

Conservation and sustainable use of crop wild relatives: a Nordic initiative

Bevarande och hållbart bruk av vilda kulturväxtsläktingar: ett nordiskt initiativ

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The basis of human civilization rests on plants and their products. All crops grown today have once been brought from the wild plant kingdom. The future of humankind stands and falls with our management of these vital resources. In a two-year project led by NordGen, the regional genebank located in Alnarp, the five Nordic countries have recently joined their efforts in developing principles regarding conservation and use of crop wild relatives and making priorities among the wild genetic resources growing in our part of the world.

What are crop wild relatives?

The concept of crop wild relatives, CWRs, is perhaps difficult to grasp. But without them our future supply of food plants, pharmaceuticals, industrial raw materials, landscaping and other herbal supplies certainly appear risky. Already today we face the challenges of having to adapt to on-going climate change and susceptibility to new diseases, or new strains of well-known diseases and pests, including to a sustainable agriculture with lower inputs of fertilizers and pesticides. Other important properties include tolerance to drought, higher annual mean temperatures, as well as milder winters with increased risk of yield losses due to attacks by plant pathogens. Using CWRs in plant breeding, such important traits can be transferred into crops (Dempewolf *et al.* 2014). But it is equally true that today we do not even have knowledge of possible future needs or challenges.

The crops we grow today are the result from domesticating wild plants. During thousands of years, humans have cultivated plants and subsequently developed agriculture, forestry and horticulture. When the wild plants were being adapted to cultivation, they often lost certain qualities that made them well adapted to a life in the wild. This includes, for example, the way they spread their seeds, their ability to produce toxic



Photo 1. Participants of the 1st joint Nordic workshop held on the island of Østre Bolærne, Færder National Park.

substances to defend themselves or the capacity to adapt their life cycle in absence of rain. Through the manipulation by humans, plants developed other characteristics that are important to us. In consequence, humans became resident, could feed a growing population and develop artistic, artisanal and technical skills.

All plant species that demonstrate affinity with our cultivated plants are usually designated crop wild relatives. This relatedness may be at different taxonomic levels: normally from the same species as the cultivated plant, but even to include species of the same family but of different genera. They are all considered as CWRs but, obviously, from the aspect of use in plant breeding there are great many differences. A relatively recent estimate states the number of CWRs in Europe, including the Mediterranean, as close to 25 000 (www.pgrforum.org).

Why do we need to care?

Most of the crops that are grown in our countries today originate from elsewhere. This means that in order to continue to develop our plant material, we depend on the continued availability of genetic diversity of crops from other parts of the world.

This includes many wild species that have valuable properties providing an insurance for future food security. Nonetheless, a great many of the world's CWRs are facing severe threats. In its second State of the World Report (2010), FAO reported on the current status of the diversity of plant genetic resources for food and agriculture. Despite an increase in recent decades in the number of protected areas around the world, the loss of CWR diversity had continued. In a recent study of wild species within the three genera *Arachis* (peanut), *Solanum* (potato) and *Vigna* (cowpea), Jarvis *et al.* (2008) predicted that between 16 and 22 % of those species were in danger of extinction by the year 2055. In particular, climate change creating unstable conditions and rapid shifts in plant habitats, but also an increased fragmentation of habitat and hence populations, are strong driving forces towards extinction. Human over-exploitation of these resources should also be taken into account.

The Nordic project

All FAO member countries are adopting measures to implement procedures and activities outlined in the so-called Global Plans of Action. This work began already 20 years ago. Notwithstanding, it has been exceedingly difficult to get work started that focus specifically on *in situ* conservation of CWRs. Now, why is that? We argue that there are several reasons for it. Firstly, the whole concept of wild plant species appears to be intimately linked to that of nature conservation and, therefore, by tradition considered to be a responsibility for the 'environment sector'. Secondly, for a long time there was a lack of competence and tools that would strengthen and facilitate the work. And, thirdly, the process and procedure for real planning and implementation of national conservation plans were either not yet developed or incomplete. Now the picture has changed drastically: clear structural frameworks, toolboxes and guidelines are well at hand to be used on the spot (Maxted *et al.* 2013). We just have to get started!

The joint Nordic project was initiated aiming at creating a network that would contribute to policy input in each country and create Nordic synergies within *ex situ* and *in situ* conservation. These synergies "[would] contribute to an exchange of knowledge, expertise and tools related to the establishment of national strategies for CWR conservation, [and] establishment of national CWR ge-

netic reserves with an emphasis on how interaction between *ex situ* and *in situ* conservation, and use, of plants shall take place."

