Utilization of tractors and agricultural machinery

Miho Yankov Mihov
Institute of Soil Science, Agrotechnology and Plant Protection "N. Pushkarov" – Sofia

Summary: *Regardless of the length of the period of use of the equipment, due to a change in technology, an increase in maintenance costs or the introduction of new requirements with a change in legislation, the machines become obsolete and are disposed of.*
The main methods for utilization of tractors and self-propelled agricultural machinery are considered. The equipment necessary for the disposal is also described. The methodology for determining the costs for utilization and the value of the equipment for utilization of the whole machine, element-by-element utilization and utilization after defecting has been supplemented.
KEY WORDS: *UTILIZATION, LIFE CYCLE, MACHINES, EQUIPMENT, DEFECTS, COSTS, CONTROL AND MEASUREMENT OPERATIONS, RECYCLING.*

Agricultural machinery, as well as all other machines from the beginning of their development to the end of their use go through a number of stages, united under the so-called life cycle. This term is used for complex, science-intensive production.

Life cycle according to ISO 9004-1 are a set of processes performed from the moment of occurrence of needs for a certain production, to the moment of satisfaction of these needs and utilization of the product / machine. Figure 1 shows the main stages of the life cycle of a technical product related to the manufacturer and its user.

The longest period of the life cycle of agricultural machinery is the period of operation. Given the specifics of agricultural activities, this period can be divided into two subperiods: use of machinery for its intended purpose and storage period.

The service / warranty and post-warranty / when using the agricultural machinery is extremely important for the users. In principle, the manufacturer chooses one of the following options from the following 1) to perform the service in its own bases and staff; 2) to delegate this activity to an official representative (dealer); 3) to provide the activity to a specialized service company. The advantage of using a service company is that it has qualified staff in the area and can provide a high level of service.

With the expiration of the warranty period of the machines, the service activity gradually passes to these companies. The reasons are mainly organizational or economic

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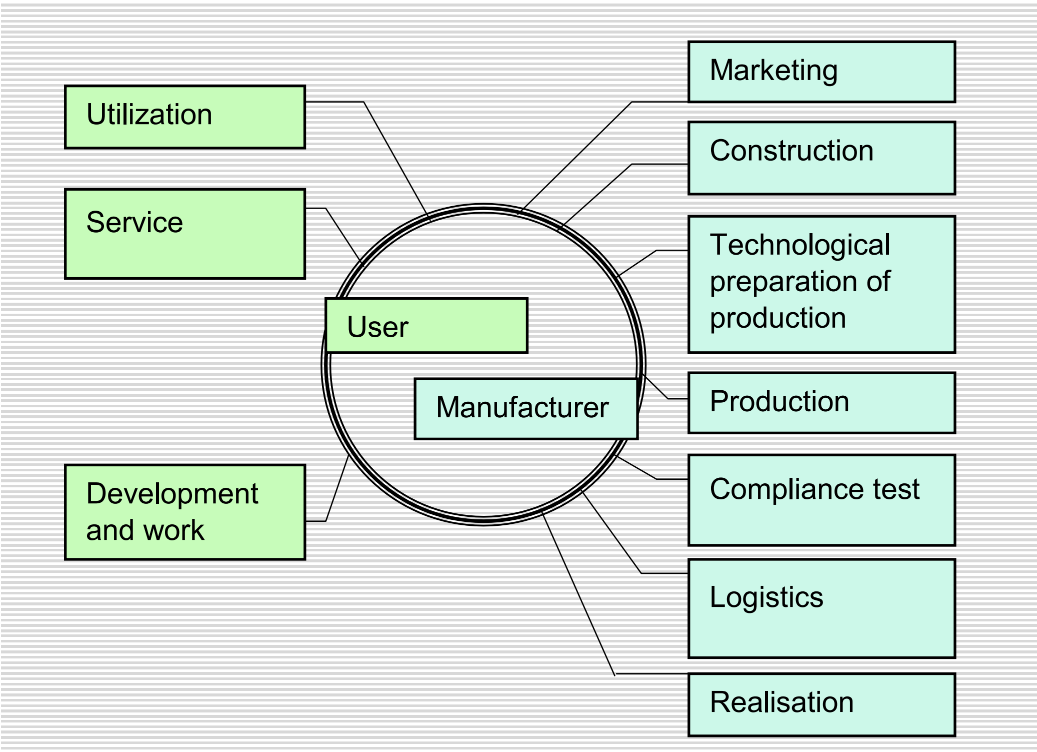

Figure.1 *Life cycle of tractors and self-propelled agricultural machinery*

In turn, the service activity also has a life cycle. It is characterized by lagging behind stages of the life cycle of machines. At the time when the machine is in the stage of maturity, the service cycle is at the beginning of the development stage. About 70% of their income from service work companies realize when the production and sales of machines are declining. For example, if the life cycle of a tractor is 8-12 years, then the service is more than 3 times longer. The income from service work for the life cycle of machines is 4-5 times higher than the prices of machines.

Regardless of the length of the period of use of the equipment, due to a change in technology, an increase in maintenance costs or the introduction of new requirements with a change in legislation, the machines become obsolete and are disposed of.

