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METHODS FOR PREPARING THE SOIL FOR RE-SOWING

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KEYWORDS: soil preparation, for re-sowing, technical means, minimum tillage, combined units, working bodies, inter-row processing, strip processing, machine designs.

ABSTRACT

The results of the analysis of the development of designs of machines and tools for strip tillage and the studies performed in this area allow us to put forward a working hypothesis that high quality strip tillage with minimal energy consumption can be ensured by improving the working bodies of existing machines and tools, taking into account the real conditions of their work and physical and mechanical properties of the soil.

From the review it follows that the quality and energy intensity of strip tillage depends on the type and parameters of the working bodies of the implement, the speed of the unit, as well as on the type and physical and mechanical properties of the soil.

INTRODUCTION

The soil and climatic conditions of the republic make it possible to grow and receive high yields of most vegetable and fodder crops in the fields freed from grain crops, as repeated ones. At the same time, the time factor plays an important role: by quickly preparing the soil, having finished sowing earlier, you can make fuller use of time, heat and moisture to obtain a high yield of repeated crops. The slightest delay in carrying out all the work on preparing the soil for sowing leads to a significant shortage of crops. Consequently, the choice of the correct technology for preparing the soil for repeated sowing and the technical means for its implementation is relevant and has an important economic significance. It is solved taking into account the characteristics of each field and the re-sown crop.

Studies carried out at the UzMEI showed that for growing forage crops after cereals, strip tillage with simultaneous sowing is the most promising. At the same time, in one pass of the unit, the soil is loosened in the zone of the passage of the seeding working bodies of the seeder and the sowing of the seeds of the cultivated crop. At the same time , labor costs, funds and fuel and lubricants are sharply (4 ... 6 times) reduced (compared to plowing or processing with a chisel - cultivator and disc harrow), and most importantly, re-crops can be sown in the shortest possible time.

At the same time, the issues of strip tillage for sowing repeated crops in the conditions of our republic have not been sufficiently studied.

Based on this, the purpose of this work is to substantiate the type and parameters of working bodies for strip tillage for repeated sowing of agricultural crops after grain crops.

Intensive use of irrigated land is associated with the introduction of repeated crops of food and annual forage crops. Getting two harvests per year on one field will make it possible to significantly increase the production of grain and fodder.

However, the type and parameters of the working bodies for strip tillage after harvesting grain in the conditions of our Republic have not been practically

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investigated. Taking this into account, the technological process of strip tillage and working bodies for its implementation were chosen as the object of research .

A BRIEF OVERVIEW AND ANALYSIS OF PREVIOUSLY CONDUCTED RESEARCH

Traditional methods of treatment of soil is costly energy and labor, and often times, as some types of work are usually carried out with certain intervals.

Crop cultivation technologies based on minimum tillage contribute to increase in labor productivity, to a large extent determine a decrease in fuel consumption and processing costs, lead to a noticeable increase in the anti-erosion resistance of soils.

The system of minimum or reduced tillage offers the use of any method of tillage and sowing of crops without the use of a plow with a small number of passes and not deep loosening.

The first noteworthy substantiation of shallow tillage belongs to I. Ye. Ovsinsky /4/, who developed a system of surface tillage and strip-row (strip) sowing, which he called "a new farming system". Somewhat later, a number of successful experiments on shallow and moldless tillage were carried out in France and Germany.

E. Volkner's experiments carried out in the 40s marked the beginning of a critical reassessment of deep tillage, first in the USA, then in many other countries of the world /4/.

In the second half of the XX century, in the world agriculture there was a sharp turn from the practice of multiple and careful tillage to their possible reduction. The ideas of the so-called "minimum" and "zero" tillage have become widespread, the purpose of which is primarily to reduce the harmful effect on the soil of the propellers of aggregates and to significantly reduce unproductive costs.

In conditions of a lack of heat, the superiority of minimum tillage is in many cases achieved by increasing the growing season due to earlier tillage or obtaining earlier seedlings of plants. It is known that minimal tillage makes it possible to sow earlier and get a higher yield as a result. It was also found that reducing the time required to prepare the soil for sowing with this treatment in many cases allows you to get two harvests per year.

