SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2025
ORGANIZATION AND MANAGEMENT SERIES NO. 230

THE ROLE OF SUPPORT IN SHAPING FARMS' INVESTMENT AND EFFICIENCY: EVIDENCE FROM LITHUANIA

Wirginia ROZUMOWSKA[1*], Aistė GALNAITYTĖ[2]

[1] Katedra Finansów Korporacji, Wydział Ekonomiczno-Socjologiczny, Uniwersytet Łódzki, Łódź, Poland; virginia.namiotko@gmail.com, ORCID: 0009-0008-3959-0550
[2] Lithuanian Centre for Social Sciences Institute of Economics and Rural Development, Vilnius, Lithuania; aiste.galnaityte@ekvi.lt, ORCID: 0000-0003-0865-7990
* Correspondence author

Purpose: The study aims to evaluate the role of support in shaping farms' investment and efficiency in Lithuania.
Design/methodology/approach: Data from Lithuanian Farm Accountancy Data Network dataset and logistic regression was used to evaluate to what extent Lithuanian farms' investment is affected by support and other factors. Data Envelopment Analysis was applied to compare the technical efficiency of Lithuanian farms with and without investment support. Study period was 2009-2019.
Findings: During 2009-2019, Lithuanian investing farms differed from non-investing farms in most of the analysed indicators. The greater part of the examined indicators were higher for investing farms. The study revealed that multiple factors affected the probability of investing in Lithuania. Among the most influential factors, investment support was consistently significant throughout the entire study period. The study also demonstrated that farms with investment support operated more efficiently than those without it. These findings are particularly important for policy makers to design effective policies and programs aimed at promoting farms' investment in Lithuania.
Originality/value: Scientific value was pursued through:
1. An original research was implemented focusing on role of support in shaping farms' investment and efficiency in Lithuania, taking into account changes in the CAP, shifts in market structure, and diverse farms' investment behaviour – an area that has so far been addressed only fragmentarily in the literature.
2. An original model for assessing the role of support in shaping farms' investment and efficiency was developed.
3. The research adopted a comprehensive approach, combining logistic regression and Data Envelopment Analysis.
4. The role of support in shaping farms' efficiency was examined by grouping farms based on their decision whether or not to seek investment support.
Keywords: DEA, efficiency, family farms, investment, logistic regression, support.
Category of the paper: Research paper.

1. Introduction

European agriculture faces many challenges. Among those are the need to improve productivity and competitiveness of farms to foster their income growth. In order to overcome this challenge, many European Union (EU) countries (particularly the new European Union (EU) member countries) declared that increasing competitiveness of farms by encouraging their investment is a priority objective of their agricultural policies.

Farms' investment drivers. When analyzing the factors of farms' investment, one can see that they can basically be divided into two groups: non-economic (i e., farm operator demographic characteristics, agronomic factors) and economic (i e., farm characteristics, external factors) factors. In the EU member countries, support including both direct payments and investment support under rural development policy plays a particularly important role in encouraging farms' investment (Zdeněk, Lososová, 2020).

Direct payments are principally an income support instrument. However, numerous studies demonstrate that these payments provide the means for enhancing farms' investment. A study by Kropp and Katchova (2011) showed that direct payments improved agricultural producers' repayment capacity and made them more creditworthy. Due to improved access to capital farms had the potential to expand production. Similarly, a study by O'Toole and Hennessy (2015) found that direct payment stimulated Irish farms' investment through reduced credit constraints. This effect was the highest for younger and dairy producers. A study by Fogarasi et al. (2014) stated that direct payments contributed to an increase in Hungarian farms' investment. A study by Gorzelak et al. (2017) and Zidkova et al. (2011) pointed out that direct payments encouraged farms' investment mainly due to higher income. A study by Zdeněk and Lososová (2020) suggested that both operational and investment support played an important role in investment decisions of Czech farms. A study by Wieliczko (2015) revealed that direct payments strongly contributed to Polish farms' investment. On the contrary, the impact of investment support was very small. This is because investment support received only a small number of farms. Similar results were obtained in a study by Bojnec and Latruffe (2011). According to them, direct payments alleviated financing constraints and thus fostered Slovenian farms' investment. As regards investment support, there was no significant effect. This is because investment support was lower than direct payments and was thus not sufficient to alleviate farms' financial constraints. However, a study by Sadowski and Antczak (2012) concluded that direct payments encouraged only large farms' investment.

Contrary to the results above, a study by Stępień and Czyżewski (2016) revealed that direct payments were mostly used to purchase agricultural inputs including fertilisers, crop protection products, seeds, etc. Also, a study by Kluba (2016) stated that direct payments were devoted to finance farm households' expenditures. According to Teszbir and Gołaś (2014), this is mainly due to insufficient levels of direct payments.

As mentioned before, in addition to direct payments, there is also investment support as an alternative source of funding farms' investment. A study by Bakucs et al. (2010) found that investment support encouraged farms' investment in both Hungary and Slovenia. However, a study by Fertő et al. (2017) pointed out that investment support can mitigate capital market imperfections only in the short-term. In the long-term, the ability to operate successfully in the market plays an essential role. A study by Pechrová (2012) concluded that investment support contributed to the introduction technological innovations in the Czech farms. A study by Aleksandrova et al. (2023) showed that investment support had a positive effect on Estonian farms' investment. However, a study by Bereżnicka (2024) revealed that investment support had a negative impact on Polish farms' investment. Also, the studies by Bartova and Hurnakova (2016) and Hlavsa et al. (2017) demonstrated that the largest part of investment support was received by large, wealthy Slovakian and Czech farms. Therefore, according to them, in the future, more investment support should be targeted at supporting small, less wealthy farms.

