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TECHNOLOGIES FOR THE PROCESSING OF NUTRITIOUS RESIDUES
ТЕХНОЛОГІЇ ПЕРЕРОБКИ ПОЖИВНИХ РЕШТОК

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Abstract. *The article investigates practical application of modern technologies for the use of crop residues as organic fertilizers and mulch. The mechanisms of conversion of straw into organic fertilizer are identified. Methods of mulching in tillage are described. The main types of mulching machines and technologies are analyzed. Emphasis is made on mulching as one of the system-forming factors in no-till and strip-till technologies. Tools of mechanical impact on crop residues are various combines equipped with shredders and special trailed shredders. Effectiveness of strip-till technology in the cultivation of potatoes, the use of which has provided optimal conditions of water regime and nutrition due to the reduction of the soil surface temperature that guarantees higher yields, is confirmed.*

Keywords: *soil, straw, burning, plowing down, organic fertilizer, mulch, mulching machine, strip tillage.*

Formulation of the problem.

The agro-industrial complex of Ukraine is a powerful segment of production, which largely determines the socio-economic development and food security of the country, living standards and employment, supply of processing enterprises with raw materials. Grain and oilseeds play a significant role in the development of the agricultural sector of Ukraine's economy (after all, their products allow access to world markets with environmentally friendly agricultural products). In Ukraine, arable land is occupied by cereals, corn, sunflower, and soybeans in recent years accounted for more than 76% of the total area of 26,8 million hectares [3]. The gross harvest of grain, legumes, and corn amounted to 75,4 million tons, sunflower – 14,5 million tons.

At the same time, approximately the same amount of straw was grown. It remains on the surface of the field and prevents further tillage, so it needs a further response.

The easiest, fastest, cheapest, but illegal, and most harmful way to rid a field of straw is to burn it. At the same time, the ecology suffers greatly due to the emission of significant amounts of carbon dioxide and the most fertile surface layer of the soil. Incineration kills soil microflora to a depth of 5 cm or more, destroys all organic nitrogen and carbon. As a result, the amount of humus and soil fertility in general decreases. At normal moisture and temperature, the soil after burning stubble and crop residues is restored in 2-3 months [12]. Most often, winter crop residues and corn stalks are burned for grain. Stems of crops such as soybeans, depending on the humidity, are collected by round balers and burned not in rolls, but in individual points, reducing the harmful effects on the soil.

Reasonable methods of processing crop residues include harvesting straw with pressing and subsequent removal from the field for use in animal husbandry, as well as for thermal energy. Other commonly used methods are the use of straw as organic fertilizer with pre-grinding and wrapping in the soil, or the use of crushed residues as mulch.

In animal husbandry, straw is used for fodder and litter, and then returned to the fields in the form of humus, living organic fertilizer, following the law of agriculture on the return of nutrients removed from the soil. Unfortunately, livestock in Ukraine is in decline, so it is not a significant consumer of straw.

The use of straw as an organic fertilizer requires time, additional costs for grinding and redistribution of residues on the surface, wrapping to the optimal depth of additional doses of mineral fertilizers, or sowing green manure. All this requires funds and a long-term systematic approach.

The simple single-use of straw as a fertilizer has a depressing effect on cultivated plants. Allelopathic action is associated with the formation during decomposition of straw of a number of soluble organic compounds - acids and phenolic groups, toxic to plant roots. Especially many such compounds in the anaerobic decomposition of straw.

To eliminate these phenomena, straw detoxification is applied by applying mineral nitrogen at the rate of 10-15 kg of active substance per 1 ton of residues, or field treatment with stubble destructor - complex in composition and multifunctional in the action of microbial preparation.

Therefore, without the use of nitrogen fertilizers, plowing straw entails a decrease in soil fertility in the next season ago and causes, among other things, the desire to burn the stubble.

The use of straw for mulching the soil has many obvious advantages. This agricultural technique is primarily used to reduce the physical evaporation of moisture from the soil. In arid conditions, unproductive moisture losses are reduced by 1,7 times, and with sufficient moisture - three times. The significant positive effect of mulching on the evaporation mode reaches a depth of 50 cm.

Mulching also improves the temperature regime, agrophysical condition of the soil, agrochemical and biological indicators. In addition, mulching significantly increases the effectiveness of mineral fertilizers, especially in arid growing conditions. Crop yields in such extreme conditions only due to mulching increase by 20-25%.

Analysis of research and publications.