The separation of the utilization process as a separate stage is imposed by the requirements for environmental safety, namely: reduction of environmental pollution with various toxic substances, reduction of unregulated landfills, resource savings and production of low cost raw materials

Disposal is also important with a view to conserving and reusing resources. The amount of metal in tractors and self-propelled agricultural machinery is easy to process and should not be left to rust in landfills. The possible ways of utilization of the equipment are planned at the stage of production. In general, the life cycle of the machine is considered complete after complete and environmentally safe disposal.

To perform the works on utilization of the machines, a base [1,2] with universal, special and specialized equipment is required, including the following main groups of equipment for:
- draining of various working liquids / oils, brake fluid, freons, etc./, including pumps and devices to them;
- cutting of metals, electrocautery and welder;
- capacities for collecting different types of liquids;
-crushers for metals, necessary to obtain pieces of similar size, for more convenient transportation;
-control-measuring devices and devices;
- lifting and transport equipment.

Methods for utilization of tractors and self - propelled agricultural machinery

For the utilization of tractors and self-propelled agricultural machines, three main approaches or combinations of them are used:

1. Complete utilization

This method is used for rapid disposal or in the absence of equipment to perform it, but is the most irrational from an economic point of view. It is used in cases when the machine is physically or morally worn out and cannot be used (due to lack of residual resources or economic benefit).

The value of the machine in case of complete utilization is the price of the scrap, minus the deduction fees, costs for preparation / draining of various liquids, removal of batteries, electronic components, dismantling of elements impeding transport, etc./ and for transport.

$$C_У^1 = G_M . C_{CK} - (C_{Tp} + C_У + C_T),$$

where $C_У^1$ is the value of the machine at disposal, BGN

G_M - machine weight, tons;

C_{CK} - the price of the scrap, BGN / ton;

C_{Tp} - costs for dismantling of elements and transport, BGN

C_y - costs for collection and utilization of fuel and lubricants, BGN;

C_T - fees paid under the current legislation upon scrapping of the machine, BGN.

2.Element-by-element utilization

In this method of utilization, after collecting fuel and lubricants, tractors and self-propelled agricultural machinery are disassembled into units and assemblies. They are sorted according to the materials from which they are made. Such an approach is applicable to harvesting machines and devices for self-propelled agricultural machinery and stationary equipment for primary processing of products.

In this case, the value / revenue from disposal / can be determined as follows:

$$C_У^2 = \sum_{k=1}^{K} G_{ke} . C_{цм} + \sum_{l=1}^{L} G_{чм} . C_i - (C_p + C_y + C_T + C_{Tp} + C_{AM}),$$

where $C_У^2$ is the value of the machine at disposal, BGN.

C_{ke} - the weight of the k-th element of non-ferrous metal, tons;

$C_{цм}$ - the price of non-ferrous metal scrap, BGN / ton;

$k = 1 - K$ - the number of non-ferrous metal elements;

$G_{чм}$ - - the weight of the l-th element of ferrous metals, tons;

$C_{чм}$ - - the price of ferrous scrap, BGN / ton;

$l = 1 - L$ - the number of ferrous metal elements;

C_p - costs for separation of ferrous and non-ferrous metals, BGN

C_{AM} are the depreciation deductions for the equipment used for utilization, BGN

3.Disposal after defect

The durability and reliability of each machine depends on a number of subjective and objective factors, such as: staff qualifications, work environment, the nature of the workload, the frequency of service and the quality of its performance, etc. When working, even the same elements of one machine fail through different designs. This applies in full force to self-propelled agricultural machinery and is sufficient reason to assume that taking into account the wear of individual elements with the valuation of their residual life is the correct way to determine the liquidation value of the machine. Figure 2 shows the residual life of the main elements of universal tractors with mechanical transmission after 10 years of use at an average annual load of 800 to 1000 hours [3,4].

In this case it is necessary to perform: disassembly of the machine elements, inspection and division of the elements into groups with and without residual resource, evaluation of the elements without residual resource for scrap and evaluation of the elements with residual resource as second-hand. The valuation of the residual resource requires the use of reliable statistical information about the average resource of the main elements of the machine, market prices of new and used spare parts, requirements and time for disassembly and assembly of elements, the need for specialized equipment for adjustments and adjustments, etc. n.

The analysis of the a priori information [3,4,5] and the performed researches [5] shows that the total labor intensity ($t_{кио}$) of the control and measuring works is a complex function of the type:

$$t_{кио} = f(t_{пио}, t_{до}, t_{кио}),$$

where $t_{пио}$ is the labor intensity of the cleaning and washing operations, hours;

$t_{до}$ - labor intensity of dismantling operations, hours;

$t_{кио}$ - labor intensity of control and measurement operations, hours.

Taking into account the complexity and complexity of the control and measurement works [7], the total costs for their implementation can be presented as follows:

$$C_р = C_{пио} + C_{до} + C_{кио},$$

where $C_{пио}$ is the cost of cleaning and washing operations, BGN;

$C_{до}$ - the cost of dismantling operations, BGN;

$C_{кио}$ - the prime cost of the control and measuring operations, BGN

- cost of cleaning and washing operations

These include the cleaning of dust and mud, external washing before the control-diagnostic examination, as well as cleaning and washing of individual elements in the process of the control itself.

