SUSTAINABLE AGRICULTURAL PRODUCTION FROM THE STANDPOINT OF BIODIVERSITY

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Abstract. *Biological diversity implies variability of the living organisms from all sources including, among other things, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. This includes diversity within species, between species and ecosystems. Biodiversity of all ecosystems stabilizes the functions of these systems and their interactions with the surrounding ecosystems. One of the ecological aspects of sustainable agricultural production is biodiversity. By biodiversity preservation, i.e. the existing genetic, i.e. genotypic and phenotypic variabilities of species beneficial to agriculture, it is possible to count on agriculture stability.*

Key Words: *Sustainable Agriculture, Agro-eco System, Biodiversity, Genotypic Variability*

1. INTRODUCTION

Agricultural production is based on the exploitation of biological resources (plants and animals). Their basic characteristic is the ability for renewal. Namely, since biological resources possess reproduction ability, they are considered to be inexhaustible. However, the development of civilization, innovative technologies in all human activities, current trends in growing only high-yielding species, strains, cultivars, races and hybrids, long-term unilateral selection for high productivity, development of the so-called agro-technopathies, increasing population numbers, as well as the resulting steady pollution of ecosystems have imposed the necessity for defining stable and sustainable agricultural production and for determining indicators of its stability (Vucinic and Pesic, 2001).

In other words, agricultural production is based on the exploitation of natural, mainly biological, chemical and physical resources. Thus the soil is the physical source, i.e, the medium for the cultivation of cereals, field crops, fruit- and vine-growing and other plant species. In addition, it represents the chemical source supplying crops with an adequate

amount of both macro- and trace elements and other nutrients. Indirectly, it is also the source of nutrients required in livestock production. Stable manure is the chemical source of nutrients necessary for plant production, i.e. for sustaining the quality of physical source-soil-, though soil itself derives from biological sources, being the result of live-stock production. Plant and animal species represent biosources of agricultural production. Atmosphere and hydrosphere, considered as static, constituent parts of the Earth, are also physical sources. However, from the aspect of dynamics, they are very vulnerable, degradable, exhaustible chemical sources for plant and animal species. Some of these sources, biological in particular, are renewable, mainly highly reproductive, while others are exhaustible, unrenewable or low reproductive. Finally, the aim of agricultural production is to increase the reproductive capacity of these sources. If agricultural production is well organized and planned, the aim is achievable. However, the ever-increasing food production endangers the existing sources. According to the EU estimates, by the year 2020 agricultural production is expected to meet the population food needs. By the year 2020 the population will rapidly grow from 7 billion to about 9.5 billion (Heap et al., 1992). Qualitative and quantitative exhaustion of resources will inevitably result in the disappearance of agricultural production.

Although there is not yet universal operational definition of a sustainable system, sustainable development, nor of sustainable agriculture, it can be simply said that today sustainable is agriculture that is "ecological". Agriculture itself is a part of an ecosystem or a micro agro-ecosystem. Being such a subsystem, it undergoes all changes taking place at the global level. The consequence of permanent ecosystem pollution is only one among many causes of disappearance or complete extinction of some plant and animal species. As soon as one of the species disappears, the established food chain in the biosphere is disturbed, survival of other species is endangered too, in both ascent and descent direction of a hierarchy, which is nevertheless of cyclic character. All above-stated is the reason for biodiversity preservation. To better understand the importance of biodiversity for sustainable and stable agricultural production programs, it is necessary to produce a definition of sustainable systems, agriculture in general, sustainable agriculture as well as the parameters, i.e. indicators of sustainability, which is the aim of the present paper.

2. DEFINITION OF SUSTAINABLE AGRICULTURAL PRODUCTION

To understand the concept of sustainable agricultural production, it is necessary to provide the definition of agriculture first. Today, three definitions of agriculture are acceptable such as:

- Agriculture is the production of food for man and of natural fibers, based on the exploitation of natural resources.
- Agriculture represents the way of transforming solar into chemical energy which man can use.
- Agriculture is a part of an ecosystem, a subsystem of an ecosystem, based on exploitation of biological, physical and chemical sources of an ecosystem, and as such agriculture would exist without man's active involvement in it.