In addition, among the factors of farms' investment are various farm characteristics. A study by Czubak et al. (2021) concluded that farms' investment was influenced by initial production potential (production factors). A study by Wang et al. (2019) pointed out that investment was affected by farm labour force. A study by Konrad et al. (2017) revealed that farms' investments depended on the farm size. The studies by Dries et al. (2012), Kaur et al. (2018) and Sadowski et al. (2021) found that investment was greater on larger farms. A study by Wieliczko (2015) showed that there were differences in investment activity among farm types: farms specializing in milk production had the highest levels of investment, while the lowest investment activity was recorded in horticultural farms. Also, it was found that investment was mostly undertaken by larger farms. A study by Carillo et al. (2021) concluded that livestock farms had the highest propensity to invest in farming activities, while the lowest propensity to invest was recorded in farms specializing in permanent crops. A study by Hennessy and O'Brien (2008) suggested that dairy farms had much higher investment levels than the other farm types. A study by Niavis et al. (2020) pointed out that orchard farms invested more than arable crop farms. In addtion, investment was higher among wealthier farms and those with income from off-farm sources. Similarly, the studies by Hertz (2009), Key (2020), Zeeshan et al. (2022) and Akber et al. (2024) demonstrated that off-farm income resulted in greater investment. According to Nguyen et al. (2021), income from off-farm sources had higher impact on farms' investment in less developed regions, where agricultural producers had less access to off-farm activities. On the contrary, the studies by Bakucs et al. (2010) and Hennessy and O'Brien (2008) revealed that farms' investment was negatively associated with income from off-farm sources. A study by Wieliczko et al. (2010) concluded that, among other factors considered, farms' investment decisions were influenced by the share of rented land. A study by Hou et al. (2017) showed that farms with higher shares of rented land made more investment. Also, a study by Bradfield et al. (2023) found a positive association between the length of land rental contracts and farms' investment.

A study by Bojnec and Fertő (2016) demonstrated that indebted farms invested more than non-indebted farms. A study by Szymańska et al. (2021) supported this by finding that the availability of loans had the largest effect on farms' investment. The studies by Kallas et al. (2011) and Zubor-Nemes (2021) mentioned that the participation in crop insurance reduced risk and thus increased farms' investment.

Finally, farms' investment is related to some other factors, among them farm operator demographic characteristics, agronomic factors. The studies by Davis et al. (2013), Kwanmuang (2014) and Olsen and Lund (2011) found that younger producers had a longer planning horizon and invested more than their older counterparts. In contrast, a study by Kallas et al. (2011) concluded that older producers had higher levels of investment. According to them, this is due to more experience in farming and better access to credit. A study by Wieliczko et al. (2010) revealed that farms' investment was also influenced by soil quality.

The nexus between support and farms' efficiency. The relationship between support and efficiency of farms received considerable attention in scientific literature, and this relationship is generally positive. The study by Czubak et al. (2021) demonstrated that investment support contributed to the improvement of farms' technical efficiency. Moreover, these efficiency improvements were observed only in farms that implemented comprehensive investment (co-financed by Common Agricultural Policy (CAP) investment support). Similarly, the study by Hlavsa et al. (2017) revealed that supported farms had higher levels of economic performance and higher labour productivity than their counterparts without support. The study by Nilsson (2017) concluded that investment support had a positive and significant effect on productivity, but this was evident only in small agricultural firms. The study of Moutinho et al. (2018) found a positive link between support and technical efficiency using both Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). The study by Martinez Cillero et al. (2017) found that also direct payments had a positive effect on farms' efficiency. The studies by Garrone et al. (2019) and Khafagy and Vigani (2022) showed that a positive effect of subsidies on farms' productivity came from Pillar I decoupled payments and some Pillar II payments.

However, the study by Bereżnicka and Wicki (2021) demonstrated that operating subsidies did not lead to an increase in labour productivity. Similar results were obtained in different EU countries (Alem, 2021; Alexandri et al., 2020; Fertő, Bojnec, 2023; Marzec, Pisulewski, 2017; Minviel, Sipiläinen, 2018). According to Frýd and Sokol (2021), the impact of subsidies was negative and depended on the farms' technical efficiency – farms with higher efficiency were less affected than those with lower efficiency. Similarly, the study by Staniszewski and Borychowski (2020) revealed that subsidies had a stimulating effect only in the group of the largest farms. Nevertheless, the study by Minviel and Sipiläinen (2018) concluded that relationship between support and efficiency was weak, especially when dynamic aspects were considered. The study by Minviel et al. (2024) showed that public support had negative effects on both transient and persistent technical efficiency.

The study aims to evaluate the role of support in shaping farms' investment and efficiency in Lithuania.

In order to achieve the aim of this study the following tasks were set:

1. To compare key indicators of Lithuanian investing and non-investing farms.
2. To determine to what extent support affects Lithuanian farms' investment.
3. To compare efficiency of Lithuanian farms with and without investment support and to propose measures to encourage Lithuanian farms' investment.

The study is organized as follows. Section 2 introduces a method and data used to evaluate the role of support in encouraging Lithuanian farms' investment and efficiency of farms with and without investment support. Section 3 discusses the main results. The last section concludes the study.

2. Method and data

The main focus of this study was the role of support in encouraging Lithuanian farms' investment and efficiency. The study comprised of two stages. In the first stage, in order to accurately measure role of support in encouraging Lithuanian farms' investment, other factors were also included in the econometric analysis: total utilized agricultural area (UAA) (in hectares), total farm labour force (in annual working units (AWU), total assets per 1 ha of UAA (in EUR), the share of animal output in total output (in %), income from off-farm sources (dummy variable (equal to one if the farm has income from off-farm sources, and zero if not), the share of rented land in total utilized agricultural area (in %), total liabilities per 1 ha of UAA (in EUR), participation in crop or/and livestock insurance (dummy variable (equal to one if the farm participates in crop or/and livestock insurance, and zero if not), age of agricultural producer (in years), location in agriculturally less favoured areas (LFA) (dummy variable (equal to one if the farm is located in agriculturally less favoured areas, and zero if not).

Selected investment indicators were compared to explore differences and similarities in investment activity of investing and non-investing farms in Lithuania. Logistic regression was applied to investigate the factors influencing farms' investment:

$$P(Y|x_1, \dots, x_n) = \frac{e^{b_0+b_1x_1+\cdots+b_nx_n}}{1+e^{b_0+b_1x_1+\cdots+b_nx_n}} \quad (1)$$

where: $x_1, \dots, x_n$ are explanatory variables, Y is a binary dependent variable which represents whether or not a farm invests, P is the conditional probability that $Y = 1$ (a farm invests) given the values of $x_1, \dots, x_n$.

In the second stage, a comparative analysis of the technical efficiency (TE) of Lithuanian farms with investment support and without it was carried out. TE was evaluated using the DEA method widely used in scientific studies within agricultural field (Gadanakis, Areal, 2020; Madau et al., 2017; Wilczyński et al., 2020). Prior to conducting the efficiency analysis of farms using the DEA method, the farms were classified into two groups – farms with and without investment support.

