STOWARZYSZENIE EKONOMISTÓW ROLNICTWA I AGROBIZNESU
Roczniki Naukowe ● tom XVIII ● zeszyt 3

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EVOLUTION OF COSTS OF AGRICULTURAL MACHINE OPERATION AND ITS IMPACT ON ORGANIC FARMS IN HUNGARY

ROZWÓJ KOSZTÓW MASZYN ROLNYCH I JEGO WPŁYW NA ORGANICZNE GOSPODARSTWA ROLNE NA WĘGRZECH

Key words: cost, basic farm, machines, optimum

Słowa kluczowe: koszt, podstawowe gospodarstwo rolne, maszyny, optimum

JEL codes: O13, Q11, Q13, Q16

Abstract. One of the most important tasks of the National Agricultural Research and Innovation Centre Institute of Agricultural Engineering (NARIC MGI) is to annually provide information on the evolution of agricultural machine operation costs in Hungary. Therefore, the Institute – in addition to other activities – monitors and updates changes concerning agricultural machinery through the use of operational data and values of basic farms on a yearly basis. The work results in the development and publication of a booklet which best summarizes the actual cost of agricultural work performed by different machines. It contains the average performance and cost of agricultural machines and equipment calculated by expected prices, wages, and other costs. In this article, our aim is to present the main results of the observation and summarize the main conclusions of traditional and organic farms in Hungary.

Introduction

Several publications deal with estimating farm machinery costs [Edwards 2015, Painter 2011, Pflueger 2005. Schnitkey 2012]. Knowledge regarding machine operating costs is very important for all involved (producers, researchers, teachers, policy makers, managers, consultants, etc.) in agriculture because they constitute a significant proportion of agricultural production costs, so they have a fundamental impact on the efficiency of production. Machinery and equipment are major cost items in farm businesses. Reducing machine operating costs is key in the asset formation of an agricultural business [Nagy 2015a,b]. The machine operating costs is effect on the outstanding debts as well. If the most suitable machine is chosen due to economic factors by farmers, it results in an increase of farming profitability. Having knowledge concerning the accurate performance, consumption and cost data of machines is essential to make solid operational and developmental decisions.

Each year the booklet, which is developed and published, helps to improve production efficiency, contributes to increased efficiency and improved quality of work, and reduces costs. It draws attention to the fact that cultivating unit costs of small (0.5-5.0 ha) fields are higher than larger ones (50-100 ha) [Gockler 2016]. With our work we aim at assisting farmers in being able to control machine costs in order to change uneconomically operated ones in time. This reduces the production cost of machine labour and should work at increasing profitability farming. Furthermore, we aim to help users make professional decisions. However, good machinery managers can control machinery and power costs in Hungary.

Material and methodology

Today, a wide variety of agricultural machine types is offered by distributors in Hungary. Thus, the portfolio of agricultural machines is very diverse and broad. Power machines include tractors, combine harvesters, self-propelled loaders, self-propelled harvesters and other self-propelled machines. Tractors are grouped on the basis of engine power as it is impossible to clearly distinguish between them in terms of cost when considering their structure, function, and stress. Regarding combine harvesters, besides engine power, it is necessary to separate normal and exceptional circumstances by recourse. Loaders have been grouped according to engine power. A wide variety of power machines belong to the category of self-propelled harvesting machines that cannot be standardized; only mowers and forage harvesters can. The group of other self-propelled machines is very complex, but its proportion is low, so the cost of this group has been defined by engine power. Equipment operated by power engines have been grouped by function (e.g. plows, discs, seeders, spreaders, etc.). The type, size, working width, etc. of equipment were not taken into consideration as they are adapted to power machines.

In agricultural practice, the performance of power engines is frequently summarized using different equivalences. Working time (shift-time hours); tonne-kilometres (TKM), the normal-hectar (NHA) and kilowatt-hours (kWh) were used as equivalents.

Costs of machine operation

The following cost factors were considered in our calculations and table 1:

- fuel and lubrication costs,
- wages and the costs charged to this: basic and supplementary salaries of the power engine driver, social contribution tax and cost of sick leave,
- maintenance and repair costs: in the latter part of the repair, materials, repair payroll and overhead costs, as well as improvements to the cost of other businesses,
- depreciation (amortization),
- other expenses: car tax, insurance + accident tax, equipment storage, clay and plant parts procurement, storage and dispensing in the workplace, as well as wage-related costs of a general nature.

