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PRINCIPLES OF ECOLOGICAL MANAGEMENT OF SOIL RESOURCES IN AGRICULTURE IN THE REPUBLIC OF MOLDOVA

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Abstract

In this article we tried to present both the results of scientific research and observations from the Republic of Moldova, as well as the experience of different countries of the world, who were convinced of the need for economic, ecological and social modernization of the modern agricultural system, in order to transition to a sustainable system of agriculture. We hope that the farmers will enrich this experience which it will be a good help at the beginning of the path towards organic farming in our countries. Soil resource management is a major social issue. The increase of agricultural production can only be achieved through the rational use of soil resources. Effective sustainable agriculture, based on conservative technologies, can be designed as part of a system of long-term protection and preservation of soil quality and production capacity. According to the directive no. 2 of 25.01.2011, the Ministry of Agriculture and Food Industry requested the elaboration of the Program for the development and implementation of conservative technologies in agriculture. As of January 1, 2011, the total area of the Republic of Moldova constituted 3384.6 thousand ha, including: 2498.28 thousand ha (73.8%) agricultural land. Of which: 1812.73 thousand ha (72.6%) arable land, 298.78 thousand ha (12.0%) perennial plantations, 352.55 thousand ha (14.1%) meadows and pastures, 34.21 thousand ha (1.4%) land not worked.

Key words*: ecological management, erosion protection, soil, sustainable agriculture, fertility.*

INTRODUCTION

Interest in organic farming is growing worldwide, due to the fact that the industrial intensification model of agriculture has not ensured a sustainable development of the agricultural sector (Dokuchaev, 1949).

Moreover, the negative consequences intensified: economic, ecological and social extensions of the concept of the "green revolution", based on increasing the use of non-renewable energy sources and their derivatives (mineral fertilizers, especially nitrogen, pesticides for the management of diseases, pests and weeds, irrigation, plowing with plow with cormane etc.). Limited sources of non-renewable energy and continuous growth of prices for them, as well as their industrial derivatives (nitrogenous fertilizers, pesticides etc.) dictate the need for continuous increase in prices for energy sources and industrial products used in agriculture. Thus, the competitiveness of farmers decreases, especially in countries that do not have their own renewable energy resources. In addition, the negative effects of narrow specialization and concentration of agricultural production became evident under the influence of intensive use of chemicals in agriculture (Oades, 1991; Боинчан, 1999), as well as heavy equipment for agricultural work (water and wind erosion, increased loss of soil organic matter compensated, soil compaction, loss of biodiversity in the aerial and underground part of the soil etc.).

The abrupt reduction of soil fertility has become one of the main limiting factors in the subsequent increase of crops. Stabilizing and reducing production levels is becoming a well-established trend for all countries of the world, including European countries, and, of course, for the Republic of Moldova. The market economy underestimates or totally ignores both the negative consequences on the environment and on society. For example, the worsening of people's health, the ruin of rural communities with the danger of their disappearance and so on. In this regard, the company has become increasingly aware that food prices do not reflect the real costs of production, because the negative consequences on the environment and human health are not taken into account. People want to know the origin of the consumed products, as well as the influence of their cultivation methods on the environment and their health. Agriculture needs a different

approach to its intensification process (Barber, 1988; Reid et al., 1981; Tansley, 1935; Vernadsky, 1965). For the transition to a more sustainable system of agriculture, including an ecological system of agriculture, it is very important that the soil be conceived as a living ecosystem, a living organism in which the biophilic elements and the energy in the form of synthesis - decomposition of matter - flow continuously soil organic matter (Vernadsky, 1965). Unfortunately, in modern agriculture the soil is often conceived as a substrate in which it is necessary to add water and nutrients, as well as to protect the plants against diseases, pests and weeds in order to maximize the level of production obtained. There is also a simplistic approach to assessing the impact of drought consequences and the design of fertile soil capacity. Both are a consequence of the lack of soil surface of live or dead mulch, as well as due to deterioration of soil structure, because of insufficient restitution of organic residues in the soil to increase the biological activity of the soil and, as a result, better supply of plants with nutrients. Traditional agriculture, based on the use of industrial inputs, is usually geared towards "fighting" the consequences, rather than eliminating the causes that caused problems. For example, the efficiency of mineral fertilizers is higher on more compacted soils than on poorly compacted soils (Krupenikov et al., 2011).

