Zsolt Baranyai[*], Gábor G. Szabó[**], Miklós Vásáry[*]

[*]Szent István University, [**] Hungarian Academy of Sciences

ANALYSIS OF MACHINE USE IN HUNGARIAN AGRICULTURE – IS THERE ANY FUTURE FOR MACHINERY SHARING ARRANGEMENTS?[1]

ANALIZA WYKORZYSTANIA MASZYN W WĘGIERSKIM ROLNICTWIE – CZY JEST PRZYSZŁOŚĆ DLA ZORGANIZOWANEJ WSPÓŁPRACY?

Key words: cooperation, empirical research, asset supply, asset efficiency

Słowa kluczowe: współpraca, badania empiryczne, podaż aktywów, efektywność aktywów

Abstract. The present paper analyses the issues of asset supply in Hungarian agricultural enterprises. The results of empirical research carried out into specialized field crop farms have revealed a number of anomalies. By analyzing the indicators which describe asset supply, a substantial capacity surplus and capacity shortage existing paralelly was observed in Hungarian agriculture. Most small farms were seen to use their assets wastefully. If the costs related with machine use are modelled, a close negative correlation between farm size and machine use cost is observed. On the basis of cost structure examination and former conclusions, a clear affirmative answer can be given to the question in the title. Unfortunately, the present farming practice is that farms with capacity shortage procure the required resources in the form of renting services and not by way of other cooperation arrangement solutions.

Introduction

The Hungarian farm structure has been coping with structural problems ever since post- socialist transition. Today, almost half of crop land is cultivated by farms of smaller size units. In their case, economies of scale cannot be utilised. This is an especially serious problem in respect to the use of technical resources (e.g. machinery) – in addition to a number of other areas. This school of thought is supported by the research report of Magó [2013] who says that the rather variable farm structure – which was formed after the post-socialist transition in Hungarian agriculture –is not always associated with efficiency in an economic and technical sense. According to Tackás [2013], however, the fierce competition on the market of agricultural products heightens the importance of farming efficiency, which requires a rational decrease in the volume of inputs.

A considerable share of inputs in field crop farming is focused on the costs connected with machine operation, thus this can be an area where some substantial reserves can be found (to increase efficiency). Due to the above, there are a number of joint machinery sharing or investment arrangements in the smallholding structure of countries with developed agriculture, the main objective of which is the minimisation of costs through rational and efficient use of available resources. These solutions (some of which have been functioning well for decades) are seen in machine associations, machine cooperatives, machine rent, hired machinery services, as well as machinery and farm assistance rings. These have clearly proved that they can contribute to more a rational use of technical resources, thus weaking the drawbacks of capacity shortage or overmechanisation [Takács 2000, Kovács et al. 2003]. There were some trials in the 1990s to adapt these Western-European models in the Hungarian agriculture (e.g. the machinery ring movement) but, following early enthusiasm, these initiatives failed. Subsequent research carried out has identified a low ”cooperation willingness” of farmers as the main reason [Baranyai-Takács 2010].

The above-mentioned empirical experiences have motivated the present research, too. Our main objective is to answer the following question – also laid down in the title: is there any future for ma-

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chinery sharing arrangements in Hungarian agriculture? Or, is it possible that the failure of initiatives targeting machinery sharing arrangements is due to a lack of economic motivation, in other words, is not necessary or justified at all? In order to answer these questions, the following chapters of the present study – on the basis of outputs from empirical research – give detailed analysis of machinery supply within the surveyed range of farms and model the costs connected with machine use.

Material and methods

Our research is based on a primary database. A questionnaire survey was made in order to examine the available assets of agricultural holdings in the South-Eastern part of Hungary, in the Southern Great Plain, in Békés County. Information was collected through the questionnaire survey from 147 private farms altogether, specialized in field crop farming. [2]. The questions of the questionnaire – compiled in the course of empirical research – dealt with the following topics: land use, crop structure, technical resource supply as well as cooperation with other farmers in the field of machinery sharing.

