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# CHALLENGES FOR THE DEVELOPMENT OF AGRICULTURAL POWER MACHINES AND THEIR OPERATING COSTS IN HUNGARY

*WYZWANIA W ZAKRESIE ROZWOJU MASZYN ROLNICZYCH I ICH KOSZTÓW OPERACYJNYCH NA WĘGRZECH*

**Key words: equipment, farm data, market, performance**
*Słowa kluczowe: sprzęt, dane gospodarstwa, rynek, wydajność*
*JEL codes: O13, Q11, Q13*

**Abstract.** One of the most important factors of competitive production is mechanization, which enables tasks to be done on time and in a high-quality manner. Nowadays, in Hungary, many distributors deal with the trading of agricultural machines and spare parts. The operating costs of these machines constitute a significant proportion of the expenses involved in agricultural production, and thus the appropriate and inappropriate use of machinery can significantly influence the efficiency of farming. The goal of this study is to present the market of agricultural power machines, examine the operating costs and analyse the causes of changes in the Hungarian machinery market during the past few years. In our research, it can be seen that EU co-financed support for machinery and equipment investment have a great impact on the replacement of power machines and average annual usage, since after EU subsidies are no longer incoming, the number of agricultural machines sold has decreased.

## Introduction

Mechanization is an important factor of successful economic processes [Némediné Kollár, Neszmélyi 2015].The most modern and latest models of agricultural equipment are available for farmers in Hungary. Nowadays, the portfolio of machines is very diverse and broad, but the agricultural machinery market is very concentrated. 70% of total agricultural machinery sales were conducted by 10 distributors. 53% of total Hungarian machine sales were concentrated in three largest manufacturers and dealers [AKI 2018].

During summer 2013, the Hungarian Central Statistical Office carried out a detailed survey of the number of farm machines in Hungarian agriculture. In December 2013, this Statistical Office also recorded the average age of power machines. The Research Institute of Agricultural Economics compiles a statistical report on Hungarian agricultural markets every year, which also includes economic data of agricultural machinery and spare parts investment. The National Agricultural Research and Innovation Centre (NARIC) at the Hungarian Institute of Agricultural Engineering annually monitors operating costs. In other words, the Institute carries out the observation of machines on so called "base farms". These farms are well-managed large units.

## Material and methods

Agricultural machinery includes many types of equipment. In our research, the kinds of power machines are as follows: tractors, combines (wheat, maize), self-propelled harvesters, self-propelled loaders, other self-propelled machines, and agricultural trucks.

Total operating costs are the sum of the following expenses: fuel and lubricants, labour, repair and maintenance, machinery depreciation, other (insurance, equipment storage), fixed as well as current assets and general costs associated with machines. The research includes statistical data between 2013 and 2017.

## Research results

### Data of agricultural equipment in Hungary

In 2013, a detailed survey of the numbers and average age of power machines was carried out by the Hungarian Central Statistical Office on Hungarian agriculture [KSH 2014]. Table 1 shows the average age of power machines at the end of 2013. According to the data of the Hungarian Central Statistical Office, the average age of machines was 18.3. The economic life of a machine is the number of years over which costs are to be estimated. It is often less than the machine's service life. This means that total service time is ca. 35-37 years in Hungary.

Table 1. Age of agricultural power machines (in December, 2013)