Setting national and joint Nordic species priorities

Before the start of the project in 2015, the five Nordic countries were at various stages of development in their national planning and implementation. Already in 2011, Bjørn *et al.* published their report *Bevaring af plante genetiske ressourcer i de vilde slægtninge til jordbrugets afgrøder* (Conservation of plant genetic resources of wild relatives to agricultural crops) about the situation in Denmark. A total of 449 taxa had been selected as so-called mandate taxa based on ten different criteria. Of these 101 plant taxa was evaluated as being of highest priority. They were further inventoried at ten different localities and recommendations for their *in situ* conservation, including complementary conservation of seeds *ex situ*, were provided. The *in situ* conservation is still being discussed in Denmark in relation to other national conservation efforts, whereas the plans for collection of seeds for *ex situ* conservation was already executed during two national projects during 2013-15 for a selection of 27 taxa of the 101 (Jacobsen, 2015; Kristensen & Jacobsen, in prep.). These 27 taxa were identified based on their status of threat and includes species of food, fodder and forage species. They were each attempted to be collected from at least three localities, which succeeded expect for four found at 1-2 localities. The taxa include 11 grasses, 4 leguminaceae, 4 brassicaceae, 2 apiaceae and 6 others. The seeds have all been transferred to long term storage in NordGen.

Finland published its national CWR strategy report in 2013 (Fitzgerald 2013) within the context of the EU-funded research project *PGR Secure*¹. The report included a comprehensive CWR checklist, priority list and *in situ* and *ex situ* gap analysis. Since 75 % of Finnish flora consists of CWR taxa, it was necessary to limit the number of species for further analysis. Priorities were given according to three criteria – relative threat, value and use – and several sub criteria resulting in a list of 209 taxa. *In situ* gap analysis recognized 5 complementary hotspots of CWR diversity within Finland which would conserve over 60 % of the

¹ <http://www.pgrsecure.org/>



Photo 2. The crop wild relative wild carrot (*Daucus carota* L.) occurs most frequently in South Scandinavia (Jens Weibull).

priority taxa. The *ex situ* gap analysis identified substantial gaps in CWR conservation. Since then several species have been added into seedbanks but many still remain to be collected. Practical *in situ* conservation measures remain still to be put into action.

In Iceland no strategy has been put forward regarding the conservation of CWRs and thus no priority list or gap analysis have been made.

Similar to Denmark, Norway has also taken a series of concrete steps from the point of view of national conservation planning. Phillips *et al.* (2016) has recently reported on the procedure of prioritizing plant taxa, aiming at reaching the long-term perspective of establishing reserves of genetic diversity hot-spots within – primarily – already existing protected areas. A subset of 204 plant taxa were being listed as priority CWR, out of a total of 2 538 taxa. Forty-four percent of these were forage CWR, 43 % food and the remainder were related to medicinal, ornamental and forestry taxa.

Finally, back in 2011, Sweden, unable to exploit the extensive list of 2 361 plant taxa prepared by the EU project PGR Forum², developed its own national list of 1 478 taxa out of which 84 were deemed as being of high priority (Aronsson *et al.* 2012). All uses of plants were considered, i.e. food and agriculture, ornamental, medicinal and aromatic, wood and fibre, and ‘multiple use’. The fact that ‘status of threat’ – according to the Swedish Red List – was included as one discriminating criterion resulted in a majority of plants belonging

² www.pgrforum.org

to ‘ornamentals’ and ‘multiple use’. Only a handful (6 % or five species) belonged to the category ‘food and agriculture’. This successful work lost momentum, however, due to lack of resources and it was not until the joint Nordic project began that the leftover strings could be taken up again.

In contrast, using slightly different criteria, the joint Nordic project concluded a list of 133 priority species and subspecies from 35 plant genera, all of which were related to either food or forage crops or, in some cases, both. In prioritizing taxa, our joint exercise took into account ‘gross economic production values’ on global and Nordic levels, ‘crop relatedness’ expressed as genepool or taxon group levels, and a ‘breeders’ estimate of wild forage grasses’ value for use’.

What more have we done?

As already mentioned, the objectives of the project were multiple:

- establish a Nordic network for genetic resources as ecosystem services aiming at policy input;
- exchange of knowledge to obtain Nordic synergies within *ex situ* and *in situ* conservation, with particular focus on *in situ* conservation of CWR in genetic reserves including developing the scientific basis for it;
- increase Nordic synergy on the interaction between *ex situ* and *in situ* conservation; and, finally
- strengthen the Nordic position within EU on CWR conservation and use, including its role as an essential ecosystem service.

Three workshops have been arranged in the course of the project. In May 2015 the participants met for the first time at Østre Bolærne in the Færder National Park situated in the Outer Oslofjord, right between Fredrikstad and Tønsberg. The national park, covering c. 340 sq. km, has recently been assigned as Norway’s first genetic reserve for CWRs due to the outstanding and well-documented plant diversity, including the willingness and enthusiasm of local authorities. The workshop, also involving participants from the Baltic countries, had three main aims: first to clarify governance and operations of a protected area that also includes a plant genetic objective, second to report on the status of national work on CWR conservation and – where occurring – use



Photo 3. Wild chive (*Allium schoenoprasum* L.) growing on a seaside, Southern Finland (H. Fitzgerald)

and, third, to plan for a follow-up workshop to be held during late autumn 2015.