It is interesting to note that minimal tillage contributes to an increase in the efficiency of mineral fertilizers, in particular phosphorus fertilizers. According to I. Zinchenko and N. Lysenko, during moldboard tillage, the increase in wheat grain yield per rotation of crop rotation from phosphorus fertilizers was 0.37 t/ha, and with minimal tillage up to 0.62 t / ha /4/.

It is possible to reduce the number of passes of the units for preparing the soil for repeated sowing by combining the performance of several operations in one unit and due to the use of more advanced tillage implements capable of preparing the soil for sowing in one pass of the unit.

A prerequisite for the creation of combined units for sowing is the coincidence of the timing of the operations and the increased power of the tractors. The combination of operations not only excludes the multiple passes of the units across the field, but also reduces the consumption of fuel and lubricants, reduces the time for idle passes and runs, and reduces the time gaps between individual operations.

Extensive work on the study of methods for combining operations and the creation of combined units was carried out in the CIS countries. In the course of the research, the influence of the combination of operations on yield, operational economic, agrotechnical and energy indicators was determined. These studies, carried out on various crops, revealed an increase in yield, a decrease in production costs and labor costs. Thus, the yield of wheat in the area where the combination of plowing, rolling and sowing was used is 3.1 c / ha higher than when using

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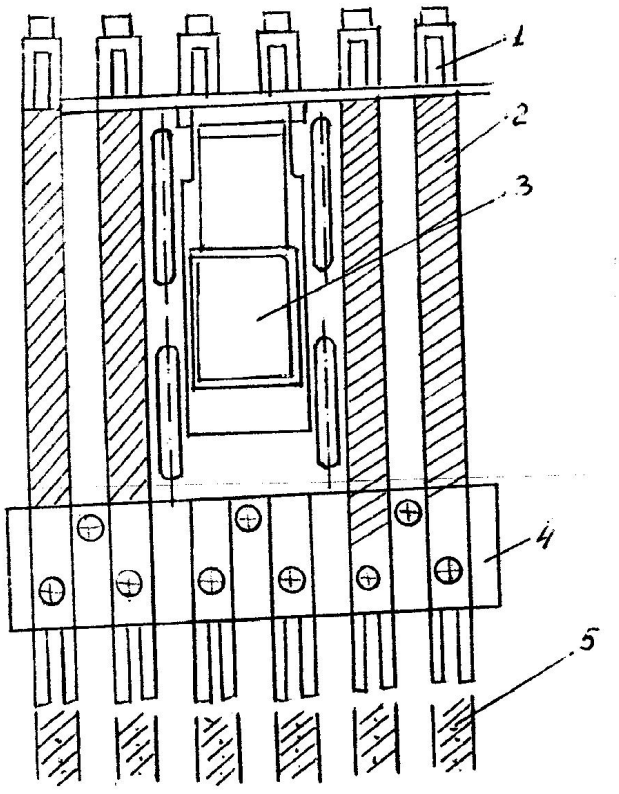
separate technology /5/. At the same time, labor costs were equal to 6.64 and 8.72 man-hour / ha, respectively. Similar indicators were obtained by combining pre-sowing treatment and sowing of corn /6/, winter rye /7.9/, carrots and beet /9/.

Based on the research results, combined units have been developed that combine various technological operations for growing various crops in different zones of the CIS.

So, the combined tillage sowing unit AKPP-3,6 is designed to combine the operations of pre-sowing soil cultivation and sowing in the conditions of the North-West zone of the Russian Federation. The unit in one pass applies mineral fertilizers, loosens the arable layer to a depth of 16 cm, evens out the surface of the field and partially harrows the surface layer of the soil, rolls in and sows grain and other crops. The use of this unit for sowing cereals, cereals and flax gives an increase in yield up to 15 ... 25% /10/.

