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Results Of Studies Of The Impact Of Agricultural Tractors And Machines On Soil

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Abstract: The article presents the results of studies of the effects of movers of agricultural tractors and machinery on the soil. To identify the multiplicity of passes of tractors and aggregates, special experience was laid down on the degree of compaction of the soil and the productivity of cotton. The degree of compaction of the soil was studied at 1, -3, -5, - and 8-fold passes through the field. The main characteristics of tractor propulsion are given. A structural diagram of the ways, methods and factors of reducing the compaction effect of the running systems of machines on the soil is presented.

In order to reduce the area of field compaction, a study is made of the kinematics of motion of machine-tractor units. To speed up the calculations, a special logarithmic nomogram was constructed with a 45-degree course of the solution beam.

Key words: aggregate, soil compaction, plowing, soil density, cultivation, harrowing, sowing, tractor, traction, two-tier plow, agriculture.

1. INTRODUCTION.

The running systems of tractors and agricultural machinery during the pre-sowing treatment and sowing period affect 30-80% of the field surface. Some areas during this period are exposed to 3-18 times the impact of propellers.

To identify the frequency of passes of tractors and units on the degree of soil compaction and cotton yield, special experience was laid in the shirkat farm named after A. Navoi, Zhandar district of Bukhara region of the Republic of Uzbekistan with tractors T-28X4, MT3-80X, T-4A.

The main characteristics of the propellers of these tractors are shown in the table

The degree of soil compaction was studied at 1, -3, -5, and 8-fold passes through the field. The soil is medium loamy gray soil, the background-field of cotton with autumn plowing with a two-tier plow ПЯ-3-35, soil moisture was 16-18%, density 1.28-1.32 g / cm3, hardness (25 ÷ 65) 10-1MPa ...[1-4]

To study the changes occurring in the soil under the influence of the running systems of tractors and agricultural machines, its main characteristics were determined to a depth of 0.50 m with an interval of 0.10. It was found that compaction at 5 and 8 fold rocks of MTZ-80X tractors extends to a depth of 0.20-0.30 m (Fig. 1). When tractors pass 8 times, the compaction of 0-0.20 m of the layer increases to 200% against the control and averages (60-65) x10-1 MPa.

