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## DRIVERS OF MACHINERY SHARING ARRANGEMENTS EXPERIENCES OF EMPIRICAL SURVEY IN HUNGARIAN AGRICULTURE

Arpad Papp-Vary<sup>1</sup>, Judit Grotte<sup>1</sup>, Shyhrete Muriqi<sup>2</sup>, Zsolt Baranyai<sup>1</sup>

<sup>1</sup>Budapest Metropolitan University, Hungary; <sup>2</sup>Szent Istvan University, Hungary  
apappvary@metropolitan.hu, jgrotte@metropolitan.hu, muriqi.shyhrete@phd.uni-szie.hu,  
zbaranyai@metropolitan.hu

**Abstract.** Empirical evidence shows that machinery sharing arrangements in Western European countries with developed agriculture are successful and largely effective in satisfaction of the machinery capacity needs of small and medium sized farms, reduction of production costs and improving profitability (see, for example, the results of machinery rings in Germany, Austria and Switzerland). In most Central and Eastern European countries, several more or less successful attempts have been made since the 1990s to introduce machine sharing partnerships similar to the ones in Western Europe. Such efforts in Hungary proved to be a failure because of the farmers' resistance. Previous research on the topic mentioned the farmers' little willingness to cooperate as the cause of the failure. Therefore, in this study we use the results of a questionnaire survey (N = 407) to try to identify the factors affecting the farmers' willingness to cooperate. Our results show that machine sharing partnerships of farmers exist in Hungary, but their number and intensity are typically low. The most typical forms of cooperation identified by our research are: machinery work based on reciprocity; lending machinery and equipment to each other; joint ownership of machinery. Our tests based on binomial logistic regression clearly justified the effect of demographic (sex, age, level of education), economic (size of farm, type of farm, asset supply) and sociological (contractual and competence trust) factors on the farmers' cooperation activity in machinery sharing arrangements. One important result is that the effect of the abovementioned factors is differentiated according to the area of cooperation.

**Keywords:** competitiveness, machine use, trust, willingness to cooperation.

### Introduction

In recent decades, several works of relevant literature have discussed the economic – and, in a broader sense, social – effects and consequences of farmers' machine sharing partnerships. The literature also includes several studies presenting the potential advantages and disadvantages resulting from machinery sharing arrangements. We will summarise these advantages and possible disadvantages below, starting our review of the literature with presentation of the advantages.

1. Reduction of capital requirement (cost of capital). The rapid technical progress in agriculture has led to the appearance of tools with increasing performance, delivering more and more services. At the same time, investment into these instruments results in increased capital tied up in production, whose recovery is only possible in the case of higher productivity and utilisation levels. It is evident that capacity utilisation improves in line with the increase in the size of the cultivated area, thus machine sharing contributes greatly to creation of conditions for economical use of machinery. Partnerships enable a more intensive use of machinery and tools, which results in a decrease in fixed costs per unit area [1;2]. Further advantages include that the reduction of capital requirement allows for investments realised through self-financing, therefore, there is no need for bank loans (or less of them are needed), which may also decrease the interest costs to be paid significantly [3]. Various sources from literature use empirical data to justify the decrease of tied-up capital resulting from machinery sharing [4;5].

2. The opportunity of using more modern technology. A further significant advantage of farmer partnerships involving machine sharing is that such cooperations enable the procurement of modern, high-performance technologies, machines and tools in an economically realistic way. Through the use of a better technology, development of the quantitative and qualitative parameters of produced crops can be projected, and harvesting losses can be avoided (or at least decreased) [3]. Further references also suggest that more modern technical and technological standards may result in improvement of the working conditions, which may increase labour productivity through the comfort of the operator, and they are also important because of the aspects of occupational health [4]. Alternative production trends requiring application of more modern technologies have attracted increasing attention in the field of agricultural production (see, for example, issues of precision nutrient management and plant

protection) [6]. As the establishment of these technologies represents significant investment items, the abovementioned partnerships may also be of great help in the promotion of this cause.

3. The opportunity of specialisation. Farmers' partnership agreements enable independent farmers to specialise in different tasks in their own farms. As a result of the farmers' proficiency and experience, the opportunity of specialisation may improve the productivity of labour and the quality of the work done. Their professional use of machinery also allows for realisation of significant savings in the field of unit costs of maintenance and repair [3;4].

