

# MACHINE FOR IMPORTING ORGANIC MATTER IN THE SOIL

Petar Dimitrov, Kaloyan Stoyanov, Hristo Beloev,  
Plamen Kangalov, Ivaylo Tsonev

## *Abstract*

*Increasing the organic matter in the soil leads to both a rise in biodiversity and productivity of ecosystems in general. This increase results in improvements of quality and productivity of soils, too. This can be done by introducing organic matter with the help of specialized equipment. With reference to this, the present paper outlines the technical parameters and performance capacity of such a device developed at Ruse University “Angel Kanchev”.*

## **Introduction**

Organic matter is measured by the amount of humus and organic carbon in the soil. It is a complex system of humus substances, proteins, amino acids, hydrocarbons, fatty acids, waxes and resins, lignin, etc. [3]. Soil organic matter facilitates the formation of soil aggregates and improves soil porosity, structure and productivity. It also improves the water retention capacity of the soil [4].

The decrease of organic substance in the soil of cultivated lands is caused mainly by loss of topsoil due to water and winter erosion; oxidation of organic carbon due to high aeration resulting from intensive cultivation and soil structure degradation resulting from soil compaction [3]. Despite the lack of systematic monitoring in our country, according to Ruseva S (2007), there is a stable trend towards reducing the reserves of organic matter in farmlands.

Adding organic materials to increase soil organic matter is not a very common practice in Bulgaria nowadays. This is due to the lack of a comprehensive policy on the issue, on one hand, and the lack of effective machinery whose use will increase the biological, technological and economic effects of adding organic substances, on the other hand. The spreading of organic matter of plant and animal origin on the soil surface, which is rarely practiced at the moment, does not have a significant agro – technical effect. What is more, it can lead to polluting the soil surface and interfere with the development of the root system of crops.

With reference to this, a team of researchers from Ruse University have designed and developed a specialized machine for adding organic matter to the plow layer of soil to increase Bulgaria’s farmland fertility and reduce soil degradation. The purpose of the present paper is to outline the technical parameters and performance capacity of this machine.

### **Research outline**

The device for importing organic matter in the soil was designed and developed during the period 2012-2013 at Ruse University “A. Kanchev”.

Prior to the development work, on the basis of expert analysis, it was decided that the import of organic matter would be done parallel to the basic subsurface soil tillage through making cuts and expanding every second cut. This method of treatment has prevailed the soil conservation farming in Bulgaria over the last years and can also be used in organic agriculture.

The basic parameters of the machine were theoretically determined in advance after taking into account the characteristics of the organic matter used in the country, i.e. its thickness, humidity, and particles size, although these can vary considerably. In addition to this, after taking into consideration the technical and agro-technical practices, it became clear that the machine had to meet certain requirements. The construction was also consistent with the technical, functional and performance requirements for this type of agricultural machinery.

It was decided that the newly developed machine for importing organic matter in the soil could work in all types of soil, at optimal soil humidity and with all types of organic matter that are shredded beforehand with particles sizes of up to 0,10 m and humidity with respect to the dry substance of up to 70%. The machine should also allow for the import of non- organic mulch. The depth reached by the cutting tools should be up to 0,42 m ( this should correspond with the thickness of the plow layer) while filling the cuts should be less than half that of the depth. The space between the filled cuts should be less than the depth of the cuts themselves.

In addition to this the designed machine should be equipped with a dosing mechanism which secures makes sure the imported organic matter is within the norm – from  $0,1 \text{ m}^3 / da$  to  $3 \text{ m}^3 / da$  transverse and longitudinal uniformity of the average of the corresponding norm. It was decided that the operational width of the machine will be 2,5 m. This together with the maximum norm requires a standard reserve of 200 m in the movement to be left which in turn makes it necessary for the machine to be equipped with a  $2,5 \text{ m}^3$  hopper.

As a result of the theoretical calculations and the determined parameters it was decided that it is necessary to aggregate the machine with a tractor whose engine power is at least 120 kN.

To meet all these requirements the research team used the appropriate combination of design solutions involving basic elements that have proved successful in practice.

The general view of the machine for importing organic matter in the soil is shown in Figure 1.