The analysis of the publications shows the need for further study and deeper explanation and detail of such an important agricultural measure as mulching. The reason is that the vast majority of information covers mulching as preparation of straw and stubble for wrapping in the soil.

Problems of the secondary use and utilization of agricultural waste are investigated by H.H. Heletukha, I. M. Demchak, A. A. Dolinskyi, T. A. Zheliezna, M. M. Zhovnir, Yu. V. Kernasiuk, M. I. Kobets, A. Ye. Konenchenkov, V. M. Lisnychyi, V. P. Sidenko, and others. However, so far the problem of crop residue and mulch management has not been finally resolved, so the need to study the

prospects for the use of advanced, environmentally friendly technologies for the disposal of organic waste is obvious.

Formulation of the goals of the article.

The aim of the study is the philosophy and strategy of mulching in agriculture and refinement of the classification of mulching methods, comparative analysis of mulching machines, and study of the role of mulching in energy-saving technologies no-till and strip-till.

Presentation of the main research material.

The results of research by domestic scientists and world experience in agriculture show that the use of straw and other post-harvest residues of cereals and legumes is promising. In addition, the abandonment of traditional straw harvesting technology in use today can have a significant economic effect due to reduced fuel and labor costs for transporting and stowing straw.

Straw recycling is a bridge between the two growing seasons. Each manufacturer operates in specific economic languages and thus justifies the chosen technology. Sometimes farmers motivate burning as a means of destroying pathogens of fungal diseases, such as fusarium wilt or egg-laying pests.

When burning stubble and straw at the rate of 2 t/ha in the Forest-Steppe zone on soil containing 4% humus, the loss of humus is 800 kg/ha, and the soil loses resistance to erosion processes. When burning straw and stubble, the microflora, which forms the most fertile layer of soil (0,2–5 cm of the surface), completely dies. After burning, the water and physical properties of the soil deteriorate sharply. It should be noted that the lethal temperature for all soil-forming organisms is 40°C, and when burning straw, stubble, leaves, the temperature reaches 340-360°C. This, of course, affects fertility and, consequently, the next harvest of crops. It takes more than one year to restore soil productivity after such an event. When burning winter wheat stubble on one hectare, such an amount of organic matter is destroyed, which can be compensated only by applying 40 t/ha of mineral fertilizers. The water-physical properties of the soil deteriorate sharply [4]. Burning stubble produces huge amounts of smoke. It floods the surrounding areas and is very harmful because it releases into the air extremely toxic compounds of heavy metals, radioactive strontium, and cesium, carbon monoxide, soot, dust.

In addition, the fire front fig. 1 [10] stubble burning poses a real danger to neighboring fields, where fires, forest belts, forests, and settlements can occur. In clear fields, in windless weather, fire can spread at speeds of up to 4 km/h, and in windy fields - up to 30 km/h, with a flame height of up to 2 m [10]. Legislation has been passed in all European countries to prevent the burning of crop residues and the punishment of violators.

The direction of using straw as an organic fertilizer is a leader in the ranking of smart ways to dispose of crop residues because it is used in all areas of agriculture and is used in most sown areas.

This state of affairs is facilitated by the use of simpler, highly productive, and cheaper technical means and technologies compared to the pressing and removal of straw from the fields. An additional favorable circumstance is that it is mainly pressed into rolls and bales dried in rolls of early grain straw.

Figure 1 – Front of fire when burning stubble

Source: [10]

The appearance on the Ukrainian market about a quarter of a century ago of imported John Deere and CLAAS and combine harvesters and machines from other manufacturers equipped with straw shredders was a turning point in the technology of preparing straw for wrapping in the soil.

Combines equipped with shredders spread straw almost evenly over the entire width of the header (fig. 2) [6]. This makes it possible to start the unit with discs after the combines and without delay to earn straw into the soil to a depth of 8-12 cm. High-quality grinding and scattering of residues allow some farmers to plow without prior discing.

In nature, the source of humus is plant remains. Humus is a complex mix of substances from the decomposition of dead plants, microorganisms, and products of their vital activity. This living substance constantly needs "food" of organic matter. Straw from the stems and leaves of cultivated plants is the most popular source of nutrients for soil biota because it contains more than 75% of hydrocarbons in the form of digestible cellulose, as well as sugars and starch, which are instantly absorbed by microorganisms.

Straw is superior to other organic fertilizers in terms of organic matter content, and very valuable for increasing soil fertility: cellulose, pentose, hemicellulose, and lignin, which are carbohydrate energy substrates for soil microorganisms.