The All-Union Institute of Mechanization VIM conducted experiments on the agrotechnical and feasibility study of the technology for combining the pre-sowing strip tillage and sowing corn and sugar beet into the treated strips with the simultaneous introduction of mineral fertilizers and herbicides. An increase in the yield of these crops was observed. Experimental sowing was carried out using combined units made up of an experimental milling cultivator KF-4.2 and a seeder mounted on a tractor: cultivator in front, seeder in the back (Fig. 1.1). At the same time, labor productivity increases by 1.5 times /11/.

Proposed by the Georgian Research Institute of Mechanization and Electrification of Agriculture, the method consists in the simultaneous processing and sowing of corn after harvesting ears of corn.



Rice. 1.1. Technological scheme of the combined milling and sowing unit for the cultivation of row crops: 1-milling cultivator, 2-processed strips, 3-tractor, 4-seeder, 5-seeded rows.

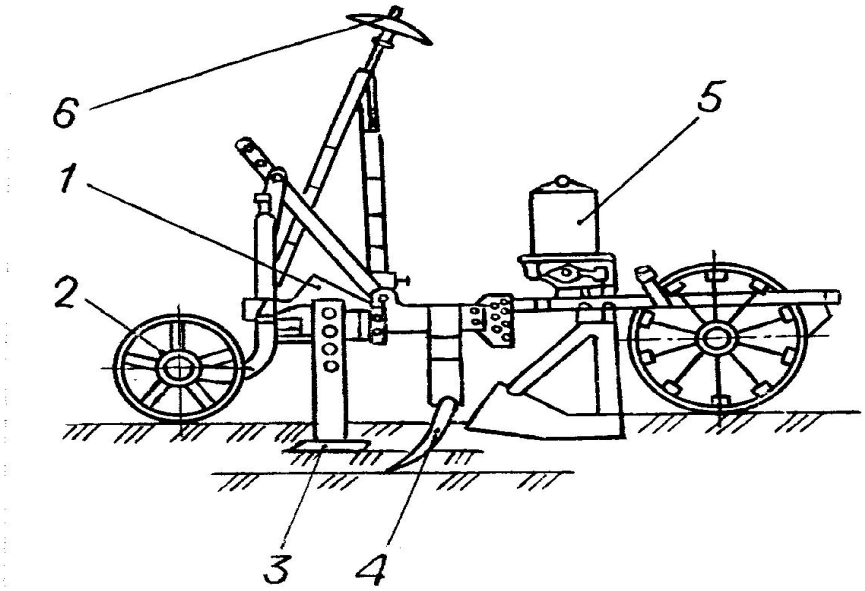
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The experimental model of the machine for minimum tillage made at the institute (Fig. 1.2) is aggregated with tractors of class 3. The machine is hinged, 4-row. The sowing strips are processed by loosening working bodies to a depth of 18 ... 20 cm, while sowing is carried out at a depth of 2...6 cm. Row spacings (0.7...1 m) are processed by flat-cutting working bodies to a depth of 7...10 cm. All these operations are performed in one pass machines /12/.

Promising methods of new technologies for cultivation of corn - strip and mid-depth tillage. Loosening the soil in strips 30 cm wide in front of the seed drill coulters with the help of active working bodies or loosening tines reduces the required power by 30 ... 40% in comparison with continuous tillage. At the same time, the quality of soil preparation does not deteriorate, since the zone between the rows has little effect on seed germination and early development of plants. The uneven, coarse surface in the aisles absorbs more moisture and promotes better aeration. Phenological observations of VIM found that with the combined milling of strips and sowing of corn, the number of emerging plants per hectare increases by an average of 15%. As a result, the yield increase is 4 ... 7 c / ha.



Rice. 1.2. Technological scheme of the experimental model of the machine for minimum tillage: 1-frame, 2-support wheel, 3-plane cutting tools, 4-ripper, 5-sowing units, 6-marker.

The Krasnodar Research Institute of Agriculture has created a unit for sowing corn in the southern zone. In one pass, he carries out non-moldboard tillage, sowing corn, fertilizing and packing the rows. Simultaneous soil cultivation and sowing during summer sowing of corn, when there is little moisture in the soil, provides a yield of more than 100 centners / ha of green mass /13/.