The direct cost is the sum of the above five costs. Other indirect costs:

- fixed and current assets, capital gains, interest on debt, other terms of income needs,
- general expenses associated with the machines (branch, main branch, economic, etc.).

The total operating cost is the sum of the above seven costs. It is important to note that the prices and costs exclude VAT. The operation cost of agricultural machinery changes every year.

The changes are determined by the actual and planned numbers of base farms, machinery and experiences of the parts distributor, the data of the Hungarian Central Statistical Office, as well as by specifications of different regulations in force. It is worth noting that a wide variety of power machines and equipment operate, and as such, are used under different conditions by farmers, so the cost can differ greatly. Our work contains only diesel operated power machines, the diesel oil price is 1.1 Euro/kg (tank car) and the lubricants to be considered at an average price of 2.72 Euro/kg. Fuel price is charged – at wholesale price – among other expenses as 4% of procurement costs, storage costs, material issuing costs and shipping costs. The cost of fuel and propellant consumption of the actual work are determined by many factors: specific engine consumption (g/kWh), the motor's technical condition, power utilized by specific work, the features of the engine driver, etc. Lubricant consumption is also influenced by many factors, e.g. it is higher in less powerful machines with hydraulics (5.0-7.0%), while lower in powerful, simpler and modern machines (1.5-5.0%). A portion of the excise tax on diesel used for agricultural work is refundable. This benefit is not taken into consideration since it is not possible to know where the machine performs and who works with it.

The wage is calculated on the basis of base farm data from NARIC MGI and the Hungarian Central Statistical Office fact figures. We calculated a 5% salary increase in 2016. The additional salary is 10% higher than the base salary. The additional salary includes paid leave and other paid absences. Other wage costs: social contribution tax is 27% of the base salary, sick leave costs amount to 2% of the base and additional salaries. The amount of other wage implicated general costs is 5% of the base and additional salaries, when it comes to base farms. This contains indirect benefits for employees, and therefore it has been recognized as other costs. These benefits are not direct costs, but it is important to calculate them, especially for the realistic comparison and evaluation of machines replacing manual labour. As a result, they are included in other costs and not in the general costs.

Table 1. The average price, performance and operating costs of powers machines
Tabela 1. Średnia cena, wydajność i koszt operacyjny maszyn energetycznych

Power machines and kW performance/ *Maszyny energeryczne i wydajność kW*	Average engine performance [kW]/ *Średnia wydajność silnika [kW]*	Performance/*Osiągi*						Total operating cost/*Całościowy koszt pracy [HUF/sh]*
		shift hour/ year/*godziny pracy w roku*	utilization of capacity/ *wykorzystanie możliwośći [%]*	nha/year/ *nha/ rok*	fuel [kg/nha]/ *paliwo [kg/nha]*	lubricants [kg/nha]/*smar [kg/nha]*	wage/ *płaca [HUF/sh]*	
Tractors/*Traktory*								
21- 40	30	1500	24	0,274	9,20	0,506	950	3581
41- 75	58	1600	27	0,595	8,80	0,396	1007	5388
76-100	88	1700	31	1,037	8,48	0,297	1066	7710
101-150	125	1800	35	1,663	8,24	0,206	1131	10739
151-200	175	1900	38	2,527	8,00	0,160	1198	14424
201-250	225	2000	40	3,420	7,76	0,116	1270	17769
251-300	275	2100	41	4,285	7,53	0,090	1347	20795
301-350	325	2200	42	5,187	7,30	0,080	1429	23775
351-400	375	2250	43	6,128	7,10	0,071	1514	26806
401-450	425	2300	44	7,106	7,00	0,070	1605	30104
Grain harvester/*Kombajn rolniczy*								
76-100	88	550	30	1,003	8,64	0,346	1198	13476
101-150	125	575	31	1,473	8,40	0,252	1270	17533
151-200	175	600	32	2,128	8,16	0,220	1347	22689
201-250	225	625	33	2,822	8,00	0,200	1429	27441
251-300	275	650	34	3,553	7,74	0,178	1514	31878
301-350	325	675	35	4,323	7,49	0,157	1605	36076
351-400	375	700	36	5,130	7,27	0,145	1702	40005
401-450	425	725	37	5,976	7,07	0,134	1804	44083
Self propelled loaders/*Samobieżne ładowarki podwórzowe*								
21- 40	30	1600	25	0,285	9,20	0,644	1066	4906
41-75	58	1700	26	0,573	8,80	0,528	1131	7694
76-100	88	1800	27	0,903	8,56	0,428	1198	10608
101-150	125	1900	28	1,330	8,40	0,378	1270	14240
151-200	175	2000	29	1,929	8,23	0,329	1347	19045

