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SCIENTIFIC AND TECHNICAL SOLUTIONS TO INCREASE THE LIFE OF PNEUMATIC TIRES OF THE UNIT FOR PROCESSING BETWEEN THE COTTON ROWS

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Abstract
This article covers the issues of increasing the efficiency of pneumatic tires installed on agregate wheels during row-spacing of cotton processing in agricultural cotton growing, factors affecting the performance of tire life, fuel consumption, as well as reducing tread wear.

Keywords: Unit, pneumatics, tire, tread, volume, resource.

Introduction

As is known, cotton growing is one of the main branches of agriculture in the world and has its own technical means. Cotton is one of the most common materials used in life. It is a comfortable, hypoallergenic, breathable and durable fabric. The use of these technologies and efficient utilization of rubber materials resources are considered as one of the major problems in this field and the article aims to solve these problems on a scientific basis.

Currently, in agriculture, as in all areas, the efficient use of energy and resources, the development and implementation of technologies and technical means that ensure their savings are the main factors of economic growth. On a global scale, it is planned to increase the yield of more than 1.6 million hectares annually due to repeated processing of various machine and tractor units, including the area of cotton cultivation in agriculture of the Republic of Uzbekistan is 1,062,293 hectares. For processing cotton, 30, 60, 76 and 90 sm according to the scheme (this is a large number of 26557 units in the republic) is used for inter-row planting at the rate of 90 cm and two-row schemes. For their use, fuels and lubricants, labor and spare parts are used. Therefore, reducing these costs in the field of cotton growing and the efficient use of existing agricultural machine and tractor units remains one of the important tasks.

Accordingly, today scientists in this field in all countries, especially in our country, are strengthening resource-saving methods and new scientific and technical foundations of agricultural machines, increasing the efficiency of operational and agrotechnical indicators, using the tractor at full capacity, preserving working resources during the warranty period, in the process operation. Targeted scientific research is being conducted on issues such as ensuring the reliability of chassis.

Currently, the agricultural machinery of our republic is equipped with high-performance foreign machine and tractor units (MTA) and implements. In this area, equipment produced by agricultural machinery companies "CASE", "NEW HOLLAND", "ARION 630C", "CLAAS" and "MTZ" is widely used. It should be noted that the operational and agrotechnical requirements during the period of inter-row processing of cotton when using agricultural Foreign-made techniques, especially when cultivating cotton, are performed a priori, that is, without scientific justification.

Preliminary observations show that this approach to work leads to wear on the tire tread pattern, increased slipping, increased fuel consumption, reduced tire life, and so on. This situation is one of the important issues for the development of reliable recommendations based on the results of experiments to increase the service life of the tire part of the chassis system of agricultural tractor units.

Processes for improving the chassis of universal wheeled agricultural machine and tractor units T. Killer (USA), Saidi Mkomwa (Italy), P. Peter (Germany), M. L. Attanda (Nigeria), Dj. C. Teylor, V. N. Tkachov, A.I. Selivanov, I.S. Levitsky, V.A. Skotnikov, V.I. Knorosa, V.N. Tarasova, N.A. Ulyanov, R. Hedekel, Ya.S. Ageikin, I.E. Ulman, E.M. Asmankin, V.A. Shakhov, A.T. Lebedev, B.A. (Russia) Kambarov, M.A. Tukhtaboev (Uzbekistan), etc.

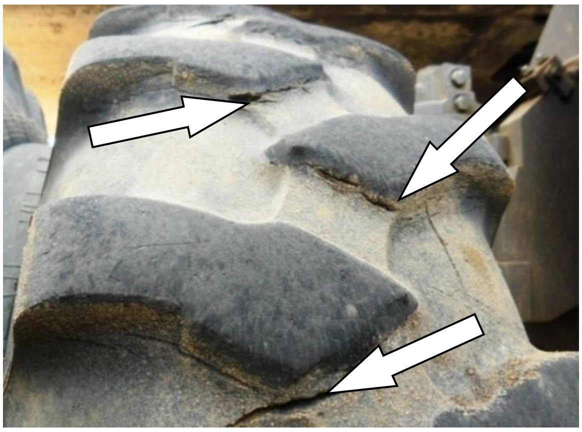
However, the scientific research of foreign and our republican scientists did not take into account the issues of the occurrence of malfunctions in the tractor drive system and their reduction in machines performing certain agricultural processes. In the field of cotton growing, the process of processing cotton between rows is not sufficiently reflected. Parameters and indicators of reliability, efficiency of MTA and agrotechnical indicators that determine the efficiency of the working resource of MTA do not have a theoretical basis. The fact that the scientific and practical problems of improving the tire part of the running system of a maintenance unit for agricultural machines have not been sufficiently studied shows the relevance of research in this direction.

