ANALYSIS OF THE INFLUENCE OF THE ROLLER TROWEL ON THE SPECIES AND THE SOIL IN PREPARING THE SOIL FOR PLANTING

M.D. Boriyev
PhD student of the Department of Agricultural Mechanization and Service
Karshi Institute of Engineering and Economics
D.B. Irgashev
associate professor of the department of general technical sciences
Karshi Institute of Engineering and Economics
https://doi.org/10.5281/zenodo.13622611

Annotation. The main purpose of post-sowing rolling is to create favorable conditions for seed germination. The fullness and uniformity of crop shoots depend on post-sowing rolling.

In many ways, the effectiveness of rolling as an agricultural technique is determined by the humidity, type and mechanical composition of the soil. Thus, on heavy clay soils with excessive moisture, rolling has a negative effect, since it promotes crust formation. Depending on the applied soil cultivation technology and sowing method, various types of compacting rollers are used on seeding machines for soil compaction. Let us dwell on their description in more detail.

Key words: soil, SZS-2.1, SZS-6/12, STS-6/12, ring-spur rollers, zero-tillage, technology, wedge-shaped, ring-spur rollers

Anyone who works in agriculture and is involved in plant growing knows that in order to obtain fast and uniform shoots, any crops must be rolled. For rolling crops, ring-spur rollers are often used, which consist of one or more batteries, including shafts mounted in bearing units, on which ring-spur disks are installed in a staggered pattern through spacer bushings. These rollers ensure the rolling of 60-70% of the surface of the sown field with virtually no formation of a loose soil layer on this surface, while the remaining part of the surface remains unrolledIn the rolled soil, a capillary cavity is formed, which ensures the supply of moisture to the seeds not only from the seed bed, but also from the soil rolled above the seeds, thereby creating optimal conditions for germination and shoots.

The technological process of rolling involves performing operations aimed at changing the physical and mechanical properties of the soil in order to create favorable conditions for plant development or to preserve moisture in the soil.

The purpose of rolling may be:

– destruction of the soil crust;

– soil compaction (creation of a dense bed for seeds, a dense layer of soil that prevents moisture evaporation or pressing seeds to a dense bed to ensure uniform germination);
- crushing lumps in arable land;
- rolling green manure;
-leveling the soil surface.

Rolling of the soil after primary cultivation and tillage is used to break up large lumps, level the surface of the field, and create a moisture-retaining soil structure (reduces moisture evaporation, especially in dry weather, when convection-diffusion movement of moisture predominates). A press roller is a part of almost every tillage implement.

Pre-sowing rolling is used to create a compacted bed at the seed placement depth and to level the field surface (this is necessary for shallow and uniform seeding and to prevent soil settling after sowing). According to L. S. Roktanen, on chernozem soils, the effectiveness of rolling is higher than on solonetzic soils. If you roll ripe soil, then its structure will not be destroyed. In the case when the moisture reserves in the soil are close to the capillary moisture capacity (which happens with early sowing of spring crops), rolling increases moisture evaporation due to the growth of ridges and leads to over-compaction of the sowing horizon. It is important not to allow the rolling of waterlogged soils, as this will form a thick soil crust that prevents the germination of plants. Rolling dry and sandy soil is ineffective. The only advantage in these conditions may be the leveling of the field surface, but this increases its dispersion. Rolling plays an important role when sowing grain crops in a compacted layer. Due to the influx of moisture and the increase in temperature, rapid and simultaneous swelling and germination of seeds occurs. The most favorable conditions: the seeds lie on a solid bed, and are covered with a less dense layer of soil on top (Figure 1). In such conditions, moisture from the lower layers vigorously flows to the dense bed through capillaries, and the upper, less dense layer of soil favors the penetration of air to the seeds and their rapid germination. In this case, no phenomena of settling of soil layers in the zone of root system development are observed. In dry conditions, post-sowing rolling is a mandatory agrotechnical technique. On rolled crops, accelerated emergence of seedlings, an increase in field germination and, as a result, an increase in yield from 5 to 20% are observed compared to unrolled ones. Therefore, the type of working bodies for rolling and the technological process performed by them must correspond to the sowing method and ensure the

