

THE INFLUENCE OF MANAGEMENT ACTIVITIES REGARDING AGRICULTURAL MACHINES MAINTENANCE AND REPAIR ON THE OVERALL FARM ECONOMIC EFFICIENCY

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Abstract

A particularly important role in the activity of farms is represented by the agricultural machinery and equipment used in production. In addition to a thorough selection and procurement process in accordance with existing needs, there is also a need for efficient management of maintenance and repair activities correlated with the technological specifications and the required work schedule. Although, on the whole, little attention is paid to this sector of the general business, possible malfunctions may lead to the impossibility of carrying out certain technological works and, consequently, to the deregulation of production plans and, subsequently, a possible negative impact on economic results. Management can be a decisive factor of production, in addition to the other factors that are given a higher importance, this field requiring more attention in terms of training the managers and implementing the principles of this science. The paper aims to highlight the importance and impact of efficient management of maintenance and repair of machinery on the economic results of agricultural farms starting from a general analysis and continuing with an analysis at the farm level, making a correlation between these activities and the economic results recorded. Maintenance and repairs within a company can be carried out, depending on the strategy approached, both by the farm employees, by an authorized service in partnership with the farm or can be carried out in a combined system. The effectiveness of the technological system is determined by the way of adapting to the characteristics of each farm. If the maintenance of agricultural equipment used in the production process is not carried out in time, regardless of the field, the activity cannot be realised in optimal conditions or there may be delays in accomplishing the task which may influence the process of organizing and coordinating activities and therefore optimal operation process is affected.

Key words: farm management, agricultural machinery maintenance, repair system, production plan, economic efficiency

The farm economic efficiency is influenced by a series of factors that contribute to the realization of the final product but the correlation between management activities regarding agricultural machinery maintenance and repair and the economic results obtained is little studied.

Modern agriculture is characterized by high level of mechanization. The number of machines and other equipment increases constantly with the increment of the operation costs. Essentially, the repair and maintenance costs are the second, after fuel, component of operation costs. The knowledge of repair and maintenance costs is essential for making decisions related, among others, to the replacement of machinery and correct preparation of farm's budget (Lorencowicz E., Uziakb J., 2015).

Farm machinery consists of complex machineries which can be used to prepare land for planting, fertilizer application, spraying,

harvesting, processing, milking, hatching of eggs, etc (Oduma O., Eze P. C. Onuoha S. N., 2014).

Agricultural machinery and especially tractors form an increasingly developed industry worldwide. This map (*figure 1*) shows which countries export or import more of tractors.

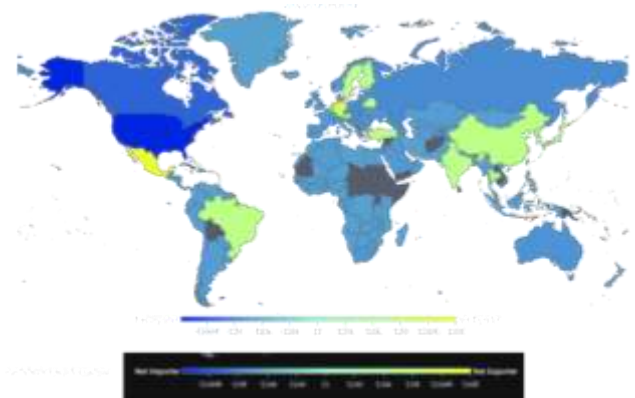


Figure 1 Global net trade for tractors (2019)

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In 2019 the countries that had a largest trade value in exports than in imports of tractors were Mexico, Germany and Netherlands. The countries that had a largest trade value in imports than in exports of tractors were United States, Canada, Russia, Poland, and Australia.

Maintenance and repair system decisions are part of a company's overall strategy. Strategic decisions concerning the overall business activity require the use of specific methods and techniques in the decision-making process, while tactical and current decisions can be made on the basis of the professional knowledge and experience of specialists (Brezuleanu S., Viziteu Șt., Robu A.D., 2017).

One of the next challenges for control engineers involved with the automation of agricultural machinery will be the automation of fault detection and diagnosis to further lighten the job of the operator. The overall maintenance strategy consists of the supporting programs. Broadly, the strategy consists of preventive and corrective maintenance programs (figure 2) (Khodabakhshian R., 2013).

