# NEW APPROACH TO THE CHOICE OF WAY OF MECHANICAL PROCESSING OF SOIL IN THE SOUTH OF UKRAINE

## НОВЫЙ ПОДХОД К ВЫБОРУ СПОСОБА МЕХАНИЧЕСКОЙ ОБРАБОТКИ ГРУНТА В УСЛОВИЯХ ЮГА УКРАИНЫ

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***Abstract:*** *At a choice of an optimum way of machining of soil each land owner pursues one main aim - creation an optimum arable layer for cultivation of crops. Cultivation of soil finds the display in three systems: moldboard tillage, moldboardless tillage and no-till. The advantages and shortcomings are inherent in each system. The right choice will provide preservation and improvement of physical and chemical properties and increase of fertility of soil, and it is one of the most important problems in the production of agricultural crops. The purpose of researches is improvement of quality of mechanical cultivation of soil, decrease in power expenses as a result of use of the boardless-subsoiler implement which can carry out at the same time two operations: loosening of surface layer of soil and decompaction of its lower layer. Scientists of university developed and patented soil-cultivating working body which carries out the moldboardless tillage of upper layer with a simultaneous decompaction of the lower layer by means of subsoiler. The offered boardless-subsoiler implement by loosening the top layer of soil and decompaction of the lower horizon, allows to keep crop residues on a surface of a tilled field and to loosen the lower layers of soil, providing the necessary water-air regime. Mechanical cultivation of the soil this boardless-subsoiler implement respond to criteria of quality of soil cultivation. Extent of crushing of the soil is lie in limits of necessary value, the sizes of structural units of the soil is 8-10mm. Forming of a necessary equilibrium condition of the soil on a depth of cultivation supports good germination of a root system and to increase in productivity of the grown-up cultures. Such processing most meets the agrotechnical requirements at growing crops such as sunflower, corn, sugar beet. The offered way of soil cultivation provides fuel savings of up to 10 kg per hectare due to reduction of number of operations. The energy intensity of technology process decreases to 50% due to reduction of number of technology operations for the preparation of the soil.*

*KEYWORDS: SOIL, BOARDLESS PLOUGH, DEEP-RIPPER, MOLDBOARDLESS TILLAGE, HUMUS, FERTILITY.*

## *1. Introduction*

At a choice of an optimum way of machining of soil each land owner pursues one main aim - creation an optimum arable layer for cultivation of crops. Improvement of soil structure, physical and chemical properties and providing the necessary water-air regime is an important factor of high-quality soil cultivation that finally renders assistance to soil fertility increase.

The leading role in increase of soil fertility belongs to biological processes which activity depends on water-air regime and respectively from tillage method. Therefore a right choice of a way of processing is the most important means of regulation of life activity of soil microflora of its number and specific structure.

For any soil type three layers are characteristic [1]: arable; "plow sole" – that appears from the influence of plowshares and blades of soil-cultivating tools; subarable layer. "Plow sole" that is formed during operation of plows and edges of soil-tilling implements increases soil density in this layer to 1,7 gr·cm$^{-3}$ [2] that much more optimum values of 1,1-1,3 gr·cm$^{-3}$. Layer thickness of "plow sole" can reach 17 cm, depending on: type of working bodies; mass of the tool; number of cultivations; moisture content; soil structure [3]. Such compaction of layers worsens soil structure, reduces humus content and reduces the number of pores, which are the main ways to move water and air in soil. [4, 5]. Roots of cultural plants are not able to overcome such soil compaction and penetrate more deeply for reach water in deeper layers. All of this negatively influences on soil fertility and reduces productivity of agricultural crops.

Near the soil compaction from tillers additional influence on this process provide multiple passes through the field of mobile energy tools, as well as agricultural machinery. The total area of their traces on the treated area greater than an area of 1.5-2 [2], that leads to decrease in productivity of grain crops on these fields to 40...65% [6].

The right choice will provide preservation and improvement of physical and chemical properties and increase of fertility of soil, and it is one of the most important problems in the production of agricultural crops. The correct choice of the method of mechanical cultivation, which takes into account: soil type; species of units; the total number of passes of units across the field; region of Ukraine, will ensure the preservation and improvement of physical and chemical properties and improve soil fertility, and this is one of the most important problems in the production of agricultural crops.

## *2. Preconditions and means for resolving the problem*

### *2.1. Analysis of recent research and publications*

Cultivation of soil finds the display in three systems: moldboard tillage, moldboardless tillage and no-till [1]. The advantages and shortcomings are inherent in each system are also used they taking into account climatic zones and soil types. It is established [2] that expenditure of energy on soil cultivation makes nearly 40%, and manning to 25% of all amount of field work.