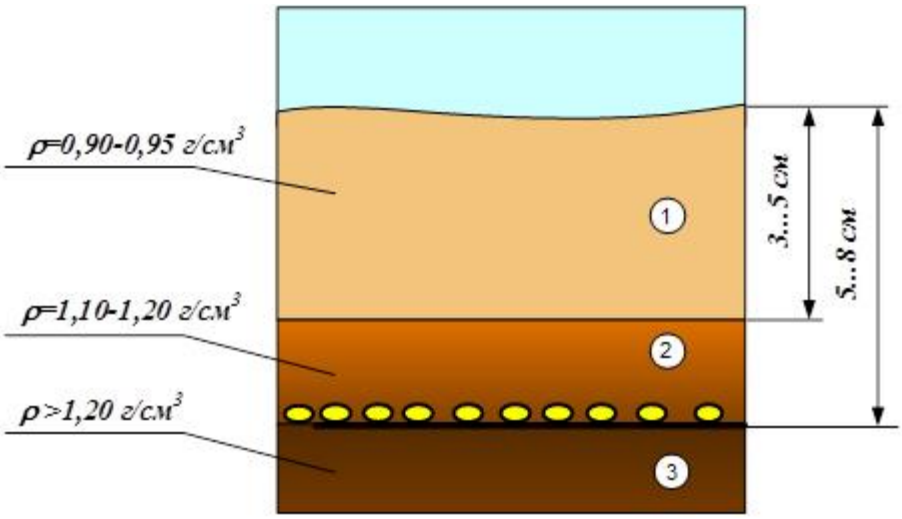
creation of optimal conditions for seed germination and further development of crops. In traditional soil-protecting and minimum soil cultivation technologies in Northern Kazakhstan, the most common is the row sowing method with a row width of 4-5 cm and row spacing of 22.8-25 cm. It is carried out by cultivator-type seeders, when pre-sowing soil cultivation is carried out simultaneously with sowing with arrow-shaped paws installed on coulters. To compact the soil with seeds in rows, wedge-shaped (or ring) rollers are most often used on seeders, due to the simplicity of their design (Fig. 2). Such seeders include the Soviet-era seeders-cultivators SZS-2.1, SZS-6/12, STS-6/12 and seeding complexes of many large foreign manufacturers equipped with wedge-shaped rollers (John Deere 1830, 1840, Bourgault 8810, Flexi Coil 5000, Morris Maxim II, Case ATX 400, etc.). Wedge-shaped rollers, moving behind the coulters, compact the underlying soil layers to a width greater than the width of the rollers, since their working surfaces are located at an angle to the horizon, while simultaneously forming a ribbed wind-resistant surface of the field.

Thanks to such a surface, the sprouts of cultivated plants, being at the bottom of the furrows, are partially protected from the effects of dry winds at the initial stage of development, in addition, the furrows accumulate moisture from light rains, which is primarily received by cultivated plants.

At average soil moisture after the rollers pass, dry soil from the surface partially covers the bottom of the furrows, reducing moisture evaporation. In wet conditions, wedge-shaped rollers, compacting the soil from the surface, contribute to the over-compaction of the surface layer, which as it dries leads to the formation of a crust, especially on heavy soils, which hinders the germination of crops. In addition, the ribbed surface of the field is preserved until harvesting, so the work of combines is difficult due to vibration and shaking, since harvesting is carried out across the direction of sowing. A variety of wedge-shaped rollers are rollers with a semicircular rim section and trapezoidal rollers. The former are used on the Esee On 7550 and Flexi Coil 5000 seeding complexes, the latter on the John Deere 1870 and Versatile C500 (-C600) seeding machines, etc. Similar to wedge-shaped rollers, such rollers roll the soil from the surface, which in wet conditions also contributes to the formation of a surface crust on heavy soils. But unlike wedge-shaped rollers, trapezoidal rollers and rollers with a semicircular rim compact the underlying soil layers to a greater extent and the soil on the sides to a lesser extent, which reduces its excessive compaction. In addition, they form a less pronounced ribbed surface of the field, which somewhat reduces the protective functions of

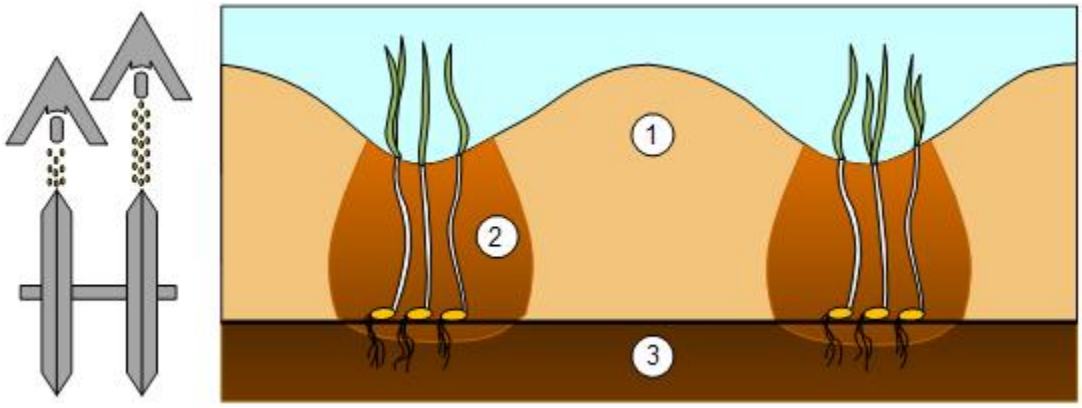
furrows from the wind, but increases the productivity of combines during harvesting due to less shaking. The working surfaces of trapezoid and semicircular rollers are more susceptible to soil sticking than wedge-shaped rollers, so scrapers are required for their cleaning.

Another method used in the traditional soil conservation and minimum tillage technologies is the strip seeding method. The width of the sowing strips varies between 10-18 cm, the row spacing (the distance between the centers of adjacent strips) is 22.8-30 cm. The strip seeding method is carried out with cultivator-type seeders. The task of the rolling rollers in this type of seeding is to compact the soil layer over the entire width of the seed strip and provide them with an equal depth of embedment, leaving the surface layer looser. For compacting the soil with strips of sown seeds in the CIS countries, the most widely used is a single-row ring-spur roller installed on seeders of the SKP-2.1 "Omichka" family (Fig. 3). Ring-spur rollers are rollers of subsurface rolling, since during operation the spurs of the rollers, penetrating into the soil, compact the underlying layer and loosen the surface layer, reducing moisture loss. In addition, they level the surface of the field quite well within their width. At present, ring-spur rollers most fully meet the requirements for the strip sowing method.