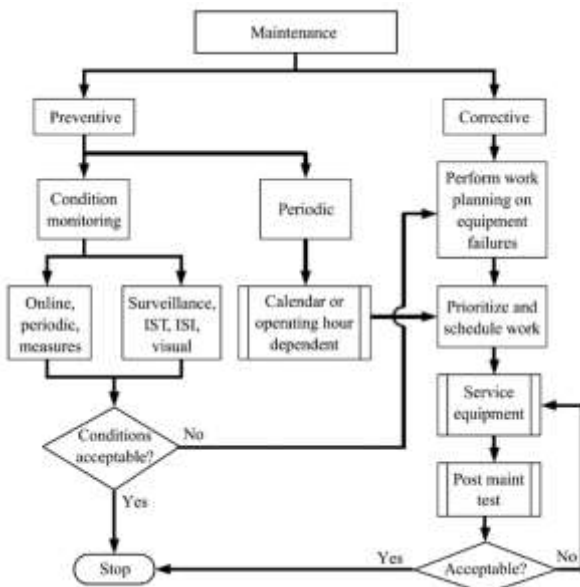


Figure 2 Equipment maintenance scheme

Throughout the years, the importance of the maintenance function and therefore of maintenance management has grown. The widespread mechanization and automation has reduced the number of production personnel and increased the capital employed (Garg A., Deshmukh S.G., 2006) that is why the costs for repairing a machine are highly variable and good management may keep costs low (ASAE, 2000).

Management and command system of agricultural machines is composed of command and management center, management network

system, land block remote sensor material, farm geographical information system, GPS dynamic tracing system, statistic and calculating of single unit workload, statistic of historical data for agricultural machine, experience communication system for machine usage etc. (Wang X. et al, 2009).

Depending on how the repair work is carried out, there can be three systems for organizing the repair works (figure 3): the centralized system, the decentralized system and mixed (combined) system.



Figure 3 Systems for organizing the repair works

In the centralized system, all maintenance and repair work is carried out by the repair shop. According to this system, the maintenance and repair teams are functionally and administratively subordinated to this workshop. This repair system is used in small and medium-sized businesses.

In the decentralized system, the responsibility for maintaining the equipment in good working order lies with the section heads who have in their subordination the section mechanics and their teams. They carry out all maintenance work, current first and second degree repairs, as well as spare parts manufacturing and adjustment work. Major repairs of special equipment, of a specific nature, are carried out in the repair shop. The other major repairs are carried out by the section mechanics with the respective teams. This system of organizing and carrying out repairs is common in large and very large enterprises, but it is also found in medium-sized enterprises.

In the combined system, the repairs of special equipment and their maintenance are carried out by the section mechanics and their subordinate teams. For the other equipment categories, maintenance and repair is done by the repair shop (Brezuleanu S., 2009).

Maintenance activities in agriculture are various and include the maintenance of both machinery and infrastructure, and the tasks range from oil and filter changes, battery charging and replacement, lubrication, clearing blockages and

maintenance of hydraulic systems and tractors to maintenance of roofs and glasshouses, maintenance of silos, slurry tanks, bins and grain tanks or maintenance of electric fences and roads.

Workshops are needed to service, repair, and adjust equipment and keep tools in one location for all kinds of farm work. Workshops may therefore contain a range of dangerous tools and substances.

It is important that workshops are properly designed and equipped. A good workshop can improve the efficiency of farm work and facilitate preventive maintenance of equipment. How a workshop is arranged, equipped and maintained is also important to prevent risks. Broken equipment, machines and vehicles have to be repaired as soon as possible and this is often done by the farmers and their employees. Only large farm companies have big workshops and employ skilled maintenance technicians (EU-OSHA, 2011).

Severe competition along with growing advanced technology resulted in high variation in industry prospective crops, methods, processing and new systems are consistently invented and employed. Therefore by using proper programming we should promote the efficiency of equipments in spite of high costs and personal a remarkable challenge exist to reduce. The cost while enhance production and its essential for our economy. In general, maintenance may be divided in two categories: Corrective and preventive maintenance. Corrective maintenance is a kind of repair which happens after destruction of the system and its goal is to prevent the further outcomes resulted from destruction.

Preventive maintenance is a kind of repairment that we should do prior to destruction of the system and its goal is to maintain the system in a specific situation (*figure 4*). This case involves proper inspection, identification and so prevention of destruction. Preventive maintenance itself divided in 3 subcategories: time based maintenance (TBM), condition based maintenance (CBM) and predictive maintenance (PM).