For the cultivation of corn and soybeans on heavy soils, the Far Eastern Research Institute of Agriculture, together with GSKB (Birobidzhan), has developed the SG-4 ridge cultivator-cultivator. In one pass, the machine cuts and forms ridges, sows corn (or soybeans), applies mineral fertilizers. After the conversion, the unit is used for plant care /13/.

The use of combined units is one of the ways to increase the efficiency of grain production when growing corn. According to the data of the All-Union Research Institute of

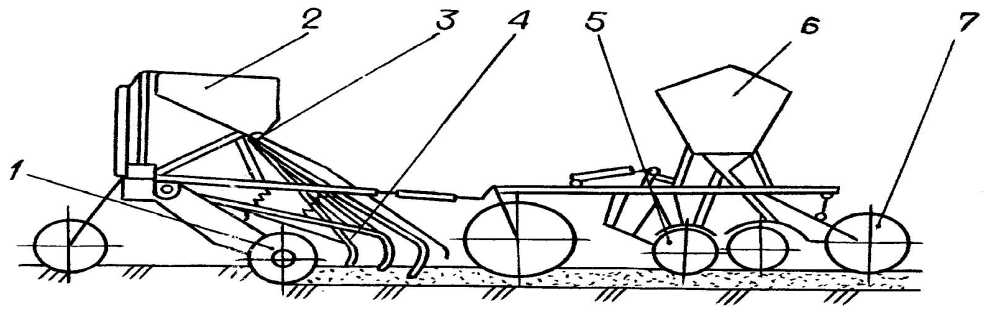
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Maize, the combination of the cultivation of plow and sowing of maize is quite justified from the agrotechnical point of view. The grain yield of maize slightly increases with the simultaneous cultivation and sowing in the years with a dry period and practically did not decrease in the usual ones compared to the separate carrying out of these methods /14/.

Scientific institutions and design bureaus have theoretically substantiated, developed and tested combined units for combining pre-sowing soil cultivation and sowing maize as the main and catch crops. For example, from wide-grip combined aggregates simultaneously providing pre-sowing soil cultivation by various working bodies (continuous or strip), sowing seeds of row crops: after sowing packing of rows, as well as the introduction of mineral fertilizers, the use of a combined aggregate APP-6-70, significantly reduces the time of soil preparation and sowing, increases the yield and completeness of seedlings, as well as the energy of germination, which contributes to an increase in the yield of green mass of corn by an average of 37.4 centners / ha /15/.

The combination of pre-sowing soil preparation and sowing of sugar beet in the forest-steppe zone of Ukraine provided a higher yield in comparison with the usual cultivation technology. At the same time, the quality of sugar beet practically did not decrease /16/.

VNIIZ and ZPE have developed a combined unit for strip tillage and sowing of grain. The combined unit (Fig. 1.3) in one pass on the untreated background carries out strip tillage, local application of mineral fertilizers in full dose, narrow-row sowing of grain crops and packing of rows. With its application, the grain yield increases by 3 ... 5 c/ha, erosion processes are excluded.



Rice. 1.3. Combined unit diagram: 1-rotor of milling sections, 2-fertilizer hopper, 3-fertilizer metering unit, 4-bar opener, 5-disc seed opener, 6-seed box, 7-roller with conical working surfaces.

The basis of the unit is a milling fertilizer and a SZP-3,6A seeder equipped with openers for narrow-row sowing. If necessary, the fertilizer and the seeder are used independently /17/.

When growing wide-row crops, along with combined aggregates for continuous milling of the soil and sowing, aggregates for milling the soil in strips are common, in which it sows seeds. This technology helps to save labor and energy costs, investment in agricultural machinery, reduces soil erosion and increases the yield of forage crops /18,19/.

In the CIS, milling strip presowing tillage and sowing maize in strips were studied in the Non-Chernozem zone and in the North Caucasus.

