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.RANKING FARM TYPES IN THE EUROPEAN UNION ACCORDING TO INVESTMENT ACTIVITY: THE I-DISTANCE APPROACH

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ABSTRACT

Investments are significant elements of farm business operations because adequate managerial decisions concerning farm investments lead to productivity growth. While the level of investments depends on a number of factors (such as farm type, profitability, value of fixed assets, labor force, cash flow, investment subsidies, etc.), investment activity itself can be measured by a variety of indicators. The goal of this research was to rank different farm types in the European Union based on their level of investment activity. To perform the analysis, the EU FADN public database for the year 2022 (covering EU27_2020) was used. Having in mind that each indicator of investment activity provides a different ranking of farm types, the authors applied the I-distance methodology to determine the overall rank of individual farm types. The results indicated that the highest level of investment activity is related to specialized granivore farms, while the most important indicator for the ranking process proves to be gross investments in fixed assets. If the percent of net investments is used as the most important indicator for the ranking process, then farms specialized in horticultural production have the highest level of investment activity. Farm types dealing with olive and fruit production, as well as sheep and goat production, recorded the lowest investment activity.

Keywords: *investments, FADN, farm types, I-distance, managerial decisions*

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INTRODUCTION

Investments in agricultural production are a precondition for its technological development and long-term sustainability. The impact of public investments in agriculture is also an important topic that should not be neglected [1]. It should be mentioned that Farm Accountancy Data Network (FADN) data can be used to facilitate the investment evaluation process as well [2]. A review of the literature [3] indicated that the issue of farm investment behavior appears to be one of the least developed. The authors indicated that recent literature deals with "topics already discussed in previous literature", while the tools used in analysis "have been refined and further developed".

Investments in fixed assets in agriculture should result in increased productivity. Analysis based on FADN data from Poland revealed that "an increase in the level of investment in agricultural holdings contributes to labor and land productivity growth", while an increase in "productivity of capital equity" is also recorded [4]. It was also determined that agricultural investments in the Baltic States "had accelerated the substitution of labor by capital in the surveyed countries" [5]. Judging by Serbian FADN data, it was concluded that "productivity is closely related to farm size" in milk production [6]. Research carried out in Poland led to the conclusion that "the level of investment outlays is crucial in the process of improving the efficiency of the use of the labor factor" [7].

At the same time, it should be taken into account that the level of farm investment activity depends on many factors. Authors who analyzed the influence of certain factors (such as the total value of fixed assets, average farm area, or labor force) on the amount of total investments and the level of investments per hectare of agricultural land [8] concluded that "explanatory variables are important in shaping" investments in agriculture. Gross farm investments are "positively associated" with factors such as real sales growth, cash flow, and investment subsidies [9], while the influence of co-financing from public funds (among other factors) on certain farm investments is also discussed [10]. Research conducted for one region in Italy indicated that the majority of farms use equity capital for investment financing [11]. According to the authors, there could be two reasons for such behavior. The first is "ineffective financial management of the farm", while the other possible cause is "a real difficulty of the farms to receive external financial funds". Certain authors [12] discussed the influence of farm location (within or outside metropolitan areas) on investment activity. It was concluded that "higher investment expenditure, and thereby faster growth, were recorded among farms located within metropolitan zones", which is explained by "greater development possibilities" for farms positioned in metropolitan areas. An assessment of investment behavior of farms in certain countries in Eastern and Western Europe indicated that there is no substantial difference between farm behavior in the observed countries [13].

It was proved that (for farm types dealing with the production of cereals, milk production, and pig rearing) investment expenditures are correlated with family farm income in the previous year [14]. According to the authors, "higher profitability of production contributes to an increase in agricultural income, and this in turn increases investment in farms". Similarly, results of other research [15] indicated that the level of investments of crop farms of certain sizes in the European Union (EU), measured by gross investments and net investments, is related to the level of farm profitability in the previous year. Analysis of factors that affect the level of investments in fixed assets of Polish farms revealed that the principal factors are "the amount of long-term liabilities, the family income of the farm, and the amount of investment subsidies" [16]. The authors also proved that "loan availability, especially preferential loans, has the largest impact on the level of farm investment". Farm ownership significantly influences investment activity, meaning that there is a "positive effect of ownership concentration on investment activity and farms' economic performance" [17]. The relationship between non-farm income and investments in agriculture revealed that farms without non-farm income have higher gross investments and subsidies for investments [18]. The analysis of factors shaping investment behavior of farms operating in Central and Eastern Europe "pointed out the importance of agricultural policy" [19].

