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# INVESTING IN AGRICULTURE: STRUCTURAL AND FINANCIAL DETERMINANTS OF FARM INVESTMENT ACTIVITY IN POLAND

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## ABSTRACT

**Aim:** This study investigates the structural and financial determinants of investment activity among Polish farms, focusing on investment propensity, planned investments, and innovative investment initiatives. **Methods:** The study draws on data collected through a nationally representative CATI survey of 800 farm owners or co-owners and was conducted between the end of 2024 and the beginning of 2025. Using logistic regression models, we identify key predictors of past investments, future investment plans, and the innovativeness of recent investments. **Results:** Results highlight the significant role of farm size, financial condition, prior investment activity, and usage of external funding in shaping investment decisions. Regional disparities and production type (plant vs. animal) also affect investment propensity and innovation adoption. Farms that applied for funding, regardless of the outcome of the process, were more likely to invest, suggesting that strategic planning itself correlates with investment activity. **Conclusions:** The research findings contribute to the literature on agricultural modernization and provide practical recommendations for policymakers seeking to promote the development of rural areas through targeted investment support. The agricultural sector in Poland is undergoing a significant transformation driven by the implementation of environmental regulations, ESG frameworks, and the shift toward sustainable production. These changes require not only financial capital but also adaptability, strategic planning, and institutional support to ensure balanced and inclusive development. Targeted policies dedicated to small and medium-sized farms, particularly those operating in disadvantaged regions and with limited access to capital, are essential to strengthen their productivity and competitiveness. Enhancing education and advisory services could help farmers develop more effective investment strategies and better access funding opportunities, especially in areas with lower levels of investment activity.

**Key words:** agricultural investment, farm size, innovation, public funding, Poland, logistic regression

**JEL codes:** Q12, Q14, C25

## INTRODUCTION

Agricultural investments play a key role in driving sectoral development. They influence, among other things, the level of technological advancement of farms, their productivity, income levels, and competitiveness [Sunding and Zilberman 2001, Kusz et al. 2015, Koloszko-Chomentowska and Sieczko 2017, Zmyślona and Barczak 2025, Zmyślona et al. 2025]. Investments are made for modernization, development of durable

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assets, and their impact goes beyond individual farms, contributing to broader structural objectives and national food security [Kusz et al. 2015, Koloszko-Chomentowska and Sieczko 2017, Dziwulski and Szymańska 2020, MRiRW 2023, Kulawik and Soliwoda 2025].

Institutionally, EU regulations classify farms as economic entities; in Poland, due to the structure of the agricultural sector, agricultural farms are treated as important microeconomic entities of the national economy [Wielechowski et al. 2023], which means that their investment activity has significant importance in implementing structural changes in agriculture and increasing its productivity.

In the context of dynamic technological changes and growing market requirements, increasing importance is attributed to investments in modern and innovative solutions. Modern agriculture requires the implementation of solutions that enhance production efficiency and competitiveness, such as digital technologies, precision farming, and knowledge-based solutions [Piwowar 2018, Kokotek and Korencki 2020, Yarashynskaya and Prus 2022, Kramarz and Runowski 2025].

The need to support agricultural investments is also reflected in strategic documents. The Strategy for Sustainable Development of Rural Areas, Agriculture and Fisheries 2030 emphasizes the key role of investments in increasing the competitiveness of agricultural farms, improving living conditions in rural areas, and protecting natural resources. The strategy indicates the need to strengthen modernization of the agricultural sector, taking into account economic, climate, and social challenges [MRiRW 2023].