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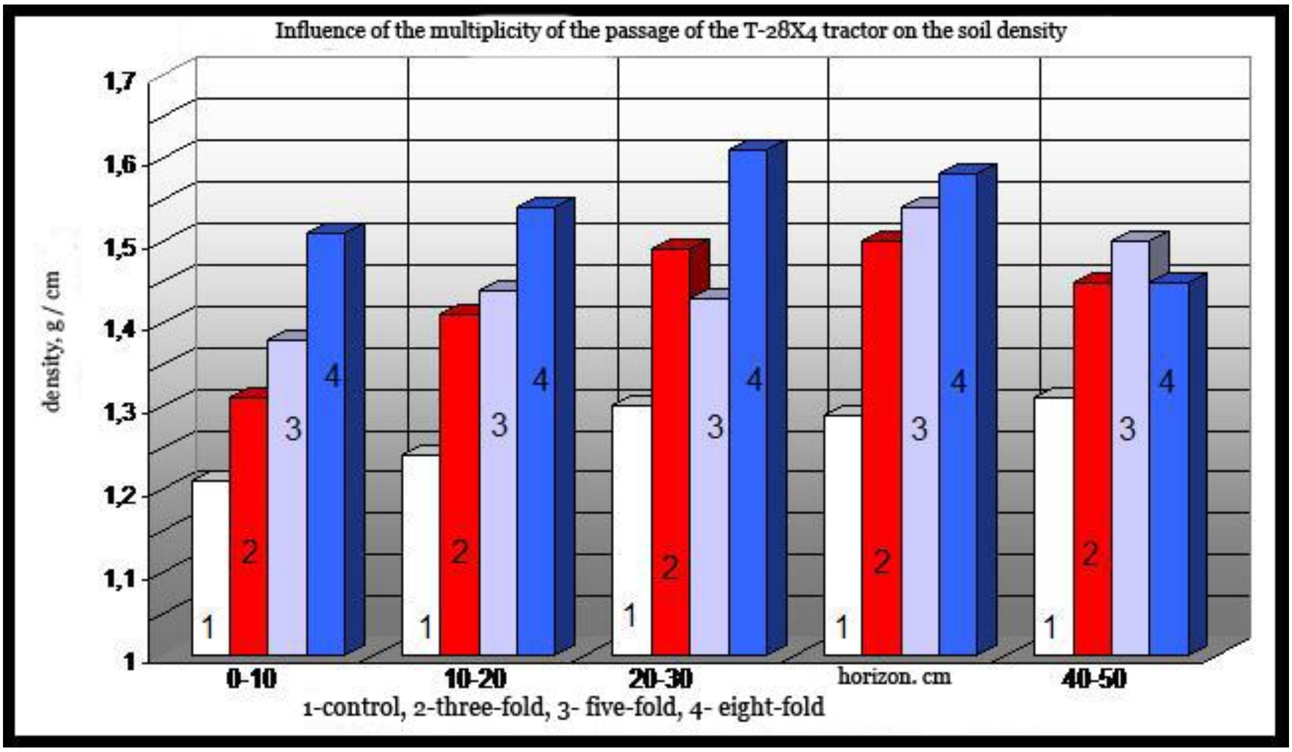
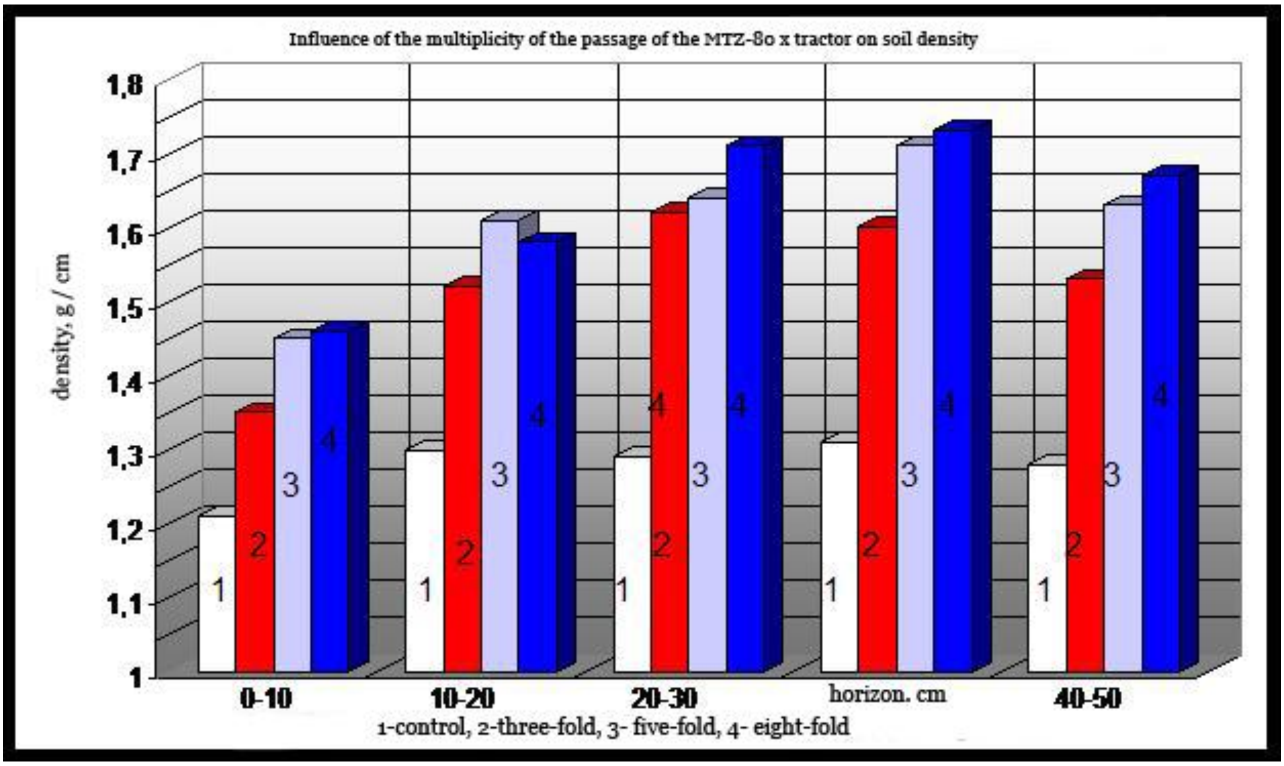
Table 1 Characteristics of tractor propellers

