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BIOTECHNOLOGY AND SUSTAINABLE AGRICULTURE

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Abstract. *It is widely understood that agricultural production is based on the exploitation of natural, primarily biological, chemical and physical resources. Thus, the soil (lithosphere) represents the physical source, i.e. the foundation for cultivation of cereals, field crops, fruit - and vine growing. Furthermore, it represents the chemical source supplying the crops with an adequate amount of both major and trace elements and other nutrients. Indirectly, it is also a source of the nutrients required in livestock production.*
According to the EU reports in the year 2020 agricultural production is expected to meet the food population needs. By the year 2050 the population will rapidly grow from 7 billion to about 9.5 billion. However, in trying to produce more and more food, there is a growing danger of exhausting the sources. The exhaustion of the sources may pose a threat to agricultural production. Therefore, major emphasis today is placed on sustainable agriculture, i.e. sustainable natural resources for exploitation.
Thus, agricultural production is expected to preserve biodiversity and an equilibrium in the biosphere, i.e. enabling the survival of genetic resources of both animal and plant origin, contributing to their adaptability and future use in food production. Moreover, agricultural production is expected to preserve and protect current genetic varieties within an agricultural ecosystem favouring the survival of animal and plant species, races, strains and cultivars adaptable to all growing conditions, resistant to diseases, i.e. high yielding under different ecogeographic conditions. By applying modern biotechnological methods and techniques, constant food production can be provided both qualitatively and quantitatively.

Key Words: *Biotechnology, Sustainable Agriculture*

1. INTRODUCTION

Agricultural production is based on the exploitation of biological resources (plants and animals). Their basic characteristic is regeneration. Namely, as biological resources have the ability of reproduction, they are considered to be inexhaustible. However, the need to define stable and sustainable agricultural production, as well as the determination of its stability indicators, has been conditioned by the development of human civilization,

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new technologies in all human activities, the current trend in breeding only highly productive breeds, kinds, sorts, races and hybrids, long-term partial selection for high productivity, the appearance of so-called agrotechnopathy, increase in human population, and consequent continuous pollution of the ecosystem (Vučinić and Pešić, 2001).

In other words, it can be said that agricultural production is based on the exploitation of natural, mainly biological and physical resources. In that way, on the one hand, soil represents a physical resource, i.e. a base for breeding cereals, farm, fruit and vine cultures, and other plants. On the other hand, it represents a chemical resource of macro- and microelements and other nutrients for plant production, and by using the food of plant origin, it indirectly represents a source of the same nutrients required for livestock breeding. Fertilizer is also a source of the nutrients required for plant production, that is, for preserving the continuous quality of the physical source – soil, although it alone stems from a biological source, i.e. the product is of livestock. Plant and animal species represent biosources of agricultural production. The atmosphere and hydrosphere, seen as static and integral parts of the Earth, are also physical sources; on the other hand, when seen from the dynamic standpoint, they are known to be sensitive, degradable and exhaustive chemical sources for animal and plant species. Some of these sources, particularly biological ones, are restorable, mainly highly reproducible, while others are exhaustible, unrestorable or of low reproduction. In the end, the aim of agricultural production is to increase the reproducibility capacity in these sources. If agricultural production is well thought-out and planned, it is possible to achieve that goal. However, in trying to produce more and more food, there is a growing danger of exhausting the sources. In that way, according to the EU reports, in the year 2020 agricultural production is expected to meet the food needs of the population which is going to be around 7 billion, while in 2050 it is going to increase to about 9.5 billion (Heap et al., 1992). If the existing sources are exhausted both qualitatively and quantitatively, agricultural production is unavoidably going to disappear.

Although there is still neither a universal definition of the sustainable system and of sustainable development nor of sustainable agriculture, the simplest way to explain it is to say that sustainable agriculture is ecological agriculture. Agriculture alone is a part of the ecosystem or of a mini agro system. As such a subsystem, it is affected by all the changes happening on the global level. The consequences of permanent ecosystem pollution are just one of the many causes for the partial or complete disappearance happening to some animal and plant species. The moment one species disappears, the fixed food chain in the biosphere is disturbed; furthermore, the survival of other species is brought into question, both in the ascending and descending way on the hierarchical cyclic ladder.

2. BIOTECHNOLOGY

According to the definition of the European Federation of Biotechnologists (1982), biotechnology is an integral application of biochemistry, microbiology and engineering with the aim of exploiting micro organisms, the cells of plant and animal cultures or their parts for getting useful products (Figure 1). By implementing genetic engineering it is possible to get products that cannot be produced by means of traditional biotechnologies.