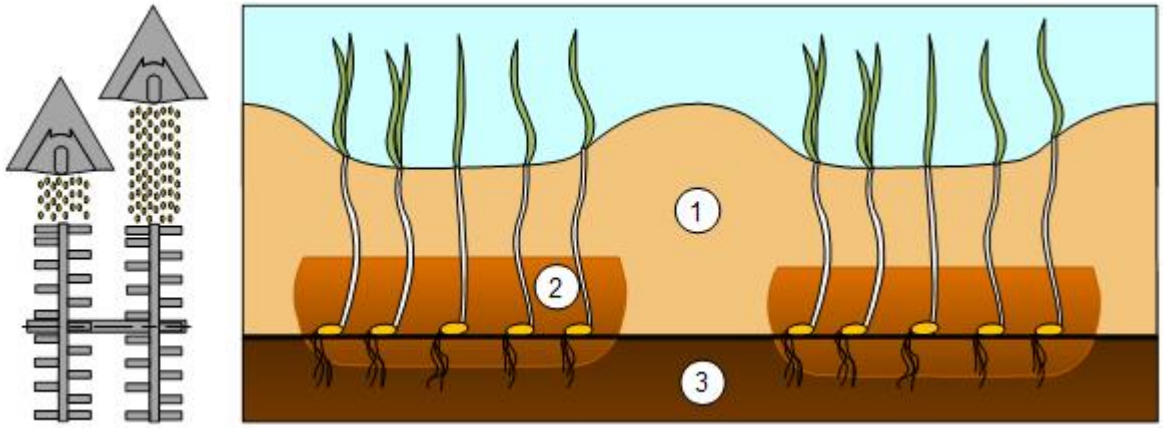
1 – moderately loose layer; 2 – compacted layer with seeds; 3 – dense layer (bed)

Figure 1 – Optimal structure of the seed layer of soil (longitudinal section)



1 – moderately loose layer; 2 – layer with seeds compacted by rollers; 3 – dense layer (bed)

Figure 2 – Row sowing with rolling by wedge-shaped rollers, cross-section of the seed layer



1 – moderately loose layer; 2 – layer with seeds compacted by rollers; 3 – dense layer (bed)

Figure 3 – Belt sowing with rolling by single-row ring-spur rollers, cross-section of the seed layer

It should be noted that along with the advantages, such rollers also have disadvantages. Firstly, the rollers with their spurs seal the stubble into the soil, reducing the wind resistance of the surface and, secondly, in wet conditions, the working surfaces of the rollers, especially between the spurs, stick with soil, which disrupts the rolling process, and even cleaning the rollers with scrapers does not always help. Therefore, the use of seeders with ring-spur rollers has a limitation on soil moisture. In seeding complexes manufactured in Russia and foreign countries, rollers with pneumatic tires are used for compaction of strip crops using serial agricultural or automobile tires. Unlike ring-spur rollers, rollers with pneumatic tires, due to the elasticity of the tires, which are

deformed during operation and restore their original shape, self-clean from soil in wet conditions, maintaining operability over a wide range of changes in soil moisture. But to create a moisture-saving soil structure after the passage of pneumatic rollers, it is recommended to loosen the surface layer with harrows.

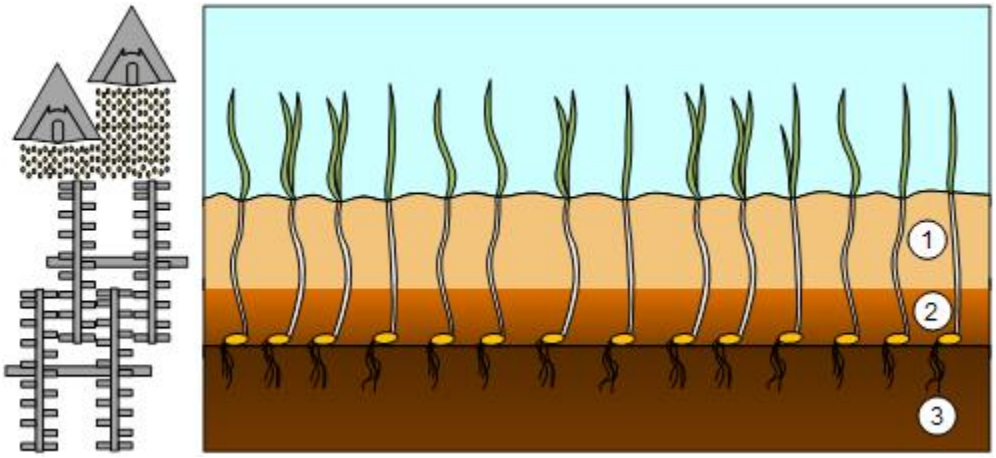
In areas with fairly good moisture, the most effective sowing method within the framework of traditional soil-protective and minimum tillage technologies is broadcast (or subsoil-broadcast). With this sowing, the seeds are distributed evenly over the entire area of the field. Broadcast sowing is carried out by cultivator-type seeders with openers with arrow-shaped paws and seed distributors. The task of the rolling rollers with this type of sowing is to evenly compact the soil layer with seeds, leaving the surface layer looser, and level the surface of the field to ensure equal seeding depth for all seeds. Two-row ring-spur rollers cope with this task most fully (Fig. 4). Firstly, being rollers of subsurface compaction, they compact the soil layer with seeds, secondly, they loosen the surface layer with spurs, thirdly, due to the two-row installation, they compact and level the entire field area and, fourthly, due to the "chessboard" arrangement, they better self-clean from wet soil.