№	Index	T-28x4	MT3-80X	T-4A
1.	Tractor weight, kg Including, coming: on the front axle on the rear axle	3000 780 2220	3375 980 2395	8370 - -
2.	Track width, m	-	-	0,40
3.	Support surface length, m	-	-	5,52
4.	Contact area with a rigid base; both movers, cm2 front wheel rear wheel	 - 437 640	 - 660 1650	 20160
5.	Average pressure on the soil, kPa both movers front wheel rear wheel	640 - 178 173	 - 148 73	 41,5

2. MATERIALS AND METHODS

It should be noted that with the 8-fold passage of the T-28X4 tractor, the soil layer 20 and 30 cm is strongly compacted. changes in soil density are presented depending on the frequency of passage of the MTZ-80X and T-28X tractors. In both cases, the density of the soil increases with an increase in the frequency of passage of tractors. So, for example, with 3, 5 8-fold compaction with a T-28X4 tractor in the arable horizon, the soil density fluctuates correspondingly within 1.31-1.49 g / cm3; 1.38-1.48 g / cm3 and 1.56-1.61 g / cm3 versus 1.21-1.30 g / cm3 in the control. **This corresponds to a 20% increase in density.**


Influence of the multiplicity of the passage of the T-28X4 tractor on the soil density
density, g / cm
1,7
1,6
1,5
1,4
1,3
1,2
1,1
1
0-10
10-20
20-30
horizon. cm
40-50
1-control, 2-three-fold, 3- five-fold, 4- eight-fold


Influence of the multiplicity of the passage of the MTZ-80 x tractor on soil density
density, g / cm
1,8
1,7
1,6
1,5
1,4
1,3
1,2
1,1
1
0-10
10-20
20-30
horizon. cm
40-50
1-control, 2-three-fold, 3- five-fold, 4- eight-fold

