Technical science and innovation

Volume 2021 | Issue 1 Article 12

3-27-2021

RESEARCH RESULTS FOR THE SELECTION OF WORKING BODY TYPES FOR STRIP TILLAGE OF SOIL

F Alimova
Tashkent state technical university named after Islam Karimov, Tashkent, Uzbekistan, hamroyevr@mail.ru

B Primkulov
Tashkent state technical university named after Islam Karimov, Tashkent, Uzbekistan

A Tolibaev
Center on certification and testing of agricultural techniques and technologies Tashkent Region, Yangiyul district, Gulbahor. Str., Samarqand 32/12

M Gulamov
Tashkent institute of irrigation and agricultural mechanization engineers

Recommended Citation

Alimova, F; Primkulov, B; Tolibaev, A; and Gulamov, M (2021) "RESEARCH RESULTS FOR THE SELECTION OF WORKING BODY TYPES FOR STRIP TILLAGE OF SOIL," *Technical science and innovation*: Vol. 2021: Iss. 1, Article 12.
DOI: https://doi.org/10.51346/tstu-01.21.1-77-0113
Available at: https://btstu.researchcommons.org/journal/vol2021/iss1/12

UDC: 631.331.

RESEARCH RESULTS FOR THE SELECTION OF WORKING BODY TYPES FOR STRIP TILLAGE OF SOIL

F.A. Alimova[1], B.Sh. Primkulov[1*], A.E. Tolibaev[2], M.S. Gulamov[3]

[1]Tashkent State Technical University named after Islam Karimov,
100095, University St. 2, Tashkent, Uzbekistan
[2]Center on certification and testing of agricultural techniques and technologies
Tashkent Region, Yangiyul district, Gulbahor. Str., Samarqand 32/12
[3]Tashkent institute of irrigation and agricultural mechanization engineers

Abstract. *The article describes the results of research on the selection of working body types for strip tillage of soil. Information on the advantages of the technology of minimal soil tillage (Strip-Till) is presented. The data obtained as a result of experimental studies to determine soil moisture and hardness, as well as the quality of soil tilling by the recommended working bodies, are presented. The arrangement schemes of working bodies for the considered technology have been drawn up. The general concept of the development of a combined aggregate on energy-resource-water-saving technologies for the cultivation of crops in permanent furrows and in row spacing ridges was selected. The aggregate is based on the SMX-4-01 domestic pneumatic planter and the front of the KXU-4B cotton cultivator and is aggregated with a class 1.4 grade universal row-crop tractor. It is noted that the most acceptable combination of working bodies for soil strip tillage is combination of working bodies consisting of 3 flat cutting discs and lancet chisel, which ensure the required quality of soil crushing and uniformity of tillage depth, as well as the width of the tilled strip and the flatness of the tilled surface, and prevent the working bodies from clogging with plant remains and soil. For the normal operation of the seed planting working bodies, the width of the tilling soil strip should not be less than the width of the planter openers. Further research was aimed at substantiating the main parameters of working bodies and the parametres are as follows: the diameter of the cutting discs, which prevents the working bodies from clogging with plant remains and soil, the coordinates of their location, the angle of installation of the lancet chisel, the distance between the cutting discs and the lancet chisel, the tilling depth, the working width, the total resistance of the aggregate, and the movement speed of the aggregate.*

Key words: *strip tillage, ridge of row spacing, re-crop, working body, single-sided cutting flat razor knife, lancet chisel, disc.*

Traditional soil tillage methods are high energy, labor costs, and often time consuming, as certain types of work are usually carried out at specific intervals. At present, much attention is paid to the technology of cultivation of agricultural crops, based on the minimum soil tillage [1]. The intensive use of irrigated lands is associated with the introduction of re-sown of food and annual forage crops. Getting two harvests per year on one field makes it possible to significantly increase the production of grain and feed.