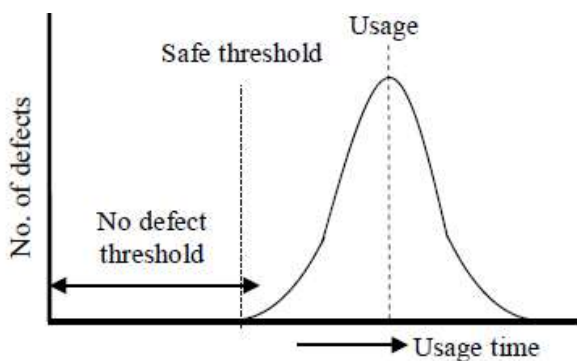


Figure 4 Bell shape curve of defects in usage time of machine

Expenditures are necessary to keep a machine operable due to wear, part failures, accidents, and natural deterioration. The costs for repairing a machine are highly variable. Good management may keep costs low. The size of the machine, as reflected by its list price, and the amount of use are factors affecting the costs. Both the use and costs are expressed in an accumulated mode to reduce variability (Oduma O., Eze P.C., Onuoha S.N., 2014).

In majority of farms there is lack of backup facilities for washing, removal of corrosion and anticorrosive maintenance of machines. These are the investments that apparently yield no direct production effects, however, one should bear in mind that a decrease in specific agricultural production costs calls for economically justified expansion of technical equipment exploitation period. Properly performed maintenance of agricultural equipment improves operational reliability of machines (Gaworski M., Ruszkowski P., Koziol L., 2014).

Successful quality management in general, including the maintenance management system is based on full documentation of all related activities. Anyone who deals with maintenance issues is aware that well-functioned efficient maintenance system must be planned and transparently documented. It must be clearly determined when, who and how to carry out the maintenance. It has to be back-indictable how, by whom and when the maintenance was performed, at what costs was the maintenance performed and what is the quality and reliability of the whole system and its elements (Jurca V., Ales Z., 2012).

MATERIAL AND METHOD

The material used within this research is formed by general literature regarding the topic, data from National Institute of Statistics or the farm balance sheets. The methods used in order to achieve the required results were: statistical data analysis and data interpretation, comparative analysis, SWOT Analysis and case study.

RESULTS AND DISCUSSIONS

The global trend regarding machinery is also maintained at the national level, so the number of agricultural machinery, especially tractors used in agricultural production is increasing from year to year as the development of activity in the agricultural field. In Romania, at the level of 2020, 17.64% more physical tractors were registered compared to 2015 (*table 1*).

The evolution of the agricultural machinery park at national level (2015-2020)

Category	Year					
	2015	2016	2017	2018	2019	2020
Physical farm tractors	199284	207901	212730	215980	221677	232654
Tractor plows	159334	168617	169647	169964	163547	160338
Mechanical cultivators	30355	30632	29648	29337	28545	33753
Mechanical seed drills	77560	81255	80038	78612	74221	73981
Spraying and dusting machines with mechanical traction	5607	5327	5494	5709	5990	5048
Self-propelled grain harvesters	27485	26923	26690	27464	27632	26802
Self-propelled forage harvesters	891	985	1069	1104	1018	1050
Potato harvesters	5403	5629	5924	6108	5856	6177
Straw and hay balers	11966	13840	14166	14697	15483	16671
Feed mowers	1254	1327	1375	1399	1356	1268

Source: National Institute of Statistics

The company under study to highlight the importance of management activities regarding agricultural machines maintenance and repair is S.C. CRANSAFERM S.R.L. The farm was founded in 2006, in Crasnaleuca, Coțușca Commune from Botoșani County. Crasnaleuca village is located 75 km from Botoșani town at a distance of 70 km from Dorohoi and at a distance of 35 km from Săveni. The main purpose of the to realize agricultural products but also the provision of services. In 2006, when the farm was established, the farm was to operate about 50 hectares and a single employee. Currently the farm is in operation around 1000 ha and 6 employees. The main purpose of the farm is to grow cereals, oilseeds and fodder plants. The main crops are: wheat, corn, sunflower, rapeseed, oats, rye and peas.

Of the total area under farm operation, approximately 50% is leased land under a 5-year contract. Currently S.C. CRANSAFERM S.R.L. has 5 tractors, from Fendt, Valtra and New Holland machines, a combine from the Fendt range plus other machines for seedbed preparation, machines for sowing and for the administration of fertilizer and herbicides.

In the yard of the farm there are two hayfields for storing fodder, a hall of 500 square meters for partial storage of grain, two stables for animals, a repair shop, a storage for seeds and other outdoor shelters for animals.

The SWOT analysis as a tool for strategic management (figure 5) identifies as the main farm strengths the location, high-yielding varieties, high-performance and modern technology or the customers loyalty. The company's management is trying to highlight these strengths and improve them.



Figure 5 SWOT Analysis for S.C. CRANSAFERM S.R.L.

SWOT analysis also indicates opportunities as technological changes in the field, new markets, access to European funds, the possibility of making alliances or th subsidies.