An ecosystem is a functional community of living organisms, chemical and physical factors of their environment, and is made up of four components: three abiotic and three biotic.

Abiotic component, which is non-reproductive, exhaustible and susceptible to pollution, comprises:

- air
- water
- soil climate.

Biotic component of an ecosystem consists of:

- producers
- consumers
- decomposers.

Biotic component is at the same time the biosources of agricultural production. Such sources are reproductive and variable, and only seemingly inexhaustible (Speeding, 1993, 1994). As the overall assimilation capacity and adaptability of an ecosystem function on genome plasticity, i.e. variability of biotic component morphological characteristics, and due to affected agricultural production, it is necessary to preserve the existing biovarieties to make agriculture stable, i.e. sustainable both today and in the future. Sustainability of chemical and physical factors pertains to the field of ecology. However, sustainability of biological sources is distinct within the context of global, regional and local biodiversity programs.

Finally, it is necessary to provide a definition of sustainable agricultural production too.

Sustainable or stable agricultural production is a production which meets human food needs at present and does not endanger the possibilities of meeting food needs for generations to come. Also, sustainable agriculture is considered to be the one which does not change qualitatively and quantitatively chemical, physical and biological sources, and in which there is no negative feedback in these two sources' interaction, between present and future generations (Harger and Meyer, 1996). Sustainable or stable agriculture is the one which does not change ecological integrity, either (Mohammed, 1990), considering biodiversity preservation, too.

3. BIODIVERSITY AND SUSTAINABILITY OF AGRICULTURAL PRODUCTION

Biodiversity is the wide diversity and interrelatedness of earth organisms based on genetic and environmental factors. Ecological factors of agricultural sustainability understand environmental protection and biodiversity. Namely, since the goal of agriculture is to produce sufficient quantities of quality food for human population, food production must be organized so as not to affect the quality of air, soil, surface and ground waters, and not to disturb the existing equilibrium in the biosphere, i.e. natural diversity of plant and animal genotypes and phenotypes and their natural heritability. Therefore, it is said that agricultural production is sustainable only if it is organized as to concurrently provide the biosphere sustainability under conditions of ever-increasing population growth (Heitschmidt et al., 1996). Biodiversity means the total of the existing plant and animal genotypes and phenotypes, i.e. natural heritability, thereby sustainability of plant and animal genome variability. Within all the existing ecosystems, biodiversity sustains their

steady stands thus enabling them to function, i.e. survive as well as to interact with surrounding ecosystems. In the same way agro-ecosystems, i.e. agricultural ecosystems influence their environment and vice versa. From the standpoint of agriculture, biodiversity preservation means production that does not affect equilibrium in the biosphere, i.e. enabling the survival of plant and animal genetic resources (bioresources) and contributing to their adaptability and future use in food production. Irrespective of highly productive breeds in animal production, cultivars and strains in field crop production, fruit- and vine-growing. efforts and investments are made to preserve traditional biotops and rare local races, strains and cultivars. Although an agro-ecosystem is only a small portion of the entire biological diversity, it is of crucial importance for human population survival. This means that in the context of agriculture biodiversity must enable continuing food production for people living in a variety of environments but not affect the evolutionary course, i.e. biodiversity of other ecosystems. In other words, agricultural production must not cause the reduction in the number of existing natural varieties within the genome of plant and animal species belonging to other mini-ecosystems that a particular agro-ecosystem interacts with (Haila, 1995).
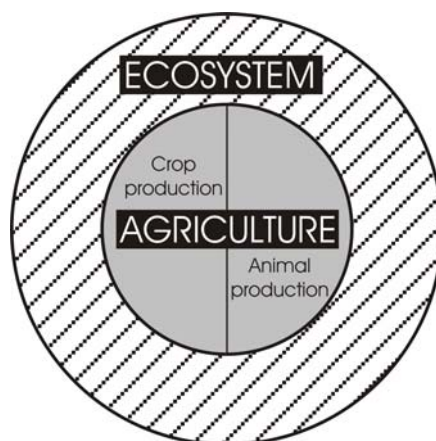