| Agricultural equipment | Average age [years] | Rate [%] | | | |
|---|---|---|---|---|---|
| | | <10 years | 11-20 years | 21-30 years | < 30 years |
| Corporation | | | | | |
| Tractors | 13.7 | 47.4 | 28.9 | 23.7 | 4.3 |
| < 8 kW | 11.7 | 52.4 | 33.6 | 14.0 | 0.7 |
| 8-20 kW | 14.8 | 44.0 | 27.1 | 28.8 | 4.9 |
| 21-40 kW | 19.9 | 24.0 | 29.4 | 46.6 | 13.6 |
| 41-60 kW | 18.5 | 23.5 | 35.4 | 41.1 | 6.4 |
| 61-100 kW | 10.4 | 61.6 | 28.3 | 10.0 | 1.6 |
| >100 kW | 10.9 | 62.8 | 22.4 | 14.8 | 3.0 |
| Combines | 10.8 | 57.6 | 31.4 | 11.0 | 1.2 |
| Other self-propelled machines | 11.5 | 59.9 | 24.0 | 16.1 | 4.0 |
| Total of power machines | 13.1 | 50.0 | 28.6 | 21.4 | 3.8 |
| Sole proprietorship | | | | | |
| Tractors | 20.5 | 24.2 | 33.4 | 42.4 | 18.4 |
| < 8 kW | 19.9 | 27.5 | 34.5 | 38.0 | 20.7 |
| 8-20 kW | 22.4 | 15.6 | 34.6 | 49.8 | 17.4 |
| 21-40 kW | 27.3 | 10.4 | 23.9 | 65.8 | 38.6 |
| 41-60 kW | 21.5 | 14.6 | 40.1 | 45.3 | 16.6 |
| 61-100 kW | 15.0 | 41.9 | 34.8 | 23.3 | 7.5 |
| > 100 kW | 13.6 | 50.5 | 27.1 | 22.4 | 7.0 |
| Combines | 17.4 | 33.6 | 34.2 | 32.2 | 10.5 |
| Other self-propelled machines | 18.4 | 31.9 | 27.6 | 40.5 | 12.3 |
| Total of power machines | 19.7 | 25.7 | 34.7 | 39.6 | 16.5 |

| Average age of machines [years] | |
|---|---|
| Tractors | 19.3 |
| Combines | 15.4 |
| Other self-propelled machines | 15.1 |
| Total of power machines | 18.3 |

Source: [KSH 2014]

It can be seen in Table 1 that most of the machines are 10 years old or younger with a higher kilowatt "size" in corporations and between 21 and 30 years old in sole proprietorships. The capacity of engine power per agricultural area is significant, however the number of machines per farm is very low (0.253 piece/per farms). In order to solve this situation, farmers outsource agricultural work.

In Hungary, the number of tractors exceeded 100 000 in the early 2000s [WorldBank 2017]. The average kilowatt "size" of power machines was 95.4 kW/piece in corporations, while 61.6 kW/piece in sole proprietorships in 2013 (see tab. 2). It can be seen that in case of corporations this number is higher because land area is bigger than in sole proprietorships, thus they can work at lower costs.

According to the data of the Research Institute of Agricultural Economics, the agricultural machinery market in Hungary is characterized by fluctuation since one of the most important factors regarding numbers is the availability of EU funding [AKI 2017a,b]. The machinery market responded strongly to the opening of support for machinery purchase funding, and once subsidies ended, machine sales decreased.

The number of agricultural machinery sales in the world market is variable. Total agricultural machinery sales increased between 2010 and 2013, the highest turnover (EUR 103 billion) in the world took place in 2013 [AKI 2018]. At the same time, the expansion of the Hungarian machinery market continued until 2014 (more than HUF 160 billion in 2014) and the number of sales declined in 2015 due to the closure of funding (about HUF 123 billion in 2016) (see fig. 1). In 2017, precision farming became

Table 2. Main data of agricultural equipment in Hungary (2013)