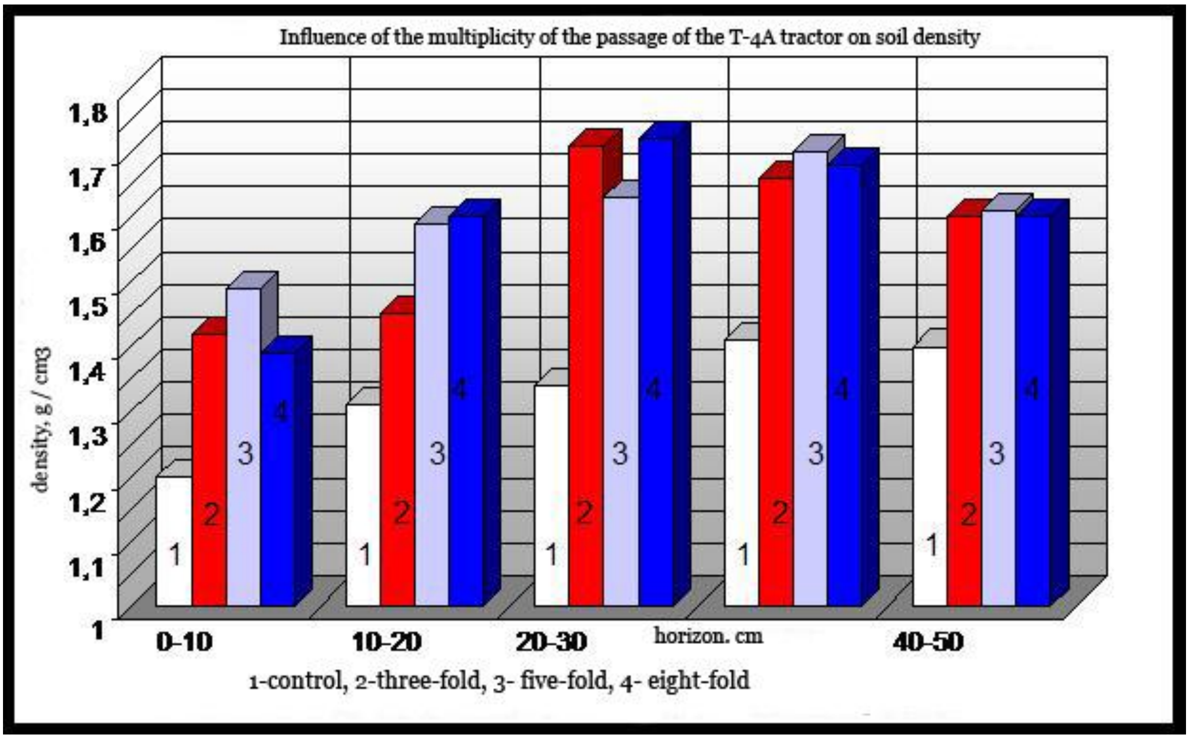


Figure: 1.

The cotton harvest was counted according to a known method. The average value of raw cotton depending on the brand of the tractor and the frequency of their passage through the field are presented in table. 1.

Table 2. Influence of compaction on the yield of cotton (kg / ha)

№	Tractor brand	The control	Frequency of passage		
			(3)	(5)	(8)
1	T-28X4	37.1	23,6	21,6	19,6
2	MT3-80	37,1	22,3	20,4	17,8
3	T-4A	37,1	22,8	21,5	17,3

As can be seen from the table, in all cases, with an increase in the frequency of the tractor passage, the cotton yield decreased. So, for example, with a yield on the control of 37.1 c / ha of threefold compaction, the cotton yield decreased by 13.6-14.8 c / ha, which is about 35%. With a 5-fold pass of tractors, the cotton yield is reduced to 16 c / ha, or by 43%, with an 8-pass pass, the cotton yield is less than 50%. [5-9]

3. DISCASSION

Thus, with the repeated passage of wheeled tractors, the soil of both arable and sub-arable layers is compacted. This is especially observed with 5 and 8-fold passage of the MTZ-80X and T-28X4 tractor. The density of the soil of the subsoil (30 -50 cm) increases to 1.65-1.70 g / cm3 from the passage of the MTZ-80X tractor and up to 1.55-1.62 g / cm3 from the passage of the T-28X4 tractor. Apparently, the decrease in cotton yield in experiments with 5- and 8-fold compaction (at a density of 1500-1600 kg / cm3) is explained by a strong overcompaction of the plow sole.

