



Background document for the DIVERSEEDS e-conference

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www.diverseeds.eu/forum/

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1. Introduction

The European Commission (FP6) funded project DIVERSEEDS is establishing a communication platform for European and Asian researchers to discuss current challenges and recommendations for the conservation and use of plant genetic resources. (See www.diverseeds.eu for further information.) In agriculture, the widespread adoption of a few improved varieties has narrowed the genetic base of important food crops and led to the disappearance of hundreds of landraces. Conserving and using plant genetic diversity is vital in meeting the world's future development needs. Given the importance of genetic resources for food safety, and the fact that centres of origin are mainly located in developing countries such as East and Southeast-Asia, we are convinced that it is absolutely necessary to link European and Asian colleagues to contribute to and improve existing communication networks. Thus our project is aimed to open European research networks to Asian research colleagues (working in centres of origin), establish a communication platform, and to promote knowledge exchange on genetic resources and their management. The main objective of Diverseeds – guided by the International Treaty on Plant Genetic Resources for Food and Agriculture¹ – is to jointly elaborate a list of recommendations and strategies to improve the conservation and use of plant genetic resources. These recommendations will be published and made available to researchers, policy makers, farmers and the general public. Diverseeds will be based on international dialogue and cooperation between researchers working on genetic resources and agricultural biodiversity.

List of DIVERSEEDS project partner organisations²:

- IDC, Biosafety Working Group (Austria)
- University of Natural Resources and Applied Life Sciences Vienna (Austria)
- University of Birmingham, School of Biosciences (United Kingdom)
- University of Kassel (Germany)
- Israeli Gene Bank for Agricultural Crops, Volcani Center (Israel)
- Institute of Botany, Chinese Academy of Sciences (China)
- Chinese Academy of Agricultural Sciences (China)
- Khon Kaen University (Thailand)
- Hanoi Agricultural University and CARES (Vietnam)
- Bioversity International

1.1. Aims and scope of the DIVERSEEDS e-conference

We have held three regional workshop (in Ljubljana, Beijing and Hanoi) in 2007 to define and discuss relevant PGR-issues for Europe, Southeast Asian and China. Following that, our first international meeting at Bioversity headquarters in Rome last December was used to discuss common PGR issues and challenges, which are presented in chapter 2,3 and 4 of this background document. Also ways to improve interaction between the regions and to enhance cooperation on PGR issues were suggested. Now we would like to share our thoughts and discuss the selected PGR issues and draft recommendations with a wider group of experts and interested stakeholders. This is why we are carrying out an **open online conference** - or e-conference – on the internet as part of our activities. The discussions and consultations during the e-conference will be an important contribution to the production of our final recommendations, which will be delivered to national governments, international organizations, research centres, universities, and other stakeholders in Europe and Asia at the end of 2008.

¹ See <http://www.planttreaty.org> for more information on the International Treaty.

² For more information about our team, see: <http://www.diverseeds.eu/index.php?page=pub-team>

1.2. Participation at the e-conference

The participation is open to everybody interested in conservation and use of plant genetic resources for food and agriculture. The e-conference is funded by the European Commission project DIVERSEEDS and it is free of charge for the participants. It is very easy to take part, just go to the e-conference website

www.diverseeds.eu/forum/

If you just want to read the contributions and comments by other participants, you can link directly on the topic of interest and read it. There are several categories (e.g. *ex situ* conservation, landrace management, neglected and underutilized crops) and sub-categories you can click on.

Registration: We encourage you to actively participate in the online discussion. You are welcome to submit your professional expertise, opinion, or point of view in our e-conference. As mentioned before it is an open e-conference and we would like to hear your contributions and thoughts on these plant genetic resources issues.

To leave an e-conference contribution you will have to get a username, which is easily done by registering for the e-conference at www.diverseeds.eu/forum, just click “register” on the top right or at the bottom left. After finishing the registration you will receive a registration email. Click on the link in this email and you will be able to log in.

Once you are logged in you can click the category of your interest.