4. Risk sharing. In many respects, agricultural production is considered one of the riskiest activities. Besides environmental and biological factors (e.g., weather, parasites, diseases) the market also presents a number of risks (both on the input and output sides), creating a degree of uncertainty regarding the size of the farmers' incomes. Therefore, partnerships with sharing of costs at least on the input side (e.g., costs of machine use) may be attractive to farmers with a strong aversion to risks. Partnership agreements including both the input and the output side (with sharing of production costs and the income from production) represent the highest level of risk sharing, and consequently, risk reduction [3]. In connection with sharing of risk, Larsen also mentions that, if farmers jointly purchase a new machine or other means of production, the risk of the new, unknown technology is also shared between the farmers investing in the new tool [7].

The relevant literature also discusses the possible disadvantages of machine sharing partnerships as follows:

1. Moral hazard problem. A central question of relevant literature on machine sharing partnerships is moral risk. The literature identifies two types of moral hazard: effort moral hazard and asset moral hazard. [8] Asset moral hazard is created, if the user of the tool does not take account of the preservation of the long-term value of the tool used (and/or is not interested in it), because he/she is not an owner of the tool, or he/she is only a co-owner [9; 10]. Consequently, the person misuses it, or wears it out too soon. As a matter of fact, the imperfect control over machinery (in the case of joint ownership, machine rental or leasing) may result in damage to the machinery, failure to carry out mandatory maintenance or a lack of necessary repairs in the case of technical problems. In terms of its content, the so-called effort moral hazard basically embodies the free-rider problem behaviour. If the personal efforts of individuals are less observable and identifiable within the group, but they benefit from the results to the same extent, the members of the group are encouraged to invest less energy in group work [11].

2. Timeliness cost. Time is a very important resource and production factor of agricultural production. For most operations, performance of a specific task in an inappropriate time can prove very costly for the farmer [12;13]. Examples include plant protection activities in the case of pests. If protection against pests is provided belatedly, the farmer may suffer significant damage both quantitatively and qualitatively. The literature calls this cost the "timeliness cost" [7].

3. Other. Based on his empirical experiences, Haag reports of disadvantages and difficulties in connection with machine sharing partnerships including the loss of independence (or giving it up forcedly), deterioration of (brand) image, and sometimes professional jealousy or envy. He also mentions the generation gap and farmers' pride as possible sources of problems [4].

Despite their undoubted benefits, empirical experiences show that the full potential of cooperation has not yet been reached in most European Union countries; this is especially true of new member countries, including Hungary [14;15]. This is all very unfortunate, because farmers' partnerships and coordination by farmers' organisations (e.g., POs) have become an issue of competitiveness and efficiency for the whole Hungarian food industry. The situation is also a consequence of the dual (and in many sectors, atomised) property and plant structure, and it is especially true of the period following Hungary's accession to the EU. Therefore, research aimed at cooperation and collaboration is essential, because its results may benefit the whole society and economy.

In connection with the abovementioned problem areas, the aim of the present study is to identify the factors affecting the cooperation activity of Hungarian agricultural farmers in the field of machine sharing, and explore the reasons that encourage the farmers to cooperate or abstain from cooperation.

## Materials and methods

In order to explore the factors affecting cooperation activity in the field of machine sharing, we conducted an online survey in the Southern Great Plain (Dél-Alföld) region of Hungary between May and October 2017. A total of 407 farmers provided information for the research ( $N = 407$ ). We consider it important to note that the sample cannot be considered statistically representative at a regional or national level because of the data collection methods used.

The logical structure of the examination is represented in Figure 1. We created binomial logistic regression models in order to explain the cooperation activity, and the cooperation activity was included as a dependent variable in a binary format (does not cooperate – 0; cooperates – 1).