As a result of the analysis of literary sources, defects that occur in tires and the causes of these defects are studied (Fig. 1).

Based on the analysis, the following can be noted: the main working part of the wheel of the tractor running system is the pneumatic tire, and due to the correct selection of tires according to the model, the optimal distribution of vertical loads falling on the tractor propulsors and the variability of the direction of the quantity are achieved, and their traction and contact properties are improved. As a result, productivity and operating resources are increased and fuel consumption is reduced.

Prepared on the basis of data obtained from cotton farms shows that tire wheels are susceptible to various damages. However, among various defects, it was found that tread wear in all cases occurs in parallel with other damage.

Solving the problems of increasing the working life of the tire part of the undercarriage system of machine and tractor units operating in the inter-row spaces of cotton plants requires a comprehensive study of the causes of failure of their tire part. It has been established that one of the main reasons limiting the durability of currently operating units is the rapid wear of the tire tread due to the presence of a heavy load. Therefore, in the agricultural conditions of Uzbekistan, the task of increasing the durability of cotton tractor tires is urgent.



a)

b)

c)

d)

Fig. 1. Defects and damage to pneumatic tires.

a) displacement and damage to the tread; b) wear according to the tread pattern.
(13.6 R38 YaR-318; 15.5-38 Ya-166); c) defects inside the frame;
d) void in the side wall.

Numerous analyzes and experiments carried out under various operating conditions over the years show that various defects and damage to the pneumatic tire of the agregate wheel occur during processing between rows of cotton in cotton farms.

According to the analysis, it is substantiated that the use of running systems of agricultural machine and tractor units can be achieved by improving tires and their effective use.
Many years of research and analysis have shown that the most common tire defect is tread wear.
Based on the analysis, we can note that the tractor traction system is the main working part of the tractor. As a result, productivity and operating resources are increased and fuel consumption is reduced.
Currently, there is no extensive research on scientific and practical issues related to increasing the range of tires by ensuring the durability of the running system in agricultural machinery. As a result, the country's supply of agricultural machinery with tires, the cost of spare parts remains high and the share of tire replacement remains low.

Materials and Methods

The methodology for selecting tires by model, analysis of energy parameters, such as energy and power of the unit, labor productivity, makes it possible to determine analytical connections between technological indicators of tire tread wear and, as a result, to substantiate the main recommended indicators that ensure improvement of the tire tread surface.
In the process of research, the basic methods of probability theory and mathematical statistics, the theory of dynamics of running systems, system analysis and mathematical modeling were used. Experimental studies were carried out using standard methods set out in ISO 4251-2-92, ISO 8664-92, ISO 7867-1-92, GOST 7463-2003, GOST ISO 4205-4-94, va O`z DSt ISO/TR 10017:2002) and developed private research methods. The method of comparative studies of a wheeled tractor and MTA was adopted as the research method. The results obtained were assessed using mathematical statistics and computer programs “Word”, “Excel” and “Statistika -10”.
The results of research on the theoretical foundations are presented: increasing the service life of pneumatic tires, wear intensity of the tire tread pattern, tire load capacity, specific tractor fuel consumption, traction, slipping, inertia and deformation are presented on inter-row processing of cotton.
The multi-mass combined model of the tractor system fully complies with the specified conditions. It allows you to determine the elements of rotational motion, the operation of tractor parts and friction elements that simulate the slipping of its drive wheels, elastic parts that characterize friction and wear of the chassis, the parameters of the drive wheels and slippage.
The given system of equations allows us to evaluate the process of movement of the unit, taking into account the properties of elasticity and damping of transmission elements, wheel slipping, redistribution of masses of the unit, which is shown by the process of substantiating the theoretical parameters of its movement are close to real values and allow us to realistically evaluate the movement of the tractor.
Determination of the wear rate of the tire tread pattern during inter-row processing of cotton. V.P. Boykov and E.M. Asmankin's studies were empirically correlated using the coefficient

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K_i, which determines the wear rate of tires of pneumatic wheels interacting with a horizontal contact surface.

$$I=\frac{K_i \cdot P_{cp} \cdot \mu_{букс} \cdot a \cdot \delta_i}{2\pi \cdot r_к} \quad (1)$$

where K_i is the soil cohesion coefficient; P_{cp} - average nominal impact pressure, MPa; μ_{buks} – coefficient of slipping of tires on the ground; δ_i – i – wheel slip angle, rad; $r_к$ – radius of rotating wheels, m; a is the length of the wheel track at egat, m.

