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## Choice Of Transport Units For The Transportation Of Haylage In Rolls.

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### ABSTRACT

Choice of machines for transport service of the process of harvesting haylage in rolls and the organization of their work significantly affects the cost of feed. To substantiate rational transport units in specific production conditions, we developed a simulation model of the process of harvesting haylage in rolls packed in film. A computational experiment on a computer with the developed model made it possible to compare automobile and tractor transport aggregates for the transportation of bales of haylage by the criterion of total costs. The studies were carried out at different rates of haymaking (100 tons, 200 tons and 300 tons) per shift for 10 hours. The distance of transportation of rolls varied from 1 km to 13 km. As a result of the experiments, it was established that the most efficient is a car train consisting of a dump truck with a carrying capacity of 10 tons and a dumping trailer with a carrying capacity of 8.7 tons, carrying 12 rolls of haylage at the same time. The vehicle unit of the KamAZ-45143 with the NefAZ-8560 trailer is, by the criterion of specific total costs, more effective than a tractor unit with a self-loading conveyor of rolls TRB-14 1.3...2.9 times with a haylage transportation distance of 1 to 5 km and 3.0...4.4 times - at distances of haylage transportation over 5 km.

**Keywords:** haylage in rolls, transport unit, car, trailer, self-loading bale transporter, total costs.

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## INTRODUCTION

In the structure of specific operating costs for the procurement of haylage in rolls packed in film, a significant proportion of the costs of transport work. Therefore, in order to organize the efficient operation of the entire fodder harvesting complex, it is important to choose transport units that are adaptive to production conditions.

## RESULTS AND DISCUSSION

Loading and transportation of rolls of haylage is carried out according to two main schemes:

- with the combination of these two operations with a special transport unit equipped with a device for loading coils;
- with the division of these operations between separate units - loading and transport.

According to the first scheme, self-loading coil transporters work, and the second, automobile and tractor transport units, which are serviced by loaders equipped with coil grippers.

The design parameters of self-loading coil transporters are most relevant to the technological requirements for loading and transporting coils. The presence of a manipulator for loading coils and a longitudinal conveyor on the platform allows these units to carry out careful loading, transportation and unloading of rolls of haylage without disturbing their shape. This creates the conditions for high-quality winding of the rolls with film.

The more common scheme of transport service - using cars and tractor trailers - does not guarantee the complete safety of the shape of the rolls in the process of their loading, transportation and unloading.

Machine-building enterprises produce rolls transporters, which differ in load capacity, number of rolls transported, power of the aggregated tractor.

In Russia, the most common models are coil transporters manufactured by Navigator-NM under the license of the Canadian firm Anderson Group. Under the TRB brand, a whole line of transporters is produced - TRB-600, TRB-10, TRB-14, TRB-20 - with a capacity of 6, 10, 14 and 20 rolls and carrying capacity, respectively: the first two - 9.0 tons each, the next two - 12.7 tons each. The design of TRB transporters, as well as other models of self-loading transporters, includes a pick-up mechanism that allows you to load the rolls without stopping, approaching them from any direction. TRB roll transporters are capable of carrying rolls with a diameter of 1.2 ... 1.8 m and a length of 1.2 ... 1.5 m.

Haylage rolls are also transported by truck and tractor transport units in combination with loaders equipped with grippers for working with haylage rolls. Automobile transport units are most often equipped with dump bodies and trailers. Tractor transport units use both dump trailers and trailers that require additional loaders to unload them.

We have carried out a comparative assessment of the efficiency of transport services for haymaking in rolls using road transport and tractor transport units with self-loading roll transporters. The number of units was calculated in order to provide a volume (rate) of haylage harvesting close to 100, 200 and 300 tons per shift for 10 hours. The distance of transportation of bales of haylage varied in the range from 1 km to 13 km.

Of the cars in the carriage of rolls most often use straight-line dump trucks such as KamAZ-45143 and GAZ-SAZ-3507.