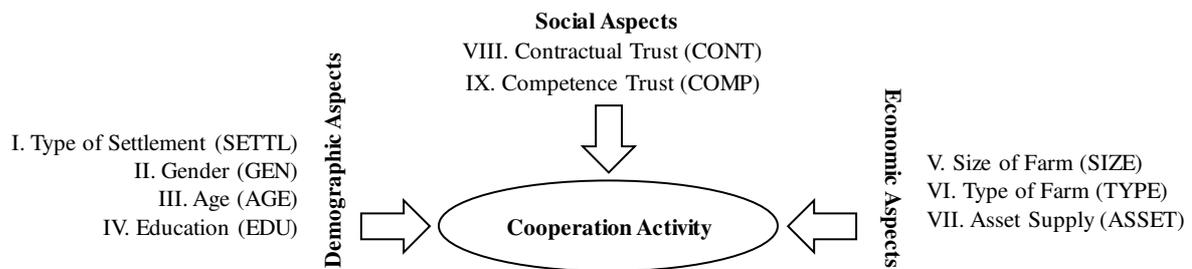


Fig. 1. Logical model of examinations

We created 3 groups of implied explanatory variables and included 9 variables in the model using the “Enter” method: I. Type of Settlement: the type of settlement serving as the residence of the farm (and probably the residence of the farmer) [(1) settlement with less than 2000 inhabitants; (2) settlement with 2000-5000 inhabitants; (3) settlement with more than 5000 inhabitants]; II. Gender: the gender of the primary manager of the farm [(1) male; (2) female]; III. Age: the age of the primary decision-maker of the farm [years]; IV. Education: the highest level of education attained by the manager of the farm [(1) less than 8 years in primary school in the Hungarian education system; (2) primary school completed in the Hungarian education system (8 years); (3) vocational school; (4) secondary school; (5) technical institute (post-secondary); (6) college or BA, BSc; (7) university or MA, MSc, or PhD]; V. Size of Farm: the size of agricultural land used by the farm [(1) 0-10 ha; (2) 10-100 ha; (3) over 100 ha]; VI. Type of Farm: agricultural activity providing the greater part of the annual revenue: 1 – plant production; 2 – animal husbandry. VII. Asset Supply: the estimated market value of the machinery and tools used by the farms [HUF]; VIII. Level of Contractual Trust<sup>1</sup>: the farmers’ responses to the statement “I trust that my fellow farmers always adhere to their word” on the 1-5 Likert scale (1 – Strongly disagree; 5 – Strongly agree.). IX. Level of Competence Trust: the farmers’ responses to the statement “I trust that my fellow farmers are properly trained and possess the competence and knowledge necessary for farming” on the 1-5 Likert scale (1 – Strongly disagree; 5 – Strongly agree.). Of the 9 variables, I, IV and V were used as categorical variables, and the last category was marked as a reference value in each case.

## Results and discussion

A key objective of this research was to provide an assessment of the farmers’ cooperation activity. In our experience, 57 % of the farms included in the sample (232 farms) are members of some machine sharing partnership. The survey identified 3 types of machinery sharing agreements:

<sup>1</sup> Trust is very important in relationships between people, therefore, it is of utmost importance in farmers’ partnerships. Several definitions of trust have been created in the past one or two decades, and we selected Sako’s definition for our present study. According to Sako, trust is an expectation held by one trading partner about another that the other behaves or responds in a predictable and mutually expected manner. The researcher defines two types of trust in business relationships: (1) Contractual Trust rests on a shared moral norm of honesty and promise keeping; an expectation held by one trading partner about another that the other partner will keep the promises; (2.) Competence Trust refers to the business partner’s expectation that the other party has the technical and managerial competencies to perform the task it has undertaken [16].

machinery work based on reciprocity<sup>2</sup>; lending machinery and equipment to each other<sup>3</sup>; joint ownership and use of machinery<sup>4</sup>. Having examined the activity according to fields of cooperation, our findings show that the activity rate value of machinery work based on reciprocity is 50 %, that of lending machinery and equipment to each other is 34 %, while that of joint ownership is 14 %.

The results of the survey indicate that 43 % of farmers are not willing to join any machinery sharing partnerships or participate in them. The results of our attempt to explore the causes of passivity among non-cooperating farmers show that the most important reasons are: the need to maintain their autonomy/independence, the lack of (economic and technological) compulsion, and the lack of another farmer in the immediate environment with whom cooperation could be established.

In our logical model (Figure 1) we identified seven factors that are believed to affect the farmers' cooperation activity. Hereinafter, we will provide a brief description of the sample based on these factors. In terms of demographic characteristics, we can state that the residence of almost a half of the farms examined is located in settlements with 2000-5000 inhabitants, while the residence of one in three responding farmers is located in settlements with less than 2000 inhabitants. In settlements with large population of more than 5000 inhabitants (typically, cities), 15 % of respondents are engaged in agricultural activity. Our examination regarding the gender of the farmers shows that males are the primary managers of the farm in almost three quarters of the cases (73 %). The average age is 54.4 years, which indicates that the farmer society in Hungary is aging rapidly. Considering the highest level of education attained by the manager of the farm, our data show that the situation is favourable: nearly one-third of respondents have a higher education degree (6 and 7), while almost 60 % of farmers have some kind of a secondary degree (3, 4 and 5). Only 7.1 % of respondents mentioned the completion of primary school (2) or the lack thereof (1) as the highest level of education attained.