Experiments carried out in the Kasansay district of the Namangan region are confirmed by the results of experimental studies and determined by the forms

$$I=\frac{2\cdot K\cdot N\cdot \mu\cdot G\cdot \sin\alpha}{(r\cdot b\cdot \pi^2\cdot C_1\cdot p\cdot \omega\cdot G\cdot \sin\alpha)+(C_2\cdot p_\omega\cdot G\cdot \cos\alpha)}, \quad (2.)$$

I = (2 · 0,6 · 80 · 0,3 · 4200 · 0,54)/(720 · 4700 · 9,86 · 0,6) + (0,5 · 300) = 46656/5004936000 = 0,0000093 mm = 0,93 mkm.

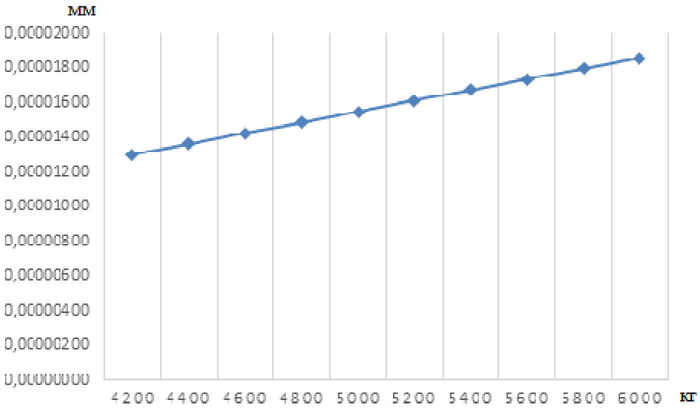

Fig.2. Tire tread wear depending on the weight of the tractor.

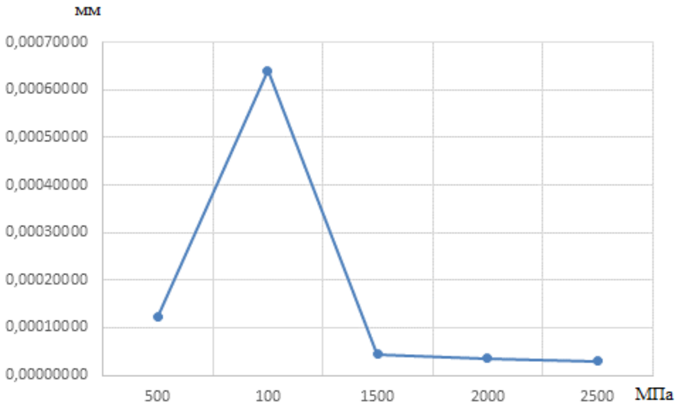

Fig.3. Dependence of tread wear on load.

As a result of research, it was found that the wear rate of the tread pattern of tractor wheels varies depending on the weight of the tractor, the pressure on the wheel and the values of the static radius of the wheel.

It became possible to theoretically determine the relative fuel consumption of a tractor, traction force and acceleration values.

Result and Discussion

A pneumatic tire is designed to operate within a certain range of vertical loads at tractor speed and corresponding internal air pressure. In addition, the quality of tires and their operating modes are usually characterized by minimum and maximum permissible internal pressures and corresponding high pressures. At runtime, these values show the correlation between loads. In this case, the service life of the tire significantly depends on the internal air pressure and impact load.

Assessment of the causes of malfunctions in the operating conditions of the tractor chassis; in some MTAs, the operating modes vary widely. As a result, the malfunction of various elements of the tractor mechanisms creates a random stream of events.

When the drive wheel moves on the ground inside the agate, its slipping is as follows:

$$\delta = (\vartheta_m - \vartheta_\partial)/\vartheta_m . \quad (3)$$

where $\vartheta_т = (\omega_F \cdot r_F^0)$ theoretical wheel speed m/s; ϑ_∂ – actual wheel speed m/s; r_F–wheel adius, m.

