ESA
EUROPEAN SEED ASSOCIATION

BIODIVERSITY AND PLANT BREEDING

Content

Foreword

The seed is the most important factor in maintaining and enhancing sustainable agricultural production. High quality seeds and propagating material of improved plant varieties for food and feed production and non-food uses deliver the genetic progress that is the base of creating value throughout the subsequent agri-food chain. By continuous development and creation of improved plant varieties the seed industry has always responded to the ever increasing needs of mankind. To continue to meet future expectations of society and contribute to the development of sustainable agriculture, plant breeding is strongly dependent on access to the genetic variability of plant species as it is the starting point for its crossing and selection work. Conserving biodiversity and promoting the access to these genetic resources is thus one of the key factors in achieving policy goals such as food security and food quality, preservation of the environment and sustainable farming.

The current international legal framework for biodiversity is governed by two treaties, the United Nations Convention on Biological Diversity (hereinafter: 'the CBD')[1], which covers not only genetic diversity in plants but also in animals and microorganisms, and the International Treaty on Plant Genetic Resources for Food an Agriculture (hereinafter: 'FAO IT PGRFA')[2], aiming at supporting global food security.

(For more information on the legal framework please consult the Annex of this paper on page 6.)

I. Biodiversity and plant breeding - clarifying the concepts

Biodiversity

The term "*biodiversity*" was first used by *Raymond F. Dasmann*, a wildlife scientist and conservationist, in a book entitled "*A different kind of country*" published in 1968, in which he advocated for nature conservation. However common usage of the term in the scientific and environmental circles only started at the beginning of the 1980s.[3]

The CBD defines biological diversity as "*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.*"[4]

Among scientists and policymakers there exist several other ways of defining biodiversity as, for instance, the totality, the variation, the variability or the diversity of genes, species and ecosystems; nature's richness, diversity and biological interdependence[5] or the complex web of life on Earth. However one thing all definitions share is the approach that biodiversity is a multilevel concept encompassing not only species diversity meaning the wide variety of plants, animals and microorganisms but also genetic diversity within each species and variety of ecosystems occurring in deserts, forests, mountains, lakes, rivers etc.[6]

Plant Breeding

Plant breeding is the science of adapting the genetics of plants for the benefit of humankind. The overall aim of plant breeding is to improve the quality, diversity and performance of crops with the objective of developing plants better adapted to human needs.

Already at the beginning of human civilization early farmers started to select plants for specific features such as faster growth, larger seeds or sweeter fruits. However, modern plant breeding only dates from the scientific discoveries on genetics by *Gregor Mendel* published in 1865.[7] Although Mendel's findings were ignored for a long time, they were rediscovered at the beginning of the 20th century, which also constituted the starting point for the development of a dedicated plant breeding sector and specialised companies.[8]

As the understanding of nature and its processes developed plant breeding activities suddenly could become much more advanced. Modern chemistry, biology, genetics and also information technology have enhanced the possibilities of plant breeders who brought their new understanding of genetics to the traditional techniques of self-pollinating and cross-pollinating plants. Nowadays many different breeding techniques ranging from simple selection to more complex molecular technologies are used to develop plants exhibiting desired characteristics.

Notwithstanding all these developments, plant breeding remains a sophisticated, time consuming and high investment business with long-term goals. R&D investment of the plant breeding industry is more than 15% of its annual turnover, which is considerably higher than in many other industries.

The development of a new variety can easily take up to 12-15 years. The plant breeding process starts with the selection of genetic resources presenting the desired characteristics which are then crossed and recombined. Then from the mixed lines and breeding material so developed the best plants are selected and stabilised which can take up a number of years. The newly developed variety then needs to be tested in different climates, which again is a lengthy process. At the end, the new and improved variety presenting added value for the farmer has to be multiplied for distribution. A good example of this complex process is the wheat variety 'VEERY' which was developed through 3,170 crosses involving 51 crop parents from 21 countries.[9]

II. Plant genetic resources - the link between biodiversity and plant breeding

What are plant genetic resources?

Plant genetic resources constitute the basis of plant breeding and they also form the link between biodiversity and plant breeding. According to the definition of the FAO IT PGRFA, which definition is also widely followed by the plant breeding industry, plant genetic resources for food and agriculture are "*any genetic material of plant origin of actual or potential value for food and agriculture*".[10] In practice, basically all plant genetic resources are of potential value in plant breeding.

Plant genetic resources and biodiversity – a matter for the society and the plant breeding industry

Diversity in plant genetic resources provides plant breeders with options to develop, through selection and breeding, new and improved varieties that are displaying the desired characteristics. Breeders have always screened all varieties, old and new, available worldwide searching for individual plants that exhibit desirable traits since the development of improved varieties disposing of specific traits directly affecting its quality, resistance and yield necessitates several varieties and thus largely depends on the genetic diversity of plants available in the different regions of the world. Access for plant breeders to plant genetic resources providing an abundant basket of potentially useful traits from which they can select is therefore crucial.