According to the definition of OECD, biotechnology is the application of scientific and engineering (technological) principles in the processing of materials by means of

biological agents, while molecular biotechnology can be defined as a discipline in biotechnology that is based on the application of the principle used in genetic engineering and the products produced by applying it.

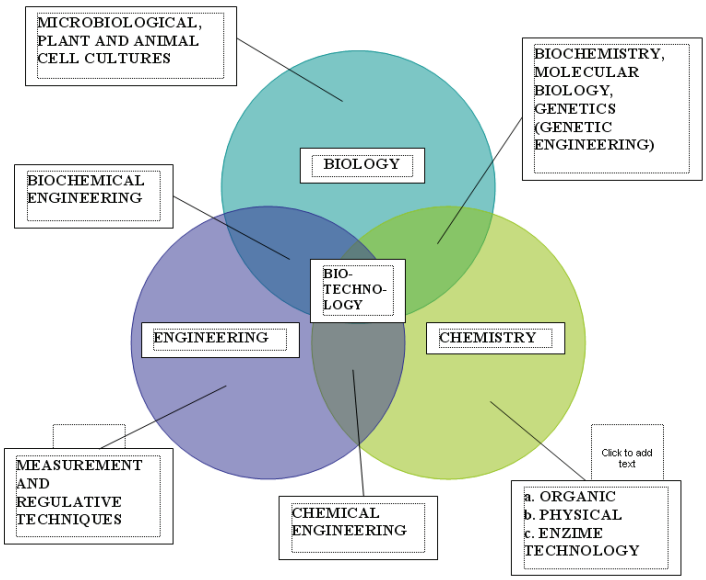

Fig. 1.

All of the means of genome manipulation belong to genetic engineering and biotechnology. The basic difference between genetic changes that occur in nature, traditional genome manipulation in plants and animals (such as selection and hybridization), and contemporary methods of molecular genetics is that by means of the last two it is possible to combine the characteristics of evolutionally different and unrelated species. In that way, molecular biology methods are replacing conventional genetic methods used in agriculture. Genome manipulation can be carried out on different levels of its organization and complexity. It is possible to manipulate genomes originating from different species, that is, complete chromosome sets, individual chromosomes or some chromosome fragments (Vučinić Marijana and Pešić, V. 1997). Manipulation of the individual genes is at the lowest level of possibility and at the highest level of complexity (Watson et al., 1992).

Genetic engineering is the most important part of biotechnology that includes several scientifically interrelated disciplines. By definition, it is a group of methods that provide gene transfer or its sequence and the more or less stabile presence of such an entity in the host cell.

Genetic engineering methods are:

1. Recombinant DNA techniques that use vector systems;
2. Techniques that directly introduce hereditary material into an organism where the material was recombined outside that organism. These techniques include microinjection and microencapsulation;

3. Techniques of hybridization by means of which new living cells are formed with a new combination of the hereditary genetic material. It is done by fusing two or more cells in the way that is unlikely to happen in nature.

Gene transfer, i.e. the transfer of segments (sequences) of a donor DNA to the recipient organism is an important subfield of genetic engineering (Figure 2). It is not limited to a specific organism, while the characteristics are transferable between plants, bacteria, fungi and animals. Defined genes with specific characteristics are introduced to the organism without altering its other characteristics and without creating new organisms.

