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AGRICULTURE IN THE REPUBLIC OF MOLDOVA IN TERMS OF SOIL REMEDIATION AND PROTECTION

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Abstract

The purpose of our research presented in this article is to remedy soil properties through phytotechnical methods by creating a positive balance of carbon, nitrogen, humus and stopping arable degradation processes. The existing system of agriculture in the republic led to the dehumification, destruction, biological degradation of the arable layer and loss of the material's resistance to compacting. The researchers are carried out in the Central and Southern areas of the Republic of Moldova. A phytotechnical process was applied from a mixture of leguminous and grassy perennial herbs in equal proportions (alfalfa + steppe raspberries + vetches), the harvest of which was used as fodder production. As a result, a positive influence on the quality of the degraded arable layer of chernozems was established. Thus, they were returned to the 0-35 cm layer of arable soil of about 25.5 t/ha of absolutely dry organic residues (5.1 t/ha annually with an average nitrogen content of 1.9%)and the synthesis of about 5.5 t/ha of humus (1.1 t/ha annually) was created, the content of organic substance in this layer increased on average by about 0.20% or 0.04% annual.

Key words*: agriculture, arable layer, phytotechnical methods, remediation, Republic of Moldova, soil quality.*

INTRODUCTION

Agriculture in the Republic of Moldova accounts for 10-15% of gross domestic product (GDP) and represents the most important branch of production. In agriculture, soil is the main means of production. The state of soil quality depends on the food security of the country and on the welfare of the population (Capcelea, 1996; Danii et al., 2003).

Agriculture currently practiced in the Republic of Moldova is confronted with a number of major problems that seriously affect rural development. The classical system of soil works has led to a gradual increase in production, but it has also led to the appearance of phenomena of degradation of features, a decrease in the production capacity of agricultural land. (Cerbari, 2011; Гейдеман, 1975).

Excessive work has favored processes to reduce soil organic matter content, damage to the structure, increased erosion risk; heavy traffic and too often led to increased compaction and, as a result, to trigger other negative phenomena (Aşevschi, 2012).

Soil is an organo-mineral system that can provide a high agricultural production capacity only if it has a permanent flow of fresh organic matter. Creating a balanced or positive balance of the organic substance in the soil is the main condition for preserving its long-term fertility and avoiding degradation of the arable layer by dehumidification, destructuring and excessive secondary compacting (Boller et al., 1997; Brown et al., 2000; Gliessman, 1990; Soule et al., 1992; Whalen et al., 2010).

This can only be achieved by the regular introduction of organic fertilizers - manure or fertilizers into the soil (Cerbari, 2010; 2011).

An effective sustainable agriculture based on conservative technologies can only be conceived within a system of long-term protection and preservation of soil quality and capacity. Soil is a limited means of production in space that cannot be multiplied as other means of production (Cerbari et al., 2013).

As a support and living environment for humans, plants and animals the soil is an inestimable wealth of the whole people, which, regardless of the form of ownership, must be used in accordance with the interests of the development of the national economy, according to the legislation in force.

Proper management of soil resource fertility is a major social problem. The increase in agricultural production can only be achieved by rational use of soil resources. It has been pointed out that the only radical remediation factor of the degraded features of the

chernozems is that which led to the formation of this type of soil - the steppe vegetation in which the grasses and legumes with radicular fascicular system dominate (Brown et al., 2000; Tonea, 1999; 2002).
The conservative farming system defines any technological system that is intended to save resources (energy, material, human, financial), as well as to reduce or even eliminate aggressive factors that determine and/or intensify any form of soil degradation or other environmental compared to the conventional system (Batîru, 2015; Cerbari, 2010, 2011).
Conservative soil cultivation systems use pre-culture crop remnants to protect soil and preserve humidity. They are human imitations of natural protection against the destructive forces of precipitation and wind, and have as potential an excellent measure to combat erosion of agricultural land (Batîru, 2015).

