INDICATORS OF SUSTAINABLE AGRICULTURE

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Abstract: - 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 by 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 agrotechopathies, increasing population numbers, as well as the resulting steady pollution of ecosystems have imposed the necessity for defining stable, sustainable and organic agricultural production and for determining indicators of its stability.

Key-Words: -Indicators, Sustainable agriculture, Organic agriculture, Agrobiodiversity, Pollution of ecosystems

1 Introduction

At the very end of the twentieth century we started to become occupied with the idea of the production of “healthy food”. It seems that the beginning of this interest coincides with the moment when we realized that the way we had produced food so far could have limitless consequences on the survival of life on Earth. We have given ourselves the right to deprive certain life forms of existence, those which are not edible for human beings, or to be scientifically precise, which don’t “have the nutritional value for humans”. We have even gone further in our carelessness. We have neglected completely those life forms which are “ non profitable for man” and we have spent a lot of time discussing productivity, rationality or economical value of all human activity, especially agricultural production. The final result of our contemplations on the consequences of wasting “ nature’s wealth” has become clear to us when we realized that we had spent most of it. The concept of stable human development is the result of our conscience and the fact that we should preserve what enables life for us as well. This concept includes agriculture, as a part of ecosystem. This imposed the need to define stable, sustainable and organic agricultural production as well as the determination of indicators of its stability [1].

In other words, agricultural production is said to be based on the exploitation of natural, mainly biological and physical sources. Thus, the land, on one side, represents physical source, i.e. the foundation for growing cereals, crops, fruit, grapevine and other plants, while at the same time it represents chemical source for macro, microelements and other nutrients for plant production while through this means an indirect source of nutrients for livestock production. Manure also represents a chemical source for plant production, i.e. maintaining continuall quality of physical source-land, although originates itself from a biological source, being a product of livestock production. Plant and animal species represent bio sources of agricultural production. Atmosphere and hydrosphere, seen as static, constituent parts of the Earth, also represent physical sources, while seen from the dynamical aspect they also represent, as widely known, very sensitive, degradable and exhaustive chemical sources for plant and animal species. Some of these sources, especially biological ones are renewable, mainly highly reproductive, while others are exhaustive, nonrenewable or low productive. The ultimate goal of agricultural production is the increase of reproductive capacity of these sources. If the agricultural production is carefully designed and planned it is possible to achieve this goal. However, in case of massive food production there is a danger of exhausting the existing sources. According to EU estimations, the agricultural production in 2020 should suffice the needs of population in food, the number of which will be around 7 billion while in 2050 the number

will rise to 9.5 billion (Near et al, 1992). If the existing sources disappear in quantity and quality agricultural production will inevitably disappear. A conference about stable and sustainable development of the environment was organized by United Nations in Brazil, in 1992 (Rio de Janeiro) (UN 1992.) One of the conclusions of this assembly was that the humanity was facing a problem of growing population, pollution and the exhaustion of resources used in food production.

That was a reson to verify Agenda 21 under the name "Environmentally Sound and Sustainable Development" (ESSD), which means which means which means – healthy environment and stable (sustainable) development. This act was accepted both globally and regionally. Agenda 21,verified in Brazil in 1992, has 40 chapters consisting of 115 different programs for a sustainable development of all activities. The name of chapter 14 is "Sustainable agriculture and rural development". This chapter includes12 different program areas (from number 45 to 56). A need to establish operative definition of stable, sustainable living systems was expressed then.

Although there still doesn`t exist a universal operational definition of sustainable system, sustainable development or sustainable agriculture, the simplest way to express this is to say that what is considered to be sustainable today is an ecological agricultural production.