There are a lot of indicators suggested in professional literature for classifying the level of technical equipment in the farms. From the selection of indicators, the number of power engines[3] (NPE) [pcs·farm^{-1}], the total rated power (TRP) [kW/farm], the average rated engine power (AEP) [kW·pcs^{-1}], average age of engines (AEE) [year], engine-density index (ESI) [pcs/100 ha] and specific capacity supply index (SCS) [kW/ha] were calculated. Asset supply could be expressed on the basis of value indicators, too. Since most of the machinery and equipment operated by the farms are old and amortised, considering the absolute (LGET) [HUF] and specific (fLGET) [HUF/ha] value of fixed machine assets according to accounting principles is not possible, and would present easily misleading results. In order to solve this problem, the market-price approach was used, that is the assets available in the farm were assessed individually, at actual market prices. The individual market value of machinery was defined on the basis of brochures, internet portals and other farmers.

The asset shortage indicator was also calculated in order to assess the level of mechanisation in the given farm and how much it can be regarded as self-supporting in respect to mechanisation. The external machine labour demand (KGMI) [HUF] was also determined as an equivalent index to express asset shortage. The specific version of the index was also calculated (fKGMI) [HUF/ha]). On the basis of technological needs arising from the production structure of farms, this indicator shows the labour value which cannot be ensured by the given farm on the basis of its own technical resource basis, so it should be procured somehow from external sources. The labour value is determined by rented service fees in the model.

In addition to the quantity aspects of asset supply, our research covered quality parameters, too. The modernisation index (MI) [-] was developed for the evaluation of asset supply of farms. The technical equipment of farms was individually evaluated in the model on a scale of 1-4 by also considering their age and relation at the same time. The modernisation index of the examined farming unit was determined as a simple arithmetic average of individual indices. The methodology of the evaluation method is based on the work of Kindler, Popp [1977]. The capacity utilisation of machinery in the agricultural enterprises was also examined through models. Calculations were made to define the average utilisation of power engines. These calculations considered only the activities within the farm. The works of Gockler (2007) and Takácsné [1994] were used as a basis in the calculations. Three cost items were considered in the modelling of costs connected with machinery use in the surveyed private farms, according to the following formula:

$$TC = VC\,(a, P, r, s) + FC\,(LGET, k) + KGMI$$

[2] It is important to note that the sample cannot be regarded representative in statistical sense, either in national or county level. On the basis of local-level representativity of the sample, however, it can be presumed that the results we got in the examined region can be generalised because this area is not really different from the key agricultural regions of the country in respect to economy and society.

[3] All kinds of technical equipment are considered engine, which have an independent power source (engine) for its operation (e.g. tractors, harvesting machines, telescoping loader, etc).

where: *TC* = total costs of machine works in the examined holding [HUF], *VC* = variable cost of machine work in relation to age (*a*) of machinery available in the holding, power category *(P)* and relation *(r)* as well as technological need of crop structure (*s*) [HUF], *FC* = total fixed costs in relation to fixed machine asset capital (*LGET*) and average yield expectation (*k*) [HUF], *KGMI* = cost of total external machine work needs [HUF]. Of course, the specific version of the index – reflected on unit area – was also calculated (fTC) [HUF/ha].

Items regarded as variable costs (VC) connected with machine use are as follows: fuel, costs of maintenance and repair, as well as some other costs. Wages and dues are not considered here because the farms typically use their own labour, which does not actually involve cash movements. The fixed costs (FC) are determined with a return expectation of 8% on assets tied in the farms.