## INVESTMENT ACTIVITY AND INNOVATION IN AGRICULTURE

Agricultural investment has been widely studied in the literature, which emphasizes its complex and multifaceted nature. Investments in this sector form the foundation for enhancing farm competitiveness, improving production efficiency, and adapting to evolving market and environmental conditions [Zmyślona et al. 2025]. Empirical studies on the implementation of financial instruments under the Rural Development Program 2014–2020 for Poland indicate that Polish farmers' investments – mainly aimed at the modernization of farms (data from 2016) – resulted in higher labor productivity compared to farms that did not use such support [Pawłowska et al. 2018]. Productivity growth, however, required a rational investment approach. Analyses from 2010 to 2019 showed that farms that invested excessively in relation to their production potential demonstrated the weakest economic outcomes, including production declines [Zmyślona et al. 2025]. Investments that were too low were also associated with production drops, stemming from a lack of competitiveness of these farms. Only optimal investment levels were linked to increased productivity and better production results [Zmyślona et al. 2025]. Similarly, overinvestment has been observed in other EU countries – data from 2004 to 2015 indicated that the highest share of farms with absolute overinvestment[1] was recorded in Estonia, and the lowest in Latvia [Pawłowski et al. 2021b].

Further studies indicate that farms implementing comprehensive investments – those exceeding 50% of the average annual value of fixed assets – improved their technical efficiency, and pro-investment public policy mechanisms contributed to proportional increases in asset values and farm growth [Czubak et al. 2021]. Additionally, direct payments play a significant role in financing agricultural investments. As Zielonka et al. [2021] demonstrate, farms could not have achieved comparable investment levels without these payments, which accounted for over one-third of farm profits in 2021, confirming their critical role in sustaining investment activity.

In addition to traditional modernization, investments in innovative solutions, such as digital and precision farming, climate-smart practices, and environmental, social, and governance- compatible (ESG) technolo-

[1] The authors developed a proprietary typology of farms, comprising the following categories: (1) Optimum investment level – where the growth rate of labor productivity exceeds the growth in the assets-to-land ratio; (2) Relative overinvestment – where labor productivity increases, but at a slower pace than the assets-to-land ratio; (3) Absolute overinvestment – where labor productivity declines while the assets-to-land ratio continues to grow [Pawłowski et al. 2021b, p. 1].

gies, play a pivotal role in increasing farm productivity, resilience, and environmental performance. Agricultural innovation is defined by the Food and Agriculture Organization (FAO) as "the process whereby individuals or organizations bring new or existing products, processes, or ways of organization into use for the first time in a specific context in order to increase effectiveness, competitiveness, resilience to shocks or environmental sustainability and thereby contribute to food security and nutrition, economic development or sustainable natural resource management" [FAO 2019].

Studies by Yarashynskaya and Prus [2022] showed that well-developed metropolitan areas have the highest potential for implementing precision agriculture, while poorly developed peripheral regions have the lowest. The adoption of advanced digital tools associated with precision farming and crop production automation in Poland remains limited. Empirical evidence [Kramarz and Runowski 2025] indicates that farm size, the age of the farm manager, and the scope of farm activities significantly increase the likelihood of implementing such technologies, whereas insufficient knowledge and lack of trust constitute major barriers, underscoring the need for targeted educational and advisory interventions, particularly for small-scale farms. Piwowar [2018] argues that Agriculture 4.0, which combines information and communication technologies (ICT) and automation, can support low-carbon farming, yet its deployment requires universal access to ICT devices and the appropriate competences and knowledge to use them.

## DETERMINANTS OF INVESTMENT ACTIVITY

Farm investment activity is shaped by a complex set of interrelated factors, which can be grouped into two categories: exogenous (external, macroeconomic) and endogenous (internal, microeconomic) [Kusz and Gędek, 2015, Kusz et al. 2015, Miłaszewicz and Nermend 2017]. The exogenous factors refer to conditions external to the farm that influence investment decisions and may include (to name a few): demand conditions, current and expected price levels, supply conditions, income, availability of preferential credit, commercial interest rates, the accessibility of EU funding, and current and future economic outlook (conditions). Additionally, they can also include geographic and socio-demographic conditions, government economic policies, inflation, the degree of openness of the economy to international connections, trade barriers and regulations, particularly those related to environmental protection and animal welfare, as well as pressures from environmental groups.