The relationship between eight farm types in the EU and their level of investment activity (covering the period from 2005 to 2018) was also the topic of discussion [20]. The authors applied an ANOVA approach, while gross investments and net investments were the focus of the analysis. The analysis proved that "directions of production of the European Union agricultural enterprises influence their level of investment". Having that in mind, the goal of this research is to rank different farm types in the European Union based on their level of investment activity.

MATERIAL AND METHOD

The entire analysis is based on FADN methodology, while the source of data for this research was the EU FADN public database for the year 2022 (covering EU27_2020). Having in mind that there are two common ways to differentiate farms by types (using 8 farm types or 14 farm types), the authors applied the TF14 approach as more detailed and informative. Besides, the reviewed literature sources are primarily oriented toward the application of FADN methodology in investment analysis.

It is possible to use various indicators to measure the level of farm investment activity. Therefore, the indicators applied in this analysis (Table 1) are based on numerous literature sources ([4], [5], [7], [8], [9], [10], [19], [21]).

Table 1. Indicators of investment activity

Indicators	Description of indicators	Short description	The way indicators are calculated
Available in FADN database	Gross investment on fixed assets (EUR)	Gross investments	SE516
	Net investment on fixed assets (EUR)	Net investments	SE521
Calculated indicators	Gross investments on fixed assets / Total fixed assets (%)	Percent of gross investments	(SE516 / SE441) * 100
	Net investments on fixed assets / Total fixed assets (%)	Percent of net investments	(SE521 / SE441) * 100
	Gross investments on fixed assets / Depreciation	Investment rate	SE516 / SE360
	Gross investment on fixed assets / Total Utilized Agricultural Area (UAA) (EUR/ha)	Gross investments per hectare	SE516 / SE025
	Gross investment on fixed assets / Total labor input (EUR/AWU)	Gross investments per AWU	SE516 / SE010
	Gross investment on fixed assets / Total livestock units (EUR/LU)	Gross investments per LU	SE516 / SE080

Source: Authors' study

Different farm types in the EU are ranked (on the basis of their level of investment activity) using the I-distance statistical approach. This method is the metric in an n-dimensional space [22], enabling a number of indicators to be synthesized into a single measure that represents the rank of the observed entities.

If $X^T = (X_1, X_2, \ldots, X_k)$ represents a set of indicators used to define the level of investment activity, then the rank between two entities $e_r = (x_{1r}, x_{2r}, \ldots, x_{kr})$ and $e_s = (x_{1s}, x_{2s}, \ldots, x_{ks})$ is calculated using the expression [23]:

$$D^2(r,s) = \sum_{i=1}^{k} \frac{d_i^2(r,s)}{\sigma_i^2} \prod_{j=1}^{i-1} \left(1 - r_{ji.12\ldots j-1}^2\right) \quad (1)$$

where:

$$d_i(r,s) = x_{ir} - x_i^-, i = 1,2,\ldots,k \quad (2)$$

represents a discriminatory effect of the indicator X_i of the observed farm type and the fictional unit X_i^-. The fictional unit, in this case, is defined by the minimum values for each observed indicator. Further, σ_i is the standard deviation of indicator X_i, and $r_{ji.12\ldots j-1}$ is a partial coefficient of the correlation between indicators X_i and X_j. Due to the definition of a fictional unit, the farm types with the highest value of I-squared distance achieved the highest level of investment activity.

The I-distance approach was applied in recent research for ranking small and medium enterprises operating in the Serbian food industry [24], for ranking banks headquartered in the Republic of Srpska [25], for ranking firms in Turkey [26], and for ranking districts in Serbia considering their organic production [27]. Besides, possibilities of combining the I-distance approach with Data Envelopment Analysis were recently examined [28]. Other theoretical issues concerning the application and improvement of the I-distance methodology were discussed in [29] and [30].

RESULTS AND DISCUSSION

The analysis is based on the data presented in Table 2, which shows the value of investment activity indicators for 14 farm types in 2022. It can be noticed that some values in the table are negative, which is primarily related to the size of net investments.