Another important note to methodology is that the private farms were classified according to size categories on the basis of size units: (1) 0 – <4 ESU, (2) 4 – <8 ESU, (3) 8 – <16 ESU, (4) 16 – <40 ESU, (5) 40 – <100 ESU, (6) ≥ 100 ESU. These group limits are the same as the previously applied ones in Farm Accountancy Data Network (FADN). It is important to add that the typology has moved to Standard Output-based categorisation since 2010, but the former, ESU – based classification is more adequate and suitable for the objectives of the current research.

Results

The main target of our research is the analysis of machine asset supply of agricultural holdings. The full range and realistic introduction of asset supply in a holding can be carried out only by the parallel presentation of more indices. Hereinafter in the evaluation, the indicators concerning the asset supply are discussed by dividing them into two main groups and delimiting the dimensions of asset supply in terms of quality and quantity.

The indices of quantity asset supply are summarised in Table 1. The „robust" indices of quantity asset supply (number of power engines (NPE, pcs/farm), total nominal power (TRP, kW/farm), value of fixed machine asset capital (LGET, HUF), show significant – statistically proven – positive correlation. Another important experience is the considerable heterogeneity observed in asset supply which is present both among and within the size categories (see the values of standard deviation).

The specific natural indices used for the expression of quantity asset supply, such as engine density (EDI, pcs/100 ha) and specific nominal power (SCS, kW/ha) are in strong hyperbolic correlation with farm size. This phenomenon also indicates the growth of capacity exploitation.

Table 1. Values of indicators expressing quantity asset supply in the surveyed farms, broken down according to size unit categories

Tabela 1. Wartości wskaźników wyrażających ilość podaży aktywów w badanych gospodarstwach według wielkości ESU

Indicators/*Wskaźnik*	Value ESU/*Wielkość ESU*						Total/ *Razem*
	0-4	4.1-8	8.1-16	16.1-40	40.1-100	100.1-	
NPE	1.04	1.13	1.50	2.80	4.67	6.00	2.23
[pcs/farm]	*(0.36)*	*(0.55)*	*(0.69)*	*(1.47)*	*(1.94)*	*(1.60)*	*(1.77)*
TRP	35.9	52.8	84.1	217.9	426.8	513.3	159.8
[kW/farm]	*(23.7)*	*(36.2)*	*(65.2)*	*(133.7)*	*(197.0)*	*(197.5)*	*(174.9)*
LGET	1.04	2.35	3.11	14.10	27.57	46.39	10.22
[mln HUF]	*(0.76)*	*(2.26)*	*(1.79)*	*(13.23)*	*(22.25)*	*(31.80)*	*(16.74)*
EDI	19.68	8.95	7.54	4.27	3.49	2.07	8.39
[pcs/100 ha]	*(13.66)*	*(6.17)*	*(9.95)*	*(2.02)*	*(2.07)*	*(0.60)*	*(9.69)*
SCS	6.86	3.84	3.60	3.29	3.15	1.75	4.00
[kW/ha]	*(6.59)*	*(2.38)*	*(3.22)*	*(1.79)*	*(1.82)*	*(0.60)*	*(3.73)*
fLGET	203.9	170.4	153.0	200.9	191.3	152.1	182.4
[1000 HUF/ha]	*(172.3)*	*(134.2)*	*(212.2)*	*(153.2)*	*(114.8)*	*(95.9)*	*(162.1)*

( ): standard deviation/*odchylenie standardowe*

Source: own calculation

Źródło: obliczenia własne

Table 2. Values of indices expressing quality asset supply in the surveyed farms broken down according to size unit categories
Tabela 2. Wartości wskaźników wyrażających jakość podaży aktywów w badanych gospodarstwach według ESU