* average annual rates in 2016, 75% of the rate forms the basis of amortization, nha – performance equivalence; its basic value is 1.0 nha by medium deep ploughing (16-21 cm) on 1 ha flat field, sh – shift hours = working hours of power engine driver, capacity utilization – shift hours per working time, multiplied by the utilization of time and performance [kWh/sh/kW]/*średnie wskaźniki roczne w 2016, 75% wskaźników jest podstawą amortyzacji, nha – jednostka wydajności; jej podstawową wartością jest 1,0 nha podczas orania o średniej głębokości (16-21 cm) na 1 ha płaskiego pola, sh – godziny zmiany= czas pracy silnika w godzinach, wykorzystanie możliwości – godziny zmiany na czas pracy, możliwość pomnożona przez czas i wydajność [kWh/sh/kW]*

Source/*Źródło:* [Erdeiné Késmárki-Gally et al. 2016]

The specific maintenance and repair costs depend on many factors in practice, which are also a function of time, and it varies widely by holding. The maintenance and repair costs are worked out with average data for 2009-2015 years and the increasing of planned cost is 6% in 2016. 4 % of the full maintenance and repair costs will be charged as other costs by the costs of material and parts storage, clay and plant parts procurement, storage and dispensing.

There are several methods for calculating depreciation, generally based on either the passage of time or the level of activity of the asset. At the beginning of the first year of depreciation book value is the original cost of the asset. The book value is reduced in every year by the amount of depreciation. Due the recent price increases the depreciation costs cannot be determined based on the previous machine prices, so it can calculated from the current machine prices. Depreciation established value is 10 % for each machine. The changes in the price of the equipment is determined generally according to information provided by equipment manufacturers and prices of ARDA (Agricultural and Rural Development Agency) machine catalogue.

Prices of 2015 were increased by 4% in the calculation of 2016 prices. Our published machine prices are average prices, therefore an actual unit price for a particular type may differ materially.

In practice, specific maintenance and repair costs depend on many factors, which are also a function of time, and vary widely by holding. Maintenance and repair costs are worked out on the basis of average data for the years 2009-2015 and, in 2016, the increased planned cost is 6%. 4 % of the full maintenance and repair costs are calculated as other costs due to the costs of material and parts storage, clay and plant parts procurement, storage and dispensing.

There are several methods for calculating depreciation, generally based on either the passage of time or level of asset activity. At the beginning of the first year of depreciation, book value is the original cost of the asset. The book value is reduced every year by the amount of depreciation. Due to recent price increases, depreciation costs cannot be determined based on previous machine prices, so it is calculated on the basis of current machine prices. The established value of depreciation is 10% for each machine. Changes in the price of equipment is generally determined according to information provided by equipment manufacturers and prices in the ARDA (Agricultural and Rural Development Agency) machine catalogue.

Prices in 2015 increased by 4% in 2016. Our published machine prices are average prices, therefore an actual unit price for a particular type may differ materially.

When calculating other costs, motor vehicle tax is not taken into account because the tractor is exempt from tax. The 10% increase of insurance and accident taxes included in 2016 calculations was due to a reduction in insurance market competition. Another cost, the 3% increase in the machine storing price – based on the data of the Hungarian Central Statistical Office – has also been included in the calculations. Fuel purchase, transportation, storage and dispensing cost is calculated as 4% of the price of used fuel (the cost of fuel has already been mentioned). To cover the cost of purchase, storage, treatment and dispensing of materials and components, as well as the general workshop cost, complete maintenance and repair costs accounted for 4% of the calculations. General nature wage costs – based on the data of base farms – accounted for 5% of basic and additional wages, among other expenses, which included the value of indirect benefits for employees of the farm.

Fixed term capital gains are charged on the purchase of capital requirement. The base is 75% of the machine price in January 2016. As capital gains shall not be recognized after the described amortization, and the annual performance of the engine – a generous approach – within its lifetime can be constant – the matter is greatly simplified – leaving 4% of capital gains recognized as the expense after the machine is half price. The current asset capital gains (income requirement) is charged after the direct costs, without depreciation, on a 2-month-average, 4% per year, after the annual cost base 0.6667%. The direct costs are fuel, salary, public dues, repair, maintenance and other costs.