A similar situation arises when using mineral fertilizers on poorer soils or more unfavorable predecessors for different crops. It is obvious that it would be preferable to reduce the dose of mineral fertilizers by enriching the soil with organic substance, which will also contribute to soil relaxation under the conditions of sunny conditions, which implies simultaneously respecting the location of crops after pre-fertilizers (Sheptukhov, 1993).

MATERIALS AND METHODS

After the renowned academic T.S. Maliţev, the efforts of the scientists in Moldova have been oriented towards increasing the level of production, without taking into account the need to restore soil fertility. As a result, soil fertility became one of the limiting factors for the subsequent increase in the level of production. The data obtained from long-term field experiments on permanent crops and cultivations of the researches from Republic of Moldova with a duration of more than 50 years testify that, despite improving the composition of crop varieties and improving cultivation technologies of them, in the mid 80's of the last century, the stabilization of autumn wheat and sugar beet crops began to stabilize with their subsequent decline in the last 20-25 years. A similar situation is marked for other cultures in the long-term experiences of the institute. In the European countries, the stabilization of the production started a little later: in Switzerland in 1990; in the Netherlands in 1993; in France and the United Kingdom in 1996 etc. There is a misconception that organic farming means giving up the country to use chemicals for plant nutrition and their protection against pests, diseases and weeds. This is important, but obviously not enough, because in the absence of systemic management capable of compensating for the renunciation of the use of chemicals, the situation can change dramatically, and the idea itself may be compromised. Modern research allows a deeper understanding of the polyfunctional role of the soil and the importance of the trophic chain in the soil. We must recognize that the biodiversity in the underground part of the soil is much higher than in the aerial part and remains little explored.

Without adequate measures for the correct selection of predecessors for all crops in the wild, and without adequate measures to restore soil fertility, it is impossible to achieve the expected results in organic farming (Figure 1).

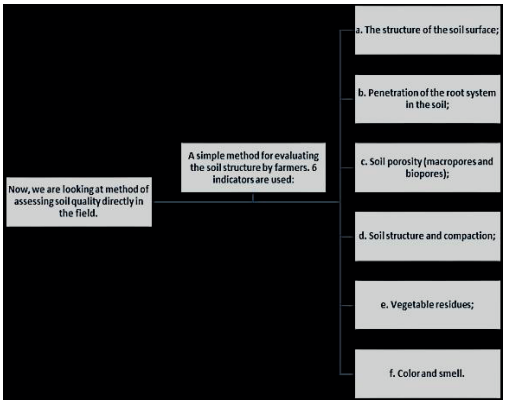

Figure 1. Basic indicators in the assessment of soil quality in the field

The situation is aggravated by ignorance and misunderstanding, especially the enormous role in soil of different groups of microorganisms in the transformation of soil organic matter.
In 10 grams of soil contains 1.5 times more microbes than the population of the earth. Satisfying their needs in nutrients and living conditions (air, water) is no less important than creating satisfactory living conditions for plant growth and development. The use of heavy equipment, the excessive consumption of mineral fertilizers and plant protection products in the control of diseases, pests and weeds will surely have a negative impact on the living conditions of the soil biota, in the formation of the soil structure (Berezin et al., 1985).

RESULTS AND DISCUSSIONS

The ecological management of the soil and of the crops implies the observance of a coherent management system, oriented not only to obtaining the expected production, but also to restoring the fertility of the soil.
This goal can be achieved over a longer period. The accumulation of organic matter in the soil allows at the same time the accumulation of a larger quantity of water in the soil, which determines the success of the agricultural system in steppe conditions (French et al., 1979; Hadas, 1990).
Soil is a relatively non-renewable natural resource, by comparison with the duration of human life. Agriculture based on depletion of natural resources cannot achieve sustainable development. Moreover, deteriorating soil fertility leads not only to reducing crop productivity but also to other undesirable consequences (Bakhtin, 1969).
This can only be done if the order is established in the three basic pillars on which any agricultural system is based (Figure 2):

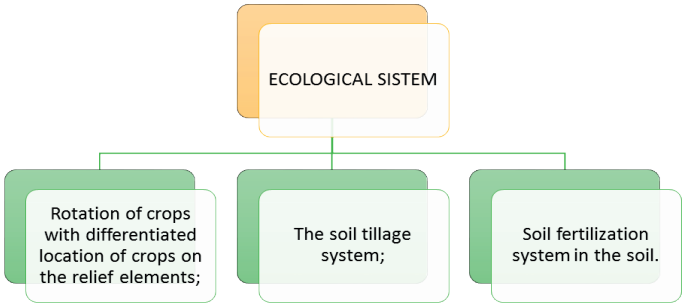

Figure 2. Basic pillars in the organic farming system

Drought and erosion are two sides of the same coin. Reduction the negative impact of drought and erosion cannot be achieved only in the context of desolation, although its role is extremely important (Bulygin, 1993; Milanovsky et al., 2002; Snakin et al., 1995; Vasilievskaya, 1994).
To effectively achieve soil erosion protection, it is necessary to consider the following facts (Figure 3):