The endogenous factors are linked to the internal potential and characteristics of the agricultural farm, e.g., availability of production resources, the level of fixed assets consumption, economic and financial situation of the farm, adoption of modern manufacturing techniques, knowledge and skills in farm management, as well as the farmer's age.

In this article, we focus on the structural and financial determinants of investment activity, as these two groups of factors – capturing the specialization of farms and regional differences on the one hand, and access to investment capital, liquidity, and credit conditions on the other – are consistently identified in the literature cited below as important drivers of investment decisions. Both groups of determinants were incorporated into our analysis.

## FINANCIAL DETERMINANTS OF INVESTMENT ACTIVITY

Among the key financial factors, the most crucial are farm income, access to external capital, opportunities to use preferential loans, and the structure of public support – especially investment subsidies. Investment subsidies remain one of the most important conditions for investment development. After Poland's accession to the EU, the value of investment co-financed from public funds increased from 2.4 billion PLN in 2005 to 6.1 billion PLN in 2015. Over 90% of these investments were self-financed [Koloszko-Chomentowska and Sieczko 2017].

Different studies indicate that various support instruments can effectively promote investment in agriculture. Some research indicates that direct payments significantly increase farmers' investment capacity [Zielonka et al. 2021]. On the other hand, preferential loans appear to be among the most significant factors influencing investment decisions, often outweighing even income levels [Szymańska et al. 2021]. Other studies indicate that EU support programs, which

include various financial support instruments, are "an equally important source of investment financing in Polish agricultural holdings" [Szymańska et al. 2021, p. 90]. Recent analyses emphasize that financial instruments, e.g., preferential loans, tend to complement public subsidies as a source of financing for agriculture in the EU [Kulawik and Soliwoda 2025].

Research by Bereźnicka [2024] shows that investment activity in Polish family farms increases with their financial flexibility. Positive cash flows, cash reserves, and financial leverage support higher investment levels, but mainly when farms simultaneously make use of credit. Therefore, the author concludes that credit is the primary driving force behind investment activity. What's interesting is that investment activity is closely linked to the financial security of farms [Szafraniec-Siluta et al. 2024]. Similarly, as equity capital and debt levels increase, so does the likelihood of an agricultural holding making investments. This means that the possibility of greater use of financial leverage has a significant impact on farmers' investment decisions [Wieliczko et al. 2019].

## STRUCTURAL DETERMINANTS OF INVESTMENT ACTIVITY

### Farm size and investment activity

Research findings indicate that farm size plays a significant role in determining both the scale and direction of investments. For instance, large farms tend to invest more in fixed assets [Wieliczko et al. 2019], and innovation, as they generate income that facilitates co-financing of investments and more frequently make use of investment support instruments [Kusz 2008, Wicki and Pietrzykowski 2018, Sass 2019 as cited in Wicki 2019].

Findings by Lorencowicz and Cupiał [2013] revealed that larger farms in Poland with an average area of over 40 ha implemented investments of greater value. This was due both to their greater capital potential and to the need to modernize production technologies or to purchase larger and more expensive machinery. Moreover, studies from 2004–2015 showed that larger farms were more likely to implement complex investments, including those co-financed with pro-investment CAP mechanisms [Czubak et al. 2021].

### Region's agricultural differences

Various studies show differences between macro-regions. These differences result not only from the different years covered by the studies but also from the indicators used by researchers, such as investment activity or interest in investment programs. According to data from 2007 to 2018, the level of investment determinants correlated with the geographical location and socio-economic status of municipalities [Kozera et al. 2021]. The highest investment activity was observed in rural municipalities located in the southern and eastern macroregions of Poland. Research by Bórawski et al. [2020] covering the period 2000–2018 showed that the level of investment in Polish agriculture varied from region to region. The highest investment expenditure was recorded in provinces with favorable conditions for animal production, especially dairy and beef production, i.e., in the voivodeships of Wielkopolskie, Mazowieckie, Warmińsko-Mazurskie, and Podlaskie, while the lowest were in the southern and eastern macroregions, characterized by poorer natural and production conditions. The study of Sadowski et al. [2021] examined the relationships between socio-economic, natural, and structural characteristics of Polish communes and the scale of EU-supported investments, showing that local agricultural development processes are partly autonomous. The highest socio-economic development was observed mainly in western Poland and near major cities, while the highest agricultural production space index occurred in selected communes in the north, southeast, and south of the country. The activity of farmers in obtaining EU funds for investment purposes also shows strong regional differentiation. Between 2004 and 2013, the majority of funds were located in central and northern voivodeships, where agriculture is more developed [Grzelak and Kiełbasa 2014].