In terms of economic factors, the size of farms was expressed by the size of the agricultural land used by the farm. The ratio of farms with a smaller piece of land (0-10 ha) was almost 20 %, while that of middle-sized farms exceeds 50 %. The weight of farms with more than 100 hectares of agricultural land was cca. 30 %. In terms of farm types, the farms were divided into groups of plant production (81.2 %) and animal husbandry (18.8 %), based on the agricultural activity providing the greater part of the annual revenue.

During the data collection stage we defined that the criterion for inclusion in the sample is that the respondent should possess at least one automotive machine (e.g., tractor, combine harvester, self-propelled loader). Having surveyed the equipment of the farms, we used market price estimates to define the amount of capital tied up in farms with an average value of almost 21.3 million HUF (cca. 65,000 EUR).

We also examined the level of trust among farmers in two dimensions according to Sako. The results show that the average level of competence trust among farmers (3.81) is higher than that of contractual trust (3.64), but this difference is irrelevant in a statistical sense.

Hereinafter we will summarise the experiences of running our logistic model. However, in order to validate the statistical model, we find it important to explain some technical details before the presentation of the results. Indicators showing the fit of the model include the Cox&Snell R<sup>2</sup> value (0.291) and the Nagelkerke R<sup>2</sup> value (0.325). The explained value representing the relationship between all values of heterogeneity is 0.218, which is reassuringly high. According to the classification table of the model, compared with the accuracy of the estimate merely based on modus (the ratio of cooperating farms is 57.2 %!), a forecast/estimation accuracy of 78.4 % can be achieved with the model, which is a significant improvement according to the related statistical tests (cross-

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<sup>2</sup> Typically they are agreements where the farmers' work for each other based on reciprocity, involving their own assets.

<sup>3</sup> This solution involves cooperation of farmers where they lend their own machinery and equipment to fellow farmers.

<sup>4</sup> In this kind of cooperation, farmers make a common investment and use the acquired technical resources collectively.

table analysis). Thus, the validity of our statistical model is justified, and its results can be generalised. The most important outputs of the model are summarised in Table 1.

Table 1  
**Factors affecting cooperation activity – outputs of the binomial logistic regression model**

Factors	B	Exp(B)	CI95 % for Exp(B)		Sig.	R
			Lower	Upper		
SETTL	-	-	-	-	0.002	0.057
SETTL(1)	0.434	1.527	0.822	2.292	0.016	0.021
SETTL(2)	0.073	0.919	0.718	1.170	0.741	-
GEN	-0.401	0.641	0.386	0.996	0.041	0.055
AGE	-0.223	0.955	0.914	1.236	0.000	0.176
EDU	-	-	-	-	0.000	0.102
EDU(1)	-1.881	0.291	0.210	0.472	0.007	0.055
EDU(2)	-1.854	0.329	0.218	0.540	0.015	0.046
EDU(3)	-0.889	0.411	0.271	0.591	0.002	0.090
EDU(4)	-0.913	0.419	0.400	0.596	0.013	0.057
EDU(5)	-1.148	0.544	0.124	0.953	0.060	0.030
EDU(6)	-0.261	0.997	0.459	1.958	0.090	0.023
SIZE	-	-	-	-	0.000	0.202
SIZE (1)	-1.119	0.745	0.502	1.098	0.000	0.102
SIZE (2)	4.181	1.724	1.251	2.564	0.000	0.176
TYPE	-0.561	0.471	0.305	0.720	0.004	0.073
ASSET	0.211	0,851	0.526	0.996	0.044	0.036
CONT	0.215	1.026	0.971	1.480	0.000	0.122
COMP	0.578	1.411	1.075	1.581	0.000	0.248
Constant	2.411	31.187	-	-	0.000	-

The results of our examination show that our assumption was correct, and all the 9 variables involved affect the activity in a way that can be validated statistically ( $p < 0.05$ ). Based on the R value, we can state that the farm size competence trust (COMP) plays the most significant role in the changes of cooperation activity (0.248), which is followed by the partial effect of the farm size (SIZE) (0.202) and age (AGE) (0.176).