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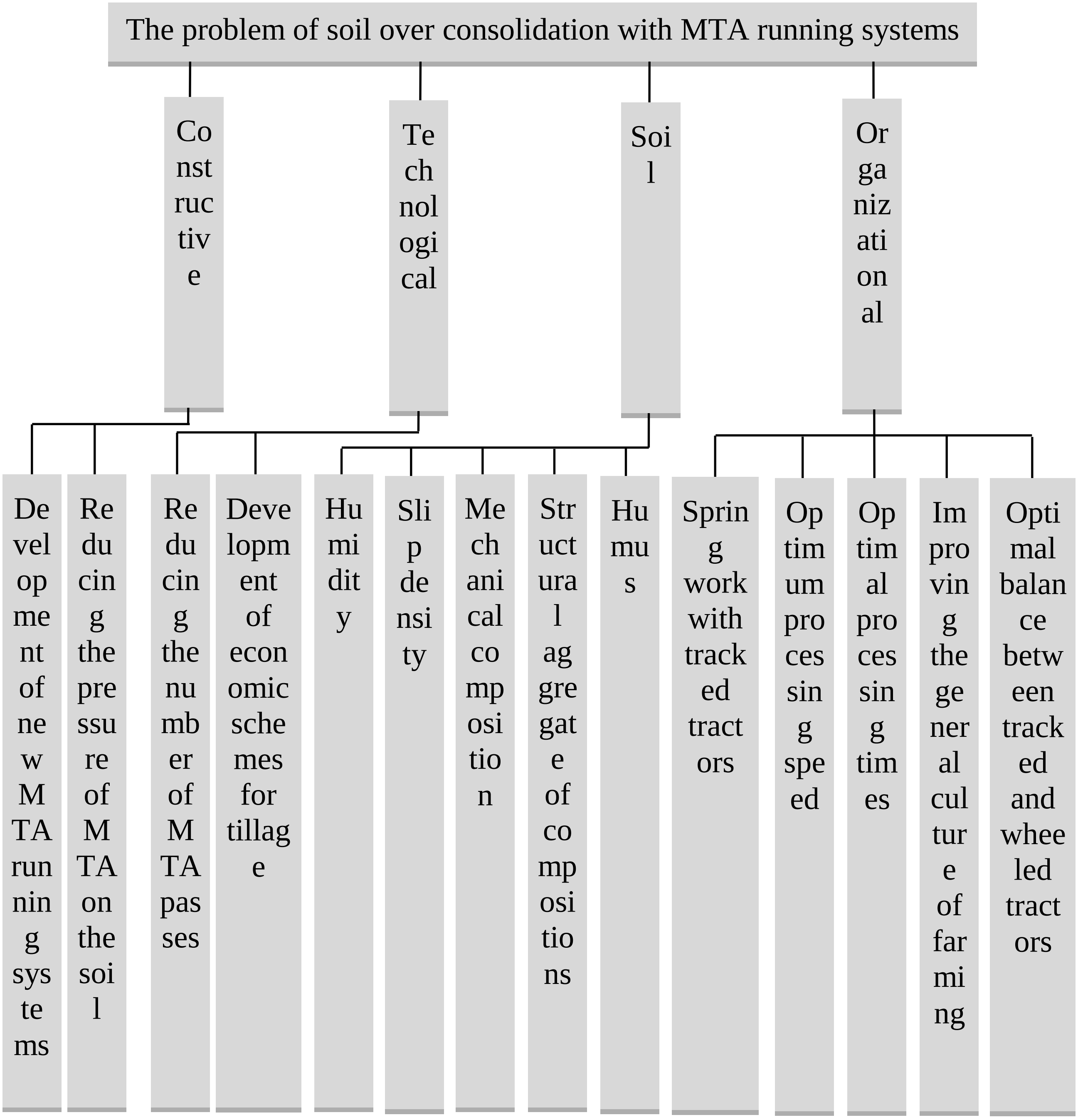
The results of numerous scientific research and practice of farmers can be generalized in the form of a structural diagram of ways and methods of reducing the compacting effect of the running systems of machines on the soil (Table 3).

As can be seen from the table, the problem of soil overconsolidation with MTA running systems is solved by implementing rational organizational, constructive, technological and soil measures. Constructive measures are solved by the development of engineering issues, such as the development of new running systems, reducing the pressure of the MTA on the soil. Technological measures to reduce the compacting effect of running systems on the soil include the development of ecological systems for soil cultivation and reducing the number of MTA passes.[10-14]

Table 3.Structural diagram of ways, methods and factors for reducing the compacting action of the running systems of machines on the soil



Organizational issues of soil cultivation have a significant impact on reducing the compacting effect of running systems on soils. These include the optimal ratio between tracked and wheeled tractors, carrying out spring work with tracked tractors, the optimal timing and speed of soil cultivation. Also, the moisture and density of the soil, the mechanical composition and the content of humus affect the reduction of the compaction effect of the running systems of machines.