| Data | Corporation | Sole proprietorship |
|---|---|---|
| Agricultural area [thous. ha] | 2 155 | 2 435 |
| Number of farms | 8 442 | 484 723 |
| Agricultural area per farms [ha] | 255 | 5 |
| Number | | |
| Tractors | 21,927 | 98,960 |
| Combines | 3,365 | 7,405 |
| Other self-propelled harvesters | 6,409 | 5,937 |
| Agricultural trucks | 4,983 | 10,624 |
| Power machines | 35,956 | 122,926 |
| Engine power [thous. kW] | | |
| Tractors | 1,891.2 | 5,544.3 |
| Combines | 677.4 | 1,033.0 |
| Other self-propelled harvesters | 133.0 | 64.2 |
| Self-propelled loaders | 165.0 | 92.0 |
| Other self-propelled power machines | 201.5 | 141.1 |
| Agricultural trucks | 360.6 | 703.1 |
| Power machines | 3,428.7 | 7,577.7 |
| Engine power [kW/piece] | | |
| Tractors | 89.2 | 56.0 |
| Combines | 201.3 | 139.5 |
| Other self-propelled harvesters | 155.5 | 77.3 |
| Self-propelled loaders | 55.0 | 46.0 |
| Other self-propelled power machines | 78.9 | 45.4 |
| Agricultural trucks | 72.4 | 66.2 |
| Power machines | 95.4 | 61.6 |
| Number of machines per thous. ha agricultural area | | |
| Tractors | 9.84 | 40.64 |
| Combines | 1.56 | 3.04 |
| Other self-propelled harvesters | 0.40 | 0.34 |
| Self-propelled loaders | 1.39 | 0.82 |
| Other self-propelled power machines | 1.19 | 1.28 |
| Agricultural trucks | 2.31 | 4.36 |
| Power machines | 16.68 | 50.48 |
| Engine power [kW per thous. ha agricultural area] | | |
| Tractors | 877.5 | 2,267.7 |
| Combines | 314.3 | 424.2 |
| Other self-propelled harvesters | 61.7 | 26.3 |
| Self-propelled loaders | 76.6 | 37.8 |
| Other self-propelled power machines | 93.5 | 57.9 |
| Agricultural trucks | 167.3 | 288.7 |
| Power machines | 1,590.9 | 3,111.7 |

Source: [KSH 2014]

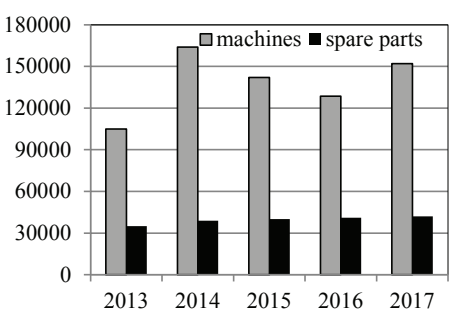


Figure 1. Machines and spare parts sales in Hungary between 2013 and 2017
Source: [AKI 2018]

a very important strategy factor, thus the number of sales started to grow.

The values in table 3 show the number of tractors sold in 2014 constituted roughly 50% more compared to the previous year. 371 combines were sold in 2015, constituting 40% more than a year earlier. It was an intensive year in EU agricultural subsidies to farmers. 2864 tractors were sold in 2017, which was 26% more than a year earlier. In addition to the sales of new equipment, the market of spare parts has doubled over the last ten years, which may indicate that despite funding and sales, the lifetime of machines has increased (AKI 2017a,b). In 2016, 61% of total agricultural machinery investments were related to power machines and 39%to others. Investment decreased by 39% in 2016 compared to 2014, while demand for more powerful machines has grown rapidly in the market. Tractors with an engine power of 37-74 kW were the best-selling machines in 2017, although the number of sales of tractors over 141 kW has also increased in recent years.

The tables imply that the Hungarian machinery market is characterized by a quantity change and the demand of new machines depends on the availability of EU and/or national funding. In recent years, the average productivity of Hungarian agriculture has improved, which is due not only to the increase of technical equipment but also to the improvement of

Table 3. Number of machines sold in Hungary between 2013 and 2017 (item)

| Agricultural machine and engine size | 2013 | 2014 | 2015 | 2016 | Agricultural machine and engine size | 2017 |
|---|---|---|---|---|---|---|
| Tractors: | 1,967 | 3,737 | 2,777 | 2 279 | Tractors: | 2,864 |
| ≤44 kW | 170 | 216 | 280 | 200 | ≤36 kW | 299 |
| 45-66 kW | 575 | 936 | 581 | 355 | 37-74 kW | 1,059 |
| 67-103 kW | 709 | 1,651 | 1,252 | 972 | 75-103 kW | 670 |
| 104-140 kW | 245 | 517 | 313 | 305 | 104-140 kW | 336 |
| 141-191 kW | 124 | 265 | 189 | 218 | 141-191 kW | 229 |
| 192-235 kW | 51 | 74 | 80 | 113 | 192-235 kW | 141 |
| ≥236 kW | 93 | 78 | 82 | 116 | ≥236 kW | 130 |
| Combines | 272 | 264 | 371 | 314 | Combines | 307 |
| Self-propelled loaders | 315 | 630 | 375 | 338 | Self-propelled loaders | 527 |
| Balers | 331 | 666 | 287 | 411 | Balers | 479 |

Source: [AKI 2017a, 2017b, 2018]

asset efficiency. At the same time, arable crop producing farms were characterized by growth. The increase 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].