Similarly, interest in pro-investment programs (according to a study from 2007–2013), measured by the number of submitted applications rather than the number of signed contracts, also reveals regional differences. Interest was higher in regions with more advanced agricultural development and better agrarian structure, that is, in western and northeastern Poland, whereas the lowest interest was observed in southeastern Poland [Kiryluk-Dryjska et al. 2021].

### Investment differentiation according to farm profile

The studies also examined the type of agricultural production as a factor differentiating investment behavior. In cereal and livestock farms (as opposed to dairy farms), changes in investment behavior were strongly correlated with income from the previous year, indicating greater sensitivity to market conditions [Szymańska and Dziwulski 2021]. Analysis of data from 2009 to 2014 [Koloszko-Chomentowska and Sieczko 2017] suggests that investment processes were related to the production profile. Although investments were implemented across all farm groups, the growth effect was most pronounced in livestock farms, while farms with no clear specialization were in the most disadvantaged position. According to research by Kusz [2008], there are differences in investment patterns – animal farms invest more often in buildings, while plant and mixed farms invest more in machinery and transportation. In turn, research by Wieliczko et al. [2019] on investment behavior indicated that mixed farms most often invested in fixed assets, while the lowest percentage was recorded in horticultural farms. The study of Zmyślona and Barczak [2025] indicated that production specialization significantly affects the level of investment and costs, with capital-intensive areas such as dairy farming generating the highest costs. A decline in investment value was recorded in the case of farms engaged in, among other things, horticultural production, other permanent crops, pasture cattle breeding, and mixed production.

## AIM AND METHODS

The purpose of the study was to examine the determinants of investment in Polish agriculture, including the determinants of investment propensity, investment plans, and innovative investments[2]. The survey employed a quantitative methodology, utilizing a computer-assisted telephone interview (CATI).

The sample was constructed to reflect the structure of Polish farms in terms of size, production type, and voivodeship. To achieve this, minimum quotas were set for key categories to ensure adequate representation (Table 1). Ultimately, 800 interviews were obtained.

Although the selection was not purely random, it was structured to enable generalization to the broader population of farms. After data collection, analytical weights were applied to adjust the sample to the actual distribution of farms in Poland. These weights were calculated based on official statistics from Statistics Poland (GUS)

**Table 1.** Minimum number of interviews by category

| Criterion | Minimum number of interviews | Final number of interviews |
|---|---|---|
| Farm size | | |
| up to 5 ha | 300 | 335 |
| above 5 to 20 ha | 300 | 311 |
| above 20 ha | 100 | 154 |
| Production type | | |
| crop production | 300 | 347 |
| livestock production | 100 | 110 |
| mixed production | 300 | 343 |
| Voivodeship | at least 30 interviews in each | at least 30 interviews in each |

Source: authors' work.

[2] The completed survey was part of a larger study aimed at assessing the functioning of the guarantees provided by Bank Gospodarstwa Krajowego (BGK) within the framework of the Agricultural Guarantee Fund (Fundusz Gwarancji Rolnych) established in 2019. The survey was carried out by IMAS International on behalf of BGK [BGK 2024].

and jointly accounted for farm size, production type, and voivodeship. This procedure corrected any over- or under-representation resulting from the use of minimum quotas and ensured that the weighted sample accurately reflects the population of Polish farms.