- If you want to add a new topic: just click “**new topic**” and post your text.
- If you want to reply to an existing topic, just click “**post reply**” and write your text.

You can add new topics or reply to other topics as much as you want and we encourage you to take advantage of this special opportunity to discuss current challenges on plant genetic resources with a global community.

Some of the most important challenges to the conservation and use of plant genetic resources for food and agriculture – from our point of view- are explained in the following chapters. We look forward to discuss these issues with you. If you would like to suggest other issues, however, you are equally welcome to share them with us.

2. Towards an integrated approach to *in situ* and *ex situ* conservation

2.1. Background

The need for conservation. Plant Genetic Resources (PGR) are subjected to an increasing range of threats in their host habitats. The rapid increase in population size and urbanization processes, combined with intensive agricultural and industrial development, threatens worldwide biodiversity and genetic variability of PGR. It is generally agreed that immediate measures of conservation should be considered. Thus, appropriate protocols need to be applied to ensure that the conservation efforts are effective and cost-efficient and that utilization options are maintained and maximized. Consequently, different conservation strategies, both *ex situ* as well as *in situ* (including on farm) are considered to be combined in order to increase insurance against loss of genetic diversity and to optimize conservation efforts.

The importance of PGR. In the term PGR we refer to Crop Wild Relatives (CWR), Neglected and Underutilized Species (NUS), and the various categories of other domesticated species such as landraces and traditional varieties, weedy forms, breeding and research lines etc. In the context of new research technologies and innovations, NUSs, CWRs and also closely related taxa are becoming potentially important for the identification and characterization of agricultural and economic important traits.

Conservation strategies. The Convention on Biological Diversity (CBD, 1992) declared on the need to develop national strategies for the conservation and sustainable use of biological diversity, and stated that each country/region has to take the responsibility of conserving its local flora and fauna. It was also stated that regulation and management of *ex situ* collections should be done in away so as not to threaten the biodiversity in the natural ecosystems and *in situ* populations of the species...." (CBD articles 8&9)³.

National conservation strategies. In view of the above we suggest that the national conservation strategy for plant genetic resources for food and agriculture (PGRFA) might be developed by:

1. Creation of national inventories of PGRFA and of *ex situ* collection
2. Establishment of a common documentation system
3. Analysis of the inventories
4. Assessment of the threat status and conservation for target PGRFAs.
5. Determination of what the optimum approaches and conservation methods are for the different species and locations.⁴

Advantages and disadvantages of *ex situ* and *in situ* techniques. In some situations, *in situ* conservation cannot be applied as the main conservation strategy. This can be exemplified in the Mediterranean ecosystems which occur in open patches, and mostly consist of herbaceous species. In such habitats woody vegetation starts to take over the landscape over time when not properly managed and thus, making *in situ* conservation of annuals problematic. Also, in *in situ* sites, species or let alone specific genotypes of interest to the user cannot be fully protected or easily accessed. Therefore, *ex situ* seed-banks become an efficient way of conservation. These highlight the need for integrated schemes of different conservation approaches.

2.2. Integrated approach: questions to be discussed

1. **Different conservation approaches:** How and to what extent do different conservation approaches contribute to the secure and effective conservation of the entire genepool of specific taxa?
2. ***Ex situ* vs. *in situ*:** What are the advantages and disadvantages of *ex situ* vs. *in situ* approaches and of different methodologies within each of them?
3. **Integrating conservation approaches:** Why and how to integrate the different conservation approaches into one integrated strategy?
4. **Backup system:** Can *ex situ* serve as backup or complementary approach for *in situ* conservation?
5. **Selection criteria:** What are the criteria to select sites for *in situ* conservation?
6. **Interdependence:** Do *ex situ* collections of PGRFAs also have to be conserved in *in situ* or on-farm, and vice versa?
7. **Genetic integrity:** How can one monitor genetic integrity of "accessions" conserved on-farm and in the gene bank (e.g. detect genetic changes)?
8. **Indicators:** What are adequate indicators for safe conservation for *in situ*, *ex situ* and on-farm?