Within the main economic results for S.C. CRANSAFERM S.R.L., 2015-2020 (table 2) there is a variation of the net profit from year to year depending on the climate changes that have an increasing influence on the production due to extreme conditions (drought, heavy rain/floods, late frosts or sudden changes in temperature) but also on the managerial strategies approached, including the maintenance and repair of agricultural machines.

Table 2

The main economic results for S.C. CRANSAFERM S.R.L., 2015-2020 (lei/number of employees)

Year	Turnover	Net profit	Total capital	Fixed assets - total	Total current assets	Stocks	Liabilities	Average number of employees
2020	1759620	3676	374744	4567762	1977398	1117520	6251485	6
2019	1964577	76891	669195	5578675	4005962	1578089	8157583	4
2018	3923431	435764	594965	4688131	3478816	1282627	6872241	4
2017	3274003	8832	376367	4890713	3021934	965126	7683000	5
2016	1692903	2250	951586	3407986	2260480	1180695	4786918	3
2015	2662313	323781	976184	2921594	2576116	1140816	4630359	1

Source: S.C. CRANSAFERM S.R.L. balance sheet

The number of employees has increased from year to year, which indicates the company's tendency to grow and develop, to expand the cultivated areas and implicitly to increase the

production, making investments in technological and infrastructure modernization. The company's income (figure 6) increased by 46% in 2020 compared to 2015.



Figure 6 Income, expenditure and gross profit for S.C. CRANSAFERM S.R.L., 2015-2020

Source: Own data processing based on farm balance sheets

The gross profit had variable values depending on the situation of natural and economic factors, being in the year 2020 of 33930

lei. The level of liabilities (figure 7) decreased during the analyzed period from 6251485 lei in 2015 to 4630359 lei in 2020.

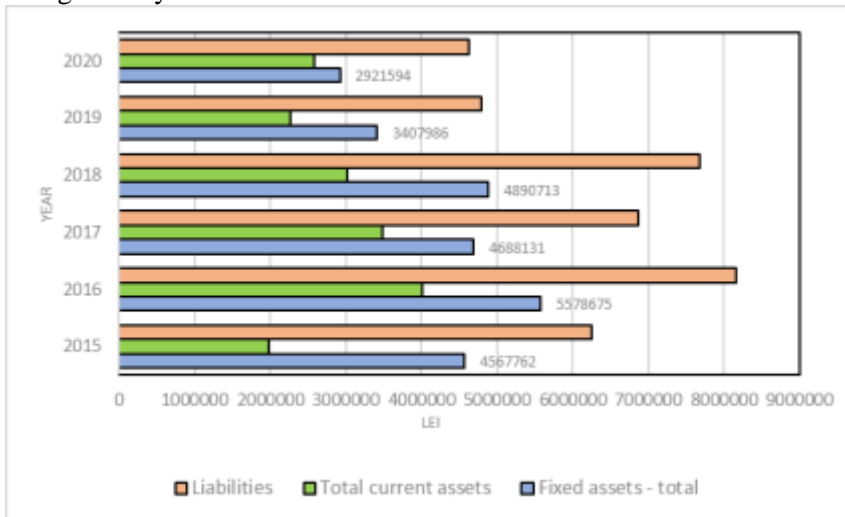


Figure 7 Liabilities, current assets and fixed assets for S.C. CRANSAFERM S.R.L., 2015-2020

Source: Own data processing based on farm balance sheets

For each farm and also for the company studied it is very important to have a properly equipped repair shop on a farm so that in case of minor breakdowns the farm staff can perform repair work without the need for specialized service. Among the most important agricultural machinery owned by the farm are FENDT VARIO 939 S4, Horsch Tiger 4 MT cultivator, VALTRA N124 tractor, FENDT X 9490 combine, or the

Horsch Focus 6 TD seeder. S.C. CRANSAFERM S.R.L. has its own repair shop, well equipped to deal with minor defects that occur in agricultural machinery, and which can be resolved by farm staff. In case of major malfunctions in the agricultural machinery or in the operation of the equipment, the farm uses the services of Agritehnica, a company based in the city of Botosani, which is the main supplier of equipment

for the farm taken into study. They have a standard fare of 25 euros/h, and 0.4 euros for each kilometer traveled to the farm.

Agritehnica has been on the Romanian market for 14 years. Agritehnica is one of the leading distributors of agricultural machinery and spare parts in our country. S.C. CRASNAFERM S.R.L. collaborates with Agritehnica since 2009.

CONCLUSIONS

Within the studied agricultural enterprise but also in the other farms, the management maintenance and repair of machinery is a very important aspect and has a direct impact on the economic results of farms.