To solve a number of problems regarding the traction dynamics of MTZ-80X and New Holland TD5 110 tractors under operating conditions, there is the concept of tractor slip coefficient δ, which is determined by the relation:

$$\delta = (V_m - V) / V_m = 1 - V/ V_m . \quad (4)$$

where V_t - theoretical speed, km/h; V - actual speed, km/h.

$$V = (1 - \delta) \cdot V_m . \quad (5)$$

From the analysis of this formula it follows that the actual speed of the front wheel when slipping is less than the theoretical speed of the wheel, but in practice it's the other way around

$$\eta_\delta = V/ V_т . \quad (6)$$

This is called the wheel slip value. Taking this definition and relation (5) into account, we write the following formula:

$$\eta_\delta = 1- \delta . \quad (7)$$

Thus, if the theoretical wheel speed $V_т$ and the wheel slip coefficient δ are known, then using formulas (4) and (5) it is possible to determine the actual speed V and the wheel slip values η_δ.

Front wheels slipping.

$$\delta_1 = 1- к_н \ (1- \delta_2) = 1 – 1{,}04 \cdot (1 – 0{,}9152) = 0{,}0848.$$

We determine the amount of tractor slip using the formula:

$$\eta_\delta = v/ v_т = (1- \delta).$$

$$\eta_\delta = v/ v_т = 1- \delta = 1- 0{,}18 = 0{,}82 \ \%.$$

Determined by the formula $\eta_т = N_{кр} / N_e = (\eta_м \cdot \eta_f \cdot \eta_\delta)$.

$$\eta_т = \eta_м \cdot \eta_f \cdot \eta_\delta = (0{,}95 \cdot 0{,}748 \cdot 0{,}82) = 0{,}582 \ \%.$$

Program for mathematical analysis of experimental studies of cotton aggregates. The design and execution of the experiment was carried out in accordance with the methodology analyzed from the literature. In accordance with the task of studying the process of using the MTZ-80X tractor with the proposed wide-profile (13.6 P38 YAR-318) tire in the process of working in the inter-rows of cotton with aggregates, a multi-factor experimental plan (24) was developed in Table 1.

Table 1 Multivariate Experimental Design

№	**Factor**	**Speed movement, m/s**	**Kryukovoe an effort, N**	**Reference angle Surfaces glad.**	**Angle of lug installation, glad**
		V	$P_{кр}$	α	β
1	Variables	X_1	X_2	X_3	X_4
2	Main level	3	11350	0,170	0,611
3	Top level	3,5	14000	0,240	0,785
4	Variation interval	0,5	2250	0,070	0,174
5	Lower level	2,5	930	0,010	0,036

The following were determined as the output factor (U1, U2, U3 and U4):
The magnitude of the half-transverse deviation from the given trajectory, slipping, the amount of fuel consumption, the average service life and wear of the tire tread, the number of extreme impacts during the period of adjustment of the tractor's trajectory.
In accordance with the data in Table 1, we will find the coefficients of the regression equations using the least squares method. In this case, the significance of the coefficients is checked using the Student's test with a confidence probability of 95%. As a result of processing the experimental data, adequate regression equations were obtained.
As shown by testing the obtained regression models, carried out using the Fisher F test:

for tread wear: $F = 1,5 < F_{кр} = 30$;
for wheel slip: $F_1 = 10 < F_{кр} = 25$;
for medium resource: $F_2 = 60 < F_{кр} = 80$;
for fuel consumption: $F_3 = 1,5 < F_{кр} = 244$;

All obtained expressions adequately describe the processes under study and response surfaces have been constructed, giving an idea of the factor space that allows for a formological study of the processes under study (Fig. 8).
Slippage, %;

$$У_1 = 48,087 - 0,859 \cdot X_2 - 1,083 \cdot X_3 - 1,663 \cdot X_4 + 0,638 \cdot X_1 \cdot X_2 - 0,274 \cdot X_1 \cdot X_3 + 0,222 \cdot X_1 \cdot X_4 + 0,687 \cdot X_2 \cdot X_3 + 0,553 \cdot X_2 \cdot X_4 - (F_1) - 0,461 \cdot X_3 \cdot X_4 + 1,027 \cdot X^2_2 \cdot + 1,6 \cdot X^2_3 + +1,837 \cdot X^2_4 . \quad (8)$$

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Average operating life, (*s*);

$$У_2= 48{,}087 - 0{,}859·X_2 - 1{,}083·X_3 -1{,}663·X_4 + 0{,}638·X_1·X_2 - 0{,}274·X_1·X_3 + 0{,}222·X_1·X_4 + 0{,}687·X_2·X_3 + 0{,}553·X_2·X_4 -(F_2) - 0{,}461·X_3·X_4 + 1{,}027·X^2{}_2·+ 1{,}6·X^2{}_3+ +1{,}837·X^2{}_4 . \quad (9)$$