In the conditions of Central Asia, it is recommended to use strip tillage with simultaneous sowing for growing corn and other fodder crops after harvesting cereals. In this case, only narrow strips (mainly the ridges of the cotton and other crop row spacing preserved from the previous year) are processed to tillage which have a sufficient width and depth for planting seeds. [2]

This technology of soil strip tillage for sowing (Strip-Till) is widely used in the countries of the Far and Near Abroad. However, the issues of strip tillage for sowing re-crops in the conditions of our republic have not been sufficiently searched. In Europe, it has been proven that for most crops, yields increase by 15 - 25%. American farmers, after three years of introducing this technique, began to spend 40% less money on plant protection products and

fertilizers. Early heating of the soil makes it possible to start sowing 5 to 10 days ahead of schedule (with a separate method). Recent studies show that strip-till increases soil humus content by 4%. [2]

Strip -Till Technology:

• In one pass, it carries out a complete tillage for row crops, saves up to 30% of fuel and lubricants;

- Introduces fertilizers directly into the soil at two depths and thus saves up to 20% of mineral fertilizers, helps to optimize plant nutrition, eliminates plant feeding as a separate technological operation;
- In the presence of a hitch for the planter, allows simultaneous sowing. [3]

Advantages of Strip - Till [4]

- Conserves energy because only part of the soil is tilled;
- Reduces soil erosion because most of the soil remains covered with crop residue throughout the year;
- Releases less carbon into the atmosphere and maintains higher levels of soil organic matter;
- Warms the tilled strips sooner in the spring to promote seed germination and plant emergence;
- Conserves soil moisture because most of the soil surface area is covered with crop residue;
- Results in crop yields that are similar or higher, compared with other tillage systems;
- Reduces expenses by eliminating some primary and secondary tillage;
- An important criterion for the successful application of the technology is the coordination of the working row spacing with the dimensions of the tractor chassis and equipping the latter with a GPS system [5].

Based on the analysis of the literature and the results of previous research, the general concept of the development of a combined aggregate on energy-resource-water-saving technologies for the cultivation of crops in permanent furrows and in row spacing ridges was selected**.** The aggregate is based on the SMX-4-01 domestic pneumatic planter and the front of the KXU-4B cotton cultivator and is aggregated with a class 1.4 grade universal row-crop tractor [6].

The following working bodies were developed and tested to select the types of working bodies for strip - till and the diagram of their arrangement on the aggregate frame (Figure 1). Here we discuss 4 options in detail. Four of the six options proposed for minimal tillage in the cultivation of re - crops in the existing (permanent) ridges of the row spacing remaining after last year‟s grain crops were selected.

For minimal tillage of soil such types of working bodies as a single-sided cutting flat razor knife, a lancet chisel, spherical and flat-cutting discs in various combinations were used

The functions of these working bodies are as follows:

1) single-sided cutting flat razor knife - cutting the soil layer with plant remains to a depth of 5–6 cm, moving the plant remains from the top of the ridge to the furrow edge.

2) lancet chisel - cutting the soil layer and loosening the soil to a depth of 10 cm, deeper than the sowing depth of sown seeds.

3) spherical discs - lifting the soil particles which are crushed by the front working bodies to the top of the ridge, correcting the shape of the ridge.

4) flat cutting disc - cutting plant remains and soil layer to prevent clogging of subsequent installed working bodies.

The process of minimal tillage and simultaneous sowing of re - crops seeds with the proposed working bodies is carried out as follows:

1) Tilling the top of the ridge with a single-sided cutting flat razor knife and partially push the plant remains aside, then loosen the soil with a lancet chisel at a depth greater than sowing depth of the sown seeds.

Then, using two spherical discs straighten the shape of the top of the ridge and raised the soil from the sides to the top. Large soil particles (greater than 50 mm) are allowed to fall from the top. This improves the fractional composition of the soil in the planter opener movement area (Fig. 1, a).

2) Till the top of the ridge with single flat cutting disc and single lancet chisel. The flat cutting disc moves in front of the lancet chisel: it cuts straw and other plant remains, cuts a layer of soil along the row of future seeds partially crushes the soil. The operation of the lancet chisel is the same as in the first variant (Fig. 1, b).

3) The top of the ridge is tilled with a single-sided cutting flat razor knife, a flat-cutting disc and a lancet chisel. The working bodies are placed one after the other and perform the functions of options 1 and 2 (Fig. 1, c).