Fig. 1 Aspect of Ecosystems and Agriculture

Concurrently, agricultural production must be organized in such a way as to preserve and protect all existing genetic varieties within an agro-ecosystem, particularly favoring the survival of plant and animal species, races, strains and cultivars adaptable to all growing conditions, resistant to diseases characteristic for certain locations, not susceptible to agrotechopathies, i.e. those productive and yielding in different ecogeographical locations. Since genetic variability is conditioned by the intensity of selection, heritability, size of population and breeding program, this means that biological diversity sustainability within an agro-ecosystem is dependent right upon these factors. Of the listed factors, the size of the existing populations of plant and animal species is most important for biodiversity preservation. The reduction of size of a certain population inevitably leads to the status of homozygosity which contributes to genetic variability reduction. By favoring the growing of only highly productive plant and animal species, all cultivars, strains, races

and even species that are low productive but disease resistant and sustainable in all living conditions may disappear from an agro-ecosystem. If this occurs, the disrupted biodiversity within an agro-ecosystem would label agriculture as an unsustainable activity and would soon endanger the preservation of natural genetic variability and heritability in all other ecosystems that agriculture interacts with. We can simply say that the goal of agriculture is to close food chain in which man is the final link. If there were no agricultural production, this link would exist. However, by unplanned and short-term selection measures, breeding methods and growing of beneficial species, agricultural production may affect the genetic variability reduction, extinction of some genetic, i.e. biological varieties. Their extinction always results in the loss of one link in a food chain, the chain is broken, and man suffers, he who has organized this activity. To avoid the consequences, the Ministry of Agriculture and Forestry in many countries enacts long-term development programs, considering specific demands in lowland, hilly and mountainous ecogeographical locations (Atkinson and Watson, 1996). It was found that unorganized favoring of pasture grazing with increasing number of herbivore population, in a certain ecogeographical location, leads to fast biodiversity degradation within plant species on a pasture susceptible to defoliation. To avoid this, it is necessary to know apical meristem position in the species grown on pasture. Extinction of some plant species from the pasture further effects full extinction or reduction, i.e. rise in population numbers, of invertebrate and vertebrate beneficial for agriculture (earthworms, birds, insects, rodents, etc). When such a condition follows, biodiversity in a pasture is disrupted, and the pasture itself has no longer its function. In situations like this, utilization of a pasture being a degraded agro-ecosystem is left without undertaking any cultural practices to improve the state. Since the instances of biodegradation accumulated from year to year coupled with other factors affecting adversely global biodiversity, it was necessary to undertake measures for its preservation.

Genetically variable populations are much more adaptable to the new living conditions compared with genetic populations grown exclusively for one production purpose like high productivity (Pesic et all, 1997). Therefore, it is a requirement to assess genetic diversity at both national and global levels. The goals of growing must be organized so as to consider all genotypic and phenotypic characters of a particular species, race, cultivar, strain, both morphological and functional characters like reproductiveness, disease resistance and stress susceptibility. The key question to the issue of sustainable agriculture and biodiversity relates to cost-effectiveness of growing rare, low-productive biological sources within certain agro-ecosystems. This is the issue of their cost-effectiveness. Heinonen (1995) has recommended a model of sustainable agriculture in the form of index and defined sustainability indicators. These indexes correlate with all aspects of agricultural sustainability and comprise eight major indexes, each containing several variables as follows:

- human component
- natural energy resources effects of environmental factors cost-effectiveness
- biological efficacy bio-sources (plants and animals)
- social aspects
- physical factors (soil, quality, erosion and the like).

According to other authors, the major three indicators of sustainable agriculture are ecological and social factors as well as cost-effectiveness (Friend, 1996). Biodiversity

preservation and its importance for agricultural sustainability are not difficult to estimate and express in terms of money value. Although this seems to be a costly and unpayable project, growing of local, autochthonous, well-adapted agricultural species in particular ecogeographical locations from which these species originate and survive, promises that they will also be found in the same locations in case the objective of growing highly productive, i.e. high yielding species has to be given up.