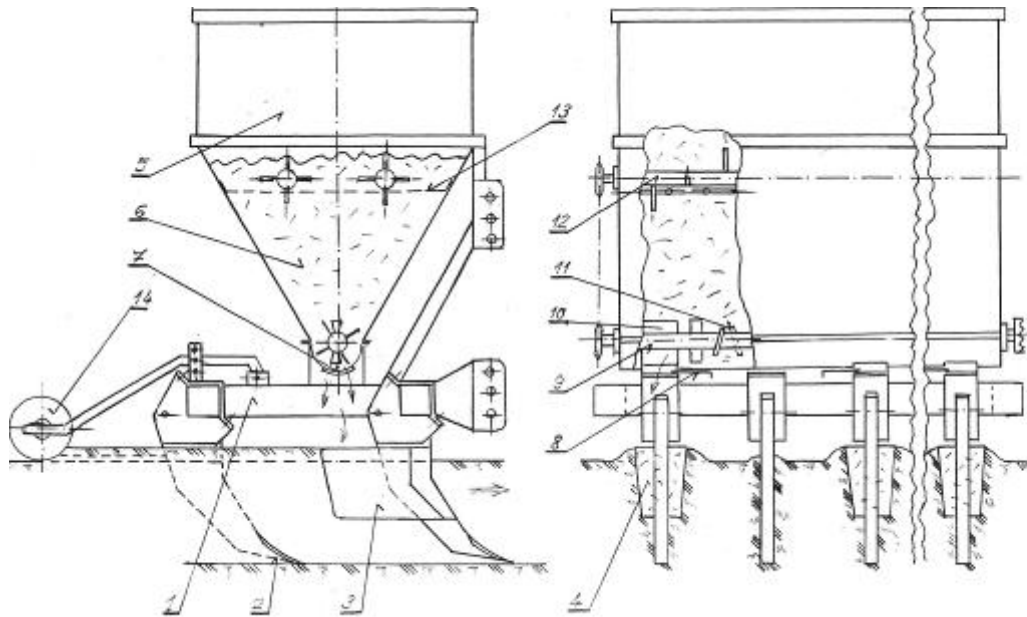


Figure 1. General view of the machine for importing organic matter in the soil

The machine consists of a frame 1. Transversely to the movement along the entire width of the frame in one or two rows there are breaking tools 2. On the breaking tools situated on the first row there are expanding breaking boards 3 between which there are chutes 4. Above them on the frame 1 there is a hopper 5 with material 6 that is to be imported in the soil. The hopper has a certain volume and dosimeters 7 in its lower part. They are situated immediately above the chutes 4 and can be closed by shutters 8. Above them inside the lower part of the hopper 5 along its entire length there is a rotor 9, mounted on bearings. On the rotor 9 opposite the dosimeters 7, radially, on the surface following the rotor axis there are fixed feeding blades 10. Aside of them, on the rotor 9 along a bi-directional helical line radially there are distributing blades 11. Slightly above the rotor 9 along the entire length of the hopper 5 on bearings there are stirrers with thumb-like blades 12. Under the stirrers, horizontally to the hopper 5 and fixed to it there is a bar grid 13. The bars of this grid are oriented transversely to the axis of the stirrer 12 so that the thumb-like blades of the stirrer are situated between the bars of the bar grid 13. Behind the cutting/breaking boards 2, to the frame and along its entire width, is mounted one at least one device 14 that is treating the surface of the soil.

The desired norm of imported material per unit of treated area is determined by the degree of opening of the dosimeters 7 by the shutters 8 and according to the frequency of rotation of the rotor 9 and the forward speed of movement of the machine. The regulation parameters have different values for each type of material with particular properties (thickness, moisture, etc.).

The machine works in the following manner: the frame 1 is attached to a tractor with the help of the three-point suspension. The rotor 9 and the stirrer

with thumb-like blades 12 are attached to the hydraulic motor of the tractor with the help of a driving mechanism which transmits rotational motion. When the formed aggregate is engaged in translational movement the included breaking tools 2 make cuts at certain depth. Some of these cuts are widened by the expanding breaking boards 3 and through the chutes 4 from the dosimeters 7, when the shutters are fixed at a certain position, the cuts are filled in with material 6 from the hopper 5.