Indicators/*Wskaźnik*	Value ESU/*Wielkość ESU*						Total/ *Razem*
	0-4	4.1-8	8.1-16	16.1-40	40.1-100	100.1-	
AEP [kW/pcs]/[*KW/szt.]*	31.71 *(13.32)*	44.74 *(19.21)*	52.26 *(17.83)*	73.43 *(18.59)*	89.29 *(9.96)*	85.00 *(21.88)*	58.14 *(25.34)*
AEE [year]/[*rok]*	25.02 *(8.56)*	16.39 *(8.40)*	16.86 *(7.26)*	13.19 *(5.66)*	10.32 *(4.67)*	9.53 *(4.98)*	16.19 *(8.33)*
MI *[-]*	1.54 *(0.64)*	2.28 *(0.68)*	2.28 *(0.60)*	2.85 *(0.57)*	3.27 *(0.46)*	3.43 *(0.50)*	2.45 *(0.81)*

( ): standard deviation*/odchylenie standardowe*
Source: own calculation
Źródło: obliczenia własne

It is interesting, however, that this tendency emerges only weakly and distorted in the asset supply expressed in value (specific tied machine asset capital index (fLGET, HUF/ha). These phenomena can be explained by the quality parameters of asset supply because the indicators expressed in value actually have some quality information besides quantity aspects in respect to asset supply.

The other group of indicators involved in the analysis consist of quality parameters of asset supply (Tab. 2). Reviewing the quality aspects of asset supply, it can be concluded on the basis of the average rated power *(*AEP, kW/pcs), t*he average* age of power engines (AEE, year) and the modernisation index (MI), that the larger the size unit of the farm, the more typical the use of machine assets of higher performance, a more advanced category representing a higher technological level (thus a higher specific value).

According to research estimations, the utilisation of technical resources in the farms is low, 25-26% on average. It is important to note, that – according to our examinations – the growth of size unit does not necessarily entail the growth of utilisation. It has been observed that the expansion rate of capacities is parallel with or often greater than the growth of the size unit, therefore the level of capacity utilisation does not actually change. The resource utilisation of smaller holdings is badly affected by substantial asset shortage, too. These farms usually have tractors but the machine park is rather insufficient which further restricts utilisation.

The complex analysis of farm-level asset supply requires examining how the available resource supply can fulfill the technological needs of the given farming unit. The introduction of technical equipment from this aspect is made with so-called asset shortage indices. According to the index of absolute external resource need, that is resource need per farm unit (KGMI, E HUF), the market value of machine works in respect to which the farms have no appropriate assets is more than 900 thousand HUF on average. The fKGMI (E HUF/ha) index expresses the rate of asset shortage per unit of area. Its value is almost 33 thousand HUF per hectare on average. It is important to note that the fKGMI index shows a moderately strong (r = -0.58) negative correlation with size unit, which means that the asset shortage significantly decreases with the growth of size unit.

In summary, it can be concluded from the indicators of asset supply that farms typically in category 4, medium or large-scale farms, of size unit 16-40 ESU (farms with approximately 50-100 hectare arable land) can be regarded independent farms in terms of mechanisation (Fig. 1, left). Although this group is strongly heterogeneous even in this regard, there are more and more farms where the mechanisation is complete and do not need the mobilisation of external sources. This has some consequences in respect to the fixed specific asset capital. (Fig. 1, right). The tendency in the group average is that the level of average specific capital tie-up monotonously decreases to size category 4. This trend breaks in category 4, then from this higher base there is again a decline in the further categories (the group averages are marked with „*" in Fig. 1).

Our research has also explored in what form the required capacities are obtained by the farms in need of assets. In general, it can be concluded that the most typical method is hired services but there are some cooperation elements, too, in the case of a certain group of farmers, namely: machinery work based on mutuality, lending machinery to each other, joint machine purchase and use.