4) The top of the ridge is tilling with three flat cutting discs and a single lancet chisel. The discs are set in stagger: the middle disc in the center, the other two on the sides, behind the middle disc. The lancet chisel is sated along the trace of the central disc. Features are as above. The installation of three flat cutting discs is intended to improve the degree of crushing of straw and soil (Fig. 1 g).

The working bodies are set on the cultivator grids mounted on the front of the tractor. A precision planter is mounted on the back of the tractor. Thus, the sowing of crop seeds is carried out simultaneously with strip till of the soil.

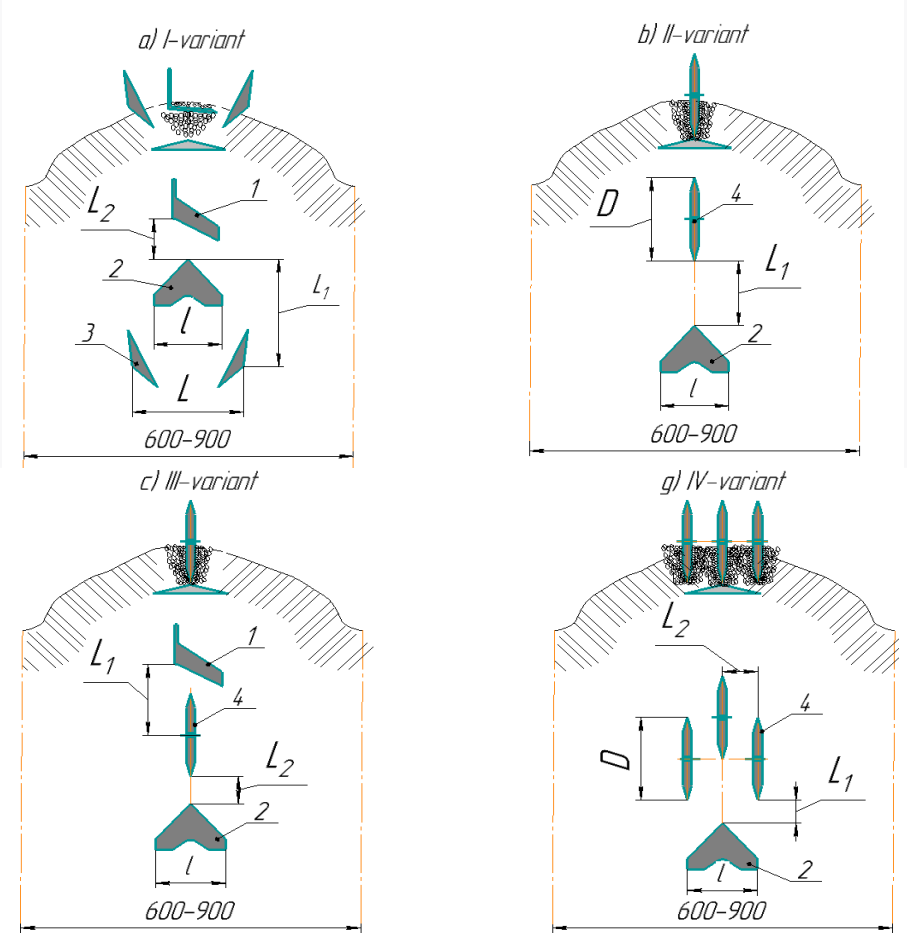

Figure 1 - Diagrams of arrangement of working bodies on the aggregate frame for strip - till:

1- single-sided cutting flat razor knife; 2- lancet chisel; 3-spherical disc; 4 flat cutting discs.