Table 2. Value of investment activity indicators

Types of farming	Gross invest. (EUR)	Net invest. (EUR)	Perc. of gross invest. (%)	Perc. of net invest. (%)	Investment rate	Gross invest. per hectare (EUR/ha)	Gross invest. per AWU (EUR/AWU)	Gross invest. per LU (EUR/LU)
Specialist COP	14,849	4,308	5.20	1.51	1.4087	226.63	11,422.31	10,383.92
Specialist other fieldcrops	11,740	1,283	3.71	0.40	1.1227	314.49	7,723.68	4,932.77
Specialist horticulture	25,727	5,748	8.41	1.88	1.2877	3,336.84	7,916.00	49,475.00
Specialist wine	16,302	2,642	6.87	1.11	1.1934	1,072.50	9,056.67	67,925.00
Specialist orchards - fruits	6,546	-959	3.39	-0.50	0.8722	614.65	3,783.82	26,184.00
Specialist olives	199	-3,408	0.14	-2.48	0.0552	13.25	180.91	1,990.00
Permanent crops combined	1,653	-3,784	0.82	-1.87	0.3040	114.39	1,242.86	3,673.33
Specialist milk	28,155	8,357	4.78	1.42	1.4221	621.52	14,512.89	442.90
Specialist sheep and goats	6,249	-97	2.92	-0.05	0.9846	137.19	4,166.00	174.21
Specialist cattle	14,757	2,073	3.40	0.48	1.1633	252.26	10,850.74	253.64
Specialist granivores	41,916	3,132	5.34	0.40	1.0808	1,064.94	16,437.65	111.38
Mixed crops	8,414	1,448	3.60	0.62	1.2079	414.89	5,161.96	4,548.11
Mixed livestock	22,517	6,808	6.61	2.00	1.4334	603.35	13,015.61	277.88
Mixed crops and livestock	11,735	2,797	5.55	1.32	1.3129	321.77	7,620.13	515.37

Source: FADN database and authors' calculation

Net investment could be defined as “gross investment minus depreciation in the accounting year” [31]. If net investments are negative, it indicates impossibility of realized investments to “replace the amortized assets” [21]. Positive net investments mean that farms “not only replaced worn out machinery and equipment, but also invested in new purchases and projects to expand their productive capacity in the analyzed period” [31]. On the other hand, negative net investments indicate that “investments are lower than the level of depreciation, which means that production capacity of such farms is decreasing” [32]. Appearance of negative net investments indicates that “a process of disinvestment is taking place” while positive net investments are related to “a steady increase in the value of physical capital” [10]. The same authors noticed that some types of farms in Polish agriculture recorded negative net investments (such as horticulture, permanent crops, other grazing livestock, mixed farms) for number of years. Discussing competitiveness of Polish organic farms, it was concluded that positive net investment rate is connected with competitive farms, while “it was negative for farms without competitive ability” [33]. Other authors [34] discussed dairy farm assets in countries of Visegrad Group, noticing negative net investments in Hungary, Slovakia and Poland (in certain years). In such cases, farms are not able “to replace the assets that were worn out” or in other words, “to replace obsolete assets”. Discussing investments in Polish agriculture (for holdings dealing with fieldcrops, milk, pigs and mixed production) for the period 2009-2014 [35] determined that net investments were positive only in production of pigs. According to these authors, other types of holdings did not grow “despite investment in fixed assets”. This research indicated that negative net investments are attributed to four farm types in the EU (Specialist orchards – fruits, Specialist olives, Permanent crops combined, and Specialist sheep and goats).

It should not be neglected that there is a possibility of a completely different scenario, which assumes overinvesting in fixed assets. Overinvesting could be observed as “reduced return on equity” [36].

Similarly, discussing possibility of farms to overinvest, [37] concluded that "investments which lead to enhancements in technical efficiency are justified if they also result in increased labor productivity". Nevertheless, the phenomenon of farms which are overinvesting will not be topic of further analysis in this paper, while the focus will be placed upon ranking farms of different types according to their level of investment activity.

Generally, the I-distance method can be implemented in two ways. The first assumes an iterative process of selecting the most important indicator. In other words, the I-distance method defines which of the input indicators is the most significant for the ranking process [38], meaning that the indicator with the highest correlation with the I-squared distance from the previous iteration is the most important one. The analysis revealed that gross investments on fixed assets are the most important indicator, while net investments on fixed assets are third in importance (Table 3). This is in line with the results of research (based on literature review) indicating that gross investments and net investments are common indicators for general farm investment analysis [39]. Apart from that, the literature review performed in our research indicated that gross investments on fixed assets are the most common indicator applied to describe the level of farm investment activity.