The second workshop, hosted by the Stockholm Natural History Museum in November 2015, focused on examples of practical use of CWRs in plant breeding, cosmetics and medicine as well as looking into the development of concrete conservation plans. This includes, among other things, developing and applying criteria for prioritizing among plant taxa, and the concept of *gap analysis* whereby the range of a species' diversity is compared to that already existing within *in situ* conservation regimes – e.g. national parks – and *ex situ* in seed or field gene banks.

The third workshop, arranged in Vilnius, Lithuania in September this year, was held in conjunction with a regular meeting of the ECPGR Wild Species Conservation in Genetic Reserves Working Group. Apart from focusing on national and regional conservation strategies, including the integration between *in situ* and *ex situ* conservation, the workshop prepared six concrete recommendations for the consideration by the Nordic Council of Ministers (NMR). These included

- developing national conservation strategies
- developing adequate policy instruments or removing those that serve as hindrance
- initiating at least one *in situ* conservation site per country
- elaborating a common Nordic CWR conservation approach
- encouraging research within a range of themes, including proper infrastructure development, and, finally
- develop and foster a Nordic network for better integration of *ex situ* and *in situ* conservation.

Being a cross-cutting issue between the agricultural and environmental sectors, we foresee that both Committees of Senior Officials at the NMR will receive these recommendations in the very near future. In addition to the policy recommendations, we expect a number of other concrete outputs including a joint Nordic action plan for *in situ* conservation, a web page focusing on CWR conservation and maintained by NordGen, a project report and a refereed article in an international scientific journal.

Reasons for joint efforts

These exercises show that while national listing can work well from the point of view of setting domestic goals and priorities, including getting a domestic process going, there is also much to be gained from applying a regional approach. First, Nordic plant breeding operates under rather specific conditions. While crop production in Denmark and southernmost Sweden may profit from varieties that have been developed in e.g. Northern Germany and the Netherlands, the main part of the region needs to have access to plant material well adapted to the specific growing conditions. This includes a different light regime, over-wintering capacity, early maturity, and others. This means that, since CWRs from the whole region may be of potential value for plant breeding, joint efforts in safe-guarding these plant genetic resources through *in situ* conservation will be more cost-effective.

Second, throughout history our Nordic countries have often shared common values, perceptions and approaches. In this article we have described how some of us have managed to take concrete steps in planning and implementing *in situ* conservation strategies for important CWRs. While some still seem to be struggling to get the formal structures in place at national level for embarking on such an endeavour, there are others who seemingly have overcome the perceived operative barriers between the agricultural and environmental sectors. Thus, there is plenty of room for learning and exchange of experience, and this is best done within a continued Nordic *in situ* conservation context such as, e.g., a formalised network.

Third, the former Nordic Gene Bank – now NordGen³ – was established already in 1979. Our Nordic regional collaboration on *ex situ* conservation of plant genetic resources has since long provided an alternative and cost-effective approach to national activities. However, although the issue of *in situ* conservation does have been raised a couple of times throughout the years, it has never developed into concrete action. With our Nordic project on CWRs as ecosystem services, including the conservation and sustainable use of them, we believe that we now have an appropriate platform to jointly address the needs and obligations that rest on us as a result of international agreements. While our national ‘homework’ obviously must be taken

care of, we see that a regional approach can serve as a supportive framework. That framework should also entail the Baltic countries.

Final remarks

There is a growing global insight that we must do much more to ensure habitats for threatened plant species and strengthen their current populations. But many of the countries that are particularly rich in important CWRs are also those lacking the most: financial resources, skilled personnel, formal structures such as government agencies and, not least, conservation priorities. The preservation of CWRs in their native habitats (*in situ*) is necessary for a continuous evolution. But such dynamic conservation must go hand in hand with plant material also maintained in living collections (*ex situ*), either as plants or seed, to be available for research and plant breeding. Successful and sustainable long-term CWR conservation therefore requires both protected areas, gene banks and botanical gardens, a close collaboration between these entities, and the necessary resources in terms of both money and knowledge.

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Swedish summary

Den nordiska floran rymmer en lång rad växtarter som utgör vilda släktingar till våra odlade grödor. I synnerhet de vilda foderväxterna är rikt representerade, men också olika närbesläktade arter av frukter, bär och grönsaker. Ett kostnadseffektivt sätt att bevara dessa viktiga genresurser för framtiden är att skydda och förvalta deras populationer i naturen (*in situ*). Trots att de nordiska länderna sedan 1979 har haft ett nära genbanksamarbete när det gäller bevarande av frö (*ex situ*) så har sådana insatser för *in situ*-bevarande lyst med sin frånvaro. I ett nyligen avslutat tvåårigt projekt, finansierat av Nordiska ministerrådet, har de fem nordiska länderna gemensamt utarbetat en förteckning över de viktigaste växtarterna samt principer och rekommendationer för *in situ*-bevarande, både nationellt och på nordiskt plan.

³ Nordic Genetic Resource Center

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