The original telephone interview questionnaire used in the study consisted of a section of closed and semi-open questions, arranged as follows: metrics (M1–M4), questions about threats and barriers to development (S1–S6), questions about the financial situation of farmers, realized and planned investments and their sources of financing (P1–P14), questions about access to financing, financial products, and plans for financing (Z1–Z15).

The survey was conducted between December 12, 2024, and January 29, 2025, by IMAS International on behalf of the National Development Bank. Respondents were owners or co-owners of farms. Participants were informed about the purpose of the survey, its anonymous character, and the voluntary nature of participation.

Frequency analysis and binary logistic regression were conducted. Observations with at least one "difficult to say" response in either the independent or dependent variables were excluded from the dataset before particular analyses. This decision was made because such responses are inherently ambiguous and do not provide interpretable information for the variables under the study. Moreover, the number of cases with "difficult to say" answers was very small, which limits their analytical value and could introduce instability or bias in the results if retained. Excluding these observations ensured that the analyses were based on clearly defined categories and improved the robustness and clarity of the findings.

There was some variation in the sets of predictors for particular regression models, but every model included variables regarding basic properties of surveyed entities, such as their size, production type, macroregion, etc. Due to space constraints, only statistically significant coefficients for logistic regression are described in the main text. The collected data were statistically analyzed using R version 4.5.1.

For the regression model employing investment plans as the dependent variable, a composite variable measuring concern about threats to Polish agriculture was used as an additional predictor. It was constructed as the mean score across 12 items rated on a scale from 0 (not threatening at all) to 10 (very threatening). These items included perceived risks such as climate regulations, market competition, demographic shifts, inflation, and access to investment capital. The internal consistency of the scale was acceptable (Cronbach's $\alpha = 0.78$), supporting the aggregation of items into a single index.

The innovativeness of the investment was assessed based on respondents' self-reported opinions. Farmers were asked a direct question regarding whether they considered the investment innovative. No external or objective measures (such as technological benchmarks or expert evaluations) were applied.

## Sample characteristics

Descriptive statistics were calculated to summarize the key characteristics of the surveyed farms ($N = 800$) after applying weighting. The majority of farms specialized in plant production (69.55%), while 15.23% specialized in animal production, and 15.22% in mixed production.

In terms of geographic distribution, the largest share of farms was located in the eastern macroregion (27.15%), followed by Mazowieckie voivodeship (15.99%), central (14.82%), and northern (14.32%) macroregions. Smaller proportions were found in the northwestern (11.91%), northern (9.84%), and northwestern (5.97%) regions.

Regarding farm size, over half of the farms (52.02%) were smaller than 5 ha. Farms between 5–10 ha accounted for 16.29%, those between 10–20 ha for 20.69%, and farms larger than 20 ha for 11.00%.

When asked about changes in liquidity over the past year ($N = 789$), 55.70% reported no change, 36.64% reported a deterioration, and 7.66% reported an improvement. Similarly, for income changes ($N = 781$), 49.49% reported no change, 40.43% reported a decrease, and 10.08% reported an increase.

In terms of investment activity, 35.63% of farms reported making an investment in the past 12 months, while 42.91% planned to invest in the next three years. Among those who invested, 67.54% characterized their investment as innovative ($N = 242$).

Regarding the financial situation ($N = 786$), 12.86% of respondents rated their situation as poor (Bottom 2 Box), 55.87% as neutral, and 31.28% as good (Top 2 Box). The majority of farms (71.58%) did not have

financial support instruments (e.g., credits, loans), while 28.42% did. When asked about funding applications in the past year, 59.94% had not applied, 10.32% applied unsuccessfully, and 29.74% applied successfully. The financing gap, calculated as the percentage of farms applying for financing in the last year that did not receive financing under the terms applied for, is 25.86%. Looking ahead, 34.48% of farms planned to apply for funding in the next year.