4. RESULT

The fight against soil compaction is carried out in three directions: reduction of compaction, decompaction and prevention of compaction. To reduce soil compaction, designers are improving the running system of power and transport units, reducing their weight, creating wide-grip and combined machines. One of the promising areas is the use of tramlines in the cultivation of agricultural crops. crops (mobile technological and transport vehicles move across the field along a constant track). There are still not enough ways to prevent soil compaction. To a certain extent, this area can be attributed to the technology of "zero" tillage, as well as proposals for the introduction of air cushion machines and bridge farming. However, for the practical use of the last two methods, long-term research and development is required. At this stage in the development of science and technology, the most effective method for decompaction of the soil is mechanical loosening with the help of subsoilers and soil-deepening working bodies.[15-20]
Particular importance for the elimination of overconsolidation of subsurface horizons is given in areas of irrigated agriculture, since long-term soil cultivation at a constant depth, the use of heavy mobile equipment, natural soil shrinkage during repeated irrigation create a compacted "plow base", which prevents the penetration of irrigation water and roots into deep layers plants. As a result, a decrease in yield reaches 40% with a significant increase in material and water resources. With a subsoil density of 1.5-1.6 g / cm3, up to 80% of the cotton root system in the irrigated zone is in the upper layers, which negatively affects the growth and development of plants.

Study of the kinematics of the movement of machine-tractor units in order to reduce the area of compaction of fields

Analysis of the existing technology for the cultivation of various agricultural crops shows that the number of operations performed is quite large and ranges from 10-15 when cultivating grain crops to 20-30 for row crops. Operations such as pre-sowing treatment, application of organic and mineral fertilizers, plowing, leveling, cultivation, harrowing, sowing, planting and harvesting are carried out separately and, moreover, some of them are performed multiple times. Machine-tractor units performing these operations differ in quantitative composition, types of agricultural machines, methods of aggregation. The energy part of the units can also be different. All this has a very strong effect on the effect of the machine undercarriage on the soil. Multiple cyclical movements of machine-tractor units on the field, lead to the fact that it is covered with compacted strips, the total area of which significantly exceeds the field area **itself(in the calculations, a compaction area of 1 ha was used - 10 thousand m2).**

The degree of influence of agricultural machinery on the soil is determined by the field crop, the number of operations performed, their frequency, and the type of tractor. The choice of the latter depends on the type of work, the size of the field, soil resistivity and other factors. In turn, the type of tractor determines the working width of the aggregates, therefore, the number of passes per unit of field area.[21-24]

To determine the compaction area, we have derived the corresponding equation. When removing it, we proceeded from the following. It is known that the area of compaction of the field depends on the width of the track formed by the undercarriage of the tractor, the working width of the unit and the number of its passes over the field. In this case, the last value is defined as

$$n = \frac{A \cdot K}{P_{kp} \cdot \eta}, \qquad (1)$$

Where,**n** - number of tractor passes;

A- field width, **m**;

K -resistivity of agricultural machines,**H**;

$\boldsymbol{P_{\kappa p}}$- tractive effort of the tractor in a certain gear, **H**;

$\boldsymbol{\eta}$ - tractor drawbar utilization factor, **H**;

The area of compaction of the surface in one pass without taking into account the compaction of the soil during idling on the headlands is calculated by the formula:

$$S = 2b(L_o - E), \qquad (2)$$

and throughout the field

$$S = S_o \cdot n = \frac{2bL_o AK\varphi}{P_{kp}}, \qquad (3)$$

Where,$\boldsymbol{S_o}$- field compaction area in one pass of the unit, $\mathbf{m^2}$;

S - compaction area of the entire field area, $\mathbf{m^2}$;

$\boldsymbol{L_o}$- field length, **m**;

$\boldsymbol{\varphi}$ - tractor travel ratio;

b - width of the undercarriage of the tractor (wheels or tracks),**m**;

E - headland width, **m**;