From one ton of straw, 4,2 kg of nitrogen, 1,7 kg of phosphorus, 8,3 kg of potassium, 4,2 kg of calcium, 0,7 kg of magnesium are returned to the soil, and a number of microelements that accumulate more in straw than in grain. Straw

fertilization increases the availability of phosphorus and potassium in the soil, due to the dissolving action of acidic substances formed during its decomposition. This is especially important with a shortage of mineral fertilizers, which occurs in many farms in the country. Earnings of one ton of straw in combination with liquid manure or mineral nitrogen are equivalent to 3,5-4,0 t/ha of straw manure [1].

Figure 2 – Combine harvester operation with a straw shredder on
Source: [6]

Additional application of nitrogen to a greater extent requires straw from winter and spring cereals, less - corn, buckwheat, and cruciferous crops. When using high-nitrogen legumes for fertilizer straw, compensatory fertilizers can be omitted. They can also not be used if the straw is used to fertilize legumes.

Legumes, annual grasses, and spring cereals respond best to straw fertilizer. The inhibitory effect of fresh straw on plants is manifested at a temperature of 200°C for 1,0-1,5 months. At lower temperatures, it is observed for a longer time. At the same time, it should be noted that winter cereals often have a positive aftereffect of straw used for fertilizer in previous years. After all, in the first 2-4 months usually decomposes only about 40% of straw, and in 1,0-1,5 years - up to 80%, the rest - later. Therefore, the value of straw as an organic fertilizer is manifested mainly in its aftereffects [1].

The stability of soil fertility indicators depends entirely on the dynamic balance between the processes of humification and mineralization of organic matter. In virgin soil formation, humification predominates and there is a gradual accumulation of soil organic matter, the content of which then stabilizes under certain conditions; in the conditions of agricultural production the processes of mineralization become more active, the humus content decreases, after which it also stabilizes over time. Thus, for a deficit-free balance of humus in arable soils, it is necessary to look for new ways

to increase fresh organic matter to ensure the superiority of humification processes over mineralization [2].

Soil mulching is one of the agronomic techniques that involves coating the soil surface with various materials to protect against overheating and drying. A layer of crushed plant residues is most often used as mulch. In horticulture and vegetable growing, in addition to straw materials, agro fiber, tree bark, polyethylene film, etc. are used.

Under natural conditions, uncovered soil is an atypical phenomenon. Arable land is formed by man artificially. Maintaining this state requires constant monitoring and significant costs for farmers.

If there is a free space on the ground, it is immediately filled with self-seeding plants - weeds, the seeds of which nature predictably redistributes over the entire surface of the earth.

Mulching with various materials covers the open ground and thus makes it possible to achieve a number of effects. Preserving moisture, delaying the germination of weeds, especially annuals, preventing new weed seeds from entering the soil, reducing the temperature between rows, the formation of organic matter - the main of them. The most popular and affordable is mulching with crop residues and specially harvested straw of cereals and legumes. Mulching techniques are very effective on light soils and with a lack of moisture. With sufficient moisture and on heavy soils, the effectiveness of reception decreases and may even be harmful.

Mulch protects the soil from overheating and penetration of harmful ultraviolet light for the microflora. Light mulch reflects some of the sun's rays and thus protects plant roots from overheating. This is especially important for crops such as potatoes. Measurements of the surface temperature of the potato field with a thermal imager recorded the difference in temperature of the mulched surfaces in the direction of reduction compared to the open twice [9].

Mulch delays the evaporation of moisture from the soil, raises the dew point closer to the surface, promotes uniform distribution of moisture in the soil layer where the roots of plants.

Covering the soil surface with fresh organic matter promotes the intensive formation of carbonic and organic acids, which are converted into available forms for plants available in the soil mineral phosphorus and potassium. The use of straw for mulch promotes the activation of soil biota in the upper layer and increases the number of earthworms. Additional treatment of straw mulch with solutions with nitrogen-fixing bacteria allows the accumulation of biological nitrogen and as a result to increases the protein content in crop products.

Mulching with straw significantly improves the percentage of plant use of nutrients, resulting in increased efficiency of mineral fertilizers (nitrogen - by 55-65%, and phosphorus and potassium - by 15-20%) [13].

There are several approaches (fig. 3) depending on the specific technology. They are united by a strategic goal - to reduce the evaporation of moisture in arable land, crops, and plantations.

