THE IMPORTANCE OF PLANT GENETIC RESOURCES IN AGROECOSYSTEM

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ABSTRACT
Monitoring and conservation of plant genetic resources are essential for the development of modern agricultural production. Biodiversity of plant resources in agriculture is a biological basis for ensuring quality world food, acting as the basis for creating new varieties through conventional crossing process or application of biotechnology. Since the laboratory and field experiments can not assume all the possible interactions that may occur in the ecosystem, monitoring is necessary in natural environment, bringing to light the necessity of collaborative interdisciplinary involvement and research.

Keywords: biodiversity, plants, genetic resources, agroecosystem

INTRODUCTION

The plant genetic resources in agriculture include wild relatives of cultivated species, varieties and hybrids, as well as breeding material, horticultural, medicinal, aromatic and other plants that can be used for breeding in agriculture, providing food for both animals and humans. It is well known that agriculture affects natural biological resources, but it also uses these resources to obtain varieties and hybrids, the reciprocal relationship leading to increased economic benefits and sustainability.

Extensive agriculture is known for the preservation of local varieties, soil and woody plants, while intensive agriculture is characterized by a decrease in biodiversity, plant species rotation and quick replacement of plant varieties (CONWAY, 1993). Therfore, monitoring and conservation of plant genetic resources are essential for the development of modern agricultural production.

The great problem of biodiversity conservation is a growing demand for food due to the continuous population growth, and decrease of arable land caused by industrialization and urbanization (BOSKOVIC ET AL., 2010). Moreover, only thirty plant species provide 95 percent of human food, and only four: rice, wheat, corn and patotes provide more than 60%. It is essential to preserve biodiversity (SWIFT et al., 2004), especially in Vojvodina, which is, according to the Fao data, the most deforested European area comprizing of 80% agricultural land (BOSKOVIC et al., 2010).

Agroecosystem differs from natural ecosystem in several aspects. In natural ecosystems, solar energy is the main functional driver, while agroecosystem cinsumes fossil fuel energy as well as human and animal labour. For the maintenance of agrocosystem, human management is crucial, especially today following the development of biotechnology and increasing use of GM plants (KONSTANTINOVIĆ AND BOSKOVIC, 2001; PRETTY, 2001; GARCIA AND ALTIERI, 2005; PRIJIĆ et al., 2008).

Monitoring the impact of GM plants on the environment is of particular importance (BOSKOVIC et al., 2001, 2003, 2004, FERRY AND GATEHOUSE, 2009). Agrobiodiversity consists of two components: the planned biodiversity that is, depending on production management, introduced by farmer on purpose, (choice of crop variety or hybrid), and associated biodiversity, which includes all other flora, fauna, and microorganisms.

Biodiversity management is only possible through an integrative framework that meets the needs of different interest groups (local, regional and national) and various stakeholders (small farmers, indigenous groups, civil society, research institutions, public agencies and private investors) at different levels (CALLO-CONCHA 2003, 2009, MCNEELI 2004).

THE IMPORTANCE OF GENETIC RESOURCES

The importance of genetic resources can be demonstrated in a number of ways. It provides wealth and food diversity for humans and animals, fiber, fuel, medicinal plants, affects water regulation in nature, prevents soil erosion and degradation, allows the development of sport, recreation and ecotourism (CONSTANZA et al., 1997). Today's global economy poses a direct threat to biodiversity because it treats the services of nature as worthless (MILOSEVIC et al, 2009).

Loss of genetic diversity (genetic erosion) was observed in many cultivated species. One of the reasons is loss of local populations and their wild relatives. The loss of wild relatives is related mainly to the reduction or loss of habitat due to land use for agriculture, urbanization and industrialization. Genetic richness of forests in Serbia according to the number of species, their diversity and number of received gen-center, unique in Europe. And in this important segment of the biodiversity present genetic erosion.

These human activities have led to pollution of water, soil and air, and thus the extinction of many plant and animal species, which eventually leads to serious damage in world economy. One example is the bee plague due to the use of some pesticides. It is believed that the value of bee pollination is 1.3-5.2 billion euros, thus bee extinction is not a problem for beekeepers only, but for the whole society (MILOSEVIC et al, 2009). While about 10,000 varieties of wheat were grown in China in 1949, that number decreased to 1000 in 1970. In Mexico today only exist about 20% of local maize varieties that were known in 1930.

The loss of genetic diversity in traditional upland rice germplasm in northern Thailand, due to the replacement of a large number of traditional varieties with a smaller number of modern varieties, but also because of gene flow from distinct cultivars to landraces.

Finally, the continued erosion of crop genetic diversity hampers agro-ecosystem functioning and its provision of services (i.e. pest and disease control, pollination, soil processes, biomass cover, carbon sequestration and prevention of soil erosion) as well as potential innovation in sustainable agriculture (WIEBE AND GOLLEHON, 2006, BOSKOVIC et al. 2010).

AGROECOSYSTEM MANAGEMENT

Agroecosystem management with the aim to reduce soil degradation and loss of agrobiodiversity prevention is complex and requires an integral approach. The difference between integrated and conventional systems is in methodology and strategy *(Table 1)*.

The aim of genetic resource management is the enhancement of conditions for the continual evolution of the species, which is the defensive mechanism of the organisms in the struggle with environmental changes.

