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TEHNOLOGIE ŞI ECHIPAMENT TEHNIC PENTRU FERTILIZARE ORGANICĂ ÎN PLANTAȚIILE POMICOLE
TECHNOLOGY AND TECHNICAL EQUIPMENT FOR ORGANIC FERTILIZATION IN ORCHARDS

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Abstract:

Sustainable agricultural principles guided the development of a machine designed for the application of organic fertilizers in fruit and vineyard plantations. Applied research was therefore conducted to design (using three-dimensional design software), construct, and test a machine with a capacity of 3 tons. The machine is capable of performing fertilization between tree rows, either across the entire inter-row width or in strips near the tree rows, ensuring efficient nutrient application directly to the root zone. The designed, constructed, and tested prototype features a ratchet mechanism driving the scraper conveyor, which delivers the manure to the rotors in the grinding and spreading section. This configuration prevents the spiral rotors from clogging and avoids conveyor chain breakage. Experimental research conducted under laboratory and field conditions demonstrated that the machine can distribute manure over a working width ranging from 960 to 1800 mm.

Cuvinte cheie: fertilizare organică, plantații pomicole, masina distribuit fertilizanti organici.
Key words: organic fertilization, orchards, fertilizers spreading machine.

1. Introduction

The excessive use of chemical fertilizers has resulted in soil degradation, environmental pollution, and an increase in global warming, thereby threatening life on Earth. In the current context, where there is a growing emphasis on the development of ecological technologies aimed at producing fruit free from chemical residues and ensuring consumer health, organic fertilization technologies are being increasingly adopted.

The main benefits of organic fertilization include:

- Improvement of soil health through the addition of organic matter, enhancement of soil structure, and stimulation of microbial activity.
- Environmental friendliness, as it helps reduce pollution and chemical runoff and is fully biodegradable.
- Support for long-term soil fertility by gradually releasing nutrients and enhancing nutrient retention capacity.
- Promotion of biodiversity by encouraging beneficial soil organisms and insects.
- Reduction of plant stress through improved moisture retention and enhanced root development.
- Safety for humans and animals, as it contains no synthetic chemicals or harmful residues.
- Effective waste recycling by utilizing compost, manure, and other agricultural by-products.

Extensive research has been conducted on the differences between organically and chemically fertilized areas in fruit tree plantations. Japanese researchers concluded in their study that appropriate organic management can ensure sufficient nutrient availability to achieve good productivity while maintaining low levels of pesticide residues (Takamitsu and Dinesh, 2001).

Researchers from Greece emphasized the benefits of using organic fertilizers in agroecosystems, noting that they can lead to improved quality fruit yields (Chatzistathis et. al., 2021).

Another study reported that reducing the use of chemical fertilizers and applying organic alternatives increases resource efficiency and circularity in agriculture. A balanced application of chemical and organic fertilizers, particularly the incorporation of organic substrates and sheep manure, was identified as the optimal strategy for sustainable orchard management (Liping et al., 2024). Additional research carried out in a nectarine orchard aimed to evaluate the effects of mineral and organic fertilizers on peach root dynamics (Baldi et al., 2010). Moreover, the use of biochar has received growing attention from researchers, who have highlighted its beneficial role in soil carbon sequestration (Jones et al., 2012, Neilsen et al., 2004).

The analysis of the benefits and risks associated with the use of organic fertilizers, compared to chemical fertilizers, is summarized in Table 1.

The application of organic fertilizers instead of chemical ones presents several management challenges that farmers must address to ensure optimal benefits. Effective management practices are essential to make organic farming systems more attractive, considering that organic fertilizers generally do not provide immediate short-term effects (Wang et al., 2018, Reeve et al, 2016).

Chemical fertilizers have traditionally ensured high quantitative yields but not necessarily qualitative improvements, which highlights the growing consumer awareness of the importance of food that promotes health rather than merely providing satiety (Panday et al., 2024). Organic fertilizers are rich in macronutrients, micronutrients, and growth-promoting substances. Their incorporation into the soil not only nourishes plants but also enhances nutrient cycling (Möller, 2018, Hydrolysis, 2008).