Table 3. Correlation of indicators with I-squared distance

Indicators of investment activity	**Correlation**
Gross investments on fixed assets	.979**
Gross investments per AWU	.836**
Net investments on fixed assets	.773**
Percent of gross investments	.740**
Gross investments per hectare	.635*
Percent of net investments	.628*
Investment rate	.555*
Gross investments per LU	.192

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*
Source: Authors' calculation

The second indicator in importance for ranking farm types by investment activity is gross investments per AWU, indicating a close relationship between investments and productivity (as mentioned previously in the paper). Only one indicator of investment activity proved to be not significant (gross investments per LU). Ranking of farm types indicated that the highest level of investment activity is associated with specialist granivores, while the lowest ranked farms are specialized in olive production (Table 4). It can be noticed that the lowest ranked types of farming are characterized by negative net investments (presented in Table 2).

The results obtained by the I-distance approach are in line with findings of other researchers who determined that an inadequate "level of investment leads to a reduction in the economic size of farms", while "increase in the level of investment outlays favors the specialization of farms" [40]. Accordingly, three farm types with the highest rank are specialized farms. At the same time, the highest ranked farms (production type specialized in granivores) are the biggest farms (Table 5). Similar conclusions were reached by other authors who concluded that a "substantially higher level of investment was noticed in the agricultural enterprises involved in animal production, especially in granivores and milk", compared to other farm types [20].

Table 4. Rank of farm types

Type of farming	I-squared distance	Rank
Specialist granivores	18.72	1
Specialist horticulture	14.38	2
Specialist milk	13.01	3
Mixed livestock	10.87	4
Specialist wine	7.82	5
Specialist COP	6.23	6
Mixed crops and livestock	4.62	7
Specialist cattle	4.29	8
Specialist other fieldcrops	3.12	9
Mixed crops	2.41	10
Specialist orchards – fruits	1.56	11
Specialist sheep and goats	1.38	12
Permanent crops combined	0.07	13
Specialist olives	0	14

Source: Authors' calculation

Nevertheless, it is necessary to consider that the most important indicator for the ranking process is the level of gross investments (Table 3). In general, the biggest farms have the highest level of gross investments (caused by their value of fixed assets and, consequently, depreciation costs). This leads to the conclusion that the level of investment activity is primarily related to farm size. Consequently, the ranking of farm types' investment activity by the I-distance approach is very similar to the ranking of farm types by size (if the farm size is presented as Economic size – SE005 or as the level of Total output – SE131) (Table 5).

Table 5. Ranking farm types using other indicators

Types of Farming	(SE005) Economic size (€'000)	Rank according to economic size	(SE131) Total output (€/farm)	Rank according to total output
Specialist COP	55	10.5	102.182	7
Specialist other fieldcrops	78	6	107.620	6
Specialist horticulture	**214**	**2**	**281.065**	**2**
Specialist wine	**125**	**4.5**	**144.068**	**5**
Specialist orchards - fruits	58	8	59.705	12
Specialist olives	28	14	28.882	14
Permanent crops combined	44	13	45.732	13
Specialist milk	**135**	**3**	**212.357**	**3**
Specialist sheep and goats	55	10.5	61.610	11
Specialist cattle	69	7	84.162	9
Specialist granivores	**598**	**1**	**656.790**	**1**
Mixed crops	53	12	63.839	10
Mixed livestock	**125**	**4.5**	**169.639**	**4**
Mixed crops and livestock	57	9	86.835	8

Source: FADN database and authors' calculation

The results of the previous analysis are primarily related to the fact that gross investments are an absolute indicator dependent on farm size. A more informative approach would rely on indicators that allow comparison of farms of different sizes (relative indicators). To perform such an analysis, the I-distance method is implemented in its second form, which assumes that researchers subjectively choose the most important indicator. According to this approach, percent of net investments is chosen as the most important indicator of farm investment activity (presenting the level of net investments relative to the value of fixed assets). In other words, the percent of net investments offers an opportunity to compare farms of different sizes (and production types) by their capability of investing over the amount of depreciation. Thus, a higher percent of net investments is related to faster expansion of production capacities, technological development, and modernization. In this case, the order of indicators (for determination of the value of I-squared distance) is determined on the basis of correlation between the subjectively chosen

most important indicator and the other indicators (Table 6). The most important indicator (apart from the percent of net investments) is the investment rate, indicating the ability of farms to replace property [5]. There are also three more indicators having correlation significant at the 0.01 level, while only gross investments on fixed assets have correlation significant at the 0.05 level. In contrast to the previous analysis (where only gross investments per LU were not significant), in this case gross investments per hectare are also not significant.

Table 6. Correlation of indicators

Indicators of investment activity	**Correlation**
Percent of net investments	1
Investment rate	.972**
Net Investments on fixed assets	.914**
Percent of gross investments	.907**
Gross investments per AWU	.736**
Gross Investments on fixed assets	.623*
Gross investments per hectare	.459
Gross investments per LU	.246

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*
Source: Authors' calculation

Overall rank of different farm types by investment activity is now different from the previous case, having specialist horticulture farms at the top of the list (Table 7).