The National Agricultural Research and Innovation Centre (Hungarian Institute of Agricultural Engineering) annually monitors the operating costs based on Hungarian farm data. As Table 4 shows, these data are similar to the above data, although the average age of machines is younger than the national average. Examining the capacities of machines, it can be noted that the proportion of engine power of 151 and 250 kW grew most notably by 2015 (37.6% of machines). Farm data have changed only slightly in recent years (e.g. average size of farms, number of agricultural machines, and average age of machines, etc.). Investment in machinery is slow and not intensive, therefore the average age of machines has not decreased during previous years. A typical owner replaces equipment and buys a new one after ca. 12 years, however The Hungarian Tax Code has permitted farmers to depreciate farming equipment over seven years.

## Operating costs of agricultural machinery

It is important to monitor operating costs. Operating costs can constitute 20-30% in annual total production costs [Lips, Burose 2012]. The

Table 4. Data of agricultural machines based on data of the NARIC

| Specification | 2014 | 2015 | 2016 |
|---|---|---|---|
| Capacity [kW/piece] | | | |
| Tractors | 100.3 | 96.5 | 89.2 |
| Combines | 304.3 | 293.5 | 231.8 |
| Self-propelled loaders | 65.4 | 67.4 | 65.1 |
| Other self-propelled harvesters | 375.0 | 375.0 | 375.0 |
| Other self-propelled machines | 149.3 | 153.0 | 93.0 |
| Average of power machines | 110.9 | 109.2 | 96.9 |
| Average age [years] | | | |
| Tractors | 11.6 | 12.4 | 13.4 |
| Combines | 2.3 | 3.0 | 3.0 |
| Self-propelled loaders | 16.4 | 16.0 | 17.0 |
| Other self-propelled harvesters | 2.0 | 3.0 | 0.0 |
| Other self-propelled machines | 5.4 | 6.5 | 4.3 |
| Average of power machines | 11.8 | 12.3 | 12.0 |
| Proportion of engine power [%] | | | |
| 21-40 kW | 3.1 | 3.2 | 6.2 |
| 41-75 kW | 32.4 | 32.1 | 29.1 |
| 76-150 kW | 23.0 | 21.6 | 18.5 |
| 151-250 kW | 35.5 | 37.1 | 23.6 |
| over 251 kW | 6.0 | 6.0 | 13.4 |
| Number of tractors per farms | 13.8 | 14.5 | 13.4 |
| Number of power machines per farms | 23.0 | 23.5 | 22.7 |

Source: own calculations

total operating cost of machines depends on several factors. It is important to keep in mind the optimum farm and land size to choose the most suitable equipment and most appropriate engine power. It could have a positive impact on profit when farmers choose most suitable machines. The profit of farms can increase if farmers choose more economically suitable machines. All equipment has service life, after which it becomes uneconomical and should be replaced. Typically, new equipment operates at low repair and maintenance costs. The skill of the operator, working conditions, and maintenance standards are recognized as important determinants of machinery repair costs, many aspects of which lie within the farmer's control [Morris 1988]. If farmers do not reduce their operating expenses, they will not be able to compete in the agricultural sector effectively.