The circular economy approach adopted at the European Union level strongly encourages the use of organic products in place of mineral fertilizers. Some studies have investigated the effects of compost derived from the organic fraction of municipal solid waste digestate (CO) and "matured" manure produced through fast and controlled aerobic treatment in aerated piles (MM), both applied in apple orchards under different soil tillage systems. The results provided new insights into the effects of these fertilizers in fruit plantations, contributing to a better understanding of how to effectively harness the nutritional potential offered by organic fertilizers (Bona et al., 2022). Additionally, several studies have demonstrated that manure quality is more important than quantity (Köninger et al., 2021, Zhou et al., 2022, Hollas et al, 2022).

In Europe, there is a continuous effort to implement measures that protect public health by promoting the transition from extensive agriculture, which relies heavily on chemical fertilizers, to high-quality, sustainable agriculture that provides crop nutrients through the use of organic fertilizers (Zanoni et al., 2021).

The objective of our applied research was to develop a machine for organic fertilization in orchards, capable of spreading manure in strips near the tree trunks, between tree rows, or by combining both methods to distribute manure across the entire inter-row width. This equipment complements the existing range of machinery designed for organic fertilization in fruit plantations.

2. Material and methods

While the importance of fundamental research remains undisputed, applied research plays a crucial role in advancing the agricultural machinery manufacturing industry. It enables the development of equipment necessary for the mechanization of agricultural operations, ensuring high efficiency and reduced labour requirements.

INMA Bucharest carried out applied researches focused on the design, construction, and testing of an organic fertilizer spreading machine for orchard applications. The objective of this research was to provide farmers with practical solutions aligned with the European Union's approach to sustainable and environmentally friendly agriculture.

Modern computer-aided design (CAD) tools were employed, utilizing specialized three-dimensional modelling software capable of simulating operational behaviour under various constraints. This allowed for the analysis of component interactions, the simulation of motion, and the identification of potential mechanical interferences or failures.

Description of the software used. The software employed in this research was SolidWorks 3D, which enabled the three-dimensional modelling of the machine, forming the basis for the design and construction of its parts and component assemblies. The software facilitates design optimization, reduces development time, and lowers manufacturing costs through efficient component sizing and the appropriate selection of construction materials.

The model can be tested under simulated real-world working conditions, allowing the analysis of mechanical behaviour during operation. SolidWorks 3D ensures high product quality while minimizing prototyping needs and reducing physical testing costs. Fig. 1 presents the main assemblies of the designed machine.

In fruit plantations, several systems are used to manage the inter-row space: the *tilled soil* system, in which fertilizers are incorporated directly into the soil, and the *grass-covered* system, where the inter-row area is covered with grass to help maintain soil moisture. In the latter case, fertilizer application requires specialized techniques - such as localized application under the tree rows or targeted fertigation - to ensure that the trees, rather than the grass, benefit from the nutrients (Fig. 2; Fig. 3).

To address this need, research was conducted to develop a machine capable of applying organic fertilizers either in strips near the tree trunks or across the full inter-row width.

For the design of this equipment, existing constructive solutions available on the market were analysed, and new design improvements were identified for the fertilizer spreading system [17–30].

The organic fertilizer spreading machine must allow the adjustment of kinematic parameters and functional speeds (conveyor speed, rotational speed of the shredding rotors, and distribution width) to ensure the appropriate fertilizer rate according to the plantation type and the nutritional requirements of the fruit trees.

The equipment consists of welded assemblies, along with standard mechanical and hydraulic components supplied by specialized manufacturers, including transmission chains, bearings, wheels, hydraulic elements, and removable fasteners (screws, nuts, washers, Grower washers, etc.). The hopper is a welded structure with a capacity of 3 tonnes (Fig. 4).

The manure conveyor is of the scraper-chain type (Fig. 5), with scrapers welded to the chain. The scrapers are driven by specially designed sprocket wheels that provide traction, powered by a transmission system with a ratchet mechanism. The speed of these traction wheels is constant but intermittent, depending on the pitch adjustment of the ratchet wheel, ensuring a peripheral conveyor speed of approximately 25 mm/s. This mechanism prevents material build-up in the helical rotor area and can be adjusted to achieve the desired application rate.