Hourly fuel consumption, (kg).

$$У_3= 48{,}087 - 0{,}859·X_2 - 1{,}083·X_3 -1{,}663·X_4 + 0{,}638·X_1·X_2 - 0{,}274·X_1·X_3 + 0{,}222·X_1·X_4 + 0{,}687·X_2·X_3 + 0{,}553·X_2·X_4 - (F_3) - 0{,}461·X_3·X_4 + 1{,}027·X^2{}_2·+ 1{,}6·X^2{}_3+ +1{,}837·X^2{}_4 . \quad (10)$$

According to agrotechnical recommendations for processing cotton rows, the results of studies of the maximum transverse slope of egat (0.24 rad) show that the amount of transverse movements in motion with installed protective zones in the experimental version is reduced by 15–22 % the amount of tractor slipping (assumed: $\varphi = 0.5–0.6$), it was found that the magnitude of the impact on the controls is reduced by 27%, and fuel consumption is reduced by 7.1 %.
The device shows the process of determining the internal air pressure of the MTZ-80X 13.6 R38 YAR-318 tractor driving wheel ICH-150 (tire pressure 0.10 MPa) using a dial indicator.
Deformation characteristics of the MTZ-80X tractor 15.5–38 YA-166 and 11.2–42 pneumatic wheel tires.

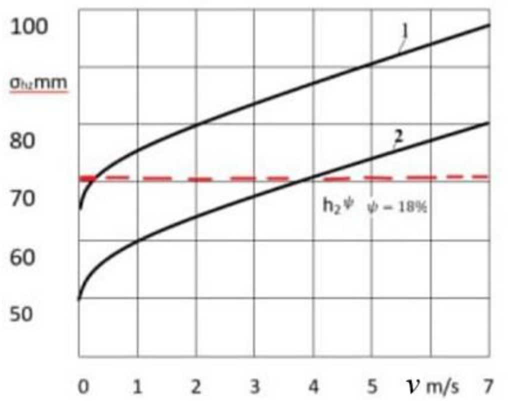

Fig. 4. The deformation characteristic of the rear wheel tire is 18.4/L30 (Air pressure in the tire Psh = 0.18 MPa; Psh = 0.20 MPa).

During tire operation, tire deformation is greatly influenced by the air pressure in the tire. Therefore, as a result of checking the air pressure before starting work every shift and maintaining it within the regulatory requirements of GOST 7463–2003, depending on the pressure supplied to the tire and the hardness-softness of the soil, technical, technological, and operational. The main factor in changes in speed, slipping and wear of the tread pattern is considered to be agrotechnical deformation, which ensures an increase in the efficiency of this chassis control system.
The values obtained in the field were based on the laws of probability and the distribution functions included in these laws.