MATERIALS AND METHODS

The high cost of chemical fertilizers and their negative effects on the environment have convinced the human community to seek an alternative to the existing farming system (Cerbari, 2011; Voloşciuc, 2009).
The physical, chemical and biological degradation of chernozems, soils occupying about 80% of the land surface of the agricultural land, leads to the expansion of the desertification processes of the land and to stop the increase of the agricultural production volume in the country.
Considering the fact that in Moldova there is no possibility of cardinal remediation of the soils quality by means of sentiment, methods of remediation of the soil characteristics without interruption of the agricultural production process have been tested by mixing perennial legumes (Figures 1-2) with pivoting radicular system (alfalfa, sparceta or vines) and ryegrass with fascicular radicular system (steppe ryegrass, drought-resistant plant with extremely developed fascicular root system).
The existing agricultural system does not ensure that soil quality is maintained in the future and leads to worsening economic and ecological conditions in the country. The overcoming of this situation is possible through the gradual implementation of a sustainable agriculture system, based primarily on the use of natural processes, on the biological and renewable resources of the household and only secondly on the resources procured (Cerbari et al., 2013).
It provided for the creation of a single polygon to study the processes of remediation of the quality of common chernozems in Southern Moldova under the influence of green fertilizers, but in 2013 it created the possibility of organizing the second unpredicted research polygon.
This polygon was organized in Central Moldova for the delluvial chernozems - soils with physical characteristics more difficult than those of the usual chernozems in Southern Moldova, formed under other conditions (Figure 1).
On both polygons, some preliminary results on the influence of green vines on the quality of soils and on the size of the basic crop yield were obtained.
In order to reduce dehumidification processes, damage to the structure, strong compaction of the arable soil layer and increase soil erosion resistance, it is recommended that in a 5 field crops a field occupied with a leguminous sidestream crop, autumn vetch and spring (2 crops of vetches incorporated into the soil as a green fertilizer on each field once every 5 years).
The structure of the crop can be as follows: field covered with vines – maize - autumn wheat - autumn wheat or barley - sunflower. This process, used in the framework of any agricultural system, will lead to the remediation of soil quality and the increase of its production capacity (Cerbari, 2010, 2011; Tonea, 2002).

RESULTS AND DISCUSSIONS

In Moldova the situation regarding the use of organic fertilizers is the following:
- in order to ensure a balanced or positive balance of the organic substance it is necessary to introduce at least 10 t/ha/year of manure into the soil. (Cerbari, 2011; Cerbari et al., 2013).
In the 90`s of the previous century, because of the developed zootechnical sector, about 7 - 8 t/ha/year of manure was introduced in the arable soil, which combined with the observance of the crop where there is a field of

perennial legumes and a field of annual grasses with the participation of leguminous crops, a balanced balance of the organic substance in the soil is ensured (Aşevschi, 2012; Danii et al., 2003; Voloşciuc, 2009; Гейдеман, 1975).

Ordinary chernozems, in terms of physical, hydrophobic, chemical and trophic properties, are part of the best soils category. They are good soil for all agricultural crops in the Republic of Moldova: field crops, legumes, vegetables, perennial herbs, vineyards, trees etc. Although they have very good qualities due to the semi-favorable rainfall regime (the dry season, especially in the summer), the main problem of agriculture in this area is the supply of water to the crop (Capcelea, 1996; Cerbari, 2011).

It should be introduced throughout the cultivation of fields in a system with alternative crops strips, placed in the general direction of the contour, ensuring the proper rotation of the crop strips and high-capacity of anti-erosion protection (Cerbari, 2011).

We recommend that the intermingling of the spaces between rows of perennial herb mixtures, the duration of the chow to 3 years, the stripe should be placed in the middle of the spaces between the rows, occupying only half of their surface.

Figure 1. Research polygon in the Central Moldova

At present the livestock sector is practically destroyed, the number of cattle has decreased 6 times, while the volume of manure produced has decreased by 6 times.

According to the statistical directories 3 million tons of manure are produced, of which 1.0-1.5 million tons are used as an energy source, and 1.5 - 2.0 million tons are dumped in the rubbish, a more serious source of pollution of rural areas.

In the soil, according to statistical data, only 10-20 kg/ha/year of manure is introduced, which means nothing. As a result, the balance of humus in the soil became deeply negative - 1.0 t/ha/year.

In order to achieve the expected goal in 2013 the following tasks were accomplished:

- the establishment of the research polygon;
- appreciation of the initial soil quality of the polygon soil;
- cultivating and incorporating into the soil two harvests of alfalfa + ryegrass + vetch;
-determination of ground and ground mass incorporated into soil, plant analysis.

In the following year 2014 the following tasks were carried out:

- sowing in April the sunflower, the basic crop;
-determination of changes in the characteristics of the arable layer as a result of the incorporation into the soil of two harvests alfalfa + ryegrass + vetch (July);
- appreciation of crop harvest of basic crops;
- the appreciation of changes in soil characteristics after harvesting the first basic crop.

In the next years, the research polygon will ensure the planned crop rotation: vines + alfalfa as occupied field - sunflower - autumn wheat – maize - autumn barley.

In 2014, the second research polygon was organized in Central Moldova, on the delluvial chernozems - soils with physical characteristics more difficult than those of the ordinary chernozems in Southern Moldova. Within both polygons, some preliminary results on the influence of green fertilizers on soil quality and basic crop yields were also obtained (Figure 6).