The first approach is mulching without cover materials. This group of agricultural measures includes early spring harrowing of frost, early spring harrowing

of winter and perennial grasses, cultivation of steam, layering between rows of row crops, destruction of soil crust after rains.

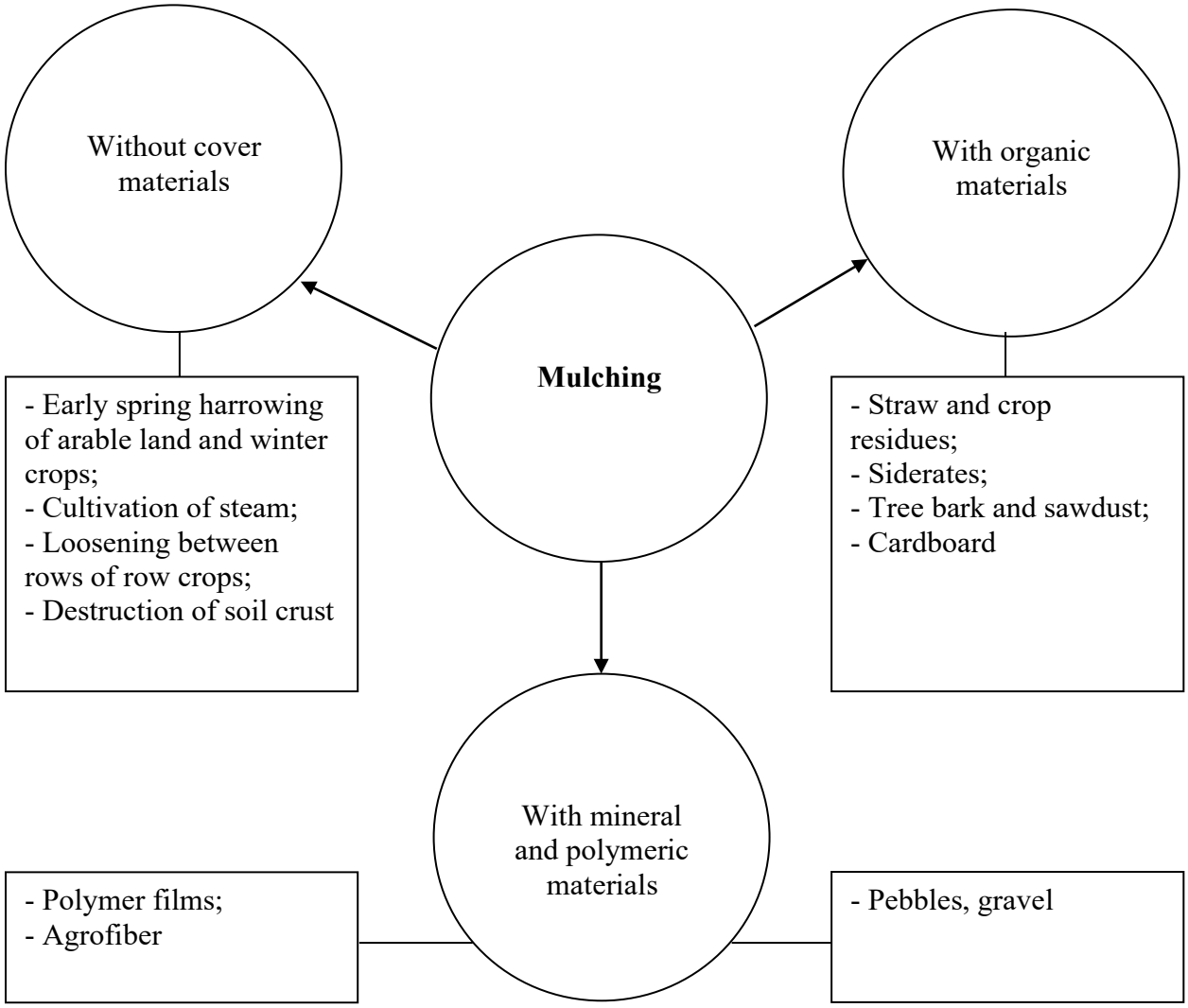

Figure 3 – Classification of methods of mulching the soil

Source: author's proposal

The effect is achieved by loosening the soil to a small depth in order to destroy the grant capillaries, which draw moisture from the lower horizons to the surface. In fact, the soil is mulched dry.