The DEA was conducted using one output – total farm output in EUR – and four inputs: total utilized agricultural area (in hectares), total farm labour force (in annual working units (AWU), intermediate consumption (in EUR), and total assets (in EUR). This study used an input-oriented model with the aim of assessing which input variables could be minimized by producers, in terms of both variable returns to scale (VRS) and constant returns to scale (CRS).

The meta-frontier production function model was constructed for all decision-making units (DMUs, in our case farms) j individually for each year within the period analysed by separating farms into two groups g: farms with investment support and without it (Savickienė et al., 2025):

$$T^g = \left\{ (x,y) | x \geq \sum_{j \in Jg} \lambda_{gj} x_g^j ; \quad y \leq \sum_{j \in Jg} \lambda_{gj} y_g^j ; \quad \sum_{j \in Jg} \lambda_{gj} = 1; \quad \lambda_{gj} \geq 0 \right\} \quad (2)$$

The input-oriented TE for each farm k in group g was calculated by solving a linear programming problem. The meta-frontier was estimated as the outer envelope of all group-specific frontiers based on all DMUs, and the overall technical efficiency TE_G^k of each farm was estimated relative to this benchmark. Additionally, technical efficiency under the CRS assumption was calculated, and scale efficiency (SE) was obtained as:

$$SE_k = \frac{TE_{CRS_k}}{TE_{VRS_k}} \quad (3)$$

Figure 1 summarizes the methodological approach used in this study.

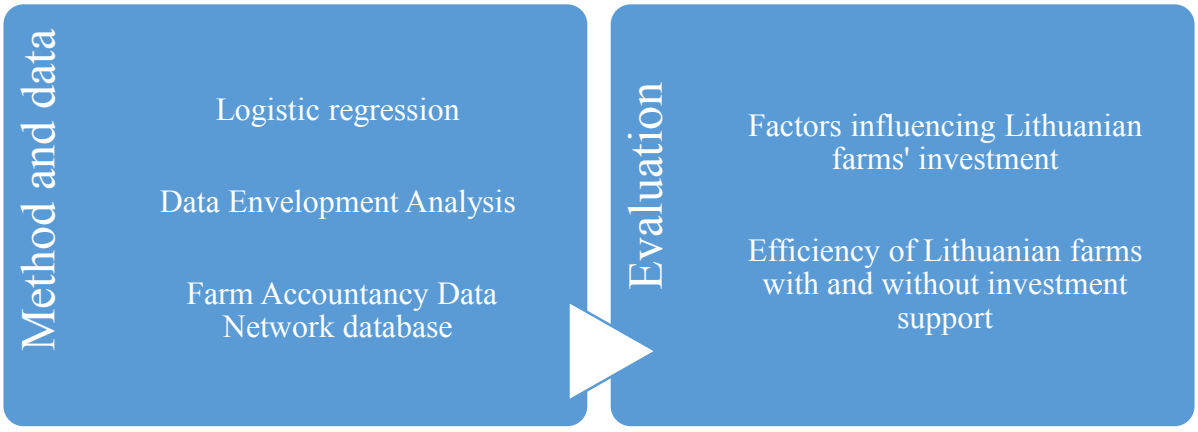

Figure 1. Methodological approach used in the study.

The data used in this study were obtained from Lithuanian Farm Accountancy Data Network (FADN) database. As one can note, these data reflect main production and economic indicators of farms producing marketable products. Farms cover all districts and reflect different natural zones and farming conditions. The study period was 2009-2019.

3. Results and discussion

3.1. Patterns of Lithuanian farms' investment

After Lithuania's accession into the EU, great attention was paid to the self-sufficiency of farms by material resources, primarily fixed assets. During 2009-2019, many measures were implemented in order to better equip agricultural producers with means of production. It was expected that better self-sufficiency of farms by capital will result in rapid growth of gross agricultural output and producers' income. As can be seen in Figure 2, the investment activity of Lithuanian farms measured by the value of gross investment was strongly related to policy factors. At the beginning of the research period, gross investment was at a higher level, but showed a downward trend thereafter. This resulted mainly from the implementation of agricultural policy measures during the 2007-2013 programming period. This trend was also evident during the subsequent programming period. Therefore, it can be said that the developments in gross investment were obviously stimulated by support payments.

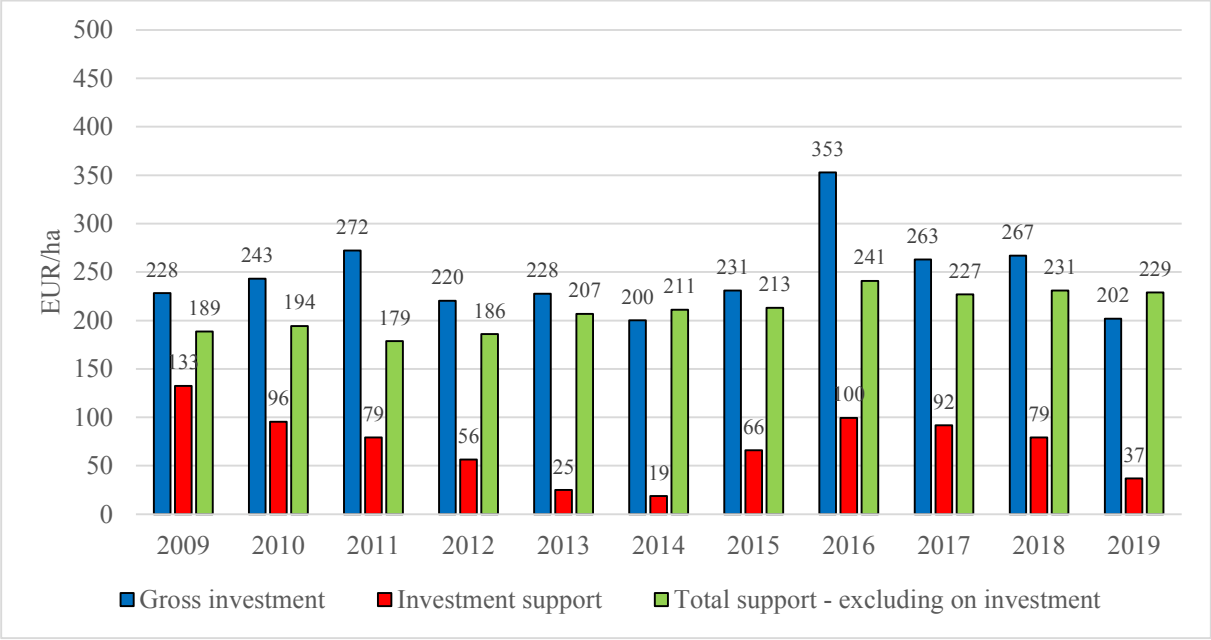

Figure 2. Gross investment, subsidies on investment and total subsidies (excluding on investment) in Lithuania in 2009-2019.