Estimating efficiency of the considered methods of cultivation of the soil it is necessary to specify the following. At present in most agricultural enterprises the soil cultivation by means moldboard implements is held. This operation is carried out in the fall and used for loosening of upper arable layer, to full closing of the straw residues and organic fertilizers. To negative factors of this tillage method can be attributed the appearance of "plow sole" due to influence of plow ploughshares and appearance on a field surface of soil blocks, therefore the necessary carrying out additional technology operations for preparation of a field for seeding crops seeds. This leads to increasing in energy consumption per hectare of cultivated area. Soil density in the horizon after thrice pass of a plow increases to 1,7 gr·cm$^{-3}$ [7], that does not allow a root system of the grown-up cultures to get reserves of soil moisture in a subarable layer.

The mouldboardless tillage method of soil cultivation is loosened well by upper layer, thus the processed surface smooth and does not need carrying out additional operations. At such processing on a surface of a field remains to 80-85% of [8] straw and stubble remains which render assistance for good snow retention, to accumulation and conservation of water and reduction of blowing and washout of the soil units. Mouldboardless soil cultivation the increases organic substance hymification coefficient in compared with a plowed land on 25... 30% [8], and increase in accumulation

of humus what are the base of soil fertility. Therefore this reception of soil cultivation finds the greatest application in poorly snow-covered and droughty southern regions of Ukraine. To shortcomings of this tillage method it is necessary include is appearance of compacted subarable soil layer from influence of blades of mould-boardless implement (as at plowing of the soil) and some increase of a contamination of crops.

As for the no-till soil cultivation method, last years this technology finds more and more broad application. . The non-interference in the soil ecosystem enables more slowly to reduce the precious natural resource - soil fertility. However this technology demands big financial costs for application of means of protection from weeds and for ensuring life activity of the growning plants.

The above methods of mechanical cultivation of the soil (moldboard and mouldboardless) have one common fault which follows from an essence of intensive agriculture is a compaction of subarable layer of the soil which demands carrying out its opening and loosening.

Producers of farm implements suggest to use subsoilers which allow to loosen soil on depth from 45 to 60 cm. As independent operation deep loosening is performed instead of a plowed land. And as additional, after work of plows or boardless tolls, for a loosening of the lower layers of the soil which is necessary to forming of a normal root system of plants.

Mechanical cultivation of soil surface layer and deep loosening of the lower layer are carried out as independent operations which using different soil-cultivating workers of bodies at present. It increases energy costs of technology process of preparation of the soil.

The existing soil-tilling implements do not provide for one pass of the tool necessary quality of soil cultivation on a depth across the all surface of field. Therefore there is a need for development of such soil-tilling implement which provides for one pass of the unit agrotechnology quality of soil cultivation across the field.

### *2.2. Purpose of the study*

The purpose of researches is improvement of quality of mechanical cultivation of soil, decrease in power expenses as a result of use of the boardless-subsoiler implement which can carry out at the same time two operations: loosening of surface layer of soil and decompaction of its lower layer.

## *3. Results and discussion*

Traditional intensive mechanical cultivation of the soil, this is when particles are formed on the surface of 0.1 ... 1 mm. They are capable to move easily on a field surface under the influence of the wind. Methods of soil cultivation at which on a surface of field do not remain straw and stubble residues lead to annual irrevocable loss of the soil 1 tonn·ha$^{-1}$ [9].

Therefore mechanical cultivation has to provide the minimum destruction and milling of upper soil layer. It causes reduction of water and wind erosion and renders assistance to growth of humus contents to 3,5... 4% that increases soil fertility [4].

Climatic conditions of the South of Ukraine, this is small quantity of snow during the winter period, insufficient amount of precipitation, availability strong winds and storms. Therefore it is reasonable to apply such way of mechanical soil cultivation which can satisfy agronomical requirements to quality. That is preservation on the untreated surface field of straw, stubble remains and a simultaneous deep loosening of the lower soil layer for best absorption of moisture and providing the optimum water-air regime.

Efficiency of the offered way of tillage is estimated by expression [10]:

$$E = P_D - C, \quad (1)$$

where: $P_D$ – produced products, Euro; C – expenses (labor, money, energy, materials), Euro ·ha$^{-1}$.

There is a need for development of working body design which for one pass would carry out two technology operations. Scientists of university developed and patented soil-cultivating working body (Fig.1.) which carries out the moldboardless tillage of upper layer with a simultaneous decompaction of the lower layer by means of subsoiler.