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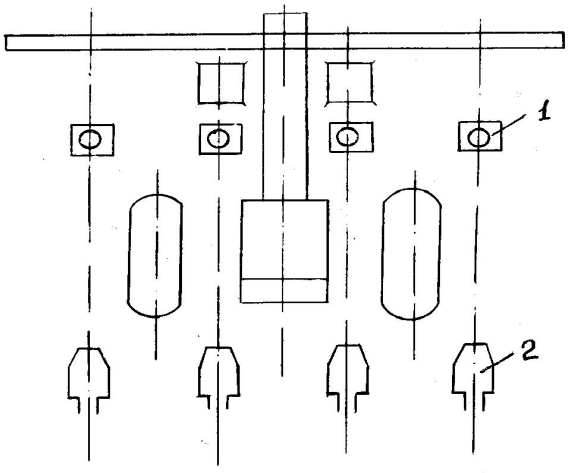
On average for 3 years, pre-sowing plowing and sowing of corn in strips did not grow into deep loosening with one subsequent cultivation in terms of influence on the yield of green mass and exceeded this indicator by 22 centners / ha in the control variant.

Combined units are being developed for strip presowing soil cultivation, application of mineral fertilizers,
sowing sugar beet seeds into treated strips and rolling. One of these units consists of a KF-5,4 row-crop milling cutter, mounted in front of the MTZ-82 tractor and driven into rotation from the side power take-off shaft, and a 2STSN-6A seeder located on the rear hitch of the tractor. The width of the milled strips is 28 cm, and the width of the untreated row spacing is 17 cm /20/.

However, the use of active working bodies (for example, a milling cutter) reduces the performance of the unit and increases the energy consumption of soil cultivation.

The Turkmen Research Institute of Agriculture has developed a technology for strip (in the opener passage zone) processing of heavy soils with milling working bodies simultaneously with sowing, and at UzMEI - a technology for inter-row processing of cotton crops with active-passive working bodies. To implement these technologies, together with the employees of the UzMEI, the Turkmen Research Institute of Agriculture and the GSKB on machines for cotton growing, an adaptation to the universal cotton cultivator KKhU-4 was developed for strip milling of heavy soils when sowing and inter-row cultivation of cotton and other row crops with row spacing of 60 or 90 cm. rice. 1.4. shows a diagram of the arrangement of the milling heads and openers of the seeder during strip processing simultaneously with sowing. In one pass, the unit mills 4 strips 22.5 cm wide each to a depth of 12 cm and seeds seeds on the treated strips /21/.

In the Tashauz regional agricultural experimental station of the Turkmen Research Institute of Agriculture, V.R. Ishchanov proposed (Fig. 1.5.) a combined unit for pre-sowing soil cultivation and sowing /22/, containing



Rice. 1.4. The layout of the milling heads and openers of the seeder during strip processing simultaneously with sowing: 1-milling heads, 2-seed drill coulter.

sequentially installed on the bead working bodies for strip belt-tier tillage, made in the form of paws, the first of which is located above the second and has a working width greater than the width of the second, a seeding device with a coulter, harvesters and a roller for sowing cotton seeds into ridges pre-formed from the loosened soil.