³ <http://www.cbd.int/convention/convention.shtml>

⁴ Meaning, when is *in-situ* conservation the most feasible and when does *ex-situ* conservation come into play in order to "compensate" the *in-situ* and/or on-farm conservation? In order to illustrate the above please see a paper that has been published by Bioversity on the complementary conservation approach of banana germplasm. See: www.diverseeds.eu/uploads/file/Complementary_Conservation.pdf

3. Landrace Conservation and Use

3.1. Background

Traditional landraces of crops are the primitive forms or heritage varieties of crops whose seed is commonly saved each year within traditional or subsistence farming systems. Maxted (2006) argued that landraces are currently the most threatened element of biodiversity. The primary justification for this statement is that they are the only element of biodiversity that is being systematically eradicated through their replacement with modern cultivars. Also, this threat to landrace diversity is compounded by: a) a lack of knowledge of how many traditional seed-saved varieties exist—few if any countries have a comprehensive landrace inventory, b) the fact that with each year those who maintain landraces are dwindling in number as they are often older people and they are not generally being replaced by younger maintainers, c) there is no formal national responsibility for the conservation of these economically important plants as they are outside the remit of nature conservation agencies because they are crops and many Ministry's of Agriculture have limited resources for conservation. Maxted (2006) concluded that unless systematic action is taken immediately, landrace diversity loss will continue. Extinction of further landraces is the only possible conclusion, as modern cultivars are even developed for marginal agri-environments and the remaining landraces are almost exclusively tied to small-scale niche markets. Failure to maintain landrace diversity would mean losing uniquely adapted agro-biodiversity that could in turn safeguard future crop breeding, particularly in the light of evolving pests and diseases, climate change and changing consumer demand.

3.2. Landrace Conservation and Use: questions to be discussed

1. **Landrace definition:** Landraces have been defined as 'dynamic population(s) of cultivated plants that have historical origin, distinct identity and lack formal crop improvement, as well as often being genetically diverse, locally adapted and are associated with traditional farming and cultural systems' (Camacho Villa *et al.*, 2001)⁵, but this definition has been criticized for not taking full account of their role in cultural heritage. What additional components might also be recognized?
2. **Landrace inventories:** When developing a more systematic approach to conservation, a logical first step is the development of a species checklist and inventory (Lughadha, 2004⁶; Mace, 2004⁷). Species checklists are a well established tool for exploration, survey and collection of plant genetic resources (crop species and wild plants) (Hammer, 1990⁸, 1991⁹; Knüpfper and Hammer, 1999¹⁰), but are they likely to prove equally beneficial for landrace conservation and how might a landrace inventory be prepared?
3. **Threat assessment:** Assuming a landrace inventory is a first step in developing a more systematic approach to landrace conservation, once an inventory is available, a second step would be to prioritize landraces on their requirement for active conservation.

⁵ Camacho Villa, T.C., Maxted, N., Scholten, M.A. and Ford-Lloyd, B.V., (2005). Defining and identifying crop landraces. *Plant Genetic Resource Characterisation and Use*, 3(3): 373-384.

⁶ Lughadha, E.N., (2004). Towards a working list of all known plant species. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences*, 359 (1444): 681-687.

⁷ Mace, G.M., (2004). The role of taxonomy in species conservation. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences*, 359: 711-719.

⁸ Hammer, K., (1990). Botanical checklists prove useful in research programmes on cultivated plants. *Diversity*, 6 (3-4): 31-34.

⁹ Hammer, K., (1991). Checklists and germplasm collecting. *Plant Genetic Resources Newsletter*, 85: 15-17.

¹⁰ Knüpfper, H. and Hammer, K., (1999). Agricultural biodiversity: a database for checklists of cultivated plant species. In: S. Andrews, A.C. Leslie and C. Alexandre (eds.) *Taxonomy of Cultivated Plants: Third international Symposium*. pp. 215 – 224 Royal Botanic Garden Kew, London.