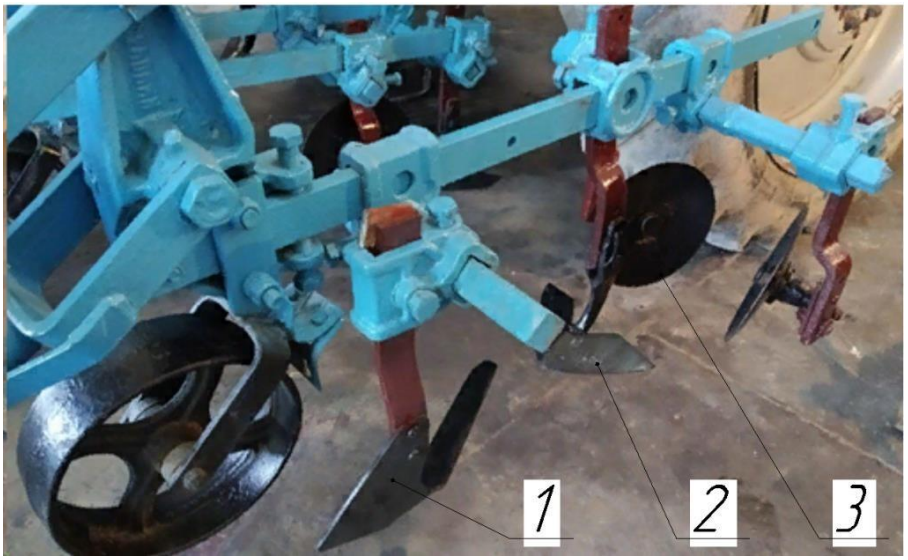

Figure 2. The first variant of the arrangement of working bodies: 1- single-sided cutting flat razor knife, 2- lancet chisel, 3-spherical disc.

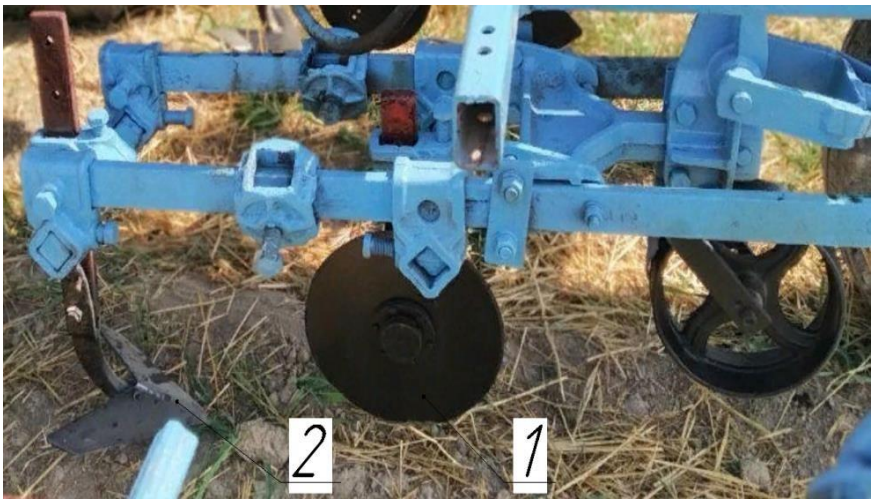

Figure 3. The second variant of the arrangement of working bodies 1- flat cutting disc, 2 - lancet chisel.

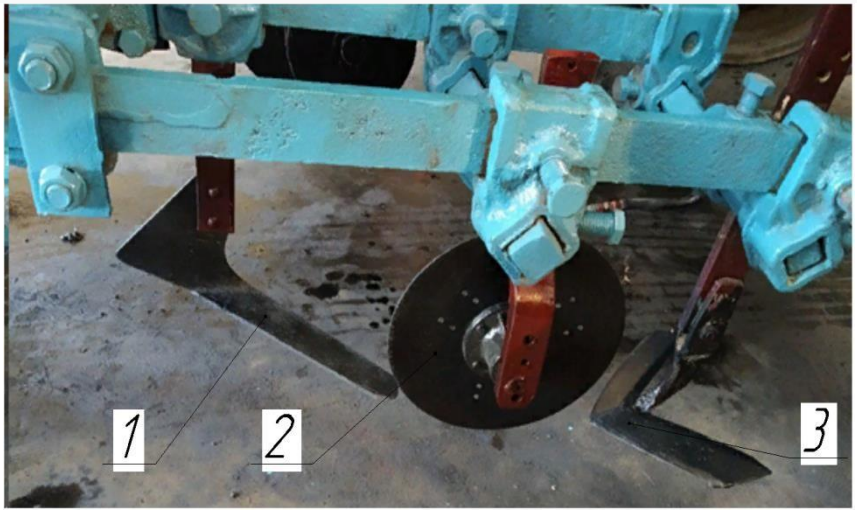

Figure 4. The third variant of the arrangement of working bodies: 1- single-sided cutting flat razor knife, 2- flat cutting disc, 3-lancet chisel.