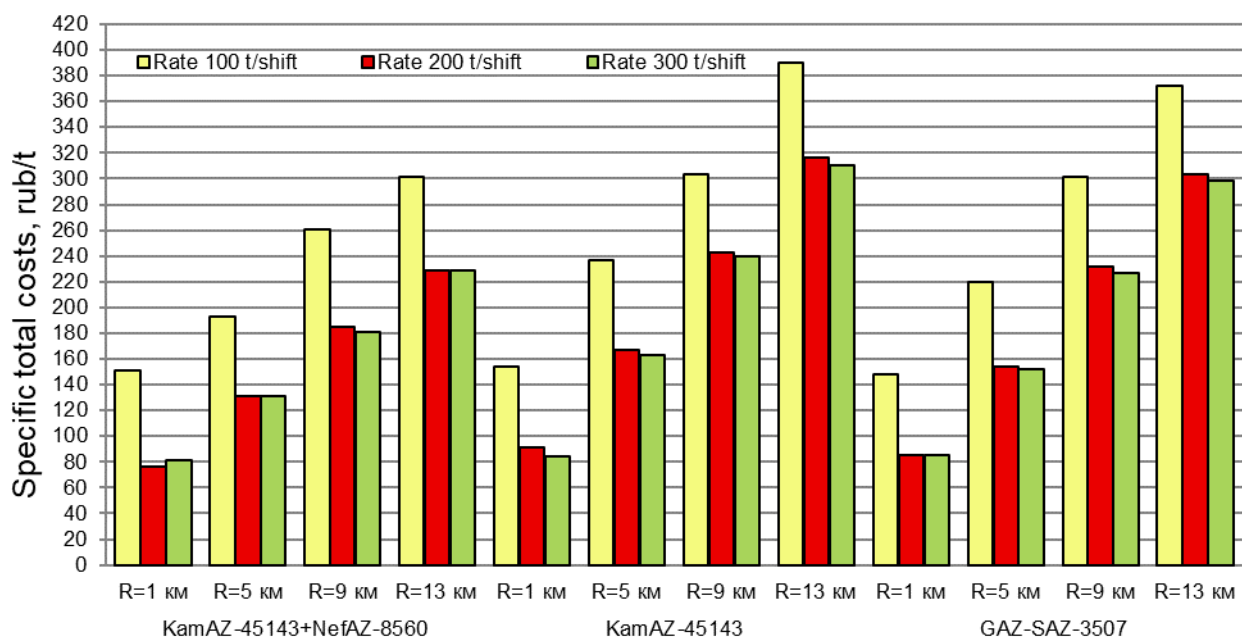
The car KamAZ-45143 is a dump truck with a lifting capacity of up to 10 tons with a 176 kW engine. Body volume with added sides - 15 m<sup>3</sup>. The direction of discharge is on two sides. A car with such design parameters is capable of transporting 6 rolls of haylage with a diameter of 1.5 m and a width of 1.2 m. The KamAZ dump truck can work as part of a train with dump trucks, such as the NefAZ-8560, with a lifting capacity of 8.7 tonnes and a body capacity with added boards - 14.8 m<sup>3</sup>. This road train holds 12 rolls of haylage.

The dump truck GAZ-SAZ-3507 with an engine capacity of 95 kW, with a lifting capacity of about 4 tons, has a metal body with folding side and rear sides. The direction of unloading - on three sides. Body volume with added sides - 10 m<sup>3</sup>. The GAZ-SAZ-3507 is not designed for use with a trailer and can hold 4 rolls of haylage with a diameter of 1.5 m and a width of 1.2 m.

For automotive transport units that are not equipped with self-loading manipulators, PKU-0.8 type loaders mounted on a 14 kN tractor (MTZ-82) with roll grip were used.

To study the complex, multivariate process of harvesting haylage in rolls, we used a simulation method [1, 2, 3, 4, 5]. Computational experiments were carried out by implementing on our computer a model of the process of haylage harvesting [6, 7, 8]. As an assessment of the efficiency of transport units, the criterion of specific total costs was used.