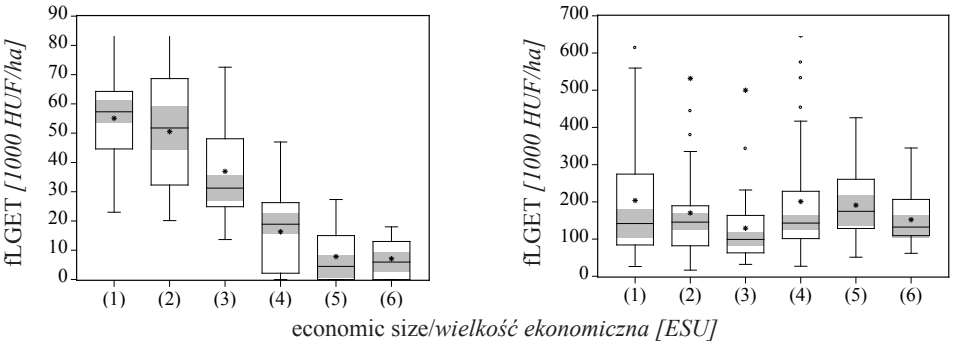

Figure 1. Boxplot analysis of asset shortage and asset supply by size unit categories
Rysunek 1. Analiza boxplot niedoboru aktywów i podaży aktywów według wielkości ESU
Source: own study
Źródło: opracowanie własne

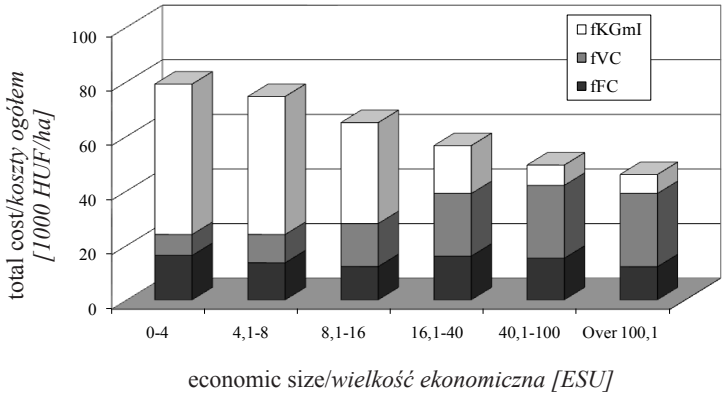

Figure 2. Costs connected with machine use by size unit categories
Rysunek 2. Koszty związane z zużyciem maszyn według wielkości ESU
Source: own study
Źródło: opracowanie własne

In the course of research we have examined the costs connected with machine use. In this regard, statistical examinations have proved that there is a close, negative correlation between size unit and costs of machine use (Fig. 2).

By breaking down the costs into components, it can be seen that the specific fixed cost (fFC, E HUF/ha) is independent from the size unit. This conclusion has serious consequences primarily in respect to smaller holdings because – in addition to the fact that they have to bear almost the same permanent costs per unit as the larger holdings – they also have a considerable external resource cost (fKGMI, E HUF/ha) due to considerable asset shortage. The pressure on them is eased by the fact that these fixed costs belong rather to the group of opportunity costs owing to the high age of machines, while typically appear as amortisation in the case of larger size units. It is a tendency in the case of specific variable costs (fVC, E HUF/ha) that the larger the size unit, the more determinant the cost components are within total costs. This phenomenon is the result of a reverse, double process: on the one hand, the costs per unit performance (costs per cultivated unit area) decline due to the use of more modern technologies of higher performance category. On the other hand, the machinery pool, which has become complete, enables labour on an own resource basis, thus increasing the weight of variable costs.

Conclusions

The current paper intends to find an answer to the question: is there any future of machinery sharing arrangements in Hungarian agriculture? The results of empirical research conducted among agricultural enterprises of Békés County prove that: "Yes, definitely there is!" Our conclusion is

