Livestock Machinery Maintenance Efficiency

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Abstract. The paper describes the livestock machinery maintenance efficiency and the system of operating mechanisms. Reforming conventional and creating new organizational structures of the economic management in the agrarian sector, which is aimed at improving the efficiency of the industry, predetermines the need for a radical solution to the issue of feasible provision of agricultural producers with all types of resources, and especially technical ones, at this stage. In solving this issue, the relevant differential rates of demand for resources considering the production volume should acquire great importance. It is suggested to increase their role as not obligatory indicators but measures of endowment, the feasibility of using resources, as well as the creation of facilities for the production of the machinery and equipment required to meet the demand of agriculture for them.

1. Introduction
One of the most important conditions for raising labor productivity in agriculture is implementing efficient zonal machinery systems and progressive energy-saving technologies. Unfortunately, in recent years, technical re-equipment of agricultural enterprises based on zonal machinery systems has been disrupted due to a sharp increase in prices for equipment, spare parts, and services. Given the limited financial and material resources of the agro-industrial complex (AIC), the optimal strategy and tactics should be developed for technical support of agricultural production. In the current conditions, it is advisable to forward capital investments primarily in the production of technical means and machinery complexes capable to ensure the growth of labor productivity in the relevant AIC branch to a greater extent. Recently, the repair and maintenance costs have been steadily increasing. However, this virtually does not lead to a noticeable increase in the technical preparedness of the machine and tractor fleet (MTF). This situation becomes a serious deterrent for agricultural production and its efficiency; therefore, the machinery maintenance specialization should be adjusted. One of the main problems is determining the need for repair and maintenance.

Until recently, repair enterprises having a near-monopoly on the distribution of spare parts and materials could dictate their terms on both the scope and cost of work and its deadline. Herewith, the
need for repair and maintenance has been determined by the achieved level of development of specialized repair enterprises without considering the economic interests of collective farms. As a result, to eliminate any technical malfunctions, it was required to attract a specialized repair company.

Regional agricultural authorities should adjust the existing engineering programs or develop new ones. Livestock farms operate the feed distribution and manure disposal equipment winter and summer, which requires regular year-round maintenance. Maintenance schedules are drawn up by month and quarter. On their basis, the annual scope of work is calculated, the mobile workshop and maintenance team activity is arranged, and the need for spare parts, replacement assemblies, and materials is determined. Technical preparation of repair is performed when commissioning the new production sites or retrofitting the existing ones to increase labor productivity, improve the repair quality, and reduce its cost. The restoration of worn-out parts in many aspects increases the repair efficiency, which is achieved through both detecting defects and selecting suitable ones and improving assembly, disassembly and cleaning, and break-in testing processes. In the market economy environment, mastering the repair of new types of products is especially important, including in small batches. Up to 80 % of the labor intensity in the technical preparation for repair falls on the development, manufacture, and implementation of process equipment.

Most tractor maintenance operations not requiring highly qualified specialists can be performed by tractor drivers under the supervision of mechanics or an MTF operation engineer. To reduce losses caused by the MTF malfunctions during agricultural work, it is required to pass from the rated supply of spare parts and operating materials to a guaranteed one. This requires studying the farm needs in repair services, spare parts, and operating materials. Herewith, it should not be forgotten that with the development of the repair and maintenance base, these needs will change over time in both scope and structure.

2. Main Part
At farms, equipment efficiency is largely determined by the structure of its operating costs. The need for maintenance associated with the prevention of malfunctions, excessive wear, and increased consumption of operating materials is determined by indicators such as fuel consumption and running time in motor hours or yield in conventional standard hectares. To reduce the non-productive time component of using machine-tractor aggregates, their joint use is rational. In this case, there is a real possibility of transition from sequential to parallel performance of mechanized work, and the duration of the preparatory and final operations is reduced due to the large pool of manpower.

The specialization of individual farms in the performance of certain process operations leads to an increase in labor productivity and improvement of their performance quality [1, 3, 7]. In the individual farm conditions, farmers spend 40 to 50 minutes on monthly (daily) maintenance of machine and tractor aggregates, of which more than half is spent on fueling a combine harvester.

Sharing machinery positively changes the working time structure. Thus, in the farms using equipment individually, the main work makes up on average 26 % of the daily labor. Herewith, this indicator varies from 12.6 % for harvesting grain and 17 % for seed sowing to 40 % for rolling. The use of machinery on the terms of, e.g., neighborly mutual assistance allows twofold increasing these values. Time allocated for the main work increases due to the reduction in the duration of the preparatory and final operations [6, 8, 12, 19, 21]. Other daily time structure components do not show such a clearly expressed positive trend. With the development of agricultural production, the issue of equipping them with highly productive machinery for crop and livestock production arises. Capital investments are used much more intensively in optimal size farms.