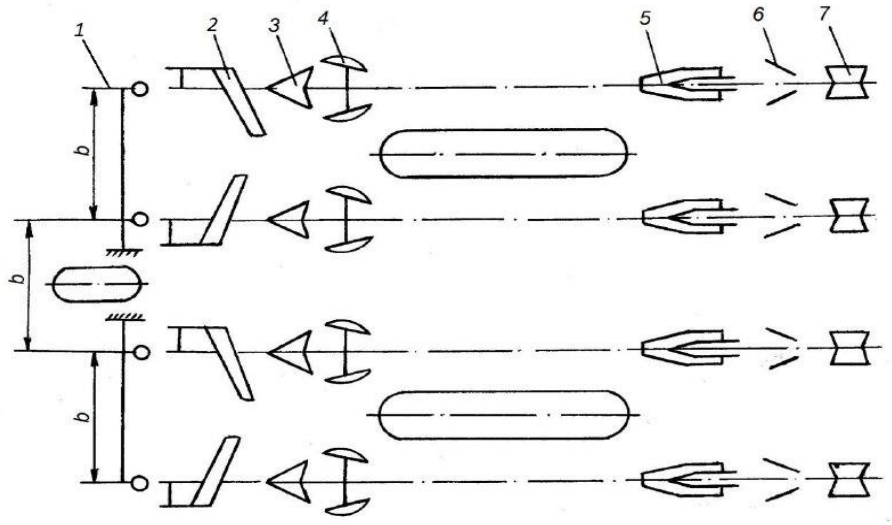
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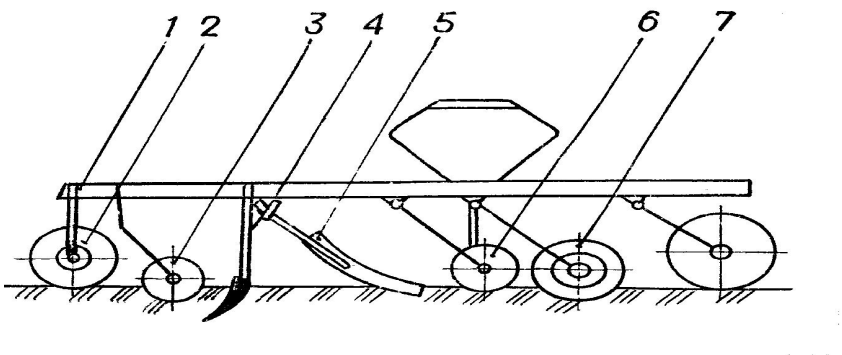
The processing process is completed by two disc rippers, which close the grooves formed by the working bodies, and form a ridge on the sowing line. However, this is only achieved on an open field. On clogged fields, this unit does not give positive results, since the section of the working organs is clogged with plant residues.

The combined unit APP-2.8 developed by UzMEI in collaboration with SKB "Sibselmash" for improving pastures of deserts with passive working bodies, as shown by comparative tests, satisfactorily copes with the technological process, is less energy intensive, more reliable.



Rice. 1.5. Scheme of arrangement of working bodies on a combined unit for pre-sowing soil cultivation and sowing: 1-beam, 2,3-tines, 4-disc ripper, 5-opener, 6-harrow, 7-roller.

The technological process of work is carried out as follows. When the unit moves, the disc knives 3 cuts the soil to a depth of 10 cm (Fig. 1.6). The loosening paws 4 following them cultivate a strip of soil 20 ... 30 cm wide. The cultivators 5 prepare the seedbed by additionally loosening the soil, treated with the cultivator 4. Thus, into the prepared soil with the openers 6



Rice. 1.6. Scheme of a combined aggregate with passive working bodies.

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Seeds of desert plants are sown and sealed with rollers 7. In one pass, narrow-band soil cultivation and sowing with seeds of desert fodder plants is carried out /23/.

Of the many minimum tillage methods that have been used and proposed in the past 30 years, strip tillage, ridge seeding and direct seeding into cultivated soil are currently the most widely used.

Strip processing is possible in cases where, when combining pre-sowing soil preparation and sowing wide-row crops there is no need to carry out continuous tillage and can be limited to processing only a relatively narrow strip. As a result, on the one hand, to reduce the traction resistance per unit of the working width of the machine and, to increase its grip and productivity, and on the other hand, leaving untreated strips, to keep a large amount of post-harvest residues on the field surface. The latter determines the soil-protective effectiveness of this technique /24/.

The soil in strips 10 ... 15 cm wide is thoroughly cultivated, no post-harvest residues remain, which facilitates sowing, allows evenly placing seeds at the required depth even when using standard sowing coulters. This processing can be carried out by machines with sets of loosening paw or rotary working bodies /25/.

Abroad, strip cultivation with simultaneous sowing is carried out by machines of the "Tiller-planter" type. As an example, we can consider a combined machine manufactured by the company "Kinze Mig" (USA). It has a set of discs with a diameter of 45 cm, which chop up post-harvest residues and loosen the topsoil within the cultivated strip. Cultivator shares are installed behind them for loosening a dense layer in strips. This is followed by rotary implements intended for a more thorough cutting of the topsoil layer and incorporating herbicides into it, behind which the coulters /26/ are placed.