The results of computational experiments on the efficiency of road transport in the transport of coils are shown graphically in Figure 1.



**Figure 1: Specific cumulative costs for transportation of 1 ton of haylage in rolls by cars at different feed preparation rates and transportation distances**

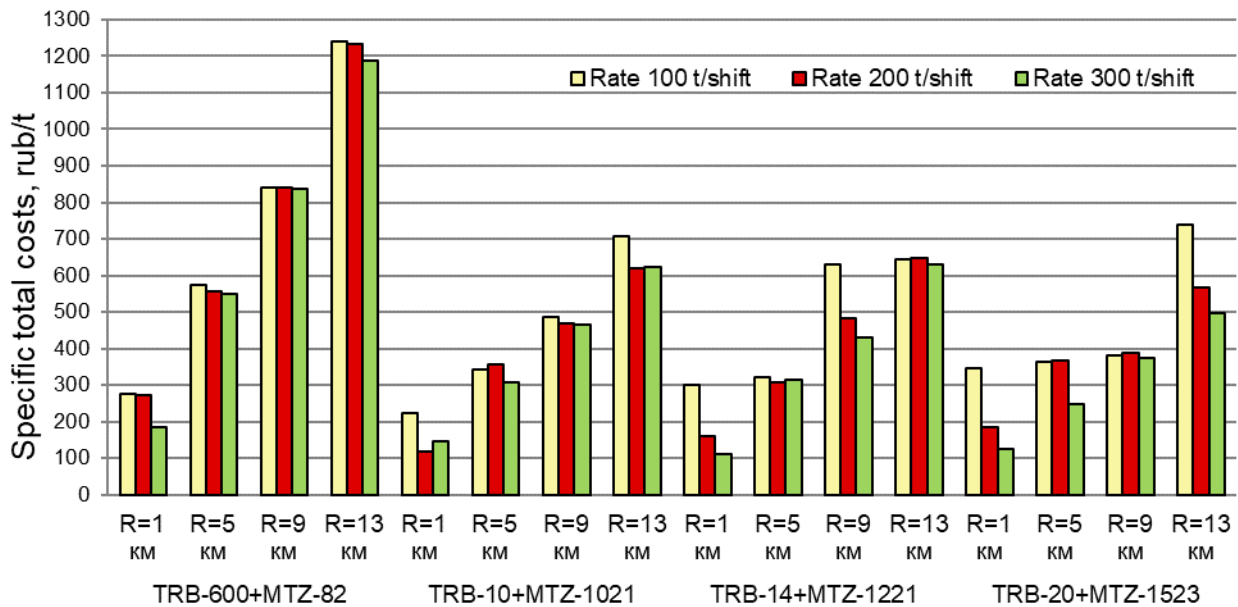
Analysis of the data presented in Figure 1 shows that by the criterion of specific total costs at rates of haymaking from 100 to 300 t / cm and transportation distances over 1 km, the vehicle unit of the KamAZ-45143 vehicle and the NefAZ-8560 trailer has the highest efficiency.

Only with a minimum distance of transportation of coils (1 km), the indicators of specific total costs are almost the same for all compared vehicles. With transportation distances from 5 to 13 km, the cost of transporting 1 ton of haylage by a transport train as part of a KamAZ-45143 car with a NefAZ-8560 trailer is 20 ... 25% lower than using the same car without a trailer or a GAZ-SAZ-3507 dump truck.

Cars without trailers KamAZ-45143 and GAZ-SAZ-3507 show almost the same efficiency, differing by 1 ... 9% under different conditions. However, to maintain the forage harvesting process at a haying rate of more than 200 t / cm and when transported over a distance of more than 5 km, a large number of such vehicles are required - up to 18 cars. Therefore, it is more expedient to use the KamAZ -45143 car in the carriage of rolls, and it is 20 ... 25% more efficient in a unit with a trailer [9].