Table 1. Comparisson between conventional and integral approach to ecosystem

Aspect	Conventional approach	Integral approach
Perspective	Natural ecosystems viewed as a free source of inputs (land, fertility, etc.) for current and future production	Natural ecosystems viewed as a sof interdependent parts, which provides a wide range of valuable goods and services
Products	Only a few products and services	wide range of goods and services
Strategy	The desire for a bigger yield, the intensification of land, labor and capital use	Optimization of total products, goods and ecosystem services
Methodology	Reduced to the minimum number of factors	System-oriented, including quantitative and qualitative characteristics with particular attention to interactions, gene flow, establishing a balance
Approach to biodiversity	Reduced biodiversity with more predictable results	Biodiversity is given the importance for a better use of resources, meeting as many needs, preservation of biodiversity - more secure and reducing the risk
Means of impact	Political and ownership links	Ecosystem, social and biophysical
Role of science	The use of science focused on biophysical resources and high technology	The combination of biophysical and social analysis, including creation and design of specific models and prototype development processes for a particular local environment

METHODS OF CONSERVATION AND PROPER USE OF GENETIC RESOURCES

Bearing in mind all of the above mentioned, it can be concluded that conservation and preservation of nature and genetic resources presents the preservation of future. The goal of conservation is to enable sustainable development by protecting and using biological resources without compromising the wealth of genes and species. There are two basic methods of genetic resources conservation: *in situ* and *ex situ*.

In situ conservation is the preservation and maintenance of the plant population in its natural environment. Evolutionary processes and plant population adaptability are present. It can be considered as conservation of ecosystems and the natural environment and the recovery of existing populations of species in their natural environment. This type of conservation is very sensitive and, for example, can be endangered by fires, extreme weather conditions, etc. (ALTIERI AND MERRICK, 1987).

Ex situ conservation is the preservation of genetic resources outside of the environment and is mainly used for saving endangered speciesmainly used for saving endangered species. This type of conservation methods includes: seed storage, DNA storage method, pollen storage, *in vitro* conservation, botanical gardens, cryoconservation (freezing plant material mainly in liquid nitrogen at -196° C), molecular marker technology. Seed storage is one of the simplest methods for long-term preservation of plant genetic material. For long term storage of vegetative plant material favourable method is cryoconservation (TANDON ET AL., 2009). Maize *ex situ* germplasm collections include landraces (maize races), improved populations (synthetic and varieties, cycles of selection), inbreds (early generation lines and homozygous lines), reference hybrids. The future maize genetic diversity and maize evolution through gene pools that the farmers and the breeders manage, are supported by the conservation activities of *ex situ* maize genebanks.

In the past, access and transfer of genetic material was limited, because the old varieties were kept solely as *in situ collections*. The data indicate that *in situ* conservation is now less used, and that far more research is done by *ex situ* methods. Differences in the methods are shown in *Table 2*.

It is necessary to supplement the in-situ conservation measures by maintaining *ex-situ* locations and implementation of *ex-situ* conservation measures.

Often *ex situ* conservation will be used as a complement to, or substitute for, *in situ* conservation of unique populations that are threatened in their natural habitat.

Table 2. Differences between *in situ* and *ex situ* conservation, expressed manifested through interest and costs

In situ conservation		Ex situ conservation	
Importance	**Costs**	**Importance**	**Costs**
Genetic resources are used in production	Paid by the farmer	Some genotypes are difficult to conserve	Mainly centralised
Evolutionary processes continue	Can lower farm productivity	Large portion of different germplasm can be expected	High cost regeneration through longer period
Can be better adjusted to particular farmers' needs	Demands land	Germplasm can be available to larger number of breeders	Danger of tartgeted selection can lpwer the value of a colection
Better for certain germplasm, e.g. plant with vegetative reproduction	Through the selection, targeted genotypes can be lost	Highly protected storage area can protect from many diseases	In practice, many collections are under-funded and insufficiently organized and documented.
Existing wild relatives can be kept outside the collection.			

GENE TRANSFER (GENE FLOW)

Vertical gene transfer is the process of transferring genes from parents to offspring by classical reproduction. Horizontal gene flow (HTG) is the transfer of genetic material between cells or genomes belonging to different species, both of which are different from conventional reproduction (POPPY AND WILKINSON, 2005, RICHARDSON AND PALMER, 2007; PONTIROLI ET AL., 2009, ANDERSSON ET AL. 2010). In nature, bacteria are known to act as carriers of genes between species (DANIELL, 2002). Genetically modified plants are a potential environmental risk due to the possible horizontal gene transfer. It has already been confirmed in experiments that genes for resistance to antibiotics incorporated in GM plants can cross to soil bacteria and fungi. Marker kanamycin resistance gene was transferred from tomatoes, tobacco, sugar beet and potatoes to soil bactera *Acinetobacter*. It was confirmed that the genetic material taken from dead and living cells is resistant to environmental conditions, does not disappear and is not destroyed, as was thought previously (LU AND SNOW, 2005). A particular problem is the monitoring of GM plants (BOCK, 2009).

MONITORING

Genetically engineered plants have become a reality, spreading over increasingly larger areas of the world each year (CLIVE, 2008, 2009). Since the experiments in the laboratory and the field can not fully assume all the possible interactions that may occur in the ecosystem, monitoring is necessary in natural environment after the release of GM plants (KHACHATOURIANS ET AL., 2002, BOSKOVIC ET AL., 2003). Monitoring should be performed in different environmental conditions over a longer period of time (ALTIERI AND NICHOLLS, 1999, ALTIERI, 2000), which is very expensive. The obtained data should be used for future monitoring in which experts from various fields including agronomy, forestry, ecology, protection etc. are to participate.

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