2 Indicators of Sustainability

UNESKO standardised quantity indicators of stable development of humankind and the three indicators are:

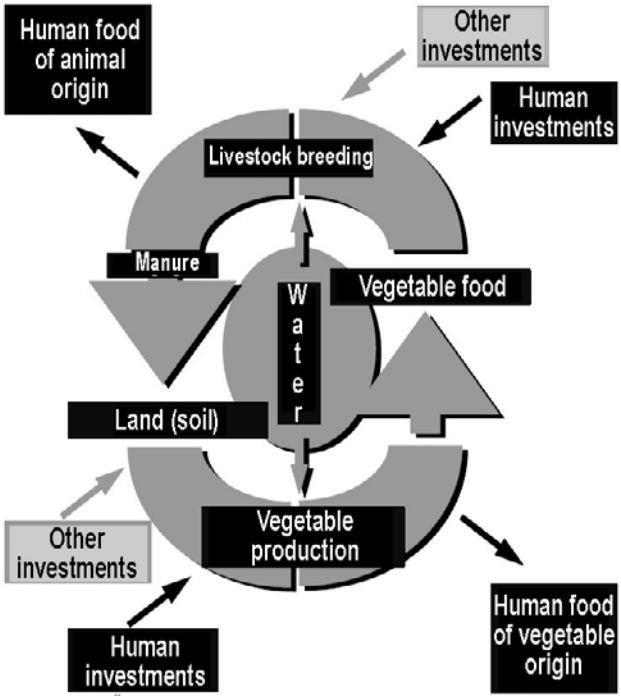
- changes in ecosystem,

- social changes and

- economical changes

The exploitation of energy sources, atmospheric changes, aquatic system changes, natural disasters and general condition of biosphere are being registered inside these changes, events and ecosystems. Indicators of social stability should point to changes and conditions in agriculture, activities related to ecosystem protection, politics, science, education, medicine, urban and rural systems, culture, public infrastructure and measures taken in prevention of poverty, stagnancy and underdevelopment.

As agriculture represents a complex system influenced by numerous factors (scheme 1), it can be said simply that indicators of its stability should include all biotic and abiotic constituents, its interactions as well as factors that enable or prevent these interactions.



Scheme 1. Complexity of relations among the factors of agrosystems

[2] suggests that the final score of all the indicators of stable development of society in a preserved eco system should always be 1. Then the value of this score should be devided into three lower levels according to potential indicators` performance in order to estimate high, medium and low level of sustainability. To conclude, in order to estimate the stability of ecosystem and agriculture as its constituent part, it is necessary to observe, measure and evaluate all the nature`s phenomena, compare them and forecast their consequences and also compare them to all the phenomena and consequences in near and distant past.Based on mutual comparisons of present events and those changes over the time the further trend of all the processes in ecosystem can be estimated. Only when consistency and changeability of observed

indicators have been estimated, is it possible to accept reference values for sustainability indicators.

In order to determine stability or sustainability of these indicators it is necessary that they fulfill certain conditions:

- to be simple, i.e. to represent the state of stability in the simplest and clearest way.

- to be competent, and at the same time universal. i.e. that one indicator, if possible covers the whole spectrum of human activities that influence stability, starting with economy and ending in environment protection and also that the differences among indicators which show the same state be as little as possible.

- that they are measurable by simple methods,

- that the trend in ecosystem can be estimated easily based on them

- that they are sensitive enough to point to slightest changes in the nature,

- that they are permanent, i.e. that in time they don`t lose the significance and cannot be replaced by new indicators and

- that reveal in due time structural and functional changes in ecosystem or other systems whose stability needs to be maintained or sustained.

Researchers [3] suggested in 1991 a simple scheme to define physical indicators of sustainable development. All ecological indicators can be devided in two groups. The first group consists of indicators which define the "pressure" of negative factors on ecosystem, while another group consists of indicators defining, consequences (results) of negative factors.

Indicators of negative factors on ecosystem reflect dynamical changes through structure but not through the function of an ecosystem. It can be set an example of monitoring certain pollutant in the environment, when the time of its concentration, distribution and deposition in different non biotic and biotic surroundings is registered as well as the time of its half-life and decomposition and different changes which an ecosystem is exposed to but still preserving its functionality. This points out that an ecosystem is flexible and contains its receptors which change in quantity and quality in order to preserve its overall functionality. These receptors are people, plants, animals, air, water and land. Indicators of consequences made by negative factors in an ecosystem can be seen and defined through changes in quantity and quality through time. These are the consequences of negative influences of pollutants or certain activities on human health, the health of animals and plants and on population of all commercial species, on biomarkers and biodiversity as well as the description of ecosystem [2].