The ratchet mechanism (Fig. 6) receives motion from the reducer through a chain wheel and transmits it via a Gall chain to a speed reduction wheel (pos. 2). Through a connecting rod-crank system, motion is transferred from the shaft on which the reduction wheel is mounted (pos. 2) to the crank (pos. 4), which is integral with the connecting rod (pos. 3). The crank produces an intermittent rotation of the ratchet wheel (pos. 1) through the action of the ratchet (pos. 9). The ratchet wheel (pos. 1) is mounted at the end of the conveyor drive shaft. The ratchet mechanism can be adjusted by positioning the disc (pos. 6), which limits the movement of the ratchet over the ratchet wheel. The position of this disc is controlled by the arm (pos. 8), allowing variation in the amount of fertilizer distributed per unit area by adjusting the conveyor's advance rate.

A device consisting of two helical rotors ensures the shredding of manure into small fragments and facilitates its distribution behind the machine, between the rows of trees, when the rear guard is open (Fig. 7).

Another device, composed of two discs equipped with blades, provides lateral distribution in strips along both sides of the machine, near the tree trunks (Fig. 8). The two discs are driven in opposite directions by OMP 125 hydrostatic rotary piston motors. These counter-rotating discs spread the material delivered by the conveyor and processed by the horizontal helical rotors.

3. Results

The experimental testing of the MGL-3 equipment was conducted under both laboratory and field operating conditions at the INMA Bucharest test facilities, following the testing methodology developed for this research stage. The testing process comprised two distinct phases: the first involved loading the machine with fertilizer, carried out using a front loader equipped with a bucket, and the second consisted of distributing the fertilizer between the tree rows, preceded by transporting the machine to the fruit plantation (Fig. 9).

- Dimensional and functional characteristics

The preliminary results obtained from the stationary tests consisted of measuring the constructive dimensions and functional parameters of the machine (Table 2). The final construction of the equipment is shown in Figure 10.

- Mass measurement

The identification of mass distribution was carried out using the weighing equipment available at INMA Bucharest. Measurements were taken for both the empty machine and the machine loaded with manure. The results obtained are presented in Table 3.

- Manoeuvrability

The inner and outer turning diameters were measured (Fig. 11), and the turning radius of the tractor-spreader assembly was calculated. The corresponding results are included in Table 3.

Based on the measurements taken, the turning radius of the assembly formed by the New Holland T80 tractor and the MGL-3 spreader was approximately 6 m.

The turning diameter between curbs and the passageway of the same tractor-spreader assembly were determined on level ground by performing left and right turns at the minimum radius that allows normal operation, in accordance with the requirements of RNTR-2/2006, Chapter IV, Point 7.8.

- Measurement of the speeds of the helical rotor device and the centrifugal disc device, as well as the conveyor belt advance (Table 4)

During stationary operation at synchronous power take-off, with the tractor running at a nominal engine speed of n_{tr}=1800 s^{-1}, the measured PTO speed was n_0=515. Under load conditions, during manure spreading with a material density of γ=574 kg/m^3, the speed measured at the horizontal helical rotors was n_{PTO} =455 s^{-1}.

The rotational speed of the blades in the centrifugal distribution device can be adjusted, as the discs are driven by hydraulic motors. Speed variation is achieved by a flow regulator mounted in the hydraulic motor supply circuit. The rotational speed of the discs can vary within the range of 320-475 s^{-1}.

The forward speed of the scraper conveyor determines the flow rate of manure delivered for spreading. Together with the angular velocity of the discs and the travel speed of the tractor-spreader assembly, it represents one of the key parameters ensuring the desired manure application rate.

The conveyor advance speed is influenced by the transmission ratio of the ratchet mechanism and can be adjusted by changing the position of the ratchet lever. The conveyor advance speed can vary within the range of $v_{\text{conveyor advance}}$ = 6 - 42 mm/s.

• Flow rate of manure spread (Table 5)

The manure flow rate of the MGL-3 machine, whose scraper conveyor is mechanically driven by a ratchet mechanism, was determined based on the measurement results and calculated using the following relationship:

$$Q = \frac{G}{t} \quad [kg/s]$$

where: Q – manure flow rate, kg/s;

G – mass of manure discharged from the hopper by the scraper conveyor, kg.

t – time during which the manure was discharged from the hopper, s.

The average manure flow rates that the MGL-3 machine can achieve are presented in Table 5.