Some seeders for continuous compaction use rollers with pneumatic tires installed in two rows. Since such rollers are rollers of surface compaction, the surface layer of soil in wet conditions is over-compacted, which leads to the formation of a crust as the soil dries out. Therefore, after the passage of such rollers, it is recommended to loosen the surface layer with harrows. Since there is still a solid fleet of STS-6/12 row seeding cultivators in Northern Kazakhstan, a number of farms are converting them to broadcast seeding by installing only coulters with seed distributors, ignoring the compacting rollers. Figure 5 shows the results of sowing with such converted seeders. Wedge-shaped rollers form a ribbed surface relief, so the seeds, even embedded in the soil at the same depth, end up at different distances from the daylight surface. And since the sprouts strive to take the shortest path to warmth, the plants on the surface are located in dense strips, leaving free space for weeds. In addition, seeds that do not fall into the zone of soil compacted by rollers are deprived of a good influx of moisture through the capillaries, so they germinate and develop worse. The situation is somewhat better when using single-row ring-spur rollers, as they are wider than wedge-shaped rollers and level the surface better, but even in this option, not all plants will be in equal conditions. Therefore, to achieve the maximum effect from broadcast sowing, it is recommended to equip STS-6/12 seeders not only with coulters with distributors, but also with double-row ring-

spur rollers, and if this is not possible, the fields must be leveled and rolled with 3KKSh-6 ring-spur rollers after sowing.

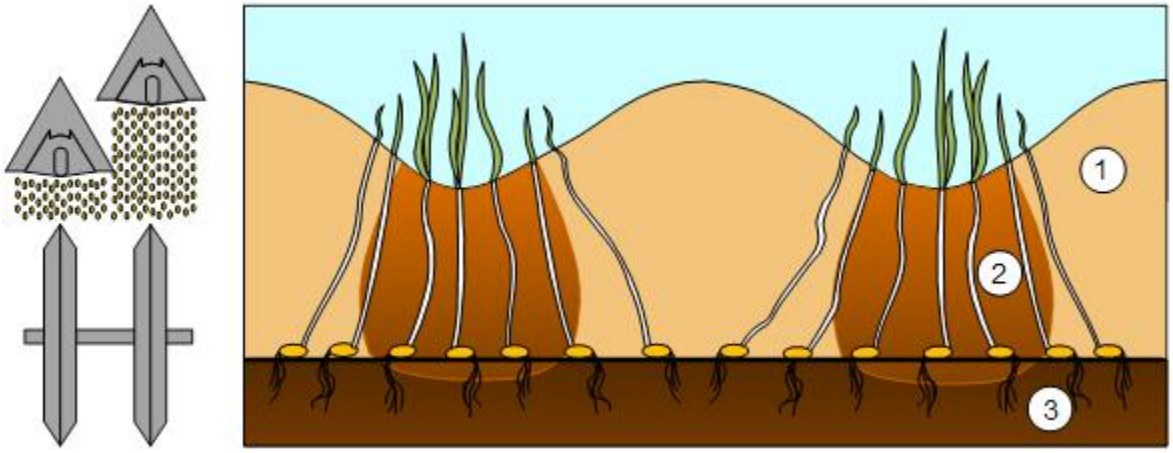
As part of the zero-tillage technology, direct seeding into unprocessed stubble is used. Sowing is carried out in rows with a row width of 2-3 cm and an inter-row spacing of 20-30 cm using seeders with disc or anchor coulters. Since one of the main requirements for such seeders is minimal loosening of the soil during sowing, the rollers must compact only the soil layer within the width of the loosened seed furrows, i.e. perform the so-called "targeted" soil rolling.
This requirement is implemented in different ways by modern seeders.

Thus, Australian seeders from Rogro, Gyral and other companies are equipped with narrow pneumatic or semi-pneumatic rollers with a trapezoidal profile (Fig. 6), the width of which does not exceed the width of the seed furrow. Such rollers compact the soil only in the seed furrows. This is due to the fact that in Australia, under conditions of moisture deficiency, a pronounced furrow sowing is used, when coulters for embedding seeds in a moist layer go at a depth of up to 18-20 cm, and narrow rollers, moving in seed furrows, form a 4-8 cm layer of soil above the seeds, ensuring