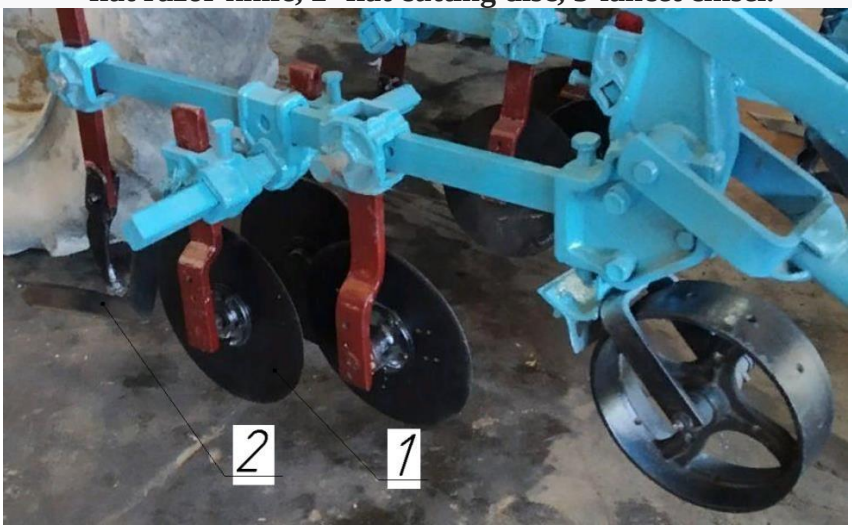

Figure 5. The forth variant of the arrangement of working bodies: 1- flat cutting disks, 2- lancet chisel.

The tests were carried out in the fields of the experimental farm of Uzbek research institute of agricultural mechanization (QXMITI), during the preparation the summer dry hart soil for re - crops sowing after the harvest of grain crops. A special aggregate was designed to test the options of these working bodies. The aggregate consists of MTZ-80 tractor and front-mounted cultivator for set the working bodies.

Tests were conducted on the fifth and seventh gears of the tractor. Prior to the experiments, soil moisture and hardness were determined at 0 ... 10 cm, 10 ... 20 cm, 20 ... 30 cm horizons. The evaluation criteria in selecting the type and setting of the working bodies were as follows:

- crushing quality of soil,
- uniformity the tilling depth;
- tilled strip width;
- unclogging the working bodies with plant remains and soil.

The quality of tillage was determined according to Tst 63.04: 2001 (Test program and methods) [7]. For each variant of the experiment, the crushing quality of the soil was determined at four points from an area of 0.25 m^2 to the depth of cultivation one hour after the passage of the aggregate.

Soil samples were taken using a bottom-separating box. The selected samples were divided directly into fractions using 50 and 25 mm diameter sieves.

The sieve holes were placed in descending order. All fractions were weighed separately and then their mass fraction was determined as a percentage of the total mass of the soil sample. Pieces of soil smaller than 25 mm are of agronomic importance.

For high-quality sowing of seeds, their content should be at least 80% [8, 9].

The depth of the tilled layer was determined by immersing the liner in the soil with a cross-sectional area of 1 cm^2 (1x1 cm section). Measurements were repeated at least 50 times.

The obtained experimental data were processed using the method of mathematical statistics. The results of the comparative tests of the working bodies are given in Table.

Table.

Results of tests of experimental combined aggregate

№		Indicators	Agrotechnical	Indicator values

			requirements	var.№1	var.№2	var.№3	var.№4
1.	1.24	Tilling depth cm: M_m ±σ	8-12	8,31 1,15	11,63 1,67	7.83 1,85	11,5 1,16
	1,66			6,12 2,5	10,93 2	5,52 3,64	10,3 2,12
	1.96			5,83 3,58	7,88 2,36	4,53 4,53	8,26 2,51
2.	1.24	Tilled strip width, cm: M_m ±σ	15±1	15,3 1,85	14,33 1,78	16,78 3,85	15,5 2,11
	1,66			16,28 2,5	14,9 1.52	15,82 3,64	14,8 2.12
	1.96			16,83 5,5	14,8 3,63	16,3 2,53	14,1 1.51
3.	1.24	The percentage of fractions of following size (mm) %: 50-25 >25	The percentage of fractions less than 25 mm is at least 80 %	44,93 55,07	29,45 70,55	13,64 86,36	6,83 93,17
	1,66			45,45 54,55	17,26 82,74	12,31 87,69	19,18 80,82
	1.96			39,22 60,78	33,85 66,15	46,22 53,78	24,57 75,43