To assess the effectiveness of self-loading transporters of coils of different capacity and carrying capacity, we investigated four brands of TRB-600, TRB-10, TRB-14, TRB-20 machines of the same type in an aggregate with MTZ-82, MTZ-1021, MTZ-1221 and MTZ-1523 tractors, respectively [9, 10].

The results of the computational experiments to assess the performance of self-loading coil transporters in graphical form are presented in Figure 2.



**Figure 2: Specific cumulative costs for transporting 1 ton of haylage by self-loading bale transporters**

Analysis of the data obtained allows us to conclude that the TRB-600 transporter in an aggregate with a MTZ-82 tractor carrying 6 rolls has the lowest efficiency in the whole range of variation of forage conditions. With a small distance of transportation of rolls (1 km) and the rate of preparation of haylage up to 200 tons per shift, the MTZ-1021 + TRB-10 transport unit is most effective. Under these conditions, the specific total costs of it are 25 ... 40% lower than those of other units. This is due to a more complete load of its potential performance, while carriers with a larger capacity of rolls in these conditions are underloaded and idle.

With an increase in the rate of harvesting up to 300 tons per shift and an increase in the distance of transportation up to 5 km, the transport unit comprising the MTZ-1221 tractor and the transporter of rolls TRB-14 is most effective. The specific total cost of its work in these conditions is 5 ... 15% less than that of aggregates, including carriers of lower and higher capacity - TRB-10 and TRB-20.

When increasing the transportation distance to 9 ... 13 km, the best performance indicators of the TRB-20 transporter in the unit with the MTZ-1523 tractor. Under these conditions, it has a 10 ... 20% lower total costs compared with units, including transporters TRB-10 and TRB-14.

Thus, in the range of feed rate varying under study (100 ... 300 tons per shift) for transportation distances of rolls up to 5 km, it is advisable to use a transport unit in the composition of the transporter of rolls TRB-14 and the tractor MTZ -1221; at distances of transportation of rolls over 5 km, the unit as a part of the transporter of rolls TRB-20 and tractor MTZ -1523 works more efficiently.

To substantiate a rational scheme of transport service of the process of haymaking in rolls packed in film, we performed a comparative analysis of the most efficient automobile and tractor transport units: a KamAZ-45143 car with a NefAZ-8560 trailer and a self-loading conveyor of rolls TRB-14 in an unit with an MTZ tractor - 1221.

Indicators of specific aggregate costs for loading, transporting and unloading bales of haylage by comparable transport units at different feed rates and distances for transportation of coils are shown in Table 1 [9].

**Table 1: Specific cumulative costs for transportation of 1 ton of haylage in rolls by automobile and tractor transport units**

Part of the transport unit	Specific total costs, RUB / t											
	Temp = 100 t / shift				Temp = 100 t / shift				Temp = 100 t / shift			
	1 km	5 km	9 km	13 km	1 km	5 km	9 km	13 km	1 km	5 km	9 km	13 km
1. KamAZ-45143 + NefAZ-8560	57,8	65,3	73,1	81,0	35,9	43,9	51,5	58,2	34,3	42,2	50,0	57,8
2. TRB-14 + MTZ - 1221	92,8	121,8	225,9	254,4	55,1	115,6	190,9	260,1	43,4	123,7	177,5	253,3
2nd unit to 1st unit,%	161	186	309	314	153	263	371	447	127	293	355	438

The data in Table 1 show a significant advantage of road transport in the transportation of rolls compared to tractor transport units.

**CONCLUSION**

The vehicle unit of the KamAZ-45143 with the NefAZ-8560 trailer is, by the criterion of specific total costs, more effective than a tractor unit with a self-loading conveyor of rolls TRB-14 1.3...2.9 times with a haylage transportation distance of 1 to 5 km and 3.0...4.4 times - at distances of haylage transportation over 5 km. This effect is due to the significantly higher annual loading of cars compared to specialized coil transporters, greater speed, lower unit costs of labor and fuel per 1 ton of transported feed.

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