The minimum compaction area of the undercarriage of tractors during this operation, taking into account their tractive effort, is determined as follows:

$$S = \frac{2bL_o A^2 K(L_o - 2E)}{\left[(L_o - 2E)A + (A + B)l\right]P_{kp}}, \qquad (4)$$

Where,***l*** - length of one turn, **m**;

B - working width of the machine, **m**;

Under the action of the tractor running systems, the soil is significantly compacted on the headlands, since the machine - tractor units make a double pass here - when turning at idle and at working strokes.
The sealing area of the headland is

$$S_{nn} = S_{xx} + S_{px} = (\frac{A}{B} - 1)2bl + \frac{2lEA}{B}. \qquad (5)$$

Then the total area of the seal during one operation can be expressed by the following formula:

$$S_{общ} = \frac{2bL_o A^2 K(L_o - 2E)}{\left[(L_o - 2E)A + (A+B)l\right]P_{kp}} + (\frac{A}{B} - 1)2bl + \frac{2lEA}{B}, \qquad (6)$$

Thus, knowing the dimensions of the field and the headland, the parameters of the undercarriage of tractors, their tractive effort on the working gear and the specific resistance of agricultural machines, depending on the specific resistance of the soil, it is possible to determine the area of compaction of the field when performing any technological operation and their sum.[25-30]
To speed up the calculations, a special logarithmic nomogram with a 45-degree path of the solution beam was built. The limits of values of all scales allows you to find the desired value for any values of the above variables encountered in practice (Fig. 2). The solution is carried out with the help of a ray intersecting with the lines drawn from the corresponding scales.The initial data for determining the compaction area of the field is its length$\boldsymbol{L_o}$and width$\boldsymbol{A}$, tractive effort of the tractor $\boldsymbol{P_{кр}}$, resistivity of agricultural machinery$\boldsymbol{K}$and width of the undercarriage of the tractor $\boldsymbol{b}$.
Using the equation and the nomogram, we determined the total area of compaction of the field during the cultivation of cotton and winter wheat using the existing technology. As expected, in row crops, i.e. in cotton, it turned out to be significantly higher than in solid sown crops.
Analysis of formula (1) allows us to outline some ways to minimize the area of compaction of the field. The energy performance of the tractor is of decisive importance. If possible, you should give preference to energy-intensive tractors, aggregating them with wide-cutting implements, you can significantly reduce the number of passes over the field. In this case, of course, one should not allow passages of energy-saturated tractors on waterlogged soil. It should be noted that the study of the kinematics of the MTA movement allows to reduce the

area of compaction of the field when cultivating leading agricultural crops.