The dosage of the material is determined by the feeding blades 10 on the rotor 9 as the space between them is constantly filled with the material and by the distributing blades 11 which push the material 6 out of the space between the dosimeters 7 in two opposite directions.

The normal work of the rotor 9 is secured by the bar grid 13 which holds the material which is above the grid and as a result of the work of the stirrer 12 the necessary quantity is distributed. In addition, the bar grid 13 does not allow large, mostly unwanted objects to be sieved through while the stirrer with thumb-like blades 12 mixes and breaks the material 6, thus making it looser. The number of filled cuts could be changed by completely closing some of the shutters 8.

After all cuts are formed, the surface treating device 14 rakes the soils and completes its further treatment. In this way the soil is prepared the subsequent technological operations.

The design documentation of the machine for importing organic matter in the soils can be prepared without using specialized technological equipment. This can be seen on Figure 2 which also shows the general view of the machine.



Figure 2. General view of the machine for importing organic matter in the soil

The advantages of the machine for importing organic matter in the soil are as follows:

- ✓ Importing organic matter or mulch into the made cuts at the appropriate depth and their subsequent covering ensures the further optimal decomposition of the organic matter and its full absorption.
- ✓ The formed cuts have comparatively lasting soil protective and water retaining effect.
- ✓ The performed soil treatment is not in conflict with other agricultural practices.
- ✓ The machine is suitable for treatment with organic fertilizers in subsurface tillage in organic and conservation agriculture.
- ✓ The machine secures even spreading of organic matter on the entire treated area.
- ✓ The machine is highly effective and in line with the trends for minimal soil treatment.

### **Conclusions**

It can be concluded that the machine for importing organic matter in the soil meets all the predetermined requirements and has a number advantages over the existing machines of this type. It also provides very good possibilities for achieving very good results when used in practice.

### **References**

- [1] Beloev, Hristo, Petar Radulov, Strahil Enchev, Angel Atanasov, Petar Dimitrov, Kaloyan Stoyanov, Ivaylo Tsonev, Method and design of a machine for importing organic matter or mulch in the soil. PATENT request form № 111653/ 16.12.2013.
- [2] Beloev, H, P. Radulov, A. Atanasov, P. Dimitrov, K.Stoyanov, T. Bileva, Using organic waste in agriculture. Ruse, 2011, p. 152.
- [3] Ruseva S. Degradation of agricultural lands in Bulgaria. Discussion paper. Project №00043007. Developing a capacity for sustainable management of agricultural lands in Bulgaria. Sofia. 2007.
- [4] Chaneyk.,R.S Swift. Studies on aggregate stability. Reformation of soil aggregates. Journal of Soil Science. Volume 37, Issue 2, p-p329-335, 1986

### **Contact information:**

Professor Eng. Petar Dimitrov Dimitrov, Ph.D. Ruse University “A.Kanchev” – Ruse, 7017, 8 “Studentska” Str. , tel.+ 359 82 888 542  
E-mail: [pdimitrov@uni-ruse.bg](mailto:pdimitrov@uni-ruse.bg)

Professor Eng. Hristo Ivanov Beloev, D.Sc., Ruse University “A.Kanchev” – Ruse, 7017, 8 “Studentska” Str. tel. + 359 82 888 240 ,  
E-mail: [hbeloev@uni-ruse.bg](mailto:hbeloev@uni-ruse.bg)

Associate Prof. Eng. Kaloyan Evgeniev Stoyanov, Ph.D. , Ruse University  
“A.Kanchev” – Ruse, 7017, 8 “Studentska” Str. tel. + 359 82 888 542  
E-mail: [kes@uni-ruse.bg](mailto:kes@uni-ruse.bg)

Professor Eng. Plamen Ganchev Kangalov, Ph.D. Ruse University  
“A.Kanchev” – Ruse, 7017, 8 “Studentska” Str., tel. + 359 82 888 441  
E-mail: [kangalov@uni-ruse.bg](mailto:kangalov@uni-ruse.bg)

Eng. Ivaylo Atanasov Tsonev, Ph.D. student, Ruse University “A.Kanchev” –  
Ruse, 7017, 8 “Studentska” Str., tel. + 359 82 888 542 ,  
E-mail: [iconev@uni-ruse.bg](mailto:iconev@uni-ruse.bg)