Table 7. Rank of farm types (based on Table 6)

Type of farming	I-squared distance	**Rank**
Specialist horticulture	16,81	1
Mixed livestock	15,92	2
Specialist milk	13,73	3
Specialist COP	12,16	4
Specialist wine	11,15	5
Mixed crops and livestock	10,36	6
Specialist granivores	9,43	7
Specialist cattle	7,09	8
Mixed crops	6,74	9
Specialist other fieldcrops	6,21	10
Specialist sheep and goats	4,11	11
Specialist orchards – fruit	3,08	12
Permanent crops combined	0,26	13
Specialist olives	0	14

Source: Authors' calculation

Although farms of this type are not the biggest, they are the most capable of investing in enlargement of production capacities (fixed assets). On the other hand, farms specialized in granivores are now ranked seventh according to the level of their investment activity. Although granivore producers have the highest absolute gross and net investments, their net investments are relatively low compared to the value of fixed assets used for farm operations.

The lowest rank of investment activity is attributed to farms specialized in olive production, as well as other farm types having negative net investments, because such farms will decrease their production capacities in the long run.

Farm investment activity could be improved and supported by adequate policy measures. Discussing an investment support to agriculture [41] stated that it is "supposed to accelerate the structural changes in agriculture and make the farms more competitive". Certain research, such is [13] stated that "farm gross investment was positively associated with investment subsidies", while other research concluded that "dependence of gross investments on investment subsidies shows medium and higher dependence" [42]. At the same time, [43] concluded "that there is some ambiguity on the impact of support on farms investments", while other research also emphasize complex relations between agricultural subsidies and farm investments [44].

Farms specialized in olive production recorded the lowest level of investment activity, while they are the smallest farms concerning economic size and total output (table 5). Similarly, farms specialized in sheep and goat production are the smallest farms among farm types specialized for livestock production (Table 5). The same conclusion was reached by [45] concerning total output and total assets of sheep and goat farms in the European Union. Older research related to olive farming [46] enlisted number of problems faced by olive producers, such as "intensified and expanding production, leading to unsustainable use of natural resources", "decreasing viability of traditional, low-input systems", "market surpluses, falling prices and continued expansion of production" etc. More recent analysis discussing Spanish olive sector [47] suggested better overall performance of organic farming comparing to conventional approach, while Common Agricultural Policy (CAP) subsidies proved to be important factor in transition to ecological production.

Although CAP support to farm investment activity is a very broad and complex topic (especially when it comes to particular farm types) it could be said that one of possible ways to improve farm performance is transition towards organic farming (which is supported with appropriate CAP measures). It could be applied not only for olive production or other permanent crops, but also for sheep and goat production. At the same time, "rural development policy provides opportunities by creating synergies between the agricultural and rural dimensions of sheep and goat farming and by means of other measures that the EU Member States can activate through their rural development programmes to support farming activity" [48]. Another research conducted in six EU countries (Greece, Italy, Spain, Finland, United Kingdom, France) and Turkey [49] discussed sustainability of sheep and goat farming. Authors described complexity of this issue having in mind "different climatic zones and methods of farming (by typology) in each country", which implies a need for in depth analysis for each country to provide "the maximum results in regard to sustainability".

CONCLUSION

Due to the importance of investments for the long-term development and sustainability of agriculture, it is necessary to discuss the level of investment activity of different farm production types. Although the analysis first revealed that the highest level of investment activity is recorded for the biggest farms (specialized in granivores), this does not necessarily mean that such farms have the highest capacity for technical and technological development. Further discussion indicated that the farm type specialized in horticultural production has the highest level of investment activity (if the rate of expanding their fixed assets is considered to be the most relevant indicator). The results suggest that the capability of farms to increase and modernize their production capacities is not necessarily related to farm size, or to the absolute level of gross or net investments.

Attention should be paid to four farm types that recorded negative net investments, meaning that their investments are lower than the amount of depreciation. Three out of four farm types with negative net investments are related to the growing of permanent crops, while one farm type is specialized in livestock production (sheep and goat production). An especially unfavorable position concerning investment activity (among all farm types) is observed for farms dealing with olive production in the EU. Therefore, it is necessary to create appropriate agricultural policy measures to prevent the decline of the above-mentioned production types. Future research in this field should be directed toward broadening knowledge on the factors influencing the level of investment activity of certain farm types.

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