- Relative threat is a means of prioritization but how might threats to landraces be assessed?
4. **Why have landraces not gone extinct?** Landraces were widely expected to disappear entirely with the introduction of modern cultivars (Zeven, 1979¹¹); however, pockets of landrace cultivation have survived, even in countries with the most industrialized and least biodiverse agriculture (Hammer *et al.*, 1999¹²; Negri, 2003¹³)—why?
 5. **What are the elements of a national landrace conservation strategy?** Assuming the final step in the development of a more systematic approach to landrace conservation is the proposal of a national landrace conservation strategy, what elements might such a strategy contain?
 6. **How do we balance landrace development with conservation?** The fact that so much landrace diversity has been lost over the last 50 years indicates that generally, modern cultivars do out perform traditional landraces; therefore, it is unacceptable for conservationists to argue that traditional farmers should continue to bear the public good costs of landrace maintenance without associated rewards. How does the conservationist balance the development aspirations of traditional farmers with systematic conservation of landrace diversity? If, as many conservationists believe, landrace use is strongly associated with sustainable landrace conservation, what strategies might be adopted by conservationists and / or farmers to promote their continued use?

4. Utilization and Policy for Neglected and Underutilized Crops

4.1. Background

What are ‘Neglected and Underutilized Crops (NUC)? According to Bioversity they are most simply described as ‘minor crops’, where minor most likely relates to production. Probably, of the two terms, ‘neglected’ is the most important because it highlights the lack of attention paid by users and the inadequate level of research and conservation efforts spent on them. ‘Underutilized’ on the other hand, is less helpful; for the people who use these crops they are not underutilized, while it is not realistic to assume that it will be possible or desirable to make them less underutilized by expanding their production to a wider area.¹⁴

Neglected? Underutilized? It may be realistic to accept that currently many or most NUC utilization will remain as it is, being grown primarily by traditional farmers, where they are still important for the subsistence of local communities on the one hand, or for species that are globally distributed, occupying special niches in production and consumption systems. However, these NUC must not remain neglected, particularly in relation to their use and conservation. Their characterisation and evaluation must also not be neglected because, quite possibly a few species that are currently NUC may be ‘converted’ into much more widely utilized crops, particularly where the future, in the context of climate change, is so uncertain.

Recent activities on NUC. The main organisations working on NUC are Bioversity International, the Global Facilitation Unit (GFU) for Underutilized Species¹⁵ and the

¹¹ Zeven A.C., (1979). Collecting genetic resources in highly industrialized Europe, especially in The Netherlands. Proceedings of Conference on Broadening the Genetic Base of our Crops, Wageningen 1978.

¹² Hammer, K, Laghetti, G. and Perrino, P., (1999). A checklist of the cultivated plants of Ustica (Italy). *Genetic Resources and Crop Evolution*, 46: 95-106.

¹³ Negri, V., (2003). Landraces in central Italy: where and why they are conserved and perspectives for their on-farm conservation. *Genetic Resources and Crop Evolution*, 50(8): 871 – 885.

¹⁴ See: http://www.bioversityinternational.org/Themes/Neglected_and_Underutilized_Species/index.asp

¹⁵ see: <http://www.underutilized-species.org>

International Centre for Underutilized Crops (ICUC)¹⁶. A previous e-conference organised as part of an EC FP6-funded project AGROFOLIO discussed Neglected and Underutilized species¹⁷. A list of about 300 species¹⁸ perceived to be of importance was produced. This included *Centella asiatica*, *Avena strigosa*, *Polyscias fruticosa*, *Dioscorea oryzenorum*, *Arachis hypogaea*, *Rhodomyrtus tomentosa*, *Momordica cochinchinensis*, *Ficus racemosa*, *Hibiscus sabdareiffa*, *Piper betel* and *Bruguira gymnorhiza*. These, almost certainly are neglected species and warrant increased conservation attention because of their possible future enhanced value. However, it is difficult to argue that they are currently underutilized because there is no immediate reason to argue for their increased use, except perhaps in the case of the *Polyscias* species as a replacement for ginseng, or *Arachis hypogaea* as a major alternative to soybean. In contrast there are good examples of underutilized species where there is a high likelihood of 'conversion' to greater utilization. One is *Artemisia annua* in the UK, which is being investigated for anti-malarial use, and the other is *Miscanthus*, a newly emerging crop of some importance in Europe as a biofuel. The Global Facilitation Unit (GFU) for underutilized species has produced a much larger list of NUC¹⁹. However, experience of the EC FP5-funded project PGR Forum²⁰ suggests that even this list is not fully comprehensive. The PGR Forum Catalogue of Crop Wild Relatives for Europe and the Mediterranean, of which many species could be regarded as NUC or their wild relatives, contains many more species (over 25,000).