Thus, at the capital investments EnK in milking units AD-100A and DAS-2B (designed for machine milking of cows into portable buckets with the indoor maintenance of livestock) considering the standard coefficient En, operating C and transferred C+EnK costs are reduced to a certain value and then increase (Fig. 1).

The dependence of the operating cost components on the service life exemplified by the hay tower store loader TKP-70 is shown in (Fig. 2) [17].
Figure 1. Dependence of the Cost ‘Z’ Components - Operating Costs ‘C’ and Capital Investments ‘K’ in Linear Units on their Service Life t.

Figure 2. Dependence of Depreciation Deductions (K/t), Actual (a_n+bt), Average (a_n+bt/2), and Average Annual Total C'(t) Operating Costs of the TKP-70 Store Loader on its Service Life t (K - capital investments, RUB, a_n - fixed costs, RUB, b - maintenance and repair costs).

To determine the impact on the indicators being studied (in our case, λ and R_r), the partial elasticity coefficient E has been found, which characterizes the average percentage of changing the indicator analyzed with a 1 % change in each factor while others are fixed: E_λ = 0.44; E_R_r = 0.34. It follows that the λ coefficient has the greatest impact on the labor intensity in milk production.

To determine the labor intensity per a unit of product (milk) depending on the λ and R_r coefficients in production conditions, the nomogram (Fig. 3) can be used.
Figure 3. Nomogram to Determine the Labor Intensity $y \cdot x$ (h/160 kg) per a Unit of Product (Milk) (digits 1, 2, 3, and 4 show the order of actions to determine $y \cdot x$).

An important reserve for reducing operating costs and increasing the machinery and equipment efficiency in livestock breeding is the implementation of a scheduled preventive maintenance and repair system [2, 5, 10, 14].

The machinery running time should also be considered to control the use of the process line equipment during a day, which allows properly arranging the maintenance [10, 18, 20]. Knowing the maintenance frequency and the annual machinery running time, the need for maintenance and repair of each machine can be determined both analytically and using nomograms and plots. In the first case, the need for maintenance and repair of each machine is $N = (B_o + B_n)/T - N_p$, where $N$ is the number of maintenance and repair types; $B_o$ is the machine running time from the last maintenance or repair of the same type, h; $B_n$ is the planned machine running time for the target year, h; $T$ is the frequency of maintenance or repair calculated, h; $N_p$ is the number of all maintenance or routine repairs types with the low frequency of the maintenance or repair type calculated. When calculating the required number of repairs, the value $N_p = 0$. The $N$ value is always rounded down to an integer, regardless of the fractional part. The $B_o$ value is found as the excess obtained when dividing the running time from the last repair or the start of operation by the frequency of the maintenance or repair type calculated.

The dependence of the machinery maintenance and repair costs on the livestock farm size is expressed by the equation $C_e = a_o + a_1/N_f$, where $a_o$ and $a_1$ are the maintenance cost reserve and reduction limit coefficients; $N_f$ is the farm livestock number. Commonly, $K_e = A/N_f + B$, where $A$ and $B$ are the capital investment reserve and reduction limit coefficients. Transport costs $C_{tr} = a' + b'R$, where $a'$ and $b'$ are the straight-line parameters; $R$ is the livestock farm and complex servicing radius, km. If the maintenance and repair costs per capita $C_1$ (RUB) and the farm livestock number $N_f$ are known, then the total maintenance and repair cost per shift at a single farm is $a = C_1N_f$. When the lifting and transport equipment is available, the efficiency of the planned preventive maintenance system for livestock machinery is significantly improved due to the engineering service specialization [9, 13, 15]. The procurement service provides a centralized supply of spare parts, a rotating pool of units and assemblies, and new equipment. At the farms, production sites have been created, which involve chief engineers (site managers), accountants, record-keepers, foremen, and repair workers. The repair and maintenance there are paid at the cost price with a 5 % accrual.
3. Conclusion
In the market economy environment, high-performance equipment will be competitive if cooperated. The main cooperation form should be integrated inter-farm mechanization and electrification of agricultural production with the cooperated mobile equipment and other production means. This will ensure the effective use of MTF in the multi-structural agriculture conditions. An important condition for improving the technical machinery and equipment operation efficiency is their maintenance and repair planning.

The specifics of operating the machinery and equipment at farms and complexes are the lack of redundant equipment at the vast majority of livestock enterprises. They operate the mechanization means all year round in an aggressive environment and direct contact with animals, which significantly affects their productivity and health of livestock, the product quality, the regularity of the pace of production processes, and the workday schedule.

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