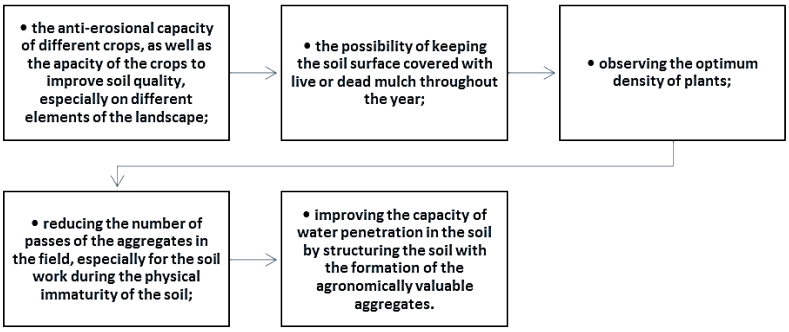

Figure 3. Analysis of the main facts in soil erosion protection

For the correct management of the organic matter of the soil are important: 1) permanent return of fresh organic matter in soil from different sources and of a diverse chemical composition; 2) use of different sources of organic matter; 3) keeping the soil covered with plants or mulch for as long as possible during the year, including during the vegetation period; 4) the minimum disturbance of the soil with mechanical works; 5) optimization of the fertilization system in isolation; 6) creating favorable conditions (habitat) for the life of organisms of the soil along the trophic chain.

The general principle for the slopes located on the slope is the need to reduce the weight of the crop and the size of the fields. As the slope increases, the share of compact seed crops, including perennial grasses, increases. The latter have the amazing property not only to better withstand erosion processes, but also to enrich the soil eroded on slopes with organic matter with an ideal distribution in the soil layers.

Kaştanov A.N., referring to the works of Prof. Zaslavski M.N., brings an ideal scheme for antierosion establishment of soils with the relationship between different cultures for the conditions of the Republic of Moldova (Боинчан, 1999). So the relationship between the sowing crops and the compact sowing crops, including the perennial grasses for the arable lands located on slopes of different inclination, constitute (Krivenkov, 1967): - up to 1 degree with the ratio 3:1 (sowing crops: compact sowing crops); - 1-5 degrees with a ratio of 1:1; - 5-8 degree 1:3 ratios (including perennial crops - 1); - more than 8 degrees (including 2 and 3 under perennial grass).

It is important to choose the right species of trees and shrubs for steppe, drought tolerant and scorching conditions. The strips of forests need to be placed perpendicular to the prevailing wind direction.

The rotation of the crops allows the prevention, but not the "fight" against pests, diseases and weeds (Dokuchaev, 1949; Vernadsky, 1965).

In the Republic of Moldova, the legal framework corresponding to the European directives for the production of organic products is elaborated.

In addition, in the Republic of Moldova, a code of good agricultural practices was developed, which are a firm step towards sustainable agriculture, including organic ones.

The soil used to produce organic produce must be homogeneous, fertile and uncontaminated. In the household is ensured the observance of the isolation during the last 5-6 years (Viter, 1969).

For the ecological farming ideal would be to provide a closed circuit of nutrients and energy within each household, by combining the phytotechnics and zootechnics branch, in order to restore a maximum amount of nutrients and energy in the soil. In this way, the certification of the household is also facilitated, for the simple reason that the sources of soil fertility restoration become known (Sheptukhov, 1993).

Manure is often used as waste for animal production. In fact, manure is an irreplaceable source for restoring soil fertility. It serves not only as a source of enrichment with soil nutrients, but also provides a guaranteed source of soil enrichment with organic matter and enhancement of soil biological activity.

At the time of sowing the grapefruit with the last cultivation between rows of maize, the grapefruit forms a carpet with a mass of 0.5-2.5 t/ha. Thus, the sowing of the ray between the rows allows not only to reduce the degree of thickening of corn with coarse pears, but also to obtain a vegetable mass for grazing animals and an underground biomass for enriching the soil with organic matter.