4. CONCLUSION

Stable or sustainable agriculture designates food production which meets the needs of present generation and does not affect the possibility of meeting food needs of generations to come. It is ecological, ethic and economically effective. One of the ecological aspects of sustainable agricultural production is biodiversity. By biodiversity preservation, i.e. the existing genetic, i.e. genotypic and phenotypic varieties of species beneficial to agriculture, it is possible to count on agriculture stability. Consequently, to preserve biodiversity, what it is favored is the growing of autochthonous, local and rare agricultural beneficial species of wide adaptability, which have retained their reproductive ability even in scarce living conditions, those that have survived and can reproduce regardless of the fact that they have been completely neglected by man. It is one of the proofs that agriculture would exist even if it were not one of man's primary activities and a source of human population survival.

REFERENCES

1. Atkinson D., Watson A.C. 1996: The environmental impact of intensive systems of animal production in lowlands.
2. Friend A.M. 1996: Sustainable development indicators: exploring the objective function. Chemosphere, 33, 9, 1865-1887.
3. Heap R.B., Ingram D.L., Wathes C.M. 1992: Scientific and technical options for sustainable livestock production. Sustainable livestock farming into the 21st century (ed. By Marshall J.B.), p. 13-30. Centre for Agricultural Strategy, Reading.
4. Harger J.R.E., Meyer: Definition of indicators for environmentally sustainable development. Chemosphere, F.-M 1996, 33,9,1749-1775.
5. Odum, E.P. & Baret, G.W, 2005, Fundamentals of Ecology.
6. Stevanovic V., Vasic V, 1995, Biodiverzitet Jugoslavije sa pregledom vrsta od medjunarodnog znacaja, Bioloski fakultet Beograd
7. Heitschmidt R.K., Short R.E., Giings E.E. 1996: Ecosystems, sustainability and animal agriculture. Journal of Animal Science, 74, 1395-1404.
8. Haila Y 1995: Biodiversiteetti ja luobbobsuojelu. Biodiversity and Production (ed. By Iliedanpaa j.), p.27-4G. Animal Science, 63, 353-361.
9. Mohammed S.M. Being green from the third world viewpoint, Environmental News Digest, 1990, V.8,3.
10. Pesic V. et all. 1997.: Genetic and breeding in Amaranthus in Yugoslavia and its usage value. 2th International Symposium "Novel and Nonconventional Plants", Proceedings, Puschino, Russia. Volume 5, pp. 995-996.
11. Spedding C.R.W. 1993: What is sustainability? Europe Gatt, sustainability and the future of farming, proceedings of Royal Agricultural Society of England national agricultural conference, UMarch 1993.
12. Spedding C.R.W. 1994: Energy and environment in bioproduction systems. MIE international forum and symposium on global environment and friendly energy technology, Tsu-City, Japan. March 1994.
13. Vucinic M. and Pesic V. 2001: Ekološki aspekti održive poljoprivrede. Institut za istraživanja u poljoprivredi "Srbija", Beograd, 1-134.

ODRŽIVA POLJOPRIVREDNA PROIZVODNJA
SA ASPEKTA OČUVANJA BIODIVERZITETA

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Biodiverzitet predstavlja biološku različitost svih živih organizama, bez obzira iz kakvog ekositema potiču ili kojeg su ekološkog kompleksa deo. Uključena je varijabilnost kako u okviru vrste, tako i među različitim vrstama i ekosistemima. Biodiverzitet je okosnica stabilnosti funkcionisanja određenog ekosistema, kao i njegove interakcije sa ekosistemima koji ga okružuju. Jedan od ekoloških činilaca održive poljoprivrede je i biodiverzitet. Samo očuvanjem biodiverziteta, tj. postojećeg genetskog potencijala - genotipske i fenotipske varijabilnosti poljoprivrednih vrsta, moguće je računati na stabilnost poljoprivredne proizvodnje.

Ključne reči: *održiva poljoprivreda, agro-eko sistem, biodiverzitet, genotipska varijabilnost*