For the normal operation of the seed planting working bodies, the width of the tilling soil strip should not be less than the width of the planter openers [10]. Thus, a combination of working bodies consisting of 3 flat cutting discs and lancet chisel, which ensure the required quality of soil crushing and uniformity of tillage depth, as well as the width of the tilled strip and the flatness of the tilled surface, and prevent the working bodies from clogging with plant remains and soil, is preferred.

Therefore, further research was aimed at substantiating the main parameters of these working bodies. The main parameters affecting the quality and energy indicators of the working bodies are as follows (Fig. 6): the diameter of the cutting discs, which prevents the working bodies from clogging with plant remains and soil (D), the coordinates of their location (L_1, L_2), the angle of installation of the lancet chisels (α), the distance between the cutting discs and the lancet chisels (L_3), the tilling depth (H), the working width (l), the total resistance of the aggregate, and the movement speed of the aggregate (V).

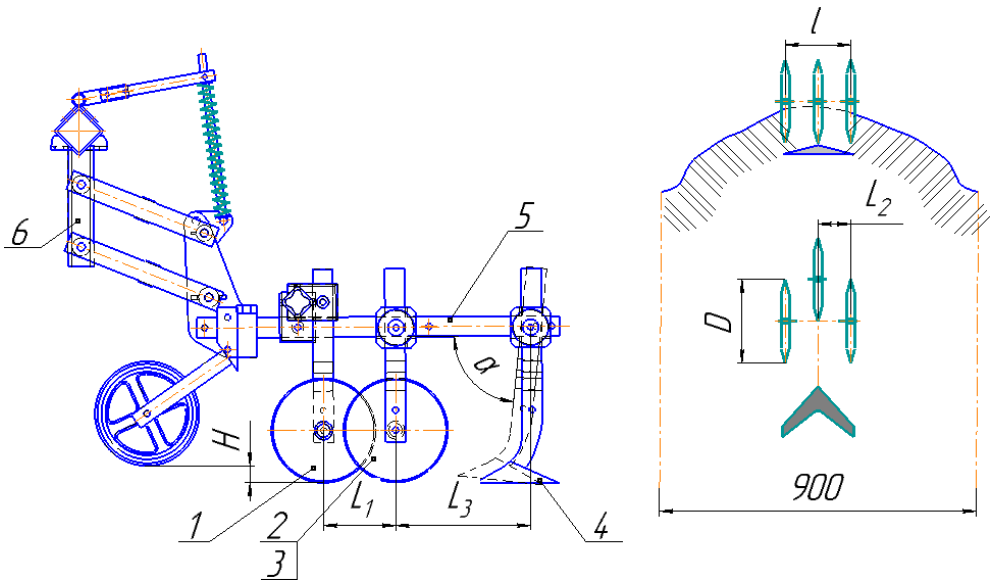

Figure 6. Working bodies of the strip - tilling aggregate:1,2,3 - flat cutting disc, 4 - lancet chisel, 5 - grid, 6 - parallelogram linkage mechanism.

Conclusion. Based on the research of the physical and mechanical properties of the soil, the results of studies to choice the types of working bodies and layout schemes for strip - tillage

revealed:

- after harvesting the crops, the soil has low moisture and high hardness, the soil moisture in the top ridge of the row spacing (0-10cm) was 5.4-6.1%. This indicator is not sufficient for seed germination;
- at the bottom of the ridges of the row spacing the soil moisture is 11.7-12.5%. Soil hardness was 3.8–4.02 MPa at the top ridge of the row spacing and 5.32–5.45 MPa at the bottom of ridge;
- to determine the mass of straw on the experimental plot of land, straw residue was collected from each corresponding plots of $1m^2$. Calculations showed that the mass of straw on the experimental plot was 4.2 t / ha and the coefficient of variation was 15.6%;
- the volumetric weight of the field soil freed from wheat was 1.13 g / cm^3;
- after harvesting the crops a combination of working bodies consisting of 3 flat cutting discs and lancet chisel, which ensure the required quality of soil crushing and uniformity of tillage depth, as well as the width of the tilled strip and the flatness of the tilled surface, and prevent the working bodies from clogging with plant remains and soil, is preferred;
- further research should focus on substantiating the parameters of the selected option working bodies through theoretical and experimental studies.