Source: own elaborations on FADN data.

Table 1 shows key indicators of Lithuanian investing and non-investing farms. As can be seen in Table 1, during the research period, Lithuanian investing farms differed in a lot of indicators from non-investing farms. During 2009-2019, investing farms showed higher values in utilized agricultural area, total labour input, the share of rented land in total utilized agricultural area, and total liabilities. However, those farms had a lower share of animal output in total output. This result is not surprising as during the research period most of the investment was made by crop producers. Also, investing farms received less support (excluding on investment) per 1 ha of UAA than their non-investing counterparts and were managed by younger farm operators. Table 1 also shows that most indicators showed an increase during the period analysed.

Table 1.
Selected characteristics of Lithuanian investing and non-investing farms

Variable	2009		2019		Change 2019, compared to 2009, %	
	Investing farms	Non-investing farms	Investing farms	Non-investing farms	Investing farms	Non-investing farms
Total support – excluding on investment per 1 ha of UAA, EUR	188	192	230	263	22.3	37.0
Total utilized agricultural area, hectares	157	67	192	92	22.3	37.3
Total farm labour force, AWU	2.8	1.9	3.1	1.9	10.7	0.0
Share of animal output in total output, %	28.8	32.6	27.3	33.5	-5.2	2.8
Share of rented land in total utilized agricultural area, %	55.4	42.8	46.6	43.1	-15.9	0.7
Total liabilities per 1 ha of UAA, EUR	408	200	736	347	80.4	73.5
Age of farm operator, years	44	46	48	50	9.1	8.7

Source: own elaborations on FADN data.

3.2. Factors of Lithuanian farms' investment

Table 2 presents factors affecting farms' investment in Lithuania. As shown in Table 2, factors of Lithuanian farms' investment were somewhat different at the beginning and at the end of the research period. At the beginning of the research period the probability of investing was higher among producers who operate larger farms. The same results were found by Dries et al. (2012), Kaur et al. (2018) and Sadowski et al. (2021). A possible explanation for this is that large producers have more opportunities to invest due to economies of scale, which results in lower production costs. Furthermore, these farms can also easily obtain financing from credit institutions due to their higher profitability and lower risk or use their own funds for co-financing of investment. In addition, farms' investment was more likely for farms having more family labourers. This is mainly due to the fact that these farms can more easily make investment decisions, as family members are more committed to the future and growth of the

farm. The probability of investing was also higher among producers who have income from off-farm sources. This finding corroborates the studies by Hertz (2009), Key (2020) and Zeeshan et al. (2022). The key reason for suchlike results is the presence of additional financial resources that ensure greater stability in risky situations. Farms' investment was also more likely for younger producers. The same results were achieved by Davis et al. (2013), Kwanmuang (2014) and Olsen and Lund (2011), who found that younger farmers had a longer planning horizon and invested more than their older counterparts. Furthermore, younger producers are more open to new technologies, more ready to take risks etc. Finally, the probability of investing was higher among farms that operate in less favoured areas. This is mainly due to exceptional conditions to receive support in these areas (for instance, in order to receive support for modernization, it was required to contribute less with their own funds).

At the end of the research period the effect of farm area, income from off-farm sources, and age of farm operator on Lithuanian farms' investment remained unchanged. In addition, farms' investment was more likely for producers having higher liabilities. The same results were found, for instance, by Bojnec and Fertő (2016). A possible explanation for this is that indebted producers often invest more as they seek to increase their income to cover debt burden.

Unlike direct payments, investment support encouraged farms' investment throughout the research period. This finding corroborates the studies by Aleksandrova et al. (2023) and Zdeněk and Lososová (2020). The key reason for suchlike results is that investment support can help to reduce financial burden. This is especially important for small and medium-sized farms, which often do not have enough funds for investment.

Table 2.
Factors of Lithuanian farms' investment

Variable	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total support – excluding on investment	0.001 (0.001)	0.000 (0.001)	0.001 (0.001)	-0.000 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)	-0.001 (0.001)
Support on investment	1.956 (0.201) ***	1.911 (0.214) ***	1.554 (0.315) ***	1.561 (0.272) ***	1.028 (0.328) ***	1.692 (0.365) ***	2.038 (0.347) ***	1.634 (0.287) ***	0.965 (0.207) ***	1.049 (0.226) ***	1.095 (0.311) ***
Total UAA	0.003 (0.001) ***	0.004 (0.001) ***	0.004 (0.001) ***	0.006 (0.001) ***	0.007 (0.001) ***	0.004 (0.001) ***	0.005 (0.001) ***	0.007 (0.001) ***	0.005 (0.001) ***	0.003 (0.001) ***	0.003 (0.001) ***
Total farm labour force	0.160 (0.074) **	-0.003 (0.029)	0.098 (0.070)	0.057 (0.063)	0.006 (0.047)	-0.025 (0.040)	-0.066 (0.039) *	-0.085 (0.052) *	0.097 (0.062)	0.049 (0.050)	0.079 (0.051)
Total assets	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000) **	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000) ***	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
Share of animal output in total output	0.001 (0.002)	0.003 (0.002)	0.018 (0.003) ***	-0.007 (0.003) ***	-0.001 (0.003)	-0.005 (0.002) *	-0.008 (0.002) ***	-0.005 (0.003) **	-0.003 (0.002)	-0.004 (0.002) **	-0.001 (0.002)
Income from off-farm sources	0.336 (0.156) **	0.361 (0.153) **	0.408 (0.180) **	0.293 (0.153) *	0.270 (0.157) *	0.092 (0.149)	0.338 (0.157) **	0.049 (0.169)	-0.050 (0.161)	0.431 (0.160) ***	0.570 (0.159) ***
Share of rented land in total UAA	-0.000 (0.002)	-0.001 (0.003)	0.008 (0.003) **	-0.003 (0.003)	0.002 (0.003)	0.004 (0.002) *	0.006 (0.002) ***	0.007 (0.003) ***	0.002 (0.002)	0.003 (0.002)	0.001 (0.002)
Total liabilities	0.000 (0.000)	-0.000 (0.000)	0.000 (0.000) **	0.001 (0.000) ***	0.000 (0.000) ***	0.001 (0.000) ***	0.000 (0.000) ***	0.000 (0.000) ***	0.001 (0.000) ***	0.000 (0.000) ***	0.001 (0.000) ***
Participation in crop or/and livestock insurance	0.073 (0.186)	0.174 (0.184)	0.474 (0.226) **	0.484 (0.184) ***	0.191 (0.187)	0.629 (0.201) ***	-0.041 (0.184)	-0.088 (0.219)	0.484 (0.280) *	0.517 (0.283) *	-0.096 (0.246)
Age of farm operator	-0.013 (0.006) **	-0.003 (0.006)	-0.003 (0.007)	-0.010 (0.006) *	-0.017 (0.006) ***	-0.002 (0.005)	-0.010 (0.005) *	-0.017 (0.006) ***	-0.011 (0.005) *	-0.009 (0.005) *	-0.018 (0.005) ***
Location in agriculturally LFA	0.278 (0.154) *	0.280 (0.158) *	-0.240 (0.182)	-0.085 (0.151)	0.107 (0.153)	0.139 (0.147)	0.053 (0.140)	0.205 (0.150)	0.196 (0.142).	-0.069 (0.145)	0.098 (0.141)