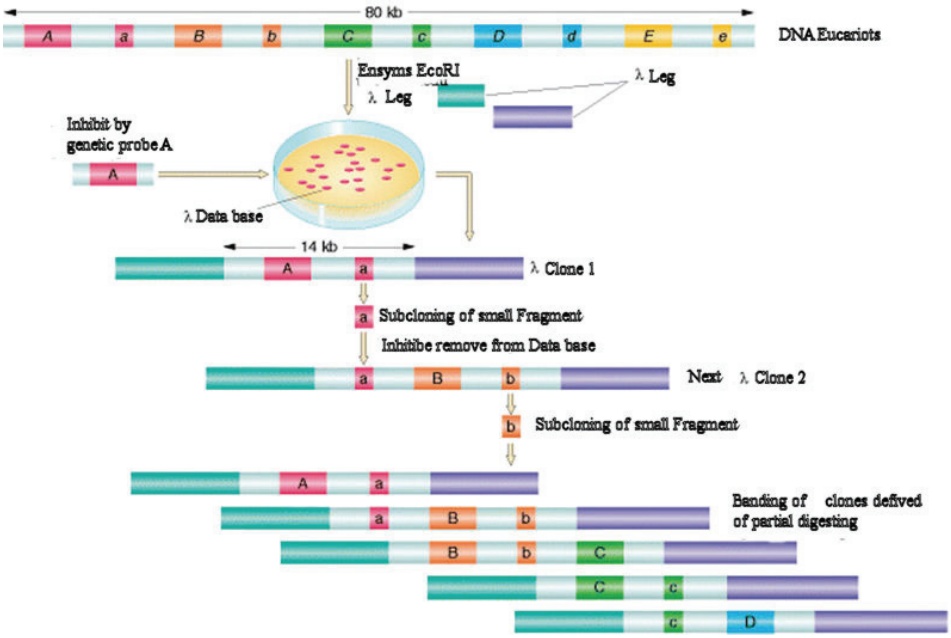

Fig. 2. Sequencing of Genes

Growing new plant species and hybrids is very expensive while the requirements for selection are increasing, so there is a growing need for new methods that will increase gene transfer or qualitative characteristics. In order to transfer desirable characteristic in conventional selection, all genetic material of two plants is combined to get a hybrid. The offspring are then reversibly crossbred with one of the parents for a couple of years until a plant with desirable characteristics is produced. Reversible crossbreeding is limited to species that can be crossbred to produce fertile offspring, because the obstacles of hybridization prevent unlimited exchange of genetic material. Cell and tissue breeding techniques can cross these barriers only to some extent.

Gene transfer brings a crucial new dimension in the process of selection. For the first time defined genes can be introduced to the recipient plant precisely without altering its existing qualitative characteristics. Theoretically speaking, genes from different sources (bacteria, fungi, etc.) can be construed in such a way that by their next transfer they become active in the chosen organ or tissue at a particular time in the period of plant

growth. Breeding objectives can thus be achieved more quickly. Many genetic engineering methods, especially the ones for gene transfer, together with cell and tissue breeding techniques are now an integral part of expert selection.

3. CONCLUSION

Stable or sustainable agricultural production is food production that satisfies the needs of present day generations and at the same time does not endanger the possibility of satisfying the needs for food for future generations. It is ecological, ethical and economical.

One of ecological and economical aspects in sustainable agriculture is biotechnology. By applying modern biotechnological methods and techniques, constant food production can be provided both qualitatively and quantitatively.

Our science and profession must follow modern trends in agriculture, because without sustainable development and technology we will not be able to keep the pace and secure our position in world food production.

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BIOTEHNOLOGIJA I ODRŽIVA POLJOPRIVREDA

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Široko je prihvaćeno da se poljoprivredna proizvodnja zasniva na iskorišćavanju materije iz prirode, prvenstveno bioloških, hemijskih i fizičkih izvora. Pojedini od tih izvora, a naročito biološki, su obnovljivi, uglavnom visoko reproduktivni, dok su drugi iscrpni, neobnovljivi ili nisko reproduktivni. Na kraju, cilj poljoprivredne proizvodnje je upravo povećanje reporoduktivosti kapaciteta tih izvora.

Međutim, u težnji proizvodnje sve većih količina hrane, javlja se i opasnost od iscrpljenja postojećih izvora. Tako prema proračunima Evropske zajednice (EU), poljoprivredna proizvodnja u 2020. godini treba da zadovolji potrebe stanovništva u hrani, čija će brojnost tada iznositi oko 7 milijardi, a već će se 2050. povećati na 9,5 milijardi. Iscrpljivanje prirodnih izvora bi moglo da

predstavlja pretnju poljoprivrednoj proizvodnji. Zbog toga su danas brojna nastojanja usmerena ka razvoju održive poljoprivredne proizvodnje, odnosno održive eksploatacije prirodnih izvora.

I pored svih navedenih zahteva, od poljoprivredne proizvodnje se očekuje da sačuva biodiverzitet, kao i ravnotežu u biosferi, čime bi se omogućio opstanak genetskih izvora, kako životinjskog, tako i biljnog porekla, čime se doprinosi adaptibilnosti biljaka i životinja u budućoj poljoprivrednoj proizvodnji. Štaviše, u poljoprivrednoj proizvodnji mora da sačuvamo i zaštitimo i one biljne i životinjske vrste, rase i kulture koje u sadašnjoj, intenzivnoj, poljoprivrendoj proizvodnji ne zauzimaju glavno mesto, ali su nosioci adaptibilnosti i otpornosti na bolesti, naročito pri određenim ekogeografskim uslovima.

Jedan od ekoloških i ekonomski isplativih aspekata održive poljoprivredne proizovdnje je biotehnologija. Savremenim biotehnološkim metodama i postupcima može se osigurati sigurna proizovdnja hrane i u kvalitativnom i u kvantitativnom smislu. Naša nauka i struka moraju da prate savremene trendove u poljoprivredi, jer bez održivog razvoja i biotehnologije ne možemo održati mesto koje nam pripada u svetskoj proizvodnji hrane.

Ključne reči: *Biotehnologija, održiva poljoprivreda*