Although new genetic material for conventional breeders mainly derives from modern varieties available in private collections and from other breeders' registered varieties, the plant breeding industry recognizes the value and potential of landraces (farmers' varieties) and wild relatives.[11] Plant genetic resources present in wild varieties, adapted to specific environments or displaying specific traits, such as resistance to diseases, pests or other environmental stresses (heat, draught, cold, etc.), and traditionally grown landraces can be highly important in achieving improvements in crops. This happened, for instance, in Africa where the use of modern breeding techniques and the diversity in landraces such as *Cardaba gaddat* and wild species such as *Musa balbisiana* allowed for the breeding of improved bananas.[12]

The diversity and availability of plant genetic resources is also incremental when a crop is attacked by a disease or when unexpected challenges need to be overcome. The rice grassy stunt virus which seriously damaged rice fields from Indonesia to India in the 1970s provides a good example. 6273 varieties were tested for resistance when one, an Indian variety known to science only since 1966, was found to perform the necessary resistance which then formed a hybrid with other varieties and is widely grown since.[13]

Biodiversity itself provides the pillars for the society to build civilization upon. Besides other benefits such as air quality, climate, disease control, pollination etc., biodiversity provides the source for industries such as cosmetics, pharmaceuticals, paper, horticulture and above all agriculture.[14] Already the very existence of agriculture is basically a consequence of biodiversity since micro-organisms prepare the soil for plants, humans sow and harvest crops and insects like bees are responsible for pollination.

Seeds and plant breeding constitute the basis of agriculture. By the recourse to genetic diversity and development of new varieties modern plant breeding has created more variation in food crops than has ever been available to farmers and consumers.[15] Plant genetic diversity is not only a basis for adapting varieties and agriculture to different environmental conditions and constraints such as drought, outbreaks of pests, diseases or climate change but it is also a major contributor to food production and nutrition. Breeding new crops is important for ensuring food security by developing new varieties that are higher-yielding, better resistant and better adapted. With more and more people to feed, shrinking and less fertile farm lands and other potential future demands and challenges agriculture may face the world will increasingly depend on plant genetic resources and the efforts of plant breeding.

III. The role of the plant breeding industry in biodiversity conservation

As already explained above, the importance of conservation, access to and use of biodiversity lies in its potential to help ensure global food supply through constant improvement of plant varieties. The conservation of biodiversity can be carried out in different ways the two main forms of which are *in-situ* conservation and *ex-situ* conservation. The first is focusing on conserving species in their natural milieu by, for instance, setting up protected areas or adopting legislation on protecting species etc, while the latter is making use of zoos, gene banks, botanical gardens to conserve species outside their natural surroundings.[16]

The plant breeding industry, having a strong interest in high-quality plant genetic resources, is non-negligibly incentivised to participate in the conservation of biodiversity. This is mainly achieved by sustainable use of plant genetic resources, activities in maintenance breeding and conservation of plant genetic resources in gene banks.

Sustainable use and conservation of biodiversity

Sustainable use of plant genetic resources for food and agriculture is supported by the multilateral system provided for by the FAO IT PGRFA.[17] This sustainable use of plant genetic resources and free access thereof is not obstructed either by intellectual property protection granted to plant breeders. The cornerstone of the specific sui generis intellectual property system for plant variety protection, the plant breeders' rights system created by UPOV, the Union for the Protection of New Plant Varieties, is the so-called breeders' exemption which allows for the use of a protected plant variety (i.e. the germplasm) for breeding new varieties and for commercialisation of those newly bred varieties without prior authorisation of the holder of the right. [18]

The maintenance of varieties is the breeder's insurance for securing high quality, stability and capacity of domesticated varieties (cultivars) over a long period of time. In addition to new varieties, the maintenance of existing ones is also very important. In order to secure continuous access to and subsequent use of their domesticated varieties, plant breeding companies maintain their plant varieties by systematic maintenance breeding. In that respect it has to be underlined that the criteria of distinctness, uniformity and stability that commercial varieties need to fulfill are necessary in order to ensure high quality. Therefore, it cannot be argued that meeting these characteristics would lead to a loss of biodiversity.