supported by the following facts: the asset supply of the surveyed holdings is rather heterogeneous and analyses made on the basis of indicators reveal that substantial capacity surplus and capacity shortages are a parallel phenomenon at farm level. Machinery sharing arrangements could help to solve this problem by offering surplus capacities and – at the same time – by eliminating the deficit among the cooperating partners. Those experiences also underline the raison d'etre of cooperative arrangements which in fact confirm the low level utilisation of technical resources in case of each type of size units. Although many smaller holdings manifest wasteful asset use, the highest number and most serious anomalies, participation in cooperation have advantages for medium and large-scale farms, too. Finally, the results of modelling machine use costs lead to conclusions similar to the above: the improvement of capacity utilisation generated in the frames of cooperation arrangements could affect machine use costs positively through decreasing fixed costs in case of all size units, while ensuring the missing capacities in the frames of a cooperation can contribute to the decline of KGMI component (substantial reserves can be detected in the case of smaller holdings). At the same time, however, variable costs could also be reduced, presuming a level of cooperation involving coordinated machine investment and joint use thus enabling the use of modern, high-performance machinery.

Bibliography

Baranyai Z., Takács I. 2010: *Present and future of cooperations for joint machine use in Hungarian agriculture, [in:]* A. Bandlerova (ed.), *Rural development and structural changes of agricultural companies in agrocomplex*, Nitra, Slovakia, 2010.04.28-2010.04.29, 305 p. ,Slovak University of Agriculture, pp. 15-21.

Kindler J., Papp O. 1977: *Komplex rendszerek vizsgálata, Összemérési módszerek,* Műszaki Budapest, Könyvkiadó.

Kovács G., Nagy I., Takács I. 2003: *Connections between virtual and real large-scale agricultural enterprises. [in:]* A. Balmann, A. Lissitsa (ed.), *Studies on the agricultural and food sector in Central and Eastern Europe,* Large Farm Management, vol. 20, Konferencia helye, ideje, Halle, Németország, 2003.11.26-2003.11.28. Halle: AgriMedia GmbH, pp. 207-227.

Magó L. 2013: *Examination of the Agricultural Machine Distribution in Hungary*, Hungarian Agricultural Engineering, 25, 9-12.

Takács I. 2013: *Changes of labour productivity on farms in Central and Eastern Europe countries after European Union accession*. Annals SERiA, vol. XV, no. 5, 318-323.

Takács I. 2000*: Gépkör – jó alternatíva?* Gazdálkodás, XLIV, Évfolyam, 4. szám.

Takácsné György K. 1994: *A családi gazdálkodás méretére ható tényezők modellvizsgálata I., II*, Gazdálkodás, 38.4, 65-69, 35,5, 54-60.

Streszczenie

Celem badań była ocena problemów dotyczących dostaw produktów rolnych w węgierskich gospodarstwach rolnych. Wyniki badań przeprowadzonych na wyspecjalizowanych gospodarstwach rolnych wykazały wiele anomalii. Po analizie współczynników opisujących dostawy produktów rolnych stwierdzono znaczącą nadwyżkę wydajności, a także jej równoczesny niedobór w węgierskim rolnictwie. W większości małych gospodarstw rolnych odnotowano błędne podejście do zasobów, co skutkowało ich marnotrawstwem. Jeśli wzorować się na kosztach związanych z użytkowaniem maszyn, można zaobserwować negatywną korelację między rozmiarem gospodarstwa rolnego a kosztem użytkowania maszyn. Po zbadaniu struktury podstawowych kosztów można stwierdzić, że obecnie gospodarstwa rolne o niskiej wydajności zaopatrują się w konieczne zasoby za pośrednictwem usług płatniczych, a nie za pomocą innych rozwiązań zorganizowanej współpracy.

Correspondence address
Zsolt Baranyai, PhD, Assistant Professor, Miklós Vásáry, PhD, Assistant Professor
Szent István University
H-2103 Gödöllő, Páter K. u. 1., Hungary
e-mail: baranyai.zsolt@gtk.szie.hu, vasary.miklos@gtk.szie.hu
Gábor G. Szabó, CSc, Senior Research Fellow
Hungarian Academy of Sciences
H-1112 Budapest, Budaörsi út 45., Hungary
e-mail: szabo.gabor@krtk.mta.hu