Our statistical model ranked the partial effect of “Type of Settlement” as one of the lowest; however, this effect is still significant (sig.: 0.002). As mentioned above, this variable was included in the model as a categorical variable, where the reference value is represented by the last category in the case of such variables, that is, the group of farmers in settlements with more than 5000 inhabitants in this case. In summary, we can state that the likelihood of cooperation activity is higher in smaller settlements, probably as a result of better awareness and closer ties. This is also expressed by the SETTL (1) Exp(B) value, that is, the farmers’ cooperation in settlements with less than 2000 inhabitants is 1.527 times more likely than that of the farmers in settlements with more than 5000 inhabitants. Nevertheless, it is important to mention that the cooperation activity of the farmers in settlements with 2-5000 inhabitants and that of the farmers in settlements with more than 5000 inhabitants do not differ in substance.

Our model also justified that the effect of the gender (GEN) is also significant in terms of cooperation activity. Our results show that farms with females as primary managers are less characterised by cooperation. In the group of men-led farms the likelihood of cooperation is 1.560 times higher (1/0.641).

Demographic characteristics with significant effect also include the age and the highest level of education attained. In terms of the direction of the relationship, the likelihood of cooperation declines with advancing age, while a clearly positive relation can be observed between the highest level of education attained and cooperation activity: as we are moving upwards among the categories of education, we see an increasing value for Exp(B), which means that the likelihood of cooperation

increases in line with the higher level of education attained, as compared to the group with the highest level of education attained (7), where cooperation activity is the highest.

Our results show that the effect of the economic factors involved in the survey on changing the willingness to cooperate is also justified. In terms of the farm size, it was found that cooperation is most typical of middle-sized (10-100 ha) farms, while the smallest farms feature the least cooperation, probably because of their low economic motivation. According to the estimates of our model, the farm type is a factor that has a statistically verifiable impact on the farmers' willingness to cooperate. As for the direction of the relationship revealed, the likelihood of cooperation is 1.41 times higher in the group of the farms producing plants than in the group of the farms engaged in animal husbandry. Finally, the partial effect of tool resources proved to be significant among the economic factors, and the direction of the relationship is positive, that is increasing of assets goes in line with increasing the likelihood of cooperation (although only slightly).

Our research also managed to justify the correlation between the level of trust and the formation of cooperation activity. As it was expected, the increase in the level of trust also increases the likelihood of cooperation. However, significant differences may be identified on the level of trust dimensions: the positive effect of competence trust on the farmers' willingness to cooperate is larger than that of contractual trust.

We find it important to mention that our findings overlap with the results of previous researches. Karli et al. 2006 [17], Kőszegi 2016 [18] and Shyhrete et al. 2019 [19] also revealed a close and positive connection between the farmers' cooperation activity and their educational attainment level: they proved that a higher level of education results in higher cooperation activity. The positive effect of trust on the cooperation activity was also empirically proven [3;17;19]. Research on connection of the farm size and cooperation activity also justified that cooperation is an attractive alternative mostly for medium-sized farms, considering decreasing of the production costs and increasing of profitability [20].

## Conclusions

The cooperation activity of farmers is one of the relatively less researched areas in the literature of agricultural economy. In our opinion, the results of the present research are also useful, because they greatly contribute to the identification of the demographic, economic and social factors of machinery sharing agreements. According to our statistical model, younger farmers living in small settlements with higher school qualifications show higher activity that can be proved statistically, while farms managed by females are less characterised by cooperation. Our calculations show that participation in cooperation is most characteristic of medium-sized farms, while our analysis of the farm types found that plant producing farms are more open to cooperation than farms active in animal husbandry. Finally, our analysis explored a strong and positive connection between the level of trust among farmers and their cooperation activity.

Based on the results of our research, we also formulated suggestions for development of the cooperation activity. In accordance with other researches, our examinations have justified the positive effect of the education attainment level on the willingness to cooperation, which highlights the importance of farmers' education and training. In terms of cooperation, the issue of trust was also identified as an important factor. According to the approach of trust examined by our study, machinery sharing agreements are more connected to competence trust, which can also be developed through education and training within the farming community. At the same time, we found that contractual trust is also an important factor, which can be particularly realised through various community development programmes.

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