The cost of cleaning and washing works is calculated by the formula:

$$C_{пио} = \sum_j \{ \sum_i C_i (t_{knd}^i + t_{el}^i) \} \quad за$$

$$\forall i = \overline{1}, \overline{m}, \ j = \overline{1}, \overline{n},$$

where t_{knd}^i, t_{el}^i, respectively, the average duration of the operations for cleaning and washing of the machine and the elements and before the control-measuring operations, hours;

Ci - the value of one hour of work in the i-th qualification category, BGN / h.

- cost of control and measurement operations

The cost of control and measurement operations is:

$$C_{кио} = \sum_j \left\{ \sum_i C_i t_b^i + t_{nb}^i) \right\}, \qquad \forall i = \overline{1}, \overline{m},$$

$$j = \overline{1}, \overline{n}$$

where t_b^i is the average duration of the control-measurement operation when using built-in sensors;

t_{nb}^i - the average duration of the diagnostic operation when using external sensors, instruments and other equipment.

C_i - the value of one hour of work in the i-th qualification category, BGN / h.

From here the determination of the residual value of the individual elements of the machine on the basis of their unused resource, in case of defect can be done by the formula:

$$C_{oi} = k_i \cdot \left[\frac{t_p}{t_{ie}} \right] . C_{не} \,,$$

where C_{oi} is the residual value of the i-th element of the machine, BGN;

k_i - the coefficient taking into account the number of identical elements of the machine.

t_p - the resource of the element after the measurement, operating hours or liters of fuel;

t_{ie} - the resource of a new element of the i-th type, operating hours or liters of fuel;

The total value of the residual life items that can be used as second-hand spare can be determined by the expression:

$$C_o = \sum_{m=1}^{M} C_{oi}$$

where C_o is the residual value of the elements of the machine, BGN

$m = 1 - M$ - the number of elements of the machine that meet the condition for profit, BGN.

Then the value of the machine in this method of disposal will be:

$$C_У^3 = \sum_{k=1}^{K} G_{чм}.C_{цм} + \sum_{i=1}^{L} G_{цм}.C_{цм} + C_o - C_P \;.$$

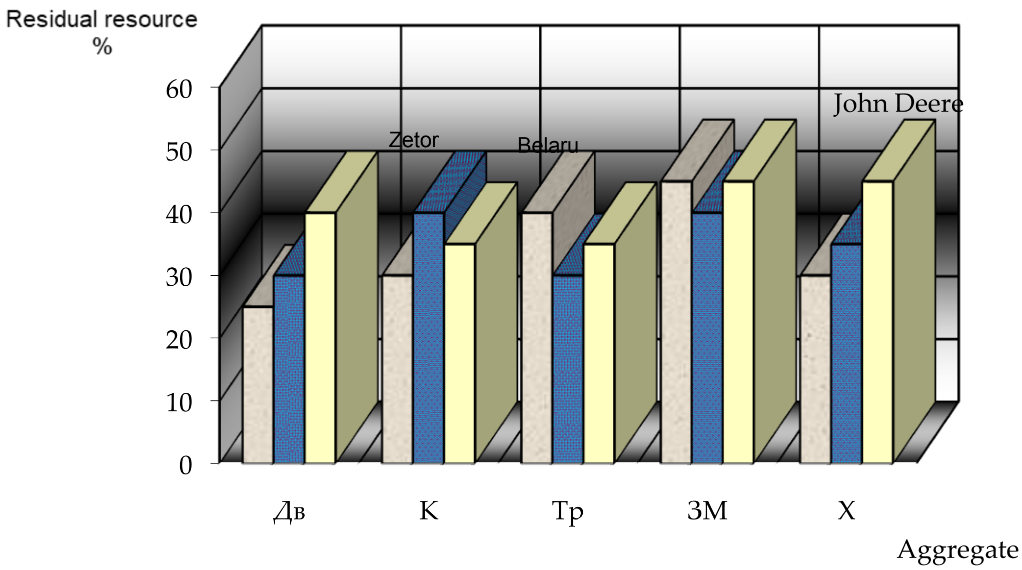

Figure 2. *Residual life of basic elements of Belarus, Zetor and John Deere tractors during utilization after 10 years of use at an average annual load of 800-1000 operating hours: Дв. - engine; K-cabin; Tr-transmission; 3M rear axle; X-hydraulics.*

Conclusions:

1. The stages of the life cycle of complex technical products, such as tractors and self-propelled agricultural machinery, are reviewed. Particular attention is paid to disposal with a view to recycling scrap and protecting the environment from pollution.

2. The main methods for utilization of tractors and self-propelled agricultural machinery are reviewed. The equipment necessary for the disposal is also described. The methodology for determining the costs for utilization and the value of the equipment for utilization of the whole machine, element-by-element utilization and utilization after defecting has been supplemented.

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