Plant breeding companies participate in the conservation of their old varieties by storing them in dedicated gene banks. The first gene banks were created by plant breeders in the 1930s in an effort to conserve agricultural biodiversity and preserve genetic material. Nowadays, there are around 1400 gene banks worldwide maintaining more than 5.4 million samples among which 48% are cultivars or breeding lines. The other half is landraces and non-domesticated plants or crop relatives. Approximately 88% of plant breeding companies conserve genetic resources and spend around 5% of their research budget on such conservation activities.[19] The benefits from ex-situ conservation of varieties are substantial to achieve greater progress towards biodiversity conservation as a whole. The major constraint of these facilities is to ensure constant access to an adequate range of genetic diversity however, in order to reach that goal taking care of the gene banks and the information they conserve is also crucial.

In addition to gene banks, *in-situ* conservation by farmers is also important. The plant material and genetic diversity they conserve is precious for and used by the plant breeding industry in its breeding activities. However it is important to underline that at the end farmers decide themselves what they put into the ground and thus have a free choice in what varieties they use and preserve.

Enhancing biodiversity

Europe has available a rich diversity in a number of crops, including cereals, fruits, vegetables, industrial crops, oil crops, forages and is also home to a great diversity of 'potentially' useful plants, which can substantially contribute to agricultural diversification.[20]

"*By incorporating and remixing genetic diversity in new varieties to develop varieties with improved traits […] modern plant breeding has created more variation in food crops than has ever been available to farmers and consumers*".[21]

When remixing genetic diversity plant breeders use genetic material of both old and new varieties in order to create further improved ones as a result of which the total genetic diversity per species can only increase.

Sustainable agriculture

Increased agricultural productivity is more and more reliant on cropland expansion at the expense of natural habitats and land conservation. The increasing global demand for agricultural land is a major challenge to alleviate the pressure on biodiversity. The development of new plant varieties is a very important and sustainable source of progress in farming. Higher yields largely depend on plant breeding and variety development rather than on the expansion of the total area of production.

In some regions, productivity gains are threatened by areal scarcity, water shortage, decreasing soil quality, climate change and an increased number of diseases and pests enhance crop failure. The development of technologies that could increase the sustainable production of food in regions where agricultural expansion continues to be a large threat to biodiversity could significantly lessen pressure on biodiversity.

"***By incorporating and remixing genetic diversity in new varieties to develop varieties with improved traits […] modern plant breeding has created more variation in food crops than has ever been available to farmers and consumers.***"

IV. Conclusions

The positive and crucial role of plant breeding in both preserving and fostering biodiversity and in promoting sustainable use of genetic resources has to be recognised. Such conservation and sustainable use of plant genetic resources is greatly based on access to these genetic resources which is enshrined in the breeder's exemption, the cornerstone of the plant variety protection system.[22]

Biodiversity, and especially the maintenance of wild relatives of domesticated species, are essential to plant breeding and sustainable agriculture.[23] In many instances these species are crops that can cope particularly well with hostile environments. Their preservation thus contributes significantly to maintain a rich diversity and more stable agro-ecosystems. The use and conservation of diversity therefore determines our food security, our health and our economic well-being. Making genetic diversity an important part of our policy priorities will also add to our overall stability and security.

V. Annex

Concern for the environment has moved to the focus of international political discussions already in the second half of the 20th century as the international community started realising the growing destruction and loss of biodiversity and became aware of the need for action. The current international legal framework for biodiversity is governed by two treaties, the CBD, which covers not only genetic diversity in plants but also in animals and microorganisms, and the FAO IT PGRFA, aiming at supporting global food security. The CBD abandons the “common heritage” vision of genetic resources and establishes the sovereignty of the State where such genetic resources are found. In practical terms for those who want to have access to plant genetic resources, i.e. the plant breeding industry, the provisions of the CBD mean that any such access is subject to bilateral agreements on benefit sharing with the State “owning” the necessary genetic resources. The FAO IT PGRFA has a different scope as it is limited to plant genetic resources for food and agriculture only. It also provides a much better system for the plant breeding industry as it covers 64 crops – which are the most important ones providing food ingredients – which are put together into a multilateral system, i.e. one pool of genetic resources freely available for the ratifying parties of the treaty who agreed to use that available material only for research, breeding and training for food and agriculture.

Besides being a Contracting Party to both the CBD and the FAO IT PGRFA the European Union also takes its own action in developing a policy concerning biodiversity conservation. The two most important biodiversity-related pieces of EU legislation are the Birds Directive[24] and the Habitats Directive[25] together with the Action Plan for Biodiversity[26] aiming at conserving biodiversity and preventing biodiversity loss by setting objectives and corresponding measures to be achieved by 2010. Based on the vision that preservation of biodiversity is essential for its intrinsic value as well as for the ecosystem services it provides the EU’s Action Plan is focussing on four key policy areas: biodiversity in the EU; EU and global biodiversity; biodiversity and climate change; and the knowledge base and identifies financing, decision-making, partnerships and public education as well as awareness and participation as the four main measures to support these objectives. Despite some measures already taken by the European Union, such as the establishment of the “Natura 2000” network aimed at protecting species or the channeling in of biodiversity into other policy areas such as agricultural, regional and fishing policy, the EU 2010 biodiversity targets have not been met.[27] The European Commission is expected to present its EU post-2010 Biodiversity Strategy by the end of 2010.[28]

VI. Notes

[1] Signed at the United Nations Conference on Environment and Development (the Earth Summit) held in Rio de Janeiro in 1992.