Minimum tillage is widely used in agricultural practice in the United States for the cultivation of corn, soybeans, grain sorghum, cereal crops, and for the restoration of pastures.

In the Federal Republic of Germany, the methods of minimal processing have passed the experimental stage for many years /27,28,29/. Mainly studied three modifications of minimal processing.

1. "Processing + sowing", which includes two operations: a) plowing, leveling and b) pre-sowing treatment + sowing.
2. "Plowing + sowing", all work (tillage, fertilization and sowing) are performed by the units in one working stroke across the field.
3. "Strip cultivation + sowing", in which only the soil is loosened with special machines to form a bed of seeds and sowing, the rest of its area remains without mechanical cultivation.

Z. Ulman /30/ describing the experience of using combined aggregates in agriculture in Germany, concludes that the combined implement allows you to more fully use the power of the tractor and reduce soil compaction with the wheels of the implement. H. Reed and G. Krupp /31,32/ noted a positive effect when combining operations.

In England, at an experimental station in Norfolk, methods of preparing soil for sugar beets were studied. Strip sowing on stubble was compared to winter plowing followed by two passes with a tine harrow just prior to sowing. The prototype unit of the IC-I firm was a Rotaveitor, with straight blades, installed for processing strips 18 cm wide and 4...5 cm deep with a distance of 32 cm between strips. A roller was installed after each cutter. A chisel-shaped

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share 2 cm wide was installed in front of each cutter, providing loosening of the soil to a depth of 20 cm in the center of each strip (Fig. 1.7) /33/.

In foreign practice, various combined machines are used for strip milling and simultaneous sowing. One of them is the rotasidor (Fig. 1.8). Rotasidor has a special cutter with 15 flanges. The cutter loosens 15 strips at a distance of 12.5 cm from each other. The coulters sow seeds in each of the strips.

A number of combined machines allows you to combine various technological operations on plowing, sowing and other operations and are designed for use in various soil and climatic conditions.

When combining operations, some authors note a significant decrease in energy consumption per unit of cultivated area /7.8/, others insignificantly /5.31/. NS Kabakov /34/ believes that a gain in energy consumption when combining operations is possible if some energy-intensive work performed by separate technology in the combined version will be replaced by less energy-consuming ones. I. Kryuchkova and N. Orlov /35/ prove that if separate operations are mechanically carried out in a combined unit, then there is no gain in energy consumption.

Yu. V. Kirtbaya /36/ showed that only having certain parameters (speed of movement, width of capture, radius and time of turning, etc.) it is possible to economically use this or that unit. The theoretical solution to this issue, under the action of active and passive loads, however, is not sufficiently covered in the literature. G.M.Buzenkov and N.S. its implementation.



Rice. 1.7. Experimental unit of the company "ICI" for strip sowing of sugar beet.

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It is known that the root system of plants in the first days of vegetation develops slowly, so the untreated part of the field can be loosened after the emergence of seedlings during the first cultivation. At the same time, reducing the number of passes of the units in the pre-sowing period, i.e. By combining soil preparation and sowing, you can expect to get the same effect as with continuous tillage. This proposal is confirmed by a number of studies carried out in the cultivation of corn and sugar beet /9,11/.



Rice. 1.8. Combined machine for strip milling of soil and simultaneous sowing (rotasidor).

The results of the analysis of the development of designs of machines and tools for strip tillage and the studies performed in this area allow us to put forward a working hypothesis that high quality strip tillage with minimal energy consumption can be ensured by improving the working bodies of existing machines and tools, taking into account the real conditions of their work and physical and mechanical properties of the soil.

From the review it follows that the quality and energy intensity of strip tillage depends on the type and parameters of the working bodies of the implement, the speed of the unit, as well as on the type and physical and mechanical properties of the soil.

Timely and high-quality carrying out of this operation contributes to the preservation of moisture in the soil, a reduction in the number of passes through the field of tillage machines, a decrease in labor costs, funds and fuels and lubricants, and most importantly, sowing of repeated crops can be carried out in the shortest possible time.