References:

[1]. Kassam A.; Fridrih T.; Derpsh R. The global spread of conservation agriculture. *Int. J. Environ. Stud.* 2019, *76* , P. 29–51. [Google Scholar] [CrossRef]

[2]. Mukhambetov, B.[a],and others, Studying the effect of preplanting tillage on the germination and forage productivity of Kochia prostrate in the northern desert of Kazakhstan, IOP Conference Series: Earth and Environmental ScienceVolume 315, Issue 5, 23 August 2019, Article number 052037International Scientific Conference on Agribusiness, Environmental Engineering and Biotechnologies, AGRITECH 2019; Krasnoyarsk State Agrarian UniversityKrasnoyarsk; Russian Federation; 20 June 2019 до 22 June 2019; Код 15207

[3]. John Nowatzki,and others, Strip Till for Field Crop Production , Agricultural Machine Systems, NDSU, Extension Service (AE1370, Revised June 2017)

[4]. Iwona Jaskulska, Dariusz Jaskulski. Strip-Till One-Pass Technology in Central and Eastern Europe: A MZURI Pro-Til Hybrid Machine Case Study. *Agronomy* 2020, *10*(7), 925; https://doi.org/10.3390/agronomy10070925

[5]. Kertesz, A.; Мадараш, Б. Conservation agriculture in Europe. *Int. Soil protection. Res.* 2014, *2* , P.91–96. [Google Scholar] [CrossRef]

[6]. Alimova F. A.1, Primkulov B.Sh 2, Investigations of Technologial Proccess Work of the Energy-Saving Combination Aggregate For Re-Sowing The Seeds, International Journal of Advanced Science and Technology, Vol. 29, No. 9s, (2020), pp. 5770-5779

[7]. Tests of agricultural machinery. Machines and implements for surface tillage. Testprogram and methods. Tst 63.04: 2001 // Official edition. - Tashkent, 2001–P.54.

[8]. GOST 20915-11, Agricultural machinery tests. Methods for determining conditional tests. – Moscow: Standartinform 2013.–P.23.

[9]. Agricultural machinery. Methods for determining the conditions of meals. GOST,20915-75. - M.: 1985, -P.34.

[10]. DeJong-Hughes, J., and J. Vetsch. (2007) On-farm comparison of conservation tillage systems for corn following soybeans. University of Minnesota Extension Publication BU-08483.

[11]. Armor " Survey of the project “Development of energy-resource-water-saving technology for cultivating crops on permanent ridges and ridges and drums and engineeping a combined aggregate for their implementation” Research Institute IMEA. Gulbakhor. 2014 y. P.167 (in Russian)

[12]. Hasanova F.M., Karabayev I.T. The influence of agricultural technology of soil cultivation on the productivity of repeated crops. Monograph. - T. Navruztypography. 2018y. P.104 - 106. (in Uzbek).

[13]. Kalimbetov, B.[a],Tukhtakuziyev, A.[b], Environment analysis of using the ripper tooth of combined unit for minimum tillage, EurAsian Journal of BioSciencesVolume 13, Issue 1, January-July 2019, P. 451-457.

[14]. Awale, R.; Chatterjee, A.; Franzen, D. Tillage and N-fertilizer influences on selected organic carbon fractions in a North Dakota silty clay soil. *Soil Tillage Res.* **2013**, *134*, 213–222. [**Google Scholar**] [**CrossRef**].

[15]. Schneider, O.; Roger-Estrade, J.; Aubertot, J.; Dore, T. Effect of seeders and tillage equipment on vertical distribution of oilseed rape stubble. Soil Tillage Res. 2006, 85, 115–122. [Google Scholar] [CrossRef].