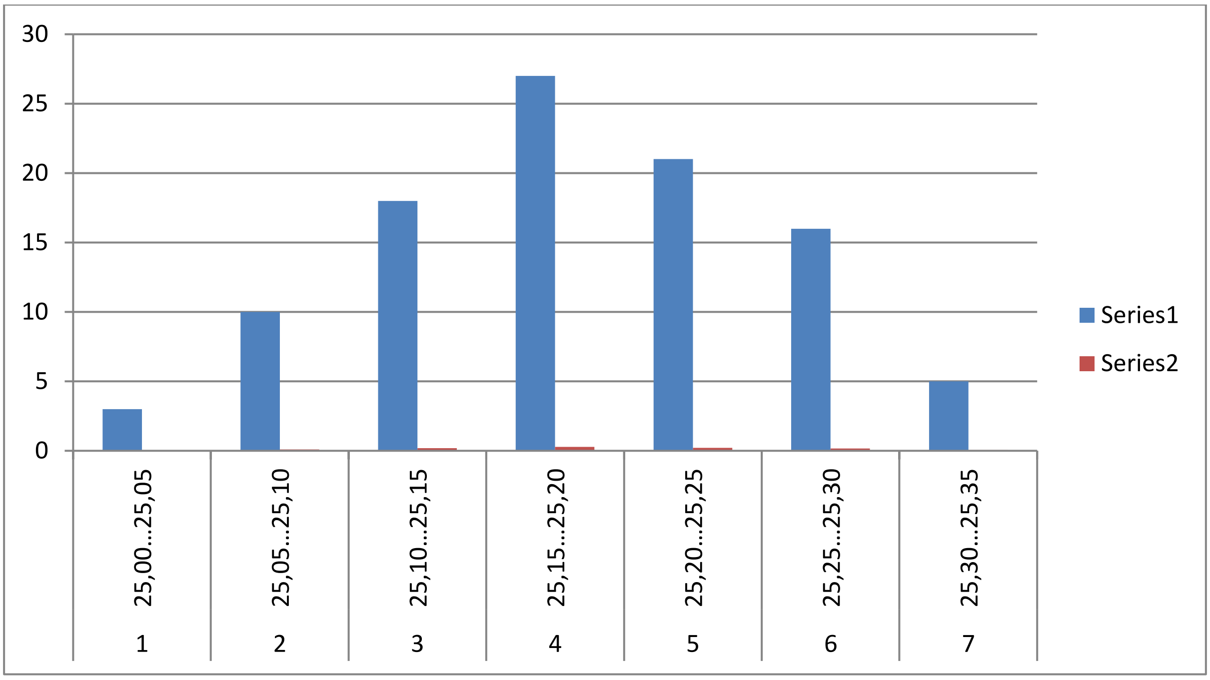

Fig. 5. Distribution of tire tread wear sizes (15.5–38 R–166). MMTP named after "Kukumboy" and "Khudayberdiev" of Kasansay district

Tires of wheeled tractors MTZ-80X and New Holland TD5 110 (9.5–42 YA-183; 13.6 R38 YA-318; 15.5–38 YA-166 and 18.4 /L30), seen in the field according to the received data, the deflection dimensions are represented by the wear of the tread patterns

By mathematical processing of experimental data, a relationship was established by which, with an accuracy of 10%, it is possible to calculate the moment Ik (N • m) on the tractor wheels depending on their mass:

$$I_к = 0{,}03 \cdot m^2_ш = 0{,}264 \cdot m_ш + 9{,}57,$$

where $m_{Ш}$ - is the mass of the wheel tire, kg.

Assessing the cost-effectiveness of research results. A comparative analysis of the results of assessing the efficiency of drive wheels under various operating conditions showed the feasibility of installing 13.6 R38 YAR-318 and 18.4/15-30 R-319 tires on MTZ-80X and New Holland TD5 110 tractors. It was determined that the free diameter and normal stiffness of the tire 13.6 P38 YAR-318, corresponding to the maximum permissible internal air pressure, must be in the range of 1.05–1.06 m and 180–120 kN/m, res.

As a result, the endurance indicators developed in the tests reliably performed the specified technological processes, and it was determined that their performance indicators were at the level of agrotechnical requirements

Conclusions

Based on the research results, the following conclusions are presented:

1. In order to reduce the cost of spare parts when operating machines in developed countries of the world, providing spare parts for repaired machines, the share of restored parts is 35–40%,

this figure in our republic is much lower and in connection with this, when restoring worn parts, the need arose to develop new ones, as well as improving existing technologies and technological measures for restoring worn machine parts.

2. According to research and testing, the use of wide-profile tires in the tire part of the running system of units in the process of inter-row processing of cotton based on agrotechnical measures, as a result of optimizing the vertical loads falling on the tires of units, improving their traction-contact properties with the soil allows increasing the productivity of units and reducing consumption fuel.

3. In the field of agricultural cotton growing in Uzbekistan, the process between rows of cotton processing causes wear of parts due to high technical, agrotechnical and operational requirements. Therefore, due to the fact that universal cotton tractors operate under high load conditions, reducing the degree of wear of the tire part of the undercarriage system made it possible to determine a way to solve the related scientific problem based on the main reasons.

4. As a result of the use of recommended wide-profile tires when processing cotton inter-row units, the probability of tire damage was 82.4%, wear of the tread pattern was reduced by 17%, a reduction in $\delta = 20\%$, the service life was increased from 80% to 86%, and fuel consumption was reduced by 16.8%.

5. Compared to the model 9.5-42 Ya-183, slipping is 8-9% with 13.6 R38 YaR-318, 11-12% with 15.5-38 Ya-166 and 18.4/15-30 R- 319 from 30–31%. When working on a tractor with tires 9.5–42 Y-183, the applied load is $G_н = 15000$ N, internal pressure $P_в = 0.18$ MPa, value h = 0.0754 m. Under the same conditions as the tire, h = 0.0676 for 13.6 R38 R–318 h = 0.0693 and 15.5–38 R–166. The smallest tread depth corresponds to a tire 18.4/15–30 R–319. At internal pressure Pw = 0.18 MPa; h = 0.0578 m.

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