## RESULTS

### Making an investment

A binary logistic regression was conducted to examine the predictors of whether a farm in Poland made an investment in the past 12 months (0 = no, 1 = = yes). The model included variables related to production type, macroregion, farm size, financial changes, financial situation, and funding activity. The analysis was based on weighted survey data ($N = 760$). Model diagnostics indicated no issues with multicollinearity (all $VIFs < 5$) and no influential observations/outliers.

The model was statistically significant, $\chi^2(20) = 107.55$, $p < 0.001$, indicating that the set of predictors reliably distinguished between farms that did and did not invest. Compared with the null model ($AIC = 934.5$), the full model demonstrated substantially better fit ($AIC = 878.0$). The model's Tjur's $R^2$ was 0.135, indicating a moderate level of predictive discrimination. All coefficients for the model are presented in Table 2.

Farms specializing in plant production were significantly less likely to invest compared to those focused on animal production. Farms located in the northwestern macroregion were also less likely to invest than those in the Mazowieckie voivodeship. In terms of farm size, farms ranging from 10 to 20 ha were significantly more likely to invest than those under 5.

Farms that reported an increase in income over the past year were more likely to invest than those with no change in income. Similarly, farms that assessed their financial situation as neutral or positive were more likely to invest than those with a negative assessment.

Finally, farms that had applied for funding in the past year – whether unsuccessfully or successfully – were significantly more likely to have made an investment (Table 2).

### Investment plans

A binary logistic regression was conducted to identify predictors of whether a farm in Poland plans to make an investment within the next three years (0 = no,

**Table 2.** Logistic regression results for making an investment

| Variable | *B* | *SE* | *z* | *p* |
|---|---|---|---|---|
| Intercept | −1.614 | 0.425 | −3.797 | <0.001*** |
| Farm type: plant production (vs. animal) | −0.773 | 0.236 | −3.269 | 0.001** |
| Farm type: mixed production (vs. animal) | −0.432 | 0.295 | −1.468 | 0.142 |
| Macroregion: Southwest (vs. Mazowieckie voivodeship) | 0.096 | 0.383 | 0.251 | 0.802 |
| Macroregion: North (vs. Mazowieckie voivodeship) | 0.390 | 0.323 | 1.207 | 0.227 |
| Macroregion: East (vs. Mazowieckie voivodeship) | 0.035 | 0.262 | 0.134 | 0.893 |
| Macroregion: Northwest (vs. Mazowieckie voivodeship) | −0.921 | 0.348 | −2.645 | 0.008** |
| Macroregion: Central (vs. Mazowieckie voivodeship) | 0.049 | 0.290 | 0.168 | 0.867 |
| Macroregion: South (vs. Mazowieckie voivodeship) | −0.238 | 0.302 | −0.786 | 0.432 |
| Farm size: 5–10 ha (vs. <5 ha) | 0.297 | 0.240 | 1.234 | 0.217 |
| Farm size: 10–20 ha (vs. <5 ha) | 0.927 | 0.224 | 4.143 | <0.001*** |
| Farm size: >20 ha (vs. <5 ha) | 0.509 | 0.289 | 1.762 | 0.078 |
| Liquidity: worsened (vs. no change) | 0.273 | 0.243 | 1.127 | 0.260 |

**Table 2.** Logistic regression results for making an investment (cont.)

| Variable | *B* | *SE* | *z* | *p* |
|---|---|---|---|---|
| Liquidity: improved (vs. no change) | 0.553 | 0.345 | 1.604 | 0.109 |
| Income: decreased (vs. no change) | 0.161 | 0.234 | 0.687 | 0.492 |
| Income: increased (vs. no change) | 0.627 | 0.312 | 2.011 | 0.044* |
| Financial situation: neutral (vs. Bottom 2 Box) | 0.741 | 0.291 | 2.542 | 0.011* |
| Financial situation: good/very good (Top 2 Box) (vs. Bottom 2 Box) | 0.924 | 0.320 | 2.891 | 0.004** |
| Has financial instruments (vs. no) | 0.100 | 0.203 | 0.492 | 0.623 |
| Applied for financial instrument: unsuccessfully (vs. no) | 1.179 | 0.281 | 4.199 | <0.001*** |
| Applied for financial instrument: successfully (vs. no) | 0.694 | 0.190 | 3.646 | <0.001*** |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

$\chi 2(20) = 107.55$, $p < 0.001$, Tjur's R2 = 0.135.