In Southern Moldova (the ordinary chernozems) incorporation of the green mass (green crops) into the soil resulted in an increase in the content of organic active substance in the layer formed by discussing 0-12 cm with 0.21% or about 0.12% of carbon, which is equivalent to soil seizure of about 1.7 t/ha of this element; the corn grain harvesting rate was 1.2 t/ha/year absolute dry mass or 19% more compared to the control.

In Central Moldova (the delluvial chernozems) the incorporation of two crops in the soil as a green fertilizer led to an increase of the content of active organic substance in the layer formed by discussion 0-12 cm by 0.38%, the crop increase in 2013 at the field humidity (12%)

accounted for 1.0 t/ha of maize or 18% compared to the blank field crop. The 2014 harvest of winter wheat harvest was 1.8 t/ha or 45% compared to the blank field.

Figure 2. Perennial herb mixtureswith pivoting radicular system (alfalfa + vetch) and ryegrass with fascicular radicular system

Improvement of the national system of soil and agrochemical research based on conservative technologies, creation of computerized information system of soil quality (monitoring of soil quality) for the proper management and use of the land fund at parcel, agricultural, commune, rayon and republic level.

In the recent situation in the country's agriculture, the use of green manure is the only possibility to restore and preserve the long-term status of the arable land of the Republic of Moldova.

In year 2012 in the Center of Moldova the minimum value of the temperature reached to minus 7.6°C and in the year 2015 maxime to plus 24.7°C (Figure 3).

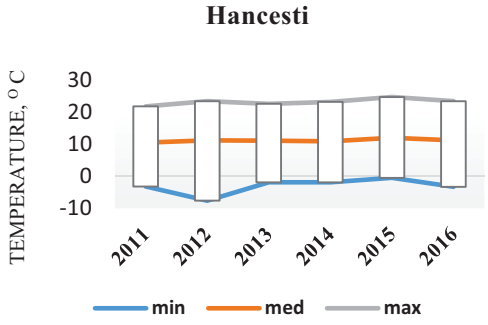

Figure 3. Temperature change in six years in the Center of Moldova

In year 2012 in the Southern Moldova the minimum value of the temperature reached to minus 7.8°C and in the year 2011 maxime to plus 33.3°C (Figure 4).

As a result, it has been established that the post-soil layer has become biogenic, its structural condition has been sufficiently improved, and the formation of the 3-5 cm thick layer has begun. It has been established that the 0-30 cm layer of soil has become biogenic, its structural condition has been sufficiently improved, and the formation of the layer of 3-5 cm thickness has begun (Figure 5).

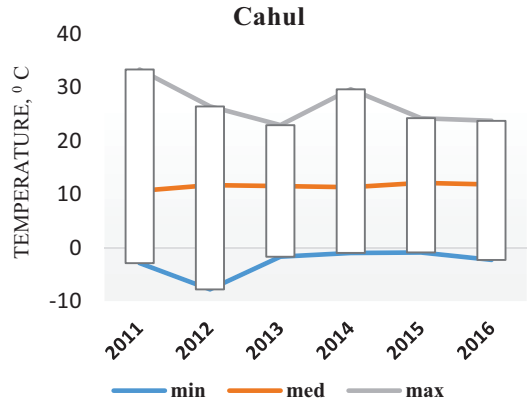

Figure 4. Temperature change in six years in Southern Moldova

Field research to assess the crop size of the crop (maize) and changes in soil quality (intermediate crop) was performed on 26.09. 2014.

The creation of a viable economic mechanism that would ensure the improvement of the pricing, credit and taxation policy in the Republic of Moldova, which would allow the realization of special programs in the agro-industrial complex, especially in the field of protection, improvement and rational use of soils.

We propose to create, in different pedoclimatic areas, specialized farmers-farm models of high profitability and optimal sizes, to determine the optimal size of peasant farms of different specialties, taking into account the soil and economic conditions of the concrete territories and the existence of the necessary car park.

In this case, we consider well-balanced conservative agriculture to stop soil degradation, increase fertility and make efficient use of natural resources.