Ensuring the maintenance and repair shop with the appropriate equipment and endowments, using the human resources prepared in the field, implementing a system for organizing the repair works (centralized, decentralized or mixed) as well as the efficient coordination of related activities has direct implications on performance of the farm as a whole.

Continuity of production processes as a result of efficient management of maintenance activities, optimal use of tractors and other agricultural machinery farms, the quality of repair work through own service or specialized service as well as the minimization of repair time are elements and factors of progress that contribute to the overall economic efficiency of a farm.

REFERENCES

- Brezuleanu S., 2008** - *Sisteme de producție în agricultură*, Editura Alfa, Iași.
- Brezuleanu S., 2009** - *Management în agricultură*, Editura Tehnopress, Iași.
- Brezuleanu S., Viziteu Șt., Robu A.D., 2017**, *Management în agricultură - îndrumar pentru lucrările practice și ghid de proiect*, Editura Ion Ionescu de la Brad, Iași.
- Garg A., Deshmukh S.G., 2006** - *Maintenance management: literature review and directions*, Journal of Quality in Maintenance Engineering Vol. 12, No. 3, Emerald Group Publishing, pp. 205-238 Limited, available on-line at: https://www.researchgate.net/publication/242347666_Maintenance_management_Literature_review_and_directions
- Gaworski M., Ruszkowski P., Kozio L., 2014** - *Investigations on agricultural equipment maintenance and storage system using an example of the selected commune in Poland*, Annals of Warsaw University of Life Sciences – SGGW Agriculture, No. 64 (Agricultural and Forest Engineering), pp. 69–75, available on-line at: <http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.agro-732e7204-6d8d-40d0-a0fd-377ac58bc4b0/c/afe2014no64p69-75.pdf>

- Jurca V., Ales Z., 2012** - *Maintenance management systems in agricultural companies in the Czech Republic*, Science and Technology, Eksploatacja i Niezawodność – Maintenance and Reliability, vol. 14 (3), pp. 233-238, available on-line at: http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-article-BAT1-0041-0068/c/httpwww_ein_org_plpodstronywydania55.pdf08.pdf
- Khodabakhshian R., 2013** - *A review of maintenance management of tractors and agricultural machinery: Preventive maintenance systems*, Agricultural Engineering International: The CIGR e-journal, Vol. 15, No.4, pp. 147-159, available on-line at: https://www.researchgate.net/publication/260339836_A_review_of_maintenance_management_of_tractors_and_agricultural_machinery_Preventive_maintenance_systems.
- Khodabakhshian R., Shakeri M. Baradaran J., 2009** - *Preventive Maintenance in Agricultural Machinery*, AIJSTPME Journal 2(2), pp.11-16 King Mongkut's University of Technology North Bangkok Press, Bangkok, Thailand, available on-line at: https://www.researchgate.net/publication/268385583_Preventive_Maintenance_in_Agricultural_Machinery
- Lorencowicz E., Uziakb J. 2015** - *Repair cost of tractors and agricultural machines in family farms. Farm Machinery and Processes Management in Sustainable Agriculture*, 7th International, Scientific Symposium, Agriculture and Agricultural Science Procedia 7, pp. 152 – 157, available on-line at: <https://www.sciencedirect.com/science/article/pii/S2210784315300103/pdf?md5=339c24d462429ef1429627eb701c1fca&pid=1-s2.0-S2210784315300103-main.pdf>
- Oduma O., Eze P.C. and Onuoha S.N., 2014** - *Survey of Farm Machinery Utilization and Maintenance in Ebonyi State*, Journal of Experimental Research, Vol 2, No. 1, pp. 18-25, available on-line at: http://www.erjournal.com/papers/oduma_june2014_2_1.pdf
- Wang X. et al, 2009** - *Agricultural machines management and assignment system of Heilongjiang reclamation area*, IFIP International Federation for Information Processing, Volume 293, Computer and Computing Technologies in Agriculture II, Vol. 1, eds. Boston: Springer, pp. 635–641, available on-line at: https://link.springer.com/content/pdf/10.1007/978-1-4419-0209-2_65.pdf
- ***, **2011** - *Maintenance in Agriculture - A Safety and Health Guide*, European Agency for Safety and Health at Work (EU-OSHA), available on-line at: https://osha.europa.eu/sites/default/files/agricultur_e-maintenance.pdf
- ***, **2000** - *Agricultural Machinery Management*, American Society of Agricultural Engineers, ASAE STANDARDS, The Society for engineering in agricultural, food, and biological systems 2950 Niles Rd., St. Joseph, MI 49085-9659, USA, available on-line at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/16/nrcs143_009503.pdf