Table 5. Machinery costs based on data of the NARIC

| Specification | Unit | 2014 | 2015 | 2016 | 2016/2015 [%] |
|---|---|---|---|---|---|
| Engine power per item | kW/piece | 110.9 | 109.2 | 96.9 | 88.7 |
| Annual usage of tractors | hour/piece | 1,243 | 1,255 | 967 | 77.0 |
| Annual usage of power machines | | 1,210 | 999 | 861 | 84.0 |
| Repair and maintenance costs of self-propelled power machines | HUF/ha | 21,055 | 18,298 | 19,913 | 108.8 |
| Total repair hours of power machines | hour/piece | 202.3 | 194.4 | 121.9 | 62.7 |
| Proportion of repair and maintenance costs of power machines from the total operating cost | % | 21.8 | 22.8 | 21.8 | 95.6 |
| Annual usage cost of tractors | HUF/hour | 7,618 | 7,191 | 6,596 | 91.7 |
| Annual usage cost of power machines | | 8,342 | 8,167 | 6,947 | 85.0 |
| Operating cost of tractors | HUF/ha | 57,474 | 58,383 | 61,270 | 104.9 |
| Operating cost of power machines | | 118,836 | 110,014 | 118,608 | 107.8 |

Source: own calculations

Nowadays, more machine types are offered by agricultural machinery distributors than in previous years. Farms often have several machines, thus the analysis of operating costs is more complicated and detailed operating costs of machines are generally not available. Table 5 shows the most important data of "base farms".

The total operating cost of agricultural machines per hectare is very hectic and repair and maintenance costs increased in 2016. The price of electricity decreased, as determined by the Hungarian government, therefore the total energy cost per hectare also decreased significantly.

## Summary and conclusions

Based on data of the Hungarian Central Statistical Office, the average farm size of individual farmers is still small. Most of them fail to own a machine, therefore they depend on agricultural machinery service providers. As a solution to this unfavourable situation, it is often observed that farmers concentrate on increasing equipment amount, but these are mostly old machines. In recent years, machine purchase subsidies have had a good impact on the number of agricultural power machines and average age.

According to data from the NARIC database, the average age of machines was 12 years old in 2016. The number of machines depends greatly on the availability of EU funding. Analysing the data, it can be stated that there is a lack of certain types of machines (e.g. advanced plant protection machines), while the quantity and capacity of other machines is higher than the optimal, which causes excess capacity and poor asset utilization (e.g. tractor, tillage) in Hungary.

Precision production has had an impact on machine demand growth in Hungarian agriculture. At the same time, it can be seen that on the one hand farmers are looking for modern and innovative

machines, while on the other, they buy simpler machines with lower investment costs. According to forecasts and other research results, machinery sales will continue to increase in 2018.

It is important to monitor and reduce operating costs. It is possible to reduce costs by: improving machine utilization, increasing annual performance, better organization management of machine work, choosing agricultural machines and engine capacity by farm and land size, monitoring maintenance and repair work, replacing machines in time, conducting depreciation according to the price of the machine as well as cooperating with others.

In case of long-term use of power machines, the operating cost increases significantly, thus the replace of equipment is essential. Total operating costs are difficult to estimate as they vary greatly depending on operating conditions, management, maintenance programs, local costs, etc. It is important for farmers, leaders and managers to keep in mind that favourable production costs may only be achieved by employing appropriate expertise, concentrating production, having an appropriately sized fleet of machinery and managing the use of machinery well.

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### *Streszczenie*

*Jednym z najważniejszych czynników konkurencyjnej produkcji jest jej mechanizacja, która umożliwia zapewnienie terminowości i wysokiej jakości wykonywanych prac. Obecnie na Węgrzech wielu dystrybutorów zajmuje się handlem maszynami rolniczymi i częściami zamiennymi. Koszty operacyjne tych maszyn stanowią znaczny odsetek kosztów produkcji rolnej, tym samym właściwe korzystanie z maszyn może mieć duży wpływ na wydajność gospodarowania. Celem artykułu jest przedstawienie rynku maszyn rolniczych, zbadanie kosztów operacyjnych oraz określenie przyczyn zmian zachodzących na węgierskim rynku maszyn w ostatnich latach. Z badań wynika, że finansowanie przez UE inwestycji w maszyny i sprzęt ma duży wpływ na proces wymiany maszyn oraz ich przeciętne wykorzystanie w ciągu roku, gdyż po zakończeniu dopłat ze strony UE liczba sprzedawanych maszyn rolniczych spadła.*

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