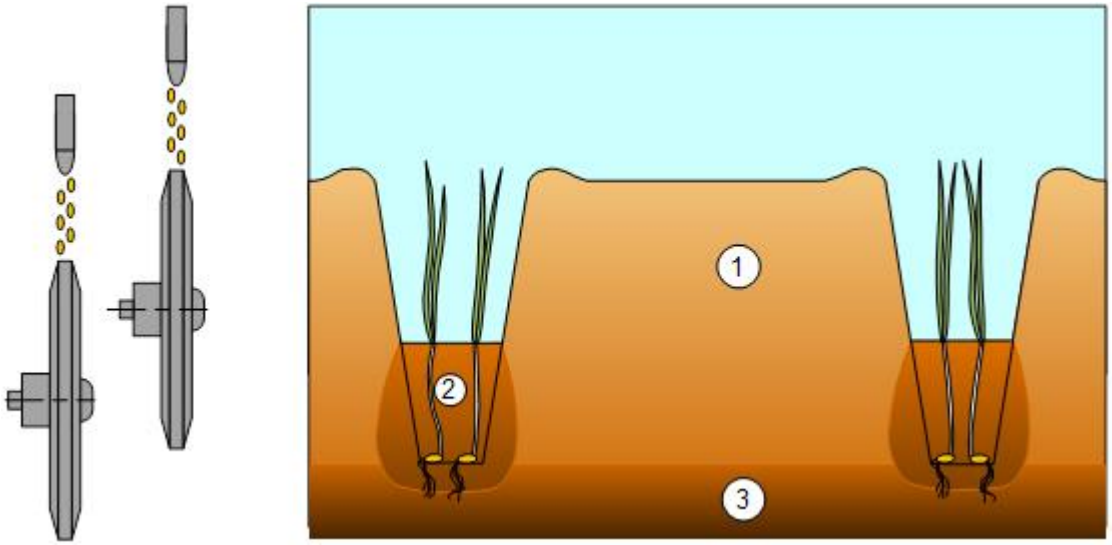
1 – moderately loose layer; 2 – layer with seeds compacted by rollers; 3 – dense layer (bed)

Figure 4 – Broadcast sowing with rolling by two-row ring-spur rollers, cross-section of the seed layer



1 – moderately loose layer; 2 – layer with seeds compacted by rollers; 3 – dense layer (bed)

Figure 5 – Broadcast sowing with rolling by wedge-shaped rollers, cross-section of the seed layer



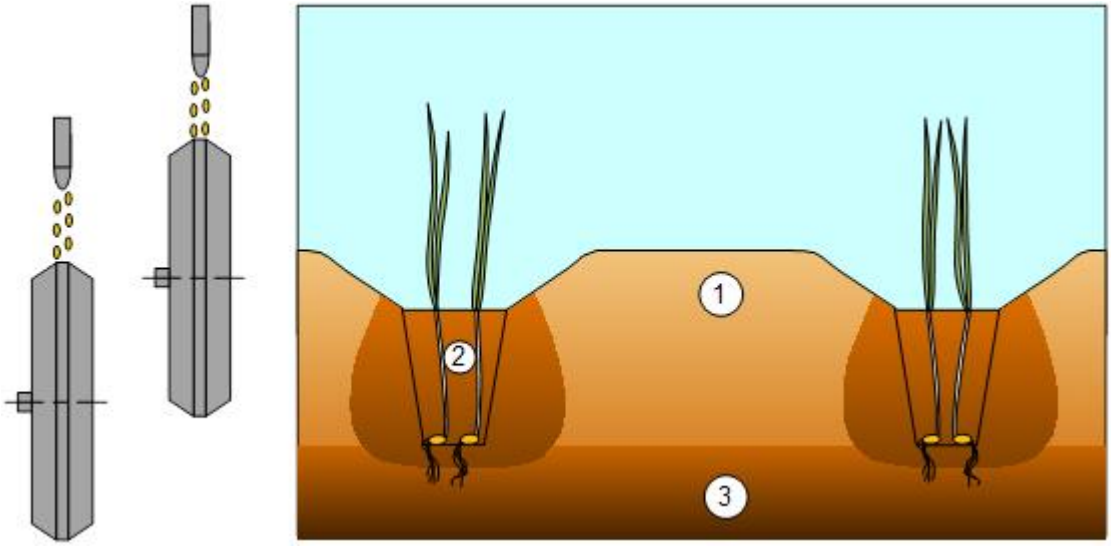
1 – uncultivated soil; 2 – soil layer with seeds compacted by rollers; 3 – dense soil layer

Figure 6 – Direct seeding with anchor coulters with compaction by narrow rollers, cross-section of the seed layer

Seeders manufactured in Canada and the USA use fairly wide pneumatic rollers of 10-15 cm with a wedge-shaped, semicircular or special profile, which compact the soil to a width exceeding the width of the seed furrows (Fig. 7). In this case, the seeding depth does not exceed 6-8 cm, and the surface relief has a