Based on the data obtained from the operational tests of the MGL-3 machine, powered by a New Holland T8040 tractor, it was found that the machine can achieve a spreading flow rate in the range of Q = 5.1–20.4 kg/s, depending on the type of manure and the forward speed of the conveyor, which in turn is influenced by the position of the ratchet mechanism and its transmission ratio. The amount of fertilizer spread is also dependent on the angular velocity of the centrifugal discs, being influenced by the hydraulic oil flow rate from the tractor's pump and the setting of the flow regulator.

• Working width

For the performance tests, plastic strips were arranged longitudinally in the direction of the machine's movement, positioned laterally on both sides (Fig. 12).

The manure that fell onto the strips was collected and weighed, and fractions larger than 6 cm were recorded separately to determine the degree of manure shredding. The results obtained were then used to calculate the qualitative working indicators.

The working width was determined under two operating conditions:

• spreading over the entire inter-row width;

• spreading in strips, near the tree trunks.

During tests, the maximum working width achieved when spreading over the entire surface was L_{max} = approx. 7m, when using fermented manure with a density of γ = 574 kg/m^3. However, the distribution uniformity remained consistent over an effective spreading width of $L_{effective}$ = 6 m.

The experiments demonstrated that the machine, equipped with a combined distribution device, can achieve a spreading width in left-right strips ranging from L = 960–1800 mm, depending on the rotational speed and inclination angle of the spreading discs.

This represents a significant advantage, as it contributes to the efficient use of organic fertilizers by applying them directly near the tree rows, thereby ensuring optimal nutrient supply to the trees.

To achieve the project's objectives, the following INMA own infrastructures were used - according to the http://erris.gov.ro/ platform:

- System design, execution and optimization of technical equipment and technologies (https://www.erris.gov.ro/SYSTEM-OF-DESIGNING-EXECUTION-AND-OPTIMISING-THE-TECHNICAL-EQUIPMENT-AND-TECHNOLOGIES);

- Research infrastructure for technical systems in agriculture, forestry and the food industry (https://www.erris.gov.ro/RESEARCH-INFRASTRUCTURE-FOR-AGRICULTURE-FORESTRY-AND-FOOD-INDUSTRY)

4. Conclusions

Following the tests carried out on the experimental model of the machine, regarding its operation, usability, and safety in use, the following conclusions were drawn:

• The machine designed for spreading manure in orchards, designated MGL-3, meets the requirements specified in the design requirements;

• A manure flow rate in the range of Q = 5.1-20.4 kg/s was obtained.

• The spreading width can vary within the range of L = 960-1800 mm.