Note: cells contain binary logistic regression coefficients with standard errors in parentheses (*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$).

Source: own elaborations on FADN data.

3.3. Efficiency of Lithuanian farms with and without investment support

It is important to note that the share of farms with investment support varied throughout the study period. The highest share was at the beginning of the research period. Later, this share decreased toward the end of the 2007-2013 programming period. Similar trends were observed during the period of the implementation of the CAP 2014-2020 measures.

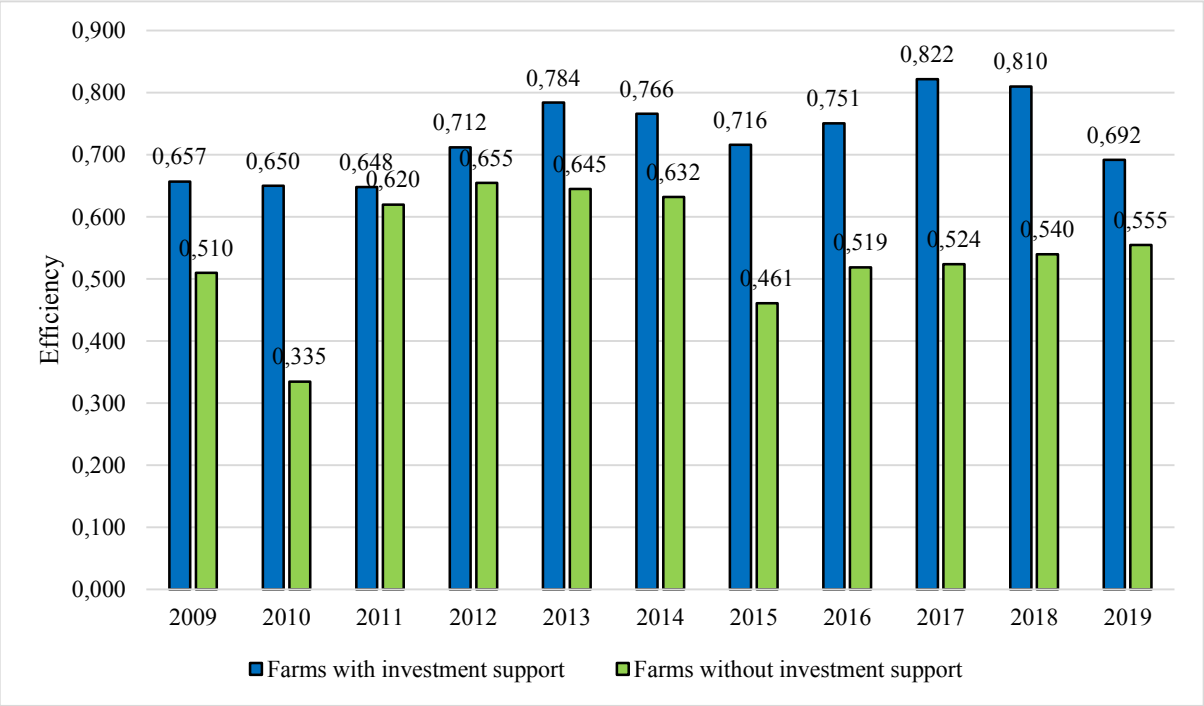

Figure 3. Technical efficiency (VRS) of Lithuanian farms in 2009-2019.

Source: own elaborations on FADN data.

The data in Figure 3 show that, throughout the entire study period, farms with investment support operated more efficiently. These findings are in line with Czubak et al. (2021), Hlavsa et al. (2017) and Moutinho et al. (2018), who demonstrated that investment support contributed to the improvement of farms' technical efficiency. However, the results of this study do not align with the findings of studies conducted in some other countries (Frýd, Sokol, 2021; Staniszewski, Borychowski, 2020). These studies showed that subsidies had a stimulating effect only in the group of the most efficient and the largest farms. It could be determined by the specific CAP instruments implemented in different countries, differences in farm structures, and the availability or effectiveness of advisory and information systems for farmers.

The largest difference in efficiency scores occurred in 2010, while the smallest difference was observed in 2012. The main reasons why farms with investment support operated more efficiently could be investment in modern machinery and technologies that increased productivity, as well as improved management practices resulting from investment project implementation. In addition, the support could reduce financial constraints, allowing for faster implementation of development decisions.