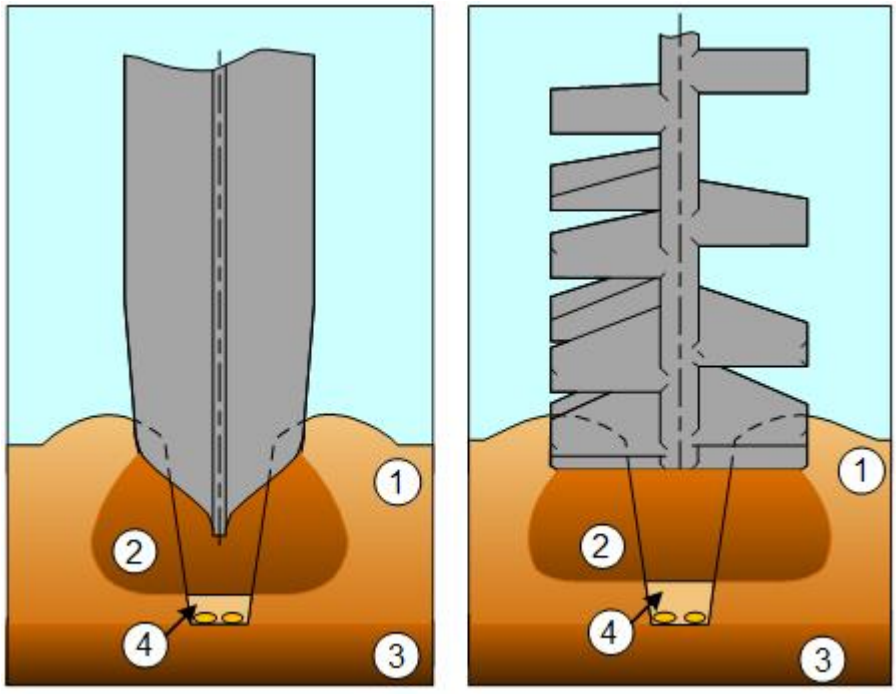
weakly expressed ribbed profile. This is due to the fact that in the conditions of the USA and Canada, significantly more precipitation falls than in the grain-growing regions of Kazakhstan, and they are more optimally distributed over the vegetation period of crops. In this case, there is no need to bury seeds to a significant depth and use targeted rollers to compact the soil, therefore, superficial, less "aggressive" compaction of the soil with seeds using wider rollers is sufficient. In the conditions of Northern Kazakhstan, soil moisture evaporates fairly quickly during the sowing period, and by the second half of the sowing work, the wet soil layers are located quite deep, which forces the seeds to be buryed deeper in search of moisture. In such conditions, the press rollers must ensure reliable contact of seeds with moist soil. This can be achieved by following the "Australian way", i.e. using narrow "target" press rollers that compact the soil directly only in the seed furrows. In this regard, it should be noted that the design of many cultivator-type seeding complexes from far abroad ("John Deere", "Bourgault", "Flexi Coil", "Morris", etc.) provides for the installation of anchor coulters instead of arrow-shaped paws, which allows them to be used for direct seeding. But at the same time, special attention should be paid to the press rollers used - if they are wide, it is recommended to replace them with narrower ones, taking into account the above. Narrow press rollers are available in the range of replaceable working bodies of almost any company that produces seeders. In a number of farms, the existing STS-6/12 seeders-cultivators with wedge-shaped rollers, and sometimes the SKP-2.1 seeders-cultivators with ring-spur rollers, are converted to direct seeding by replacing the openers with arrow-shaped paws with openers with anchor points 2-3 cm wide. Such a conversion is a half-solution, since wedge-shaped rollers, and especially ring-spur rollers, are not the optimal solution for soil compaction in narrow seed furrows. From Figure 8 it is clear that the main part of the rim of such rollers rolls over uncultivated soil (in fact, over the surface of the field), and only the central part of the rollers has a compacting effect on the loosened soil in the seed furrow. At a shallow seeding depth, such compaction is sufficient, but in the case where it is necessary to sow deeper, the compacting effect of such rollers is not enough. For reliable compaction of soil with seeds, we recommend using narrow rollers with a semicircular rim 5-6 cm wide or standard wedge-shaped rollers with a flange 3 cm wide welded along the outer diameter (Fig. 9).

In the first option, the narrow roller completely rolls in the seed furrow, and in the second, a cylindrical flange rolls in the furrow, providing the necessary compaction of the soil with seeds.



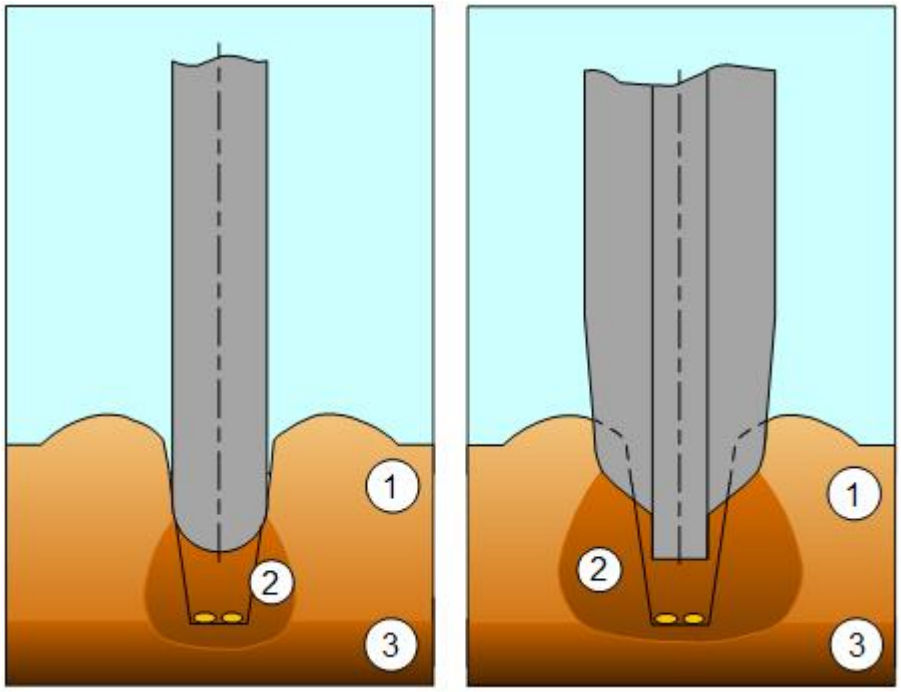
1 – uncultivated soil; 2 – soil layer with seeds compacted by rollers; 3 – dense soil layer