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References

1. Baldi E., Toselli M., Eissenstat D.M., Marangoni B., Millard P., 2010. Organic fertilization leads to increased peach root production and lifespan. Tree Physiology, Volume 30, Issue 11, 1373–1382, https://doi.org/10.1093/treephys/tpq078.
2. Bona D., Cristoforetti A., Zanzotti R., Bertoldi D., Dellai N., Silvestri, S., 2022. Matured Manure and Compost from the Organic Fraction of Solid Waste Digestate Application in Intensive Apple Orchards. International Journal of Environmental Research and Public Health, 19(23), 15512. https://doi.org/10.3390/ijerph192315512.
3. Chatzistathis T., Kavvadias V.A., Sotiropoulos T.E., Papadakis I.E., 2021. Organic Fertilization and Tree Orchards. Agriculture, Vol.11(8), 692, https://doi.org/10.3390/agriculture11080692.
4. Hydrolysis A.R., 2008. The Impacts of Yield on Nutritional Quality: Lessons from Organic Farming. HortScience, 44(1), p.12.
5. Hollas C.E., Rodrigues H.C., Oyadomari V.M.A., Bolsan A.C., Venturin B., Bonassa G., Tápparo D.C., Abilhôa H.C.Z., da Silva,J.F.F., Michelon W., et al., 2022. The potential of animal manure management pathways toward a circular economy: A bibliometric analysis. Environ. Sci. Pollut. Res. 29, 73599–73621.
6. Jones L., Rousk J., Edwards-Jones G., DeLuca H., Murphy V., 2012. Biochar-mediated changes in soil quality and plant growth in a three-year field trial. Soil Biol Biochem 45:113–124, https://doi.org/10.1016/j.soilbio.2011.10.012.
7. Köninger J., Lugato E., Panagos P., Kochupillai M., Orgiazzi A., Briones M.J., 2021. Manure management and soil biodiversity: Towards more sustainable food systems in the EU. Agric. Syst. 194, 103251.
8. Liping Zhuang, Pengli Wang, Wen Hu, Ruyi Yang, Qiqi Zhang, Yuyu Jian, Yangjun Zou, 2024. A Comprehensive Study on the Impact of Chemical Fertilizer Reduction and Organic Manure Application on Soil Fertility and Apple Orchard Productivity. Agronomy, Vol.14(7), 1398, https://doi.org/10.3390/agronomy14071398.
9. Möller K., 2018. Soil Fertility Status and Nutrient Input–Output Flows of Specialised Organic Cropping Systems: A Review. Nutr. Cycl. Agroecosyst. 112, 147–164.
10. Neilsen G.H., Hogue E.J., Neilsen D., 2004. Use of organic applications to increase productivity of high density apple orchards. Acta Hortic. 638:347–356 https://doi.org/10.17660/ActaHortic.2004.638.46.
11. Panday, D., Bhusal, N., Das, S., Ghalehgolabbehbahani, 2024. A. Rooted in Nature: The Rise, Challenges, and Potential of Organic Farming and Fertilizers in Agroecosystems. Sustainability 16,1530. https://doi.org/10.3390/su16041530.
12. Reeve J.R., Hoagland L.A., Villalba J.J., Carr P.M., Atucha A., Cambardella C., Davis D.R., Delate K., 2016. Chapter Six - Organic Farming, Soil Health, and Food Quality: Considering Possible Links. Advances in Agronomy. 137, 319-367.
13. Takamitsu K., Dinesh A., 2021. Effect of Organic and Chemical Fertilizer Application on Apple Nutrient Content and Orchard Soil Condition. Agriculture, Vol.11(4), 340, 2021. https://doi.org/10.3390/agriculture11040340.
14. Wang Y., Zhu Y., Zhang S., Wang Y., 2018. What could promote farmers to replace chemical fertilizers with organic fertilizers? J. Clean. Prod. 199, 882–890.
15. Zanoni Sara, Morelli Raffaella, Zanzotti Roberto, 2021. Conversion of organic apples orchard: yield and quality. Conference: II Convegno AISSA# under40, Sassari 1-2 July 2021.
16. Zhou W., Ma Q., Wu L., Hu R., Jones D.L., Chadwick D.R., Jiang Y., Wu Y., Xia X., Yang L., et al., 2022. The effect of organic manure or green manure incorporation with reductions in chemical fertilizer on yield scaled N2O emissions in a citrus orchard. Agric. Ecosyst. Environ. 326, 107806.
17. *** Technical file Gilibert Manufacturer.
18. *** Technical file Kemper Manufacturer.
19. *** Technical file NewHolland Manufacturer.
20. *** Technical file Samas-Franta Manufacturer.

 DOI 10.33045/fgr.v41.2025.18

21. *** www.degelman.com.
22. *** www.fbbossini.it.
23. *** www.fliegl.com.
24. *** www.juscafresa.com.
25. *** www.industriasdavid.com.
26. *** www.kemper.com.
27. *** www.msort.pl.
28. *** www.KuhnNordAmerica.com.
29. *** www.record-trailers.com.
30. *** www.renmark.it.

Tables and figures

Table 1. Comparison between organic and chemical fertilizers

	Organic fertilization	Chemical fertilization
Nutrient Release	Slow and steady release; depends on microbial activity	Ensures immediate nutrient availability, with a rapid effect but shorter duration.
Soil Quality	Improves soil structure, increases organic matter, and enhances microbial and earthworm activity.	May cause soil compaction and reduce microbial diversity over time.
Soil Health	Improves soil structure and promotes beneficial microbial life.	Can degrade soil quality over time with excessive use.
Environmental Impact	Low risk of leaching and runoff; environmentally friendly	Higher risk of water pollution and soil acidification.
Tree Health & Growth	Provides balanced and gradual nutrition; promotes stronger root systems and better drought resistance.	Encourages rapid vegetative growth but may cause nutrient imbalances or weaker wood structure.
Fruit Quality	Often results in higher antioxidant content, better flavour, and firmer texture; lower nitrate levels.	Produces larger fruit and sometimes higher yields, but may lead to thinner skins and reduced shelf life.
Pest & Disease Resistance	Healthier trees are more resistant to pests; relies on ecological balance.	Rapid growth may attract pests; repeated chemical use can increase resistance development.
Long-term Sustainability	Enhances sustainability and resilience of orchards.	Requires increasing inputs over time as soil quality declines.
Cost	Can be cost-effective if produced locally (e.g., compost, manure), though commercial organic fertilizers may be more expensive.	Usually cheaper in the short term, particularly for large-scale farming.
Crop Yield	Supports sustainable yields in the long term, though initial growth may be slower.	Provides a rapid yield increase, but long-term sustainability is lower.
Safety	Safe for handlers, consumers, and beneficial organisms.	Requires careful handling due to potential toxicity.