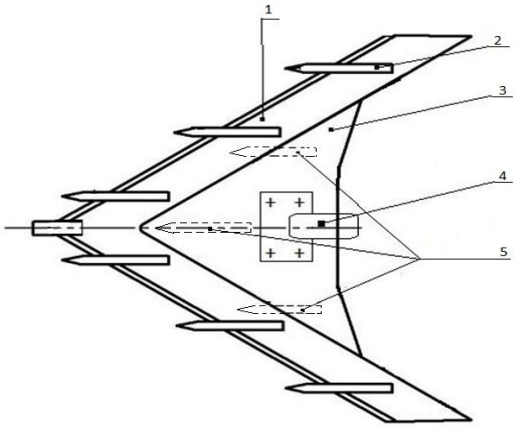


Fig. 1. Soil-cultivating working body (boardless-subsoiler implement): 1 – boardless plow; 2 – wedge-shaped plates; 3 – housing; 4 – blade holder; 5 – subsoilers

Process of mechanical cultivation of the soil by offered soil-tilling implement is represented in Fig. 2.

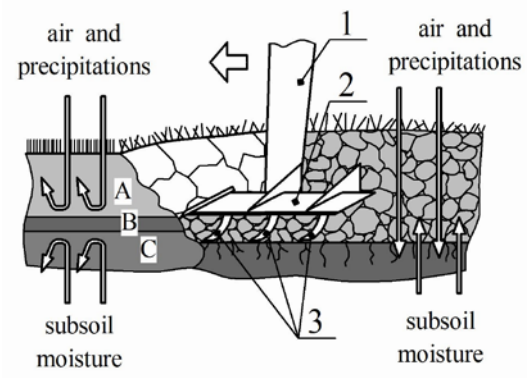


Fig. 2. Scheme of soil cultivation of boardless-subsoiler implements: A – soil layer which is processed by traditional soil-tilling implement; B – layer compacted with a plow; C – lower layers of the soil

The offered way of mechanical cultivation of the soil allows to receive the necessary density of the soil on all depth of the processed layer, which provides the necessary water-air mode in the soil, good root system growth of the cultivated plants for one pass of the tool across the field (Fig. 3).

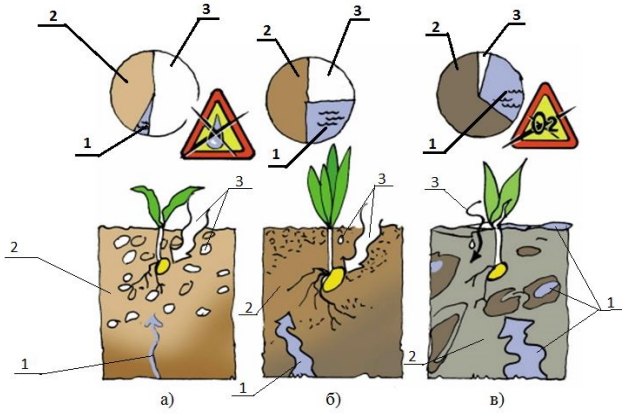


Fig. 3. Effect of structure and density of soil on the growth of plant roots: 1 – water; 2 – soil; 3 – air; a – insufficient access of water; b – optimum density on depth, enough water and air; c – increased soil density, upper layers are oversaturated by water, oxygen access is limited.

From Fig. 3 we see that soil compaction leads to reduction of amount of pores therefore access of water and air to a root system of plants which slows down their normal growth becomes complicated and, respectively, reduces productivity of agricultural cultures.

## 4. Conclusion

1. The offered boardless-subsoiler implement by loosening the top layer of soil and decompaction of the lower horizon, allows to keep crop residues on a surface of a tilled field and to loosen the lower layers of soil, providing the necessary water-air regime. This leads to soil fertility improvement.

2. Mechanical cultivation of the soil this boardless-subsoiler implement respond to criteria of quality of soil cultivation. Extent of crushing of the soil is lie in limits of necessary value, the sizes of structural units of the soil is 8-10mm.

3. Forming of a necessary equilibrium condition of the soil on depth of cultivation renders assistance to good germination of a root system and to increase in productivity of the cultivated plants.

4. Developed processing method of mechanical soil cultivation mostly meets the agrotechnical requirements at cultivation of such cultures, as sunflower, corn, sugar beet.

5. The proposed method of soil cultivation provides fuel savings of up to 10 kg per hectare at the expense of reducing the number of operations.

6. Power consumption of technology process decreases to 35% due to reduction of number of technology operations by soil preparation.

## 5. Literature


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