More attention to NUC is attracted by the international symposium²¹ on "Underutilized plants for food, nutrition, income and sustainable development" in Tanzania, March 2008.

4.2. Neglected and Underutilized Crops: questions to be discussed

What are the major issues involving improved conservation of NUC and the possibility of increasing their use in the future?

1. **Biotechnology as a driving force?** Sweet potato in Uganda, millets in Africa and South Asia and tef in Ethiopia have been highlighted recently as 'orphan crops'.²² It may well be that these crops have been neglected in terms of crop improvement, and biotechnology could help in this respect. Is it realistic however to think that they will become substantially more utilized in the future because of their biotechnological improvement?
2. **Impact of climate change on NUC.** Threats to crop production from climate change have identified certain regions and crops whose production will be threatened substantially by global warming. Such studies²³ have focused on major crops and predicted reduced production in the absence of adaptation. Is it possible that current NUC will become more competitive and valued in such circumstances, and if so, can we predict which they will be? What factors can we use to make these predictions?

¹⁶ See: <http://www.icuc-iwmi.org/>

¹⁷ See: <http://www.agrofolio.eu/index.php?page=pub-summary-e-conference>

¹⁸ See: <http://www.agrofolio.eu/db/>

¹⁹ See: http://www.underutilized-species.org/institutional_mapping/Species%20and%20Countries.xls

²⁰ See: <http://www.pgrforum.org>

²¹ See: <http://www.icuc-iwmi.org/Symposium2008/index.htm> for further information.

²² See: Rosamond L. Naylor, Walter P. Falcon, Robert M. Goodman, Molly M. Jahn, Theresa Sengooba, Hailu Tefera, Rebecca J. Nelson. 2004. Biotechnology in the developing world: a case for increased investments in orphan crops. *Food Policy*. 29. 15–44

²³ See: David B. Lobell, Marshall B. Burke, Claudia Tebaldi, Michael D. Mastrandrea, Walter P. Falcon, Rosamond L. Naylor. 2008. Prioritizing Climate Change Adaptation - Needs for Food Security in 2030. *SCIENCE VOL 319*. 607-610. Molly E. Brown and Christopher C. Funk. 2008. Food Security Under Climate Change. *SCIENCE VOL 319*. 580-581

3. **Conserving NUC now.** If we cannot predict the extent to which crops that are currently NUC will be in demand in the future, we must stop neglecting them and improve their conservation status. How can we do this?
4. **Local vs. global.** Would conversion be more likely if the interest in NUC moved away from being based locally to a global interest? DIVERSEEDS aims to increase dialogue between Europe, China and Southeast Asia. Could enhanced cooperation itself lead to increased use and characterisation of NUC?
5. **Implement information systems in Asia.** In Europe, PGR Forum (see above) has catalogued crop wild relatives, many of which are NUC or relatives of NUC. CWRIS (Crop Wild Relative Information System) developed in PGR Forum will enable information to be gathered that will enhance our conservation capability for NUC. Can such a system be extended rapidly to China or Southeast Asia so that data are made available on which to base future conservation policy for NUC?
6. **Prioritisation of some NUC.** Prioritisation is essential given the size of the task and the numbers of NUC worldwide – how do we undertake prioritisation? Are food NUC more important than others? Prioritisation must be simple and objective, but must involve a threat assessment. How do we measure threat for individual NUC?
7. **Demonstration NUC?** Should we select some exemplary NUC and focus on them? Which NUC would that be, and what are the selection criteria.