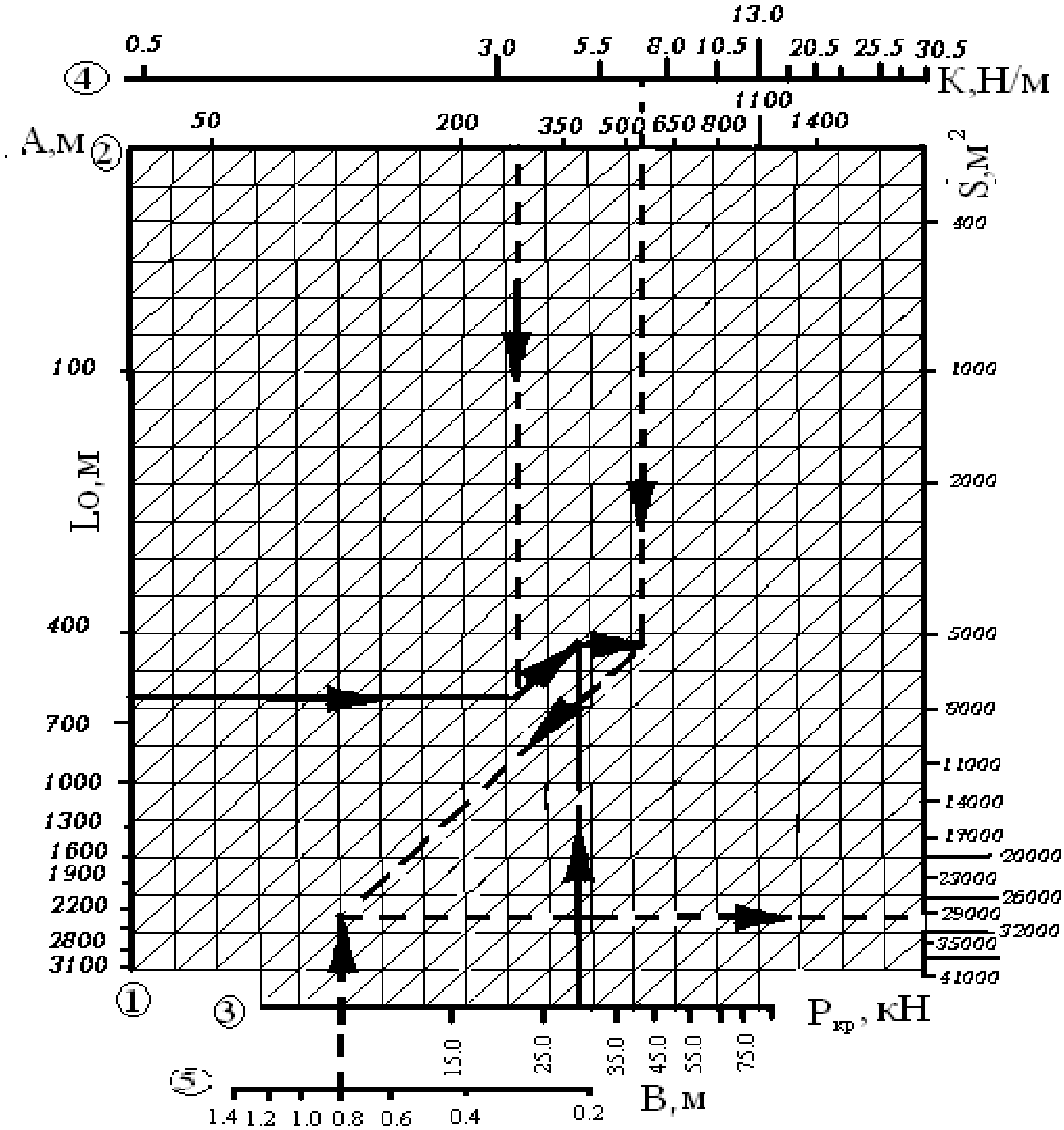


Figure: 2. Nomogram for calculating the compaction area of the field

Routing traffic in relation to energy-rich tractors helps to eliminate unnecessary passes through the field, improves the organization of field work, reduces fuel costs and increases crop yields.

Despite the fact that routing is a fairly simple and effective way to reduce the negative impact of MTA on the soil, its implementation is fraught with a number of difficulties due to the different working widths of existing implements for seedbed preparation and sowing of agricultural crops. Therefore, for the widespread introduction of routing, it is necessary to provide for such a complex of machines that would have the same working width or make the capture of some tools a multiple of the working width of the basic machines. Both do not require significant costs, since the design of the machines does not change, only the width of their capture changes. If these conditions are met, the MTA routing will be carried out automatically during the cultivation of any crop, that is, the MTA will move in the field only along constant tracks. Then the area of compaction of the field will decrease, localized in the volume of the field in permanent ruts and easier to eliminate with periodic deep loosening. In the USA and Western Europe, the routing (kinematics) of MTA movement shows positive results without significant negative consequences for the properties and regimes of soils in compacted ruts, provided they are deeply periodically cultivated.

5. CONCLUSION

Localizing compaction by routing the movement of agricultural machines is an effective way to reduce the negative impact of their driving systems on the soil. The correct composition of the aggregates and the reduction of the number of their passes through the field ensures minimal soil compaction. The above formulas and nomogram allow you to correctly select the composition of the unit, which will give the smallest compaction area when performing various mobile agricultural operations.

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