Early spring harrowing of plowed, pruned, or loosened paw units allows achieving several agronomic advantages. First, it allows the primary leveling of the area. Secondly, to form a protective fine-grained layer on the surface of the field, which significantly slows down the evaporation of moisture. Third, destroy small weed sprouts in the white thread phase. An additional advantage of early spring harrowing is a more uniform and partial shredding of semi-decomposed straw if it remains on the surface.

Early spring harrowing does not require significant fuel costs, even with the use of large-scale units. It should be emphasized that in regions with a sufficient level of moisture for early spring harrowing are used gear units, and in arid regions - needle. The most efficient designs of such harrows include mesh units, in which each sector

moves independently of the other. The ability to assemble hitches for early spring harrowing of significant working width provides exceptional productivity and does not require the use of heavy tractors.

Equally important is the destruction of the spring soil crust, which sometimes leads to mass oppression and even the death of winter cereals in many regions of Ukraine. At the same time, the activation of microbiological processes in the soil and the improvement of moisture and air circulation are launched. According to quite realistic scientific and practical data, early spring harrowing of winter allows increasing future yields by 10–20% [11].

The next type of mulching is mulching technology using cover materials. It in turn is divided into two directions. Mulching with straw and plant residues, as well as the use of agro fiber and various polymer films.

The use of artificial materials is partially practiced in vegetable growing and horticulture. The rest of the area is mulched with straw and crop residues.

Mulching is an integral part of soil protection agriculture, which can not only preserve soil fertility but also significantly reduce the number of pests and weeds in the field.

In agriculture, mulching with straw materials is used for different periods. Short - from harvesting the predecessor to furrow plowing, and long - for a year or more, in the case of application in strip-till and no-till technologies.

According to the method of formation of the cover layer, mulching is carried out by combine harvesters simultaneously with threshing by grinding and scattering straw and chaff in the field (fig. 2), or with the use of special mulchers or combined.

Field research shows that the quality of combined harvester shredders over the age of five or six does not quite meet the agronomic requirements for mulching, even for cereals.

Uniformity of heap distribution after the combine shredder is not reached. The bulk of the straw is placed on a width of 1,5 - 2 m on both sides of the longitudinal axis of the combine. The whole floor is laid in a rough layer of 10-15 cm in a strip the width of the thresher. The situation with uniformity of distribution worsens on slopes, on turning lanes, and in the presence of a crosswind (fig. 2), and at the raised humidity of stalks.

To improve the uniformity of the distribution of shredded heap on combine harvesters of recent years with reapers with a width of 9-11 m, improved systems for shredding and distribution of crop residues have been installed. They have remotely controlled guide deflectors that allow you to adjust the direction of mass flow from the shredder on the slopes and in crosswinds. In addition, it is possible to scatter the floor separately from the straw. To reduce the amount of straw on the turning lanes, they must be expanded to 3-4 passes of the reaper.

Despite such improvements, combine harvesters still do not provide uniform scattering of the heap, especially with wet stems.

Crop residues with massive stems and high cuttings - rapeseed, sunflower, corn, sorghum, green manure stalks, or straw stacked in rolls - require additional grinding and distribution on the field surface. And if with classical technology this requirement is desirable, then for strip-till and no-till technologies it is extremely

important because the presence of unprocessed residues complicates further work (fig. 4).

Figure 4 – Consequences of non-compliance with agricultural requirements for crop residue management

Source: author's proposal

In some farms, there are attempts to dissect the stubble of sunflower or corn, or even immediately plow the remains. Such attempts give questionable results because both disks and plows are hammered in obstructing blockages which interfere with the movement of units when carrying out the subsequent operations. In fig. 4 examples of the condition of such fields before and after sowing winter crops.

Another way to process crop residues into mulch than to grind and scatter straw with combine harvesters is to use mulchers.

A mulcher is an agricultural machine, usually with active working bodies driven by the PTO shaft of the tractor, which grinds crop residues and then evenly distributes the crushed mass on the field surface.

There are three types of mulchers according to the type of aggregation: mounted, semi-mounted, and trailed. The main working bodies of mulchers are rotors on which stationary cutters or mobile hammers are fixed. According to the number and location of rotors, mulchers are single and multi-rotor, with the horizontal or vertical placement of rotors.

Units with mulchers are able to move at speeds up to 15 km/h. The rotor of the mulcher, on which the knives or hammers are fixed, rotates at a speed of up to 2000 r/m, grinds any plant mass in its area of action, and evenly distributes it across the width of the grip.

