO, Rome, pp. 245–260.

Hardon, J., 1999. Plant genetic resources conservation in Europe – a retroperspective. In: Gass, T. Frese, L. Begemann, F. Lipmann, E. (Comp.): Implementation of the global plan of action in Europe

- Conservation and sustainable utilization of plant genetic resources for food and agriculture. Proc. Eur. Symp. 30 June – 3 July 1998 Braunschweig, Germany, Rom, IPGRI, pp. 3-7.

Haussmann, B. I. G., Parzies, H. K., Presterl, T., Sušic, Z., Miedaner, T., 2004. Plant genetic resources in crop improvement. Plant Genetic Resources 2 (1), 3–2.

Herzele, van A., Gobin, A., Gossum, van P., Acosta, L., Waas, T., Dendoncker, N., Frahan, de B. H., 2013. Effort for money? Farmers' rationale for participation in in agri-environmental measures with different implementation complexity. Journal of Environmental Management 131, 110–120.

Howarth, C., Griffiths, I., Langdon, T., Marshall, A., Powell, W., 2014. Oat MAGIC. http://openwetware.org/images/c/c6/CatherineHowarth_Oats (Last visited on 05 August, 2014).

IBPGR, 1984. The ECP/GR. Introduction to the European Cooperative Programme for Conservation and Exchange of Crop Genetic Resources. AGPG/IBPGR 84/148, October 1984.

White, G. A., Shands, H. L., Lovell, G. R., 1989. History and Operation of the National Plant Germplasm System. In: Janick, J. (ed) Plant Breeding Reviews: The National Plant Germplasm System of the United States, Volume 7. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.

Kell, S.P., Maxted, N. and Bilz, M., 2012a. European crop wild relative threat assessment: knowledge gained and lessons learnt. In: Maxted, N., Dulloo, M. E., Ford-Lloyd, B. V., Frese, L., Iriondo, J. M. and Pinheiro de Carvalho, M. A. A. (eds.) Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces. CAB International, Wallingford, pp. 218-242.

Kell, S. P., Frese, L., Maxted, N., Iriondo, J. M., 2012b. *In situ* conservation of crop wild relatives: a strategy for identifying priority genetic reserve sites. In: Maxted, N., Dulloo, M. E., Ford-Lloyd, B. V., Iriondo, J. M., Pinheiro de Carvalho, M. A. (eds.) Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces. CAB International, Wallingford, pp. 7–19.

Khoury, C., Laliberté, B., Guarino, L., 2010. Trends in *Ex situ* Conservation of Plant Genetic Resources: A Review of Global Crop and Regional Conservation Strategies. Genetic Resources and Crop Evolution 57(4), 625–639.

Kurlovich, B. S., Rep'ev, S. I., Petrova, M. V., Buravtseva, T. V., Kartuzova, L. T., Voluzneva, T. A., 2000. The significance of Vavilov's scientific expeditions and ideas for development and use of legume genetic resources. Plant Genetic Resources Newsletter, 124, 23–32.

Lehmann, Chr. O., 1990. Hundert Jahre Sammlung und Nutzung von Landsorten – zur Erinnerung an Emanuel Ritter von Proskowetz und Franz Schindler. In: FAL & ZIGUK (eds) Gemeinsames Kolloquium Sicherung und Nutzbarmachung pflanzengenetischer Ressourcen, 3.-5. Juli 1990, Braunschweig – Gatersleben, pp. 10-22.

Mathews, A., 2011. Court of Auditors launches broadside against deficiencies in agri-environment schemes. http://capreform.eu/court-of-auditors-launches-broadside-against-deficiencies-in-agri-environment-schemes/ (Last visited on 05 August, 2014).

Maxted, N., Hawkes, J.G., Ford-Lloyd, B.V. and Williams, J. T., 1997. A practical model for in situ genetic conservation. In: Maxted, N., Ford-Lloyd, B.V. and Hawkes, J. G. (eds) Plant Genetic Conservation: The in situ Approach. Chapman and Hall, London, pp. 339–367.

Maxted, N., Avagyan, A. Frese, L., Iriondo, J. M., Kell, S. P., Magos Brehm, J., Singer, A., 2013. Preserving diversity: a concept for in situ conservation of crop wild relatives in Europe – the Background Document. Bonn, Germany: In Situ and On-farm Network, European Cooperative Programme for Plant Genetic Resources.

Negri, V., Freudenthaler, P., Gasi, F., Goldringer, I., Moreira, P. M., Strãjeru, S., Tan, A., Veteläinen, M., Vögel, R., Weibull, J., Maxted, N., 2014. The ECPGR concept for *in situ* (on-farm) conservation in Europe.

PCGIN [Pulse Crop Genetic Improvement Network], 2014. http://www.pcgin.org/index.htm (Last visited on 23 October, 2014).

SAVE [Safeguard for Agricultural Varieties], 2014. http://www.arca-net.info/index.htm (Last visited on 05 August, 2014).

Seidewitz, L., 1974. Thesaurus for the International Standardisation of Gene Bank Dokumentation. Part I. Cereals (incl. Maize, Rice and Sorghum). Genbank, Institut für Pflanzenbau und Saatgutforschung der Forschungsanstalt für Landwirtschaft, Braunschweig-Völkenrode, F.R. Germany.

Seidewitz, L., 1979. Data Base Concepts for a Rational Handling of Information in Relation to Plant Genetically Valuable Material. In: Technical Aspects of Information Management and Means of Communication in Plant Genetic Resources Work for a Future Utilization of Genetic Material in Plant Breeding. Proc. of a Colloquium held in Braunschweig on 7th and 8th November 1978. Institut für Pflanzenbau und Saatgutforschung, Bundesforschungsanstalt für Landwirtschaft Braunschweig-Völkenrode (FAL), pp. 31–71.

Spoor, W., Simmonds, N. W., 2001. Base-broadening: introgression and incorporation. In: Cooper, H. D., Spillane, C., Hodgkin, T. (eds.) Broadening the genetic base of crop production. IPGRI/FAO, Rome, pp. 71–79.

Steinbach, D., Alaux, M., Amselem, J., Choisne, N., Durand, S., Flores, R. I., Keliet, A.-O., Kimmel, E., Lapalu, N., Luyten, I., Michotey, C., Mohellibi, N., Pommier, C., Reboux, S., Valdenaire, D., Verdelet, D., Quesneville, H., 2013. GnpIS: an information system to integrate genetic and genomic data from plants and fungi. Database, Vol. 2013, Article ID bat058, doi:10.1093/database/bat058.

Thorne, E., 2012. Shortcuts costly when buying conservation from farmers. http://www.eurekalert.-org/pub_releases/2012-03/uon-scw030112.php (Last visited on 05 August, 2014).

Tuberosa, R., Graner, A., Frison, E. (eds.), 2014. Genomics of Plant Genetic Resources. Volume 1. Manageing, Sequencing and Mining Genetic Resources. Springer Science+Business Media Dordrecht.

Vincent, H., Wiersema, J., Kell, S.P., Dobbie, S., Fielder, H., Castañeda Alvarez, N.P., Guarino, L., Eastwood, R., León, B. & Maxted, N., 2013. A prioritised crop wild relative inventory as a first step to help underpin global food security. Biological Conservation, 167: 265-275.

Whitefield, J., 2006. Agriculture and environment: how green was my subsidy? Nature 439, 908–909, doi:10.1038/439908a. Published online 22 February 2006.