Table 2 Constructive Dimensions

Characteristics	Value from technical documentation	Measured Value
Overall dimensions, mm - length - width - height	 approx. 5200; max. 2142 approx. 2383	 5150 2200 2375
Diameter of centrifugal distribution discs, mm	640	640
Disc rotational speed, rpm	480	320...475
Rotor diameter with spiral and knives, mm	440	440
Track gauge, mm	1400	1402
Wheelbase, mm	3575	3570
Height to coupling eye, mm	420	422
Tires 6.00/65-16. Static radius		340

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Table 3. Manoeuvrability of the Tractor-Spreader Assembly

No.	Parameter	Maximum allowed value according to RNTR-2/2006 chapter IV point 7.8 and SR ISO 303:1995 pos. 4 (mm)	Measured Value (mm)	
			Left turning	Right turnin g
1.	Outer turning diameter of the tractor-spreader assembly (measured at the outer wheel of the turn)	-	15300	15300
3.	Turning diameter between curbs	max. 20000	12000	12000
5.	Passageway	7200	3300	

Table 4. Conveyor speed

Conveyor speed [m/min]	Lever position of the ratchet mechanism							
	1 (45°)	2 (90°)	3 (135°)	4 (180°)	5 (225°)	6 (270°)	7 (315°)	8 (360°)
V_{tr}	6	12	18	24	30	34	34	42

Table 5. Manure Flow Rate Values of the MGL-3 Machine

Scraper conveyor feed speed (mechanical drive with ratchet mechanism)		Average flow rate, Q [kg/s]
		Unfermented manure γ=574 kg/m^3
Transmission ratio of the ratchet mechanism	**m/min**	
1	0.006	5.1
4	0.028	10.6
7	0.042	20.4

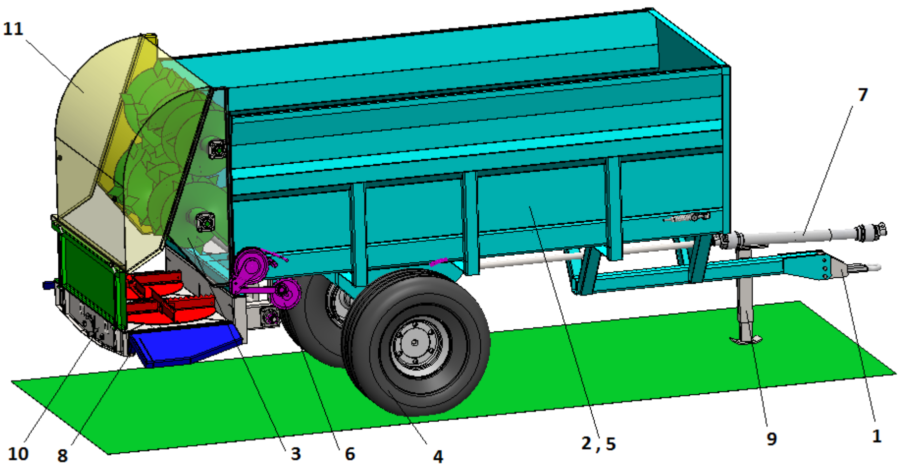

Fig. 1. Machine for spreading organic fertilizers in orchards

1-towing eye; 2-hopper; 3-distributor with horizontal spiral rotors; 4-running gear; 5-conveyor; 6-ratchet drive mechanism; 7-mechanical transmission; 8-hydrostatic transmission; 9-support device; 10-centrifugal distributor with discs; 11-guards