A good example of indicators of consequences of pollutants are listed by [4], when they pointed out that pollutants in the environment act on all levels, starting with molecular-genetic level, through ontogenetic, all the way through ecosystem-biosphere level. Even when they act on the lowest, molecular-genetic level, pollutants express their activity on the highest, ecosystem-biosphere level. Then they affect bio membrane, protein-enzyme systems and genetic cell system. If pollutants affect genetic cell system, changes can be foreseen on descendants which influenced other, new negative and non- vital varieties in bio sphere which can disturb its balance that had been formed for millions of years through complex evolutional flows with inevitable adaptation process.

According to [5] criteria that could be used for evaluation of stable agricultural development are:

- Environment (the quality of land, underground and surface water, air and their degradation)

- biodiversity (current situation, endangerment by the inclusion of bio technological methods of new generations well as the advantages and dangers of bio technology)

- ethical aspects, which consists of two components, human component and human relation to the welfare and health of animals.

When human component is taken into consideration then all the factors influencing moral obligation of every individual to participate in the program of development of sustainable agricultural production and the sustainability of ecosystem in general as well as the level of conscience about potential needs of future generations are taken into account.

Finnish explorer [6] recommended a model for stable development of agricultural production in an index form. The model of indicators of sustainable and organic production in the form of index was

given by [7] The index system contains 10 major indicators where each consists of 10 variables. In this manner the value of the index can span from 0 to 10. Index with maximum value (***Ioop=10***) reveals a completely sustainable organic model of production. The interval of index value of 9 to 10 shows an almost ideal model of sustainable and organic agricultural production.The interval 8-9 shows almost stable system of production. The interval of 7-8 shows an incomplete system of organic production which with certain corrections can be transformed to an almost stable system of sustainable and organic agricultural production.

Indicators which are basis for calculation of the index value (***Ioop***) are:

1.the quality of land;

2.the quality of water;

3.the quality of air;

4.the external influences (geographic, climate, edaphic etc.);

5.the need for livestock and plant production;

6.biological efficacy;

7.the influence of external energy sources (fertilizers, oil and its derivatives, protection devices etc.)

8.Participation of humane component (work ethics, training in working in agro systems which are expected to be functional in organic food production, wish for agro system preservation, a level of general education, etc.)

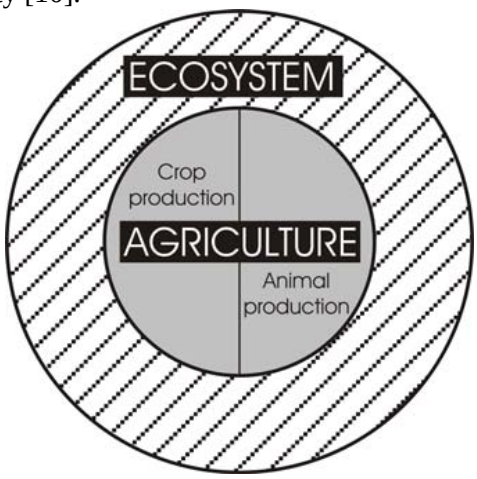
9.social aspects

10.economic influence.

3 Biodiversity and Sustainability of Agriculture

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 [8]. 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 vinegrowing. 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 [9].
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 [10].



Scheme 2. Complexity of relations among the factors of agrosystems

4 Conclusion

Stable or sustainable agricultural production means food production which satisfy the needs of present generations and at the same time not endangering the possibility of satisfying the needs of generations to come.Due to a vast heterogeneity of agricultural production systems it is necessary to do specific analyses for every agro system mainly to establish all the criteria for stability assessment, i.e. to define indicators of agricultural sustainability.

Our science and practice must follow all trends in sustainable and organic agriculture since without sustainable development and production of healthy and biologically worthy food we cannot maintain the high position we deserve in the world division of work. To conclude, it is crucial to define and apply indicators for stability assessment and sustainability of agricultural production, which was represented by this paper.

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