Figure 7 – Direct seeding with anchor coulters with rolling by wide rollers, cross-section of the seed layer



a – wedge-shaped roller STS-2; b – ring-spur roller SKP-2.1; 1 – uncultivated soil; 2 – soil layer compacted by rollers; 3 – dense soil layer; 4 – loose soil layer with seeds

Figure 8 – Non-recommended rollers for stubble seeders converted for direct seeding



a – box s semi-circular sweet 5 cm; b - wedge-shaped coil with filling rib 3 cm; 1 – unprocessed soil;2 – uplotnennyy katkami sloy pochvy s semenami; 3 – solid layer soil

Figure 9 – Recomenduemye katki dlya sternevyx seyalok, pereoborudovannyx dlya pryamogo pseva

In production, rolling is used not only after sowing. This technological process is actively used in the process of shallow soil cultivation (cultivation) after the passage of loosening working bodies to break up the formed lumps, level the field surface and create a moisture-saving soil structure. As a rule, continuous rolling is used, for which rod or spiral rollers are used, providing continuous processing of the soil across the entire width of the implements. In addition to the compacting effect, these types of rollers break up large lumps, level and remove weeds to the surface. Rollers are part of combined cultivators and tillage tools and perform the "finishing" soil cultivation. In this case, the main indicators of the quality of rolling are: the density of the surface soil layer, the size of the mulch layer, the size of the lumps, and the leveling of the field surface. When cultivating the soil in dry conditions, rolling allows preserving 15-25% of moisture lost due to evaporation by creating a moisture-saving structure.

Rod rollers for continuous rolling are installed on soil-cultivating units for primary cultivation APK-3; 6; PShK-3.8, etc. Here, the main purpose of rolling is to crush large lumps and level the soil surface.

In the soil-protective farming system, the following agrotechnical requirements are imposed on the rolling process:

- the soil density in the 5-10 cm layer should be 1.00-1.20 g / cm3;
- the upper 0-5 cm layer should be loose p = 0.90-0.95 g / cm3, it prevents excessive evaporation of moisture;
– the amount of erosion-hazardous particles in the upper 0-5 cm soil layer should not increase by more than 5%;
– stubble preservation after the rollers pass should be at least 70%;
– a leveled, wind-resistant field surface should be provided after the rollers pass;
– the soil rolling process should not contribute to the destruction of its structure and violate the requirements for the main technological process in different soil and climatic conditions.

The possibility of high-quality rolling of soils of different moisture content and mechanical composition depends on the shape of the rim and the material of the working part of the roller. The most common to date are wedge-shaped rollers - rigid (metal) and with an elastic rim (rubberized). The former are more common due to the simplicity of the design. The wedge-shaped shape of the rim promotes self-cleaning of the rollers from sticking soil at its average moisture content (16-20%), which contributes to the normal implementation of the technological process. But wedge-shaped rollers, especially those with a rigid rim, compact the soil from the surface, which in wet conditions leads to over-compaction of the surface layer, and on heavy soils to the formation of a soil crust. Wedge-shaped spiral rollers made of square rolled steel are more difficult to manufacture and are more susceptible to sticking in wet conditions (over 20%). Rollers with a semicircular rim section can be rigid (metal) or with a rubberized rim. Rollers with an elastic rim are more expensive, but self-clean better due to its elastic deformation during rolling, while rigid rollers require special scrapers. Rollers with a semicircular rim, unlike wedge-shaped ones, compact the underlying soil layer to a greater extent and the soil on the sides to a lesser extent, which reduces its excessive compaction. Narrow rollers form almost the same ribbed surface of the field as wedge-shaped rollers, but with a smaller furrow depth due to the crumbling of looser soil from the sides of the furrows. After wide semicircular rollers, a less pronounced wavy relief is formed. Since semicircular rollers compact the soil from the surface, in wet conditions the surface layer also

becomes overcompacted with the subsequent formation of a crust on heavy soils, especially after the passage of narrow rollers. Trapezoidal rollers can be either with a rigid rim or with a rim made of elastic material (rubberized). The latter are becoming more widespread, as they self-clean better on wet soils. Rollers with a trapezoidal surface are used for rolling row sowing, so their width usually does not exceed 8-10 cm. The compacting effect of the rollers is directed to a greater extent at the underlying soil layers and to a lesser extent at the soil on the sides of the rollers. Trapezoidal rollers compact the soil from the surface, which in wet conditions leads to over-compaction of the surface layer and the formation of a crust on heavy soils as it dries. Metal ring-spur rollers are simple in design and have found application mainly in neighboring countries. Experience in using these rollers shows that they embed stubble into the soil with their spurs, and in wet conditions the working surfaces of the rollers, especially between the spurs, stick with soil, which disrupts the rolling process, and even cleaning the rollers with scrapers does not always help. Therefore, the use of seeders with ring-spur.

List of references:

1.В. Л. Астафьев, А. А.Курач, А. В. Семибаламут, Журнал «Нивы России» №10 (154), ноябрь 2017

2. Irgashev, D. B., RX Tovashov AR, and O. T. Sadikov. "Mamadiyorov. Technical Analysis of Plug Software When Working Between Gardens." International Journal of Advanced Research in Science, Engineering and Technology 9.5 (2022).