The rotors of this technique are mainly equipped with universal knives sharpened on both sides, which can grind any crop residues, including sunflower and corn, as well as weeds and green manure.

The working width of mulchers depending on the needs of the farm can be from 1,5 to 9 m and work in the temperature range from -50 to +40°C. However, it should be noted that for high-quality equipment, soil moisture should not exceed 25%, and its hardness should not be less than 2,0 MPa.

Today on the market of agricultural machinery of Ukraine there is a wide choice of mulchers at reasonable prices. First of all on the market of equipment for agrarian and industrial complex already traditional shredders of the PN-2,0 and PN-4,0 brand of production of LLC SPE "BILOTSERKIVMAZ" (Ukraine), MR-2,7 and MR-5,4 of PJSC "Umanfermmash" (Ukraine), RCM5515 from Great Plains (USA), as well as the Gaspardo CHIARA 200 and Gaspardo TORNADO 230/250/280/310 and Grifone 470 (Italy), KUHN RM (France), Bednar (Czech Republic) and others.

The most popular in terms of quality of work are mulchers with a horizontal shaft, a width of 2-3 m, a rotor diameter of up to 300 mm, and Y-shaped knives, such as PN-2,0, MR-2,7, KUHN RM, PTO shaft of the tractor power up to 60 kW. They are versatile and ideal for shredding straw rolls, have a cover with deflectors that ensure even spreading of the shredded mass. The mulcher of plant remains MR-2,7 is intended for crushing of crop residues (including coarse-stem) with a simultaneous scattering of the crushing weight on a soil surface. Working body rotor with movable knives. Works in a wide range of climatic conditions at various temperatures. Grinding of the remains which remain after harvesting provides the creation of organic fertilizer. Even distribution over the field - provides access to organic matter to the soil in the cultivated areas. Improves the physical and chemical properties of the soil. The mulch formed during processing by the unit creates an additional protective layer. Protects the soil from drying out and other negative influences. Saturates the soil with nutrients without the use of chemical fertilizers. Provides accumulation and preservation of moisture in the soil.

MR 2,7 mulcher - a combination of classic reliability and modern efficiency, structural simplicity, and ease of use. The unit grinds weeds and mechanically without the use of chemicals, fights pests. The mulcher MR 2,7 - the unit with a semi-hinged design of aggregation (fig. 5).

Figure 5 – Mulcher of plant residues MR-2,7

Source: [7]

The shredders have two support wheels, the raising, and lowering of which regulates the height of the rotor above the ground. If necessary, the mulcher blades can partially mix the crushed residue with the soil.

The advantage of mulchers with vertical shafts is a larger width of capture, namely 4,5 and 6 m compared to machines of the previous group at the same power more uniform distribution of residues, and most importantly so accurate copying of the terrain that they can mow ditches and roadsides. They are designed for shredding crop residues of sunflower and corn, large grasses, shrubs, and young trees with a trunk diameter of up to 8 cm. The combination of the high speed of the unit guarantees high productivity at low daily costs (fig. 6).

Figure 6 – MZ mulcher from Bednar FMT

Source: [8]

Bednar FMT mulchers are equipped with 3 rotors with a speed of 540 r/m. or 1000 r/m. On each of them, there are 4 knives that provide high-quality crushing of the plant remains.

These units also have a high level of protection against mechanical damage and corrosion. Yes, the car is based on a strong and reliable frame, which was specially created for seasonal extreme loads. In addition, the working surface of the mulcher is covered with an armored layer that protects it from stones and corrosion. During production, the body of the machine was subjected to hot-dip galvanizing, which provided reliable protection of the mulcher from corrosion. The mulcher can change the angle of the side wings relative to the central section in the range from -20° (in the model MZ 6000 -15°) to + 90°.

Recently, crushing rollers, such as KZK-6-06 (Uman), have appeared on the

market of tillage implements (fig. 7). They are successfully used on rapeseed, sunflower, and corn stubble. The greatest efficiency of a roller is shown on the crushing of fragile stalks of sunflower and rape. The roller is also intended for leveling and partial mulching of the field surface.