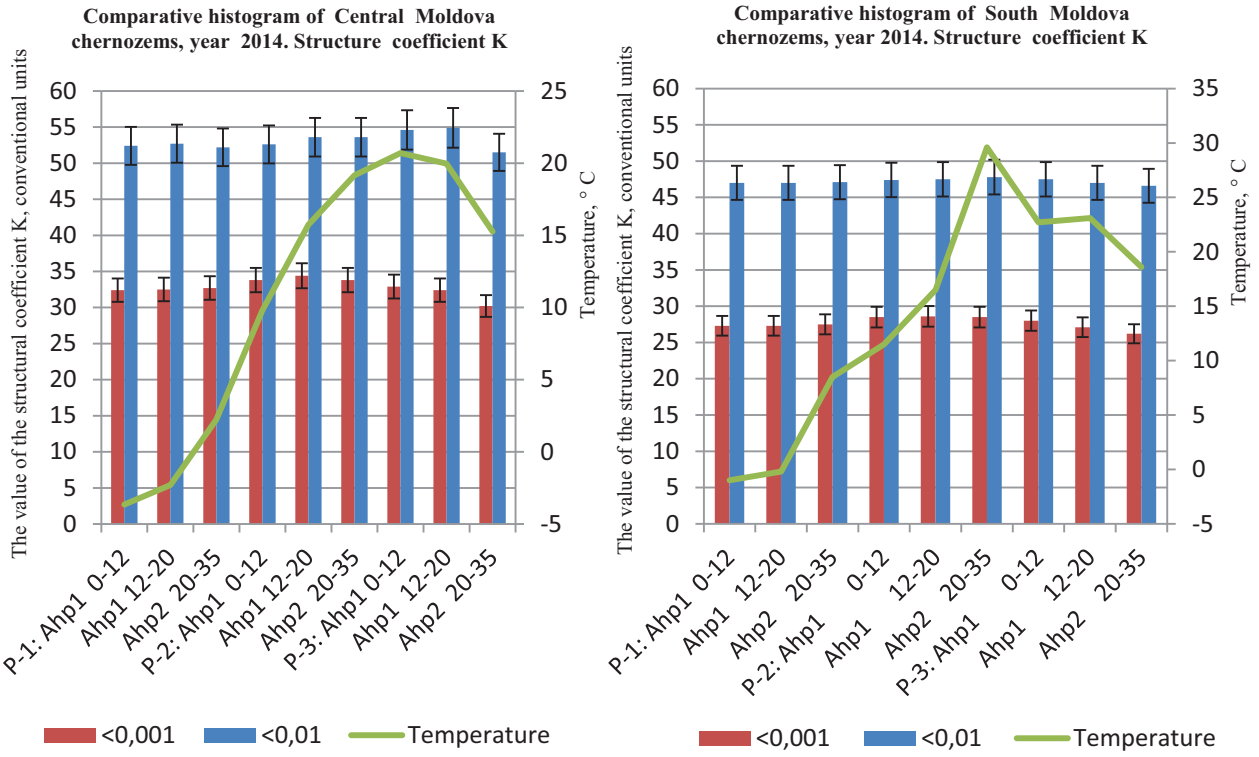

Figure 5. Comparative histogram of the results of structural analysis of Central and South of Moldova chernozems

So, the remediation of the quality condition and the increased production capacity of the studied soil are possible only by increasing the flow of organic matter into the arable layer. The use of green fertilizer is an effective way to achieve this goal (Cerbari, 2010, 2011; Cerbari et al., 2013).

The humidity of the green mass on April 25, 2014 was found to be equal to 81.5 percent from the wet green mass of the perennial and vegetable herbs.

Thus, 5.6 t/ha of absolute dry mass with a nitrogen content of 4.1% is included in the soil, which is equal to about 230 kg/ha of biological nitrogen, of which 60% is nitrogen of symbiotic origin atmosphere.

The results of the green mass yields were as follows: 1-30 t/ha; 2-29 t/ha; 3-28 t/ha; 4-29 t/ha; 5-32 t/ha.

The average crop of the green mass on the polygon, embedded in the soil - 30 t/ha.

CONCLUSIONS

Improvement of the national system of soil and agrochemical research based on conservative technologies, creation of computerized information system of soil quality (monitoring of soil quality) for the proper management and use of the land fund at parcel, agricultural, commune, rayon and republic level.

We propose to develop standards, technical regulations, exploitation rules for agricultural land. In addition, improvement of land legislation, solving problems regarding the calculation of land tax, land price, lease payments, land tax; how to accumulate and use funds collected in the form of land payments.

The systemic use of the mixture of perennial and leguminous crops as organic fertilizer in field crops will gradually lead to the long-term remediation of the physical, chemical and biological quality of agricultural soil will ensure a balanced or weakly positive balance of humus and carbon in the soil and will create premises for the formation of non-polluting agriculture in the Republic of Moldova.

The researches carried out repeatedly confirmed that the existing agricultural system in the Republic of Moldova led to the dehumification, destruction of the arable layer and loss of the resistance of the material to the compaction.

The researches carried out for the soils in the South and the Center of Moldova have established that with the incorporation of a green mass crop and grass root roots in the soil about: 8 t/ha of vegetal remains are returned to

the dry matter (containing nitrogen about 3.4%) which provides the synthesis of 2 t/ha of humus or about 1.2 t/ha of carbon.

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