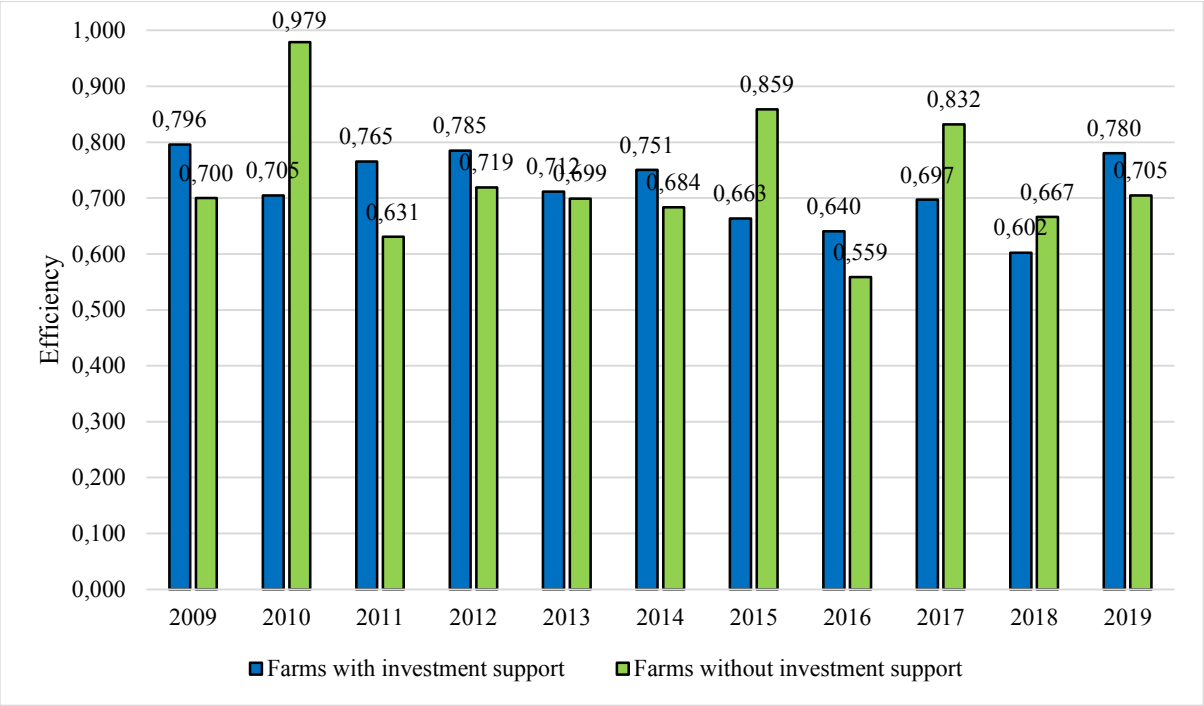

Figure 4. Scale efficiency of Lithuanian farms in 2009-2019.

Source: own elaborations on FADN data.

Somewhat different trends were observed when analyzing scale efficiency of farms with investment support and those without it (Figure 4). Although farms with investment support generally demonstrated higher scale efficiency, in some years, farms without investment support were more efficient. These findings suggest that farms with investment support tended to operate closer to the optimal scale. This trend can be attributed to the fact that investment support is more frequently received by larger farms, which typically possess the capacity and administrative resources to apply for and manage such support. Moreover, larger farms are generally in a better financial position to contribute with their own resources toward the co-financing of investment, which is often a prerequisite for accessing investment support.

Findings of both the present and previous analyses indicate that future measures aimed at promoting investment should be improved by adapting them to specific groups of farms. Specifically, it is important to ensure access to both non-repayable subsidies and financial instruments, because especially in small farms there is a lack of funds to cover investment and even their own contribution. Low creditworthiness and low own capital make it difficult to effectively modernize farms and operate efficiently.

CAP investment support could be better designed by differentiating support intensity based on farm size and development stage. Simplified application procedures could be applied for smaller farms. Separate calls or measures by farm type and size would ensure fairer competition. Support could be combined with advisory services in order to enhance farm operators' competences. The findings of this study may be valuable for policymakers seeking to optimize support measures and promote farms' investment and efficiency. The results can

contribute to informed decision-making regarding the improvement of CAP measures, ensuring a more targeted allocation of investment and enhancing farms' efficiency.

The study assessed the role of support for farms' investment and efficiency, however it has several limitations. First, although the developed model was based on a comprehensive review of the literature, it relied solely on the indicators available in the FADN database, and therefore some relevant factors may not have been included in the analysis. The study period ends in 2019 because data for the subsequent years were not yet available at the time of the research, and therefore the analysis results may not reflect the most recent developments in the sector. The study analyzes data only from Lithuanian farms. In the future, it would be worthwhile to address these issues in the context of other countries, considering that the implemented CAP measures, farm structures, and farmers' management capabilities differ across countries.

3.4. Concluding remarks

During 2009-2019, Lithuanian investing farms differed from non-investing farms in most of the analysed indicators. The greater part of the examined indicators, such as utilized agricultural area, total labour input, the share of rented land in total utilized agricultural area and total liabilities, were higher for investing farms. However, non-investing farms received, on average, more support (excluding on investment) per 1 ha of UAA than their investing counterparts and were managed by older farm operators.

During the study period, many different factors affected the probability of investing in Lithuanian farms. Among the most influential factors, investment support was consistently significant throughout the entire study period. This finding highlights that public support mechanisms played a crucial role in shaping investment behavior of Lithuanian farms throughout the period analysed.

Despite several exceptions, throughout the entire study period, farms with investment support operated more efficiently than those without it. This trend can be largely explained by the fact that investment support was more frequently received by larger farms during 2009-2019. These findings suggest that future measures aimed at promoting investment should be improved by adapting them to specific groups of farms. The implementation of these changes is a necessary condition for enabling more farms to invest in modernization and achieve higher levels of efficiency.

Acknowledgements

The article was partially funded by the project Junior Research in Residence titled "Behaviour of agricultural producers in the context of impact of selected Common Agricultural Policy instruments based on example of Lithuania and Poland", carried out at the University of Łódź during 2022-2025.