[2] Signed in 2001 and entered into force in 2004.

[3] When Thomas E. Lovejoy, an American tropical biologist and conservation biologist, introduced this notion into the scientific community in the forward to a book bearing the title “Conservation biology” in 1980. (Source: Wikipedia)

[4] Article 2 of CBD

[5] OECD Observer : Sustainable agriculture depends on biodiversity, No ; 233, August 2002.

[6] Secretariat of the Convention on Biological Diversity : Sustaining life on Earth, How the Conventio n on Biological Diversity promotes nature and human well-being, April 2000.

[7] Mendel was the first to understand the biological laws according to which heritable information is passed from one generation of plants to the other. He published this discovery in his paper entitled “Experiments in Plant Hybridization” in 1865.

[8] Source : Wikipedia

[9] Laura van der Meer and Annik Dollacker: Sustainable agriculture: Replicate and expand winning solutions! IN: Business 2010, April 2008, p. 18.

[10] Article 2 of FAO IT PGRFA.

[11] However, the use of exotic varieties in plant breeding activities is more costly and often requires time-intensive research investment.

[12] IPGRI : Why genetic diversity matters? 2004

[13] Source : Wikipedia. A similar example is presented by the case of southern maize leaf blight which attacked maize in the United States in the 1970s and caused a 15% fall in yields and considerable financial loss to producers. The crop could recover thanks to a Mexican maize variety. (OECD Observer : Sustainable agriculture depends on biodiversity, No ; 233, August 2002.)

[14] Secretariat of the Convention on Biological Diversity : Sustaining life on Earth, How the Convention on Biological Diversity promotes nature and human well-being, April 2000.

[15] ISF : Plant genetic resources for Food and Agriculture, May 2007

[16] Secretariat of the Convention on Biological Diversity : Sustaining life on Earth, How the Convention on Biological Diversity promotes nature and human well-being, April 2000.

[17] The positive contribution of the FAO IT PGRFA to food security and climate adaptation and mitigation through the conservation and sustainable use of genetic resources is also stressed by the Council of the European Union in its conclusions on Biodiversity adopted on March 15, 2010.

[18] Article 15(1)(iii) of UPOV 1991

[19] Source : Survey carried out by ASSINSEL in 1996 IN: ISF : Seeds for Mankind; Plant breeding, seed and sustainable agriculture, 2002.

[20] www.biodiversityinternational.org

[21] Bernard Le Buanec: Looking at plant genetic resources used for food and agriculture. IN: Busi ness.2010, January 2008, p. 28.

[22] See also endnote no. 18.

[23] World Summit on Sustainable Development 2002, "A Framework for Action on Biodiversity and Ecosystem Management", www.johannesburgsummit.org/html/documents/wehab_papers.html

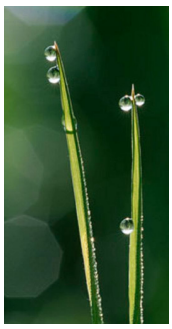
[24] Directive 2009/147/EC of the EP and of the Council, OJ L 20 of 26.01.2010, p. 7.

[25] Council Directive 92/43/EEC, OJ L 206 of 22.07.1992, p. 7.

[26] COM(2006)216 final of 22.05.2006

[27] Conclusions of the Council of the European Union on Biodiversity, March 15, 2010, point e)

[28] Idem, point 4.



VII. Suggestions for further reading

www.euroseeds.org

www.planttreaty.org

http://www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/en/

www.upov.int

www.worldseed.org

http://www.fao.org/nr/cgrfa/en/

http://www.ecpgr.cgiar.org/AEGIS/AEGIS_home.htm

www.ec.europa.eu/environment/nature/biodiversity

www.ec.europa.eu/environment/biodiversity/campaign

Laura van der Meer and Annik Dollacker: Sustainable agriculture: Replicate and expand winning solutions! IN: Business 2010, April 2008, p. 18.

Bernard Le Buanec: Looking at plant genetic resources used for food and agriculture. IN: Business.2010, January 2008, p. 28.

Contact

ESA European Seed Association

Rue du Luxembourg 23
1000 Brussels (Belgium)
T: +32 2 743 28 60
F: +32 2 743 28 69

Email: secretariat@euroseeds.org
Website: www.euroseeds.org

ESA

EUROPEAN SEED ASSOCIATION