The overall cost charged is significantly different by farm. The overall economic costs are not included in the supplementary operating sector, so there is no realistic starting point. The overall economic cost of main operating sector costs is about 20-30% of the direct cost by crop production. Only 5% overhead should be charged on direct costs. The calculation is based on the total direct cost. Table 1 contains the main data of the 2016 booklet.

Cost reduction possibilities

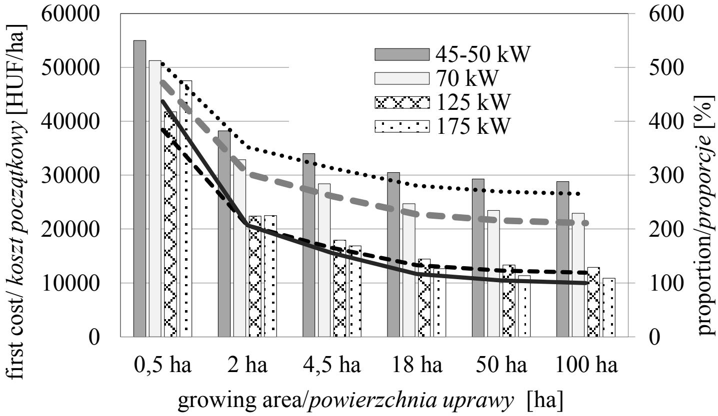

Figure 1. Costs of medium deep plowing and its proportion depending on field size

Rysunek 1. Koszty średnio głębokiej orki oraz jej proporcje w zależności od wielkości pola

Source/*Źródło:* [Erdeiné Késmárki-Gally Sz. et al. 2016]

Operating costs of agricultural machines are constantly changing. The effect of cost increases of previous years has resulted in a growing importance for farms to cost save as well as manage more effectively. Machine operating information has to be monitored and errors must be corrected as soon as possible for efficient management.

Among cost-saving opportunities probably the most important aspect is to improve the utilization of machines and to increase annual performance. The specific value of machine operating costs can be reduced by improving annual shift hours of machines with better organization or with lease work.

Another important issue is the amount of fuel consumption, where the amount of propellant per performance unit is usually 5-20% higher than the optimal level (30.4 kg/100 kWh). This ratio can be reduced by higher technical standard, optimal power machine-equipment combination, by proper engine maintenance, as well as by choosing the right power machine type and engine performance. According to our data, the operating costs of more powerful engines (in normal usage) are more favourable.

The table 1 and figure 1 clearly show that the performance of power machines [ha/h] compared to 100 ha field size are considerably lower than 50 ha fields, and significantly lower in 18 ha fields. However, the cultivation cost [Ft/ha] increases due to smaller field size. The operating costs of more powerful power machines are better. However, larger machines cannot be used by small farms and/or small fields, and therefore an increase in the size of the fields would be justified.

Of course the cost of production is affected not just by the abovementioned factors, but by other factors, too (eg. soil conditions). The average productivity of Hungarian agriculture has improved in recent years; not only due to technical equipment supply growth, but also device efficiency (capital productivity) improvement. However, arable crop producing farms were characterized by extensive growth; the increasing of technical equipment supply was not accompanied with improvements in capital productivity. Investment subsidies may have played an important role in this process [Takácsné, Takács 2016].

Cost developments on organic farms

Organic farming is a method of crop and livestock production focused on fertilizer (synthetic) and pesticide-free, natural biological cycles based on a form of biological pest management. The principles of organic farming:

– a closed design management system that uses local resources,
– long-term soil fertility maintenance,
– minimal pollution associated with agricultural activities,
– preparation of a sufficient quantity of highly nutritious food,

– minimal use of fossil energy for the whole farming system,
– meeting the physiological and behavioral needs of animals kept on the farm,
– good livelihood provided to farmers and their families,
– preservation of the rural environment and non-agricultural habitats.