References

1. Akber, N., Paltasingh, K.R., Mishra, A.K., Goyari, P. (2024). Land ownership security, farm investment, and investment risk in Indian agriculture: Evidence from nationally representative survey. *Journal of Agricultural and Applied Economics, 56(2)*, 278-296.
2. Aleksandrova, O., Fertő, I., Viira, A.H. (2023). Investments, subsidies and financial constraints in Estonian agriculture. *Agricultural Finance Review, 83(4/5)*, 597-616.
3. Alem, H. (2021). The role of technical efficiency achieving sustainable development: A dynamic analysis of Norwegian dairy farms. *Sustainability, 13(4)*, 1841.
4. Alexandri, C., Pauna, B., Saman, C. (2020). The relationship between total factor productivity and subsidies in the case of Romanian farms. *Romanian Journal of Economic Forecasting, 23(4)*, 85-98.
5. Bakucs, L.Z., Bojnec, S., Ferto, I., Latruffe, L. (25-27.08.2010). *The impact of non-farm income on the investment in agriculture: evidence from Hungary and Slovenia*. 118th EAAE Seminar "Rural Development: Governance, Policy Design and Delivery". Ljubljana, Slovenia: EAAE.
6. Bartova, L., Hurnakova, J. (25-27.05.2016). *Estimation of farm investment support effects: A counterfactual approach.* The International Scientific Conference "Quantitative Methods in Economics: Multiple Criteria Decision Making XVIII", Vrátna, Slovakia: Letra Interactive.
7. Bereżnicka, J. (2024). Sources of Financial Flexibility and Investment Activity in Family Farms in Poland. *Annales Universitatis Mariae Curie-Skłodowska, Sectio H Oeconomia, 58(1)*, 7-22.
8. Bereżnicka, J., Wicki, L. (2021). Do operating subsidies increase labour productivity in Polish farms? *Studies in Agricultural Economics, 123(3)*, 114-121.
9. Bojnec, Š., Fertő, I. (2016). Financial constraints and farm investments in Slovenia. *New Medit, 15(4)*, 2-9.
10. Bojnec, Š., Latruffe, L. (2011). Financing availability and investment decisions of Slovenian farms during the transition to a market economy. *Journal of Applied Economics, 14(2)*, 297-317.
11. Carillo, F., Licciardo, F., Corazza, E. (2021). Investments financing at farm level: A regional assessment using FADN data. *Economia agro-alimentare/Food Economy, 23(3)*, 1-24.
12. Czubak, W., Pawłowski, K.P., Sadowski, A. (2021). Outcomes of farm investment in Central and Eastern Europe: The role of financial public support and investment scale. *Land Use Policy, 108*, 105655.
13. Davis, J., Caskie, P., Wallace, M. (2013). Promoting structural adjustment in agriculture: The economics of New Entrant Schemes for farmers. *Food Policy, 40*, 90-96.

14. Dries, L., Gorton, M., White, J., Urutyan, V., Sardaryan, G. (2012). The role of agribusiness in stimulating on-farm investments–case-study of the armenian dairy sector. *Applied studies in Agribusiness and Commerce, 6(1-2)*, 85-91.
15. Fertő, I., Bakucs, L.Z., Bojnec, S., Latruffe, L. (2017). East-West European farm investment behaviour: The role of financial constraints and public support. *Spanish Journal of Agricultural Research, 15(1)*, 1-7.
16. Fertő, I., Bojnec, Š. (2023). The common agricultural policy subsidies and the technical efficiency of Hungarian wine farms. *International Journal of Wine Business Research, 35(3)*, 413-426.
17. Frýd, L., Sokol, O. (2021). Relationships between technical efficiency and subsidies for Czech farms: A two-stage robust approach. *Socio-Economic Planning Sciences, 78*, 101059.
18. Gadanakis, Y., Areal, F.J. (2020). Accounting for rainfall and the length of growing season in technical efficiency analysis. *Operational Research, 20(4)*, 2583-2608.
19. Garrone, M., Emmers, D., Lee, H., Olper, A., Swinnen, J. (2019). Subsidies and agricultural productivity in the EU. *Agricultural Economics, 50(6)*, 803-817.
20. Gorzelak, A., Herda-Kopańska, J., Kulawik, J., Soliwoda, M., Wieliczko, B. (2017). Kontrowersje wokół europejskiej wartości dodanej tworzonej przez WPR. *Zagadnienia Ekonomiki Rolnej, 1*, 3-28.
21. Hennessy, T., O'Brien, M. (2008). Is off-farm income driving on-farm investment? *Journal of farm management, 13(4)*, 235-246.
22. Hertz, T. (2009). The effect of nonfarm income on investment in Bulgarian family farming. *Agricultural Economics, 40(2)*, 161-176.
23. Hlavsa, T., Hruška, M., Turková, E. (2017). The impact of investment support from the Rural Development Programme of the Czech Republic for 2007-2013 on the economic efficiency of farms. *Studies in Agricultural Economics, 119(1)*, 11-17.
24. Hou, J., Huo, X., Yin, R. (2017). Land rental market participation and its impact on fixed investment and household welfare: Evidence from Chinese apple production sites. *Sustainability, 9(11)*, 1961.
25. Kallas, Z., Serra, T., Gil, J.M. (2012). Effects of policy instruments on farm investments and production decisions in the Spanish COP sector. *Applied Economics, 44(30)*, 3877-3886.
26. Kaur, M., Singh, S., Sharma, V.K., Kingra, H.S., Arora, R. (2018). Farm investment and income variations across different farm size categories and regions in Punjab. *Indian Journal of Economics and Development, 14(1a)*, 330-335.
27. Key, N. (2020). Off-farm income, credit constraints, and farm investment. *Journal of Agricultural and Applied Economics, 52(4)*, 642-663.
28. Khafagy, A., Vigani, M. (2022). Technical change and the common agricultural policy. *Food Policy, 109*, 102267.