Fig. 2. Orchard with tilled soil system

Fig. 3. Orchard with grass-covered inter-row area

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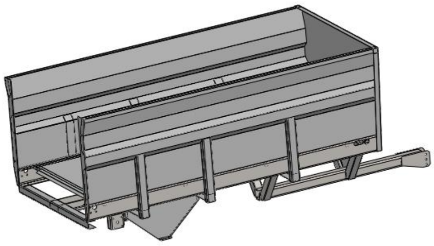

Fig. 4. The hopper of the machine

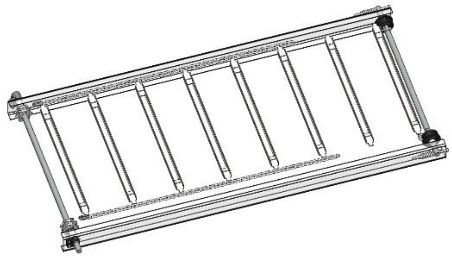

Fig. 5. Manure conveyor

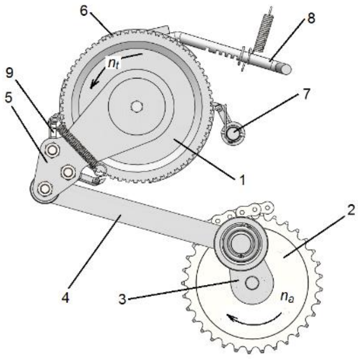

Fig. 6. Ratchet mechanism

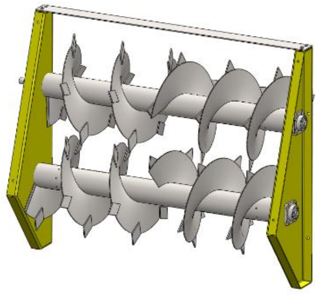

Fig. 7. Manure grinding and distribution device, with spiral rotors

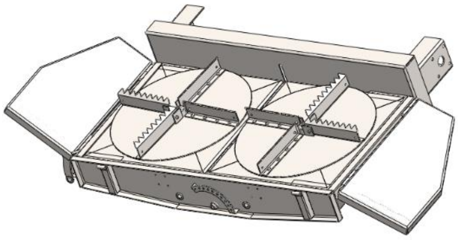

Fig. 8. Centrifugal distributor, with 2 discs and blades

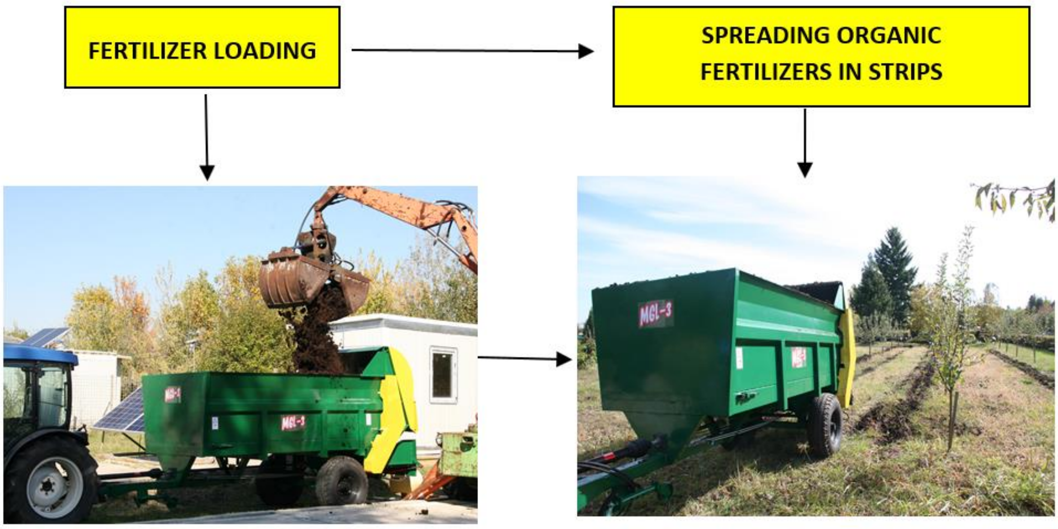

Fig. 9. Testing technology

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Fig. 10. Manure spreading machine for orchards, operating in strips near the tree trunks (MGL-3)

Fig. 11. Manoeuvrability tests

Fig. 12. Image from the working width experiments