3. Irgashev D. Improved plug-softener technology for working between garden rows //Science and innovation. – 2022. – Т. 1. – №. 7. – С. 330-336.

4. Irgashev D. B., Hamarayev O. S. The Use of Disc Chisels in Surface Treatment Between Garden Rows //American Journal of Engineering, Mechanics and Architecture (2993-2637). – 2023. – Т. 1. – №. 10. – С. 278-287.

5. Irgashev D. B. Analysis of Machines Providing Liquid Fertilizer to the Root System of Orchard and Vine Seedlings //American Journal of Engineering, Mechanics and Architecture (2993-2637). – 2023. – Т. 1. – №. 10. – С. 356-362.

6. Irgashev, D., Toshtemirov, S., Maiviatov, F. M., & Muqimov, B. (2023). Placement of working bodies on the frame of the tool plow-ripper. In E3S Web of Conferences (Vol. 390). EDP Sciences.

7. Irgashev D. The effect of the upper softener of the sloped column working body working on the soil of garden fields on the energy indicators //Science and innovation. – 2023. – Т. 2. – №. A8. – С. 133-137.

8. Irgashev D. B. et al. High softening performance indicators of plug-softener //IOP Conference Series: Earth and Environmental Science. – IOP Publishing, 2023. – T. 1284. – №. 1. – C. 012032.
9. Irgashev D. B. Analysis of Machines Providing Liquid Fertilizer to the Root System of Orchard and Vine Seedlings //American Journal of Engineering, Mechanics and Architecture (2993-2637). – 2023. – T. 1. – №. 10. – C. 356-362.
10. Irgashev D. B., Buriyev M. Analysis of the Coils Used in Soil Drilling //American Journal of Engineering, Mechanics and Architecture (2993-2637). – 2023. – T. 1. – №. 10. – C. 302-308.
11. Irgashev D. B. Basing the Constructional Parameters of the Plug-Softener that Works Between the Garden Rows //Journal of Research in Innovative Teaching and Inclusive Learning. – 2023. – T. 1. – №. 3. – C. 14-19.
12. Irgashev D. B. Calculation of the strength of winged joints //journal of theory, mathematics and physics. – 2023. – T. 2. – №. 7. – C. 1-6.
13. Irgashev D. B. Couplings used in mechanical engineering and their importance //journal of engineering, mechanics and modern architecture. – 2023. – T. 2. – №. 7. – C. 1-10.
14. Mamatov F. M. et al. Bog ‘qator oralarini ishlov beradigan qiya ustunli ishchi organlarni parametrlarni nazariy asoslash //journal of engineering, mechanics and modern architecture. – 2023. – T. 2. – №. 5. – C. 42-45.
15. Mamatov F. et al. Justification of the bottom softening parameters of working organ with a sloping column //E3S Web of Conferences. – EDP Sciences, 2023. – T. 434. – C. 03010.
16. Irgashev D. Theoretical justification of the longitudinal distance of a plug-softener that works without turning the soil between garden rows //Science and innovation. – 2023. – T. 2. – №. D11. – C. 482-487.
17. Begmurodvich, Irgashev Dilmurod. "Development and Problems of Vineyard Network in Uzbekistan." Web of Synergy: International Interdisciplinary Research Journal 2, no. 1 (2023): 441-448.
18. Irgashev D. B., Buriyev M. Analysis of the Coils Used in Soil Drilling //American Journal of Engineering, Mechanics and Architecture (2993-2637). – 2023. – T. 1. – №. 10. – C. 302-308.
19. Bekmurodovich I. D. Technical classification of machines that till the soil between rows of vineyards //Uzbek Scholar Journal. – 2022. – T. 10. – C. 369-379.

20. Irgashev D. Боғ қатор ораларига ишлов беришда такомиллашган плуг-юмшаткичнинг техник тахлили //Science and innovation. – 2022. – Т. 1. – №. D7. – С. 330-336

21.Bekmurodovich I. D. Technical classification of machines that till the soil between rows of vineyards //Uzbek Scholar Journal. – 2022. – Т. 10. – С. 369-379.

22.Irgashev D. B., Buriyev M. Theoretical Justification of the Forces Generated on the Cylinder Surface of a Double Row Cat //American Journal of Engineering, Mechanics and Architecture (2993-2637). – 2024. – Т. 2. – №. 2. – С. 157-162.

23.Irgashev D. B. Agrotechnical requirements for deep tillage without turning the soil //научное обеспечение устойчивого развития агропромышленного комплекса. – 2021. – С. 591-594.

24.Иргашев Д. Б. и др. Боғ қатор ораларини текис ағдармасдан ишлов берадиган қия устунли юмшаткични рама констурукциясида жойлашиш асослаш //barqarorlik va yetakchi tadqiqotlar onlayn ilmiy jurnali. – 2022. – Т. 2. – №. 11. – С. 138-146.

25.Irgashev D. B., Ganiev B. G. Based On Longitudinal Distance Of Sloped Column Working Bodies Working Between Garden Rows //American Journal of Engineering, Mechanics and Architecture (2993-2637). – 2023. – Т. 1. – №. 9. – С. 48-51.

26. Irgashev D. B., Safarov A. A. Tuproqqa agdargichsiz ishlov beradigan ishchi organ konstruksiylari va ularga qo'yilagan talabllar //Analysis of International Sciences. – 2023. – Т. 1. – №. 3. – С. 6-12.