Often we do not appreciate the role played by the greater diversity of weed species in breeding and breeding animals. Farmers in organic farms appreciate this fact. Qualified farmers can diagnose their fields based on native weed species.

It is beneficial to crop rotation include high biological capacity to compete with the weeds (for example, buckwheat) and successive crops (rape, mustard, phacelia, vetch etc.). Incorporating them into the soil in the spring is more effective than the fall, but requires caution regarding the water regime for the next crop.

Soil management on an ecological basis implies respect for the entire (new) agricultural system, which differs essentially from the way of approaching soil and crop management. This is more than just observing crop cultivation technologies. Cultivation technologies need to be respected, but not necessarily in the context

of farms and in the systems of management, including agriculture.
Recently, areas planted with autumn cereal crops are being grown using the No-Till method. The efficiency of this process is determined by observing crop rotation and soil enrichment measures with fresh plant residues.
In the Register of varieties of the Republic of Moldova, there is a sufficient range of varieties suitable for cultivation under different climatic and soil conditions, as well as on different agrofunds, including varieties created in the Republic of Moldova. Each farmer must use 2-3 varieties of each crop.
The annual legumes have the ability to accumulate nitrogen from the atmosphere, due to the knots on the roots of the plants, but at the same time, the aerial biomass is also enriched in nitrogen.
Leguminous crops can enrich the soil with nitrogen only in case of incorporation into the soil of the aerial biomass, because at maturation most of the nitrogen is concentrated in seeds, which are extracted from the field with the harvest.
The amount of nitrogen extracted with primary and secondary production is equal to or even exceeds the amount of nitrogen returned back to the soil with the stubble and the underside of plants.
Soybeans and peas are a reliable source of protein for human and animal feed. Beans are the favorite food of the local population, but not only.
Maize is a traditional crop for agriculture of the Republic of Moldova. The successful cultivation of this crop is predetermined by the lack of droughts, which can totally compromise the production of maize. Compliance with the entire set of measures to increase productivity and restore soil fertility within the sustainable agriculture system allows to reduce the negative effects of droughts. When wheat grains are used as predecessors for maize, it is recommended to use successive crops as green manure. Sunflower is less suitable as a predecessor to maize, but is excellent when followed by corn at silo. This is explained by the fact that the green maize-silage table is harvested together with the sunflower, improving the nutritional qualities of the green mass.
In connection with the advancement of advanced technologies, used in recent years in agriculture, the minimum method of conservative soil tillage - up to a depth of up to 15 cm, is increasingly applied.
Landowners and farmers could thrive on such land: no state in Europe has 80% of the black soil in its soil cover. However, the chernozem region, such as Moldova is, is currently experiencing environmental, economic, and social difficulties. One of the reasons is the improper use of soil cover. In an agricultural country, there is no more valuable natural wealth than soil. The crop yield, food security of the country depends on its condition. The need to double grain production in the world until 2030 is even more discouraging due to a decrease in cultivated land per capita and a decrease in fresh water reserves, the threat of a decrease in the efficiency of use of agricultural resources due to projected climate change. Thus, the need to identify processes, methods, and policies that support sustainable soil management is now even more relevant than ever. The goal of Sustainable Development is to reduce the risk associated with soil degradation by increasing its sustainability and improving the functioning of such a fragile and depleted resource as soil (Krupenikov et al., 2011).

CONCLUSIONS

A healthy soil provides a healthy root system and thus enhances the competitive capacity of crops in relation to weeds in the use of water and nutrients.
Regardless of the way of transition to ecological (organic) farming, the basic purpose remains to comply with the requirements regarding the growth of organic products in accordance with the applicable standards.
The key to success in the transition period depends on the health of the soil. Smooth and compacted soils need time for improvement. The desired results can be achieved only if the sun, the compost, the green fertilizers and other organic fertilizers are respected.
The rotation of the basic and successive crops must ensure the maximum coverage of the soil surface with vegetation and vegetal debris, not only during the growing season, but throughout the year. Thus, the development of erosion processes, nitrate leaching and other negative processes can be avoided during the most critical periods of the year.

A good improvement of the soils is due to the inclusion of perennial legumes in the settlement; it is possible to respect a closed circuit of nutrients and energy in each household. The plants are used for animal feed, and the manure is returned to the ground.

In order to increase the volume of agricultural production, at the same time with the long-term preservation of soil quality, it is recommended to implement conservative technologies, which include a complex of organizational, pedo-ameliorative and agro-technical measures.

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