29. Kluba, J. (2016). Wpływ instrumentów wspólnej polityki rolnej na gospodarstwa indywidualne w województwie opolskim w opinii rolników. *Studia Obszarów Wiejskich, 42*, 139-153.
30. Konrad, M.T., Nielsen, H.Ø., Pedersen, A.B., Elofsson, K. (2019). Drivers of farmers' investments in nutrient abatement technologies in five Baltic Sea countries. *Ecological economics, 159*, 91-100.
31. Kropp, J.D., Katchova, A.L. (2011). The effects of direct payments on liquidity and repayment capacity of beginning farmers. *Agricultural Finance Review, 71(3)*, 347-365.
32. Kwanmuang, K. (2014). Factors Influencing Farm Investment Planning A Case Study in Nakhon Si Thammarat Province, Thailand. *Journal of Developments in Sustainable Agriculture, 9(1)*, 51-55.
33. Madau, F.A., Furesi, R. Pulina, P. (2017). Technical efficiency and total factor productivity changes in European dairy farm sectors. *Agricultural and Food Economics, 5(1)*, 17.
34. Martinez Cillero, M., Thorne, F., Wallace, M., Breen, J., Hennessy, T. (2018). The effects of direct payments on technical efficiency of Irish beef farms: a stochastic frontier analysis. *Journal of Agricultural Economics, 69(3)*, 669-687.
35. Marzec, J., Pisulewski, A. (2017). The effect of CAP subsidies on the technical efficiency of Polish dairy farms. *Central European Journal of Economic Modelling and Econometrics, 3*, 243-273.
36. Minviel, J.J., Sipiläinen, T. (2018). Dynamic stochastic analysis of the farm subsidy-efficiency link: Evidence from France. *Journal of Productivity Analysis, 50(1)*, 41-54.
37. Minviel, J.J., Sipiläinen, T., Latruffe, L., Bravo-Ureta, B. E. (2024). Impact of public subsidies on persistent and transient technical efficiency: evidence from French mixed crop-livestock farms. *Applied Economics, 56(55)*, 7286-7301.
38. Moutinho, V., Madaleno, M., Macedo, P., Robaina, M., Marques, C. (2018). Efficiency in the European agricultural sector: Environment and resources. *Environmental Science and Pollution Research, 25(18)*, 17927-17941.
39. Nguyen, H.T.T., Pham, X.H., Kondo, T. (2021). The impact of non-farm activities on agricultural investment in Vietnam: the difference made by credit constraints levels. *Studies in Agricultural Economics, 123(3)*, 141-152.
40. Niavis, S., Kyrgiakos, L.S., Kleisiari, C., Vlontzos, G. (2020). What Drives Farmers' Decisions to Invest? The Role of Research Engagement, Information Collection and Type of Farm. *International Journal on Food System Dynamics, 11(3)*, 241-257.
41. Nilsson, P. (2017). Productivity effects of CAP investment support: Evidence from Sweden using matched panel data. *Land Use Policy, 66*, 172-182.
42. Olsen, J.V., Lund, M. (2011). The impact of socio-economic factors and incentives on farmers' investment behaviour. *Food Economics – Acta Agriculturae Scandinavica, Section C, 8(3)*, 173-185.

43. O'Toole, C., Hennessy, T. (2015). Do decoupled payments affect investment financing constraints? Evidence from Irish agriculture. *Food Policy, 56*, 67-75.
44. Pechrová, M. (18-19.09.2012). *Contribution of Supports to Modernisation for Enhancing Competitiveness of the Czech Agricultural and Forestry Holdings*. 131st EAAE Seminar "Innovation for Agricultural Competitiveness and Sustainability of Rural Areas", Prague, Czech Republic: EAAE.
45. Sadowski, A., Antczak, W. (2012). Kierunki wykorzystania dopłat bezpośrednich przez rodzinne gospodarstwa rolne położone w wybranych województwach. *Journal of Agribusiness and Rural Development, 4(26)*, 103-113.
46. Sadowski, A., Wojcieszak-Zbierska, M.M., Beba, P. (2021). Territorial differences in agricultural investments co-financed by the European Union in Poland. *Land Use Policy, 100*, 104934.
47. Savickienė, R., Namiotko, V., Galnaitytė, A. (2025). Evaluating the Technical Efficiency of Dairy Farms Under Technological Heterogeneity: Evidence from Lithuania. *Agriculture, 15(14)*, 1469.
48. Staniszewski, J., Borychowski, M. (2020). The impact of the subsidies on efficiency of different sized farms. Case study of the Common Agricultural Policy of the European Union. *Agricultural Economics [Zemědělská Ekonomika], 66(8)*, 373-380.
49. Stępień, S., Czyżewski, A. (2016). Economic Aspects of the Implementation of the Rural Development Programme 2014-2020. Reminiscences and Projection. *Journal of Agribusiness and Rural Development, 42(4)*, 651-658.
50. Szymańska, E.J., Dziwulski, M., Kruszyński, M. (2021). Determinants of fixed asset investment in the Polish farms. *Sustainability, 13(24)*, 13741.
51. Teszbir, H., Gołaś, Z. (2014). Kierunki rozdysponowania płatności bezpośrednich w wybranych gospodarstwach rolnych województwa lubelskiego. *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, 16(4)*, 323-327.
52. Wang, S., Tian, Y., Liu, X., Foley, M. (2019). How farmers make investment decisions: Evidence from a farmer survey in China. *Sustainability, 12(1)*, 247.
53. Wieliczko, B. (7-8.10.2015). *Agricultural investment in Poland in the years 2007-2013*. 147th EAAE Seminar "CAP Impact on Economic Growth and Sustainability of Agriculture and Rural Areas", Sofia, Bulgaria: EAAE.
54. Wieliczko, B., Kurdyś-Kujawska, A., Sompolska-Rzechuła, A. (2019). Investment behavior of the Polish farms–is there any evidence for the necessity of policy changes? *Journal of Central European Agriculture, 20(4)*, 1292-1301.
55. Wilczyński, A., Kołoszycz, E., Świtłyk, M. (2020). Technical Efficiency of Dairy Farms: An Empirical Study of Producers in Poland. *European Research Studies Journal, 23(1)*, 117-127.

56. Zalewski, K., Bórawski, P., Żuchowski, I., Parzonko, A., Holden, L., Rokicki, T. (2022). The Efficiency of Public Financial Support Investments into Dairy Farms in Poland by the European Union. *Agriculture, 12(2)*, 186.
57. Zdeněk, R., Lososová, J. (2020). Investments of Czech farms located in less favoured areas after EU accession. *Agricultural Economics [Zemědělská Ekonomika], 66(2)*, 55-64.
58. Zeeshan, Khan, M.A., Khan, M.R., Pandey, N., Kaushik, I., Hoda, M.N., Khatoon, N. (2022). How access to non- farm income affects farm investment in rural India? *Journal of Public Affairs, 22(4)*, e2681.
59. Zidkova, D., Rezbova, H., Rosochatecka, E. (2011). Analysis of development of investments in the agricultural sector of the Czech Republic. *Agris on-line Papers in Economics and Informatics, 3(665-2016-44905)*, 33-43.
60. Zubor-Nemes, A. (2021). The relationship between crop insurance take-up, technical efficiency, and investment in Hungarian farming. *Studies in Agricultural Economics, 123(3),* 122-130.