Based on the data of the FIBL AMI Survey [2016] intensive development can be observed in organic farms. The main results of the latest survey on certified organic agriculture worldwide show (data end of 2013) that 43.7 million hectares of agricultural land are managed organically by 2.3 million producers. The regions with the largest areas of organically managed agricultural land are Oceania (17.3 million hectares or 40% of the global organic farmland), Europe (11.6 million hectares or 27% of the global organic farmland) and Latin America (6.8 million hectares or 15%). On a global level, organic agricultural land area increased by 0.5 million hectares compared with 2013. The countries with the most organic agricultural land are Australia (17.1 million hectares), Argentina (3.1 million hectares) and the United States (2.2 million hectares).

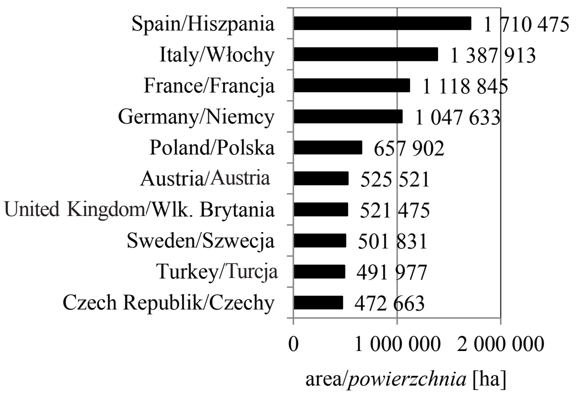

Figure 2. Europe: The ten countries with the largest organic area (2014)
Rysunek 2. Europa: Dziesięć krajów o największej powierzchni organicznej (2014)
Source/*Źródło:* FIBL AMI Survey [2016]

The countries with the highest per capita organic consumption in Europe in 2014 was Switzerland at 221 Euros in 2014, followed by Luxembourg, Denmark, Sweden, Liechtenstein, Austria, and Germany. The organic share of the total food market is highest in Denmark (7.6%), Switzerland (7.1%) and Austria (6.5%). Retail sales in 2014 totalled 23.9 billion Euros in the European Union and 26.2 billion in Europe. The four biggest markets were Germany (7.9 billion Euros), France (4.8 billion Euros), the UK (2.3 billion Euros) and Italy (2.1 billion Euros). The first market data available for 2015 show that growth continues in these large markets. In a global context, the US is the largest market (27.1 billion Euros with a per capita consumption of 85 Euros in 2014), followed by Germany.

As well as the markets, the area of land under organic cultivation also continued to grow: by almost 0.3 million hectares. Organically cultivated land constitutes 11.6 million hectares in Europe and 10.3 million hectares in the European Union, which is 2.4 % and 5.7% of total agricultural land respectively. The European countries with the most organic land are Spain (1.7 million hectares), Italy (1.4 million hectares), France (1.1 million hectares) and Germany (1.0 million hectares). Figure 2 shows the ten European countries with the largest organic area.

In the case of organic farming it is important to take into consideration the use of these costs in that the farmer should not be forced to maximize his/her profits. The quality of the environment at its (animal welfare, the aesthetic landscape, harmless food) present value is more important for the farmer than actual profit. The profit simply acts as a tool, not an aim, the goal is to enhance the quality of life.

Summary and conclusions

The direct and indirect costs of factors amount to the total cost. Over the last few years, the cost has increased, but nowadays, total machine operating costs (compared to previous years) has decreased with by an average 1.5% regarding tractors and increased by 5.6% when it comes to equipment in 2016. Production costs constituted a significant proportion of machine operation, therefore it is important to focus attention on the possibilities of using machines in a more efficient and less expensive manner. To improve the current situation, all managers should be aware of prices, production costs, profitability, as well as factors influencing them.

In practice, utilising machines has an impact on many factors. In order to improve effectiveness, producers need to increase efficiency, the quality and discipline of work, and reduce costs. The prerequisite for good management and development decisions is to be aware of the achievement, cost data and fuel consumption of machines.

Based on various domestic studies, it can be stated that some factors of machine operation costs are gradually changing and, therefore to ensure a profitable management it is necessary to economize costs.

What is most important is to improve the utilization of machines and increase annual performance as with better management, this can significantly improve the annual number of working hours, working hours per kWh or nha, as well as output, as a result of which, specific machine operating costs may decrease. Others believe that good farm and board size, appropriate choice of tractors, power engines, machine selection connections, careful maintenance and repairs, as well as the timely exchange of machines are key.

A description of detailed cost figures and costing methods can be found in the NARIC MGI booklet, entitled: Agricultural machine operation costs in 2016.

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Streszczenie

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