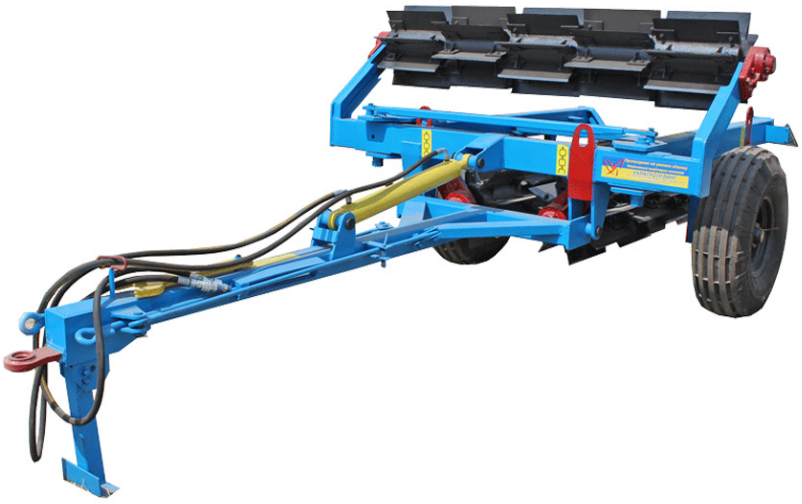

Figure 7 – Roller crusher KZK-6-06

Source: [5]

The machine has three two-meter sets of six sections of rotary rollers with a width of 2 meters. 8 straight knives are fixed on each section, which enters the ground at a certain angle of attack. Moving at speed, the rollers are pressed to the ground and cut the fragile stems of sunflowers. At the exit of the soil, the knives capture soil particles and throw them forward along the course of the unit, sprinkling crop residues.

The roller-crusher KZK-6-06 with the minimum expenses will turn crop residues, stubble, and straw, inhomogeneous, carefully mixed with the top layers of soil a healing layer. During autumn and winter, the crushed green mass will rot and only increase soil fertility, which will have a positive effect on future yields.

Distinctive features:

- due to its own transport wheels allows you to move quickly from field to field and over long distances;
- due to the optimal distance between the knives of the shredder 18,5 cm there is no clogging of the knives with soil;
- due to the diameter of the roller, which is 584 mm, as well as a high operating speed of 12-20 km/h. the cultivated area increases;
- due to a reliable and tested frame CPC - 6 increases the service life and reliability of the roller;
- due to its own weight and the possibility of its weighting with water (skating rinks have plugs to fill them with water), increases the density of attraction to crop residues, after which the remains are crushed to unprecedented proportions, which gives faster metabolism and fertilizer;
- reliable bearing units.

The use of mulching techniques in resource-saving technology is fundamental.

One of the basic scientific positions at zero cultivation is the obligatory leaving of all plant remains on the surface and their uniform placement in the field. In order for plant remains to fulfill their task, it is necessary to work with them purposefully, ie to grind them carefully.

Management of crop residues in the "no-till" farming system is performed by mechanical and biological measures. Tools for mechanical impact on crop residues are various combines equipped with shredders and special trailed shredders, such as domestic and foreign production. For successful direct sowing of winter crops the thickness of the mulched layer should not exceed 2 cm.

The essence of the biological method of managing plant residues is to regulate the rate of their biological decomposition. Acceleration of the process of straw decomposition is achieved with the help of various biological preparations, which include cellulose and lignin-decomposing, nitrogen-fixing, phosphorus-mobilizing, and other microorganisms.

Strip-till technology provides a compromise between tillage between traditional plowing and direct sowing.

Tillage today is quite a resource-intensive process because it requires not only labor costs but also energy costs, fuel, which is becoming more and more expensive every year. Quite often, farmers simply resort to reducing costs or reducing their level to zero for fertilizing land and plowing. Of course, this situation has a bad effect on yields but has a positive effect on reducing erosion.

Due to the use of a combination of different working bodies on Strip-till units, which grind and wrap plant residues, carry out deep loosening and grinding of the soil, form a furrow, and compact the soil in one pass, it is possible to perform only one soil tillage operation (usually in autumn).

Therefore, according to this technology, the soil is deeply loosened only in the row area, and the row spacing is not cultivated. Throughout the year, the row spacing is covered with mulch from the crop residues of the predecessor.

This creates the optimal hardness and structure of the soil in the area of the main part of the root systems, opens opportunities for the deposit of mineral fertilizers and root crops. Loose strips absorb precipitation and air well. Fields treated with Strip-till technology have satisfactory resistance to water and wind erosion with the right choice of tillage [9].