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At the same time, the issues of strip tillage when preparing it for re-sowing after grain crops have not been sufficiently studied in our republic.

On the basis of the foregoing, for research we have selected a technological scheme of the unit, consisting of a row-crop tractor, front sections of the KKhU-4 cotton cultivator and a seeder mounted on the tractor's hinged system. When the unit moves across the field, the working bodies installed on the ridges of the front sections of the cultivator clean the cultivated strips from post-harvest residues and loosen their top layer, the seeder sows and seeds seeds into these treated strips.

A BRIEF OVERVIEW OF THE RESEARCH WORK CARRIED OUT TO SUBSTANTIATE THE MAIN PARAMETERS OF THE FLAT-CUTTING WORKING BODIES OF ROW CULTIVATORS

The literature review covers work on the study of the working bodies of row-crop cultivators. The main attention was paid to the work carried out in the conditions of irrigated agriculture. Taking into account the completeness of the destruction of weeds with paws, their clogging with weeds, etc.

M.E Pakhomov /38/ believes that the opening angle of the lancet paw most of all affects the process of cutting the roots of weeds and recommends it equal to 40 degrees.

Studies of V.A. Sergienko /39/ found that with an increase in the speed of movement from 1.00 to 2.36 m / s, the number of cut weeds increases by 6.0% (from 92.8 to 98.8%).

Kh. Adylov /40/ in field conditions determined the energy and agrotechnical indicators of soil cultivation in the aisles, depending on various schemes of arrangement of working bodies. He found that the maximum completeness of cutting weeds is achieved when the overlap between the flat-cutting paws is 4 ... 8 cm.

For pruning weeds on ridge crops Yu. A. Pogosov /41/ suggested using flat-cutting paws installed at an angle of 45 degrees to the horizon.

A theoretical solution to the issue of combating deboning of working organs with plant residues was proposed by G.N. Sineokov /42/, G.M. Rudakov /43/, A. Khamidov /44/, P.M. Vasilenko /45/ and many others /46,47/.

In particular, G.N. Sineokov /42/ believes that the main reason for clogging the working bodies with weeds and plant debris is the shape of their frontal profile, formed by the chest of the paw and strut. The author proposes to round off the front edge of the paw leg.

V.V. Trufanov /47/, investigating various forms of the frontal surface of the strut of the working body, found that with the semicircular shape of the frontal surface of the working body, plant residues, due to friction with the soil, easily slide off the smooth surface of the frontal side of the struts and the working bodies are not clogged. The author proposes a semicircular frontal surface or to fix special fairings on it.

A.A. Nasriddinov /48/ also proposed a razor-paw with soil-shifting plates. But due to the fact that the plates in its design were welded to the razor shelf, with high humidity, they would stick to the soil. Therefore, they have not found widespread use.

S.P. Chirtsov /49/ studied the parameters of a spherical disc, for the heating of the soil above the sowing rows. He found that as it moves, the disc raises a layer of soil and throws it aside. In this case, the ability of a spherical disk to throw the soil at a certain distance depends on a number of factors, the most significant of which are the translational velocity of the unit, the angular velocity of the disk, the curvature of the spherical surface, the absolute velocity of particles at the moment of separation from the disk and its angle of attack. But all these studies were studied only in kinematic and static terms.

CONCLUSIONS

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Based on the foregoing, the purpose of this work is to develop a technological scheme of work and substantiate the parameters of working bodies for strip tillage for sowing re-crops after harvesting grain.

Analysis of existing technologies and technical means for minimum tillage allowed to formulate the following research tasks:

- to study the physical and mechanical properties of the soil after harvesting grain crops,
- select the technological scheme and type of working bodies for strip tillage for sowing re-crops,
- to develop mathematical models of interaction of working bodies for strip cultivation with the soil, allowing to determine their rational parameters,
- to carry out experimental studies to verify the theoretical premises and substantiate the rational values of the parameters of the working bodies for strip tillage,
- to determine the technical and economic performance of the developed tool.

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