In Ukraine, there are processes of careful testing of energy-saving technologies on the example of popular row crops, as well as winter wheat. Thanks to the efforts of enthusiasts, strip-tillage technology has accumulated a certain amount of lasting positive experience in terms of advantages over direct sowing. However, there are a number of inconveniences in using the technology, especially by small farmers. These are the high cost of imported equipment, the need to match the width of the rows with the width of the tractor, the mandatory presence of automatic driving systems, the impossibility of cultivating too heavy and very light soils. Absence of a transition period of 3-5 years and preservation of traditional terms of the beginning of sowing in the spring favorably distinguish strip cultivation from direct sowing, and unprocessed on two-thirds and covered with mulch inter rows combine it with No-till.

One of the main principles of No-till is the preservation and accumulation of

plant remains in the field. Plant residues, in addition to being a source of organic fertilizers, play several other important functions - protect the soil from heat and moisture loss, prevent wind and water erosion, and retain snow in winter in the fields.

Crops that do not require a special approach to the distribution of residues are crops after which a small mass of plant residues remains and they are rapidly mineralized. These are sunflower, rapeseed, soybeans, peas, mustard, flax, and other crops.

When harvesting these crops, it is enough to follow the rules - evenly distribute the remains on the width of the combine harvester, do not make piles and rolls, and do not grind. So the plant remains will be useful and will perform the necessary functions for No-till technology.

Strip cultivation is promising in terms of resource conservation, rational and efficient use of fertilizers, and crop residue management. At the same time, today there is a clear lack of information about technological schemes, requirements for technological processes of stripe formation and sowing, selection of working bodies, technical solutions. There is also a lack of information on the hydrothermal properties of the soil in the strips and interband space, especially during droughts.

Despite the significant savings in resource and labor savings, weeds are a major vulnerability in bandwidth technology. There is an urgent need for herbicides. However, the cost of weed control is insignificant compared to the total cost of growing the crop. In addition, herbicides against the same weeds are also applied during traditional tillage.

Conclusions.

Therefore, abandoning the traditional technology of harvesting straw from the field can have a significant economic effect due to the reduction of fuel and labor costs for the transportation and dumping of straw.

Straw outperforms other organic fertilizers in terms of organic matter content, which is very valuable for increasing soil fertility.

Straw fertilization increases the availability of phosphorus and potassium in the soil, due to the dissolving action of acidic substances formed during its decomposition. Earnings of one ton of straw in combination with liquid manure or mineral nitrogen by its action are equivalent to 3,5-4,0 t / ha of straw manure.

Mulching with various materials covers the open ground and thus makes it possible to achieve a number of effects. Preserving moisture, delaying the germination of weeds, especially annuals, preventing new weed seeds from entering the soil, reducing the temperature between rows, the formation of organic matter - the main of them.

The use of mulching techniques in resource-saving technology is fundamental. We believe that the basic rules of crop residue management are that plant residues should be evenly distributed throughout the field. This rule eliminates rolls and piles of debris in the field after threshing. This effect can be achieved by using special machines for processing crop residues - mulchers.

As a result of our research, we confirmed the effectiveness of strip-till technology in growing potatoes, the use of which provided optimal conditions for water regime and nutrition by reducing the surface temperature of the soil, which is a

guarantee of higher yields.

Straw, plants and plant debris are an accumulator of living solar energy, fixed in the form of carbon compounds. It must go into the soil for the life of microorganisms that transmit it to plants, and those - to humans, animals, and all living things on earth. By burning it, we send energy into space, violating the harmony of nature, the laws of the universe, the laws of God. Can it be good if we so contemptuously (consciously or unconsciously matter) reject the Gift of God?

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Анотація. *У статті досліджено практичне застосування сучасних технологій використання пожнивних решток як органічного добрива і мульчі. Розкриті механізми перетворення соломи на органічне добриво. Охарактеризовано способи мульчування в рільництві. Проаналізовано основні типи машин і технологій мульчування. Акцентовано увагу на мульчуванні як одного із системоутворюючих факторів в технологіях no-till і strip-till. Знаряддями механічного впливу на рослинні рештки є різні комбайни, обладнані подрібнювачами та спеціальні причіпні подрібнювачі. Отримано підтвердження ефективності технології strip-till при вирощуванні картоплі, застосування якої забезпечило оптимальні умови водного режиму і живлення за рахунок зменшення поверхні температури грунту, що є гарантом вищої врожайності.*

Ключові слова: *ґрунт, солома, спалювання, приорювання, органічне добриво, мульча, мульчататор, смуговий обробіток.*

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