Reference categories for categorical variables are indicated in parentheses.

Source: authors' work.

1 = yes), based on weighted survey data ($N$ = 760). The model was statistically significant, $\chi^2(23) = 258.6$, $p < 0.001$, and showed a substantial improvement in fit over the null model ($AIC$ = 779.4 vs. 980.6). Tjur's $R^2$ was 0.309. All coefficients for the model are presented in Table 3.

Farms that had made an investment in the past 12 months were more likely to plan future investments than those that had not. Farms with a neutral or positive assessment of their financial situation were also more likely to plan investments. Having financial support instruments was associated with a higher likelihood of planned investment, as was having unsuccessfully applied for funding in the past year. Farms that intended to apply for funding in the next year were significantly more likely to plan investments. Finally, greater concern about threats to Polish agriculture was associated with a lower likelihood of planning.

Model diagnostics indicated no issues with multicollinearity (all $VIFs$ < 5), no influential outliers, and no violations of the linearity of the logit for the continuous predictor (concern about threats to Polish agriculture).

### Innovativeness of the investments made

A binary logistic regression was conducted to examine the predictors of whether a farm's investment in the past 12 months was innovative (0 = no, 1 = = yes), using weighted survey data ($N$ = 219). The model was statistically significant, $\chi^2(21) = 34.03$, $p$ = = 0.034, and showed an improvement in fit compared to the null model ($AIC$ = 264.1 vs. 276.5). Tjur's $R^2$ was 0.109. All coefficients for the model are presented in Table 4.

Farms specializing in plant production were more likely to report innovative investments compared with those focused on animal production. Farms located in the eastern macroregion were significantly less likely to report innovative investments than those in Mazowieckie voivodeship. Additionally, farms with a neutral or positive assessment of their financial situation were more likely to report innovation.

Model diagnostics indicated no issues with multicollinearity (all $VIFs$ < 5), no influential outliers, and no violations of the linearity of the logit for the continuous predictor (monetary value of investment).

## DISCUSSION

### Determinants of investment propensity

The data from the conducted research confirm that investment decisions in agriculture are strongly determined by a range of structural, economic, and spatial

**Table 3.** Logistic regression results for investment plans

| Variable | *B* | *SE* | *z* | *p* |
|---|---|---|---|---|
| Intercept | −1.745 | 0.686 | −2.543 | <0.001* |
| Farm type: plant production (vs. animal) | 0.286 | 0.259 | 1.104 | 0.270 |
| Farm type: mixed production (vs. animal) | −0.101 | 0.332 | −0.303 | 0.762 |
| Macroregion: Southwest (vs. Mazowieckie voivodeship) | −0.188 | 0.432 | −0.435 | 0.663 |
| Macroregion: North (vs. Mazowieckie voivodeship) | −0.516 | 0.361 | −1.430 | 0.153 |
| Macroregion: East (vs. Mazowieckie voivodeship) | −0.460 | 0.290 | −1.586 | 0.113 |
| Macroregion: Northwest (vs. Mazowieckie voivodeship) | −0.200 | 0.350 | −0.570 | 0.568 |
| Macroregion: Central (vs. Mazowieckie voivodeship) | −0.150 | 0.317 | −0.473 | 0.636 |
| Macroregion: South (vs. Mazowieckie voivodeship) | −0.272 | 0.320 | −0.850 | 0.395 |
| Farm size: 5–10 ha (vs. <5 ha) | −0.375 | 0.264 | −1.419 | 0.156 |
| Farm size: 10–20 ha (vs. <5 ha) | 0.197 | 0.247 | 0.795 | 0.427 |
| Farm size: >20 ha (vs. <5 ha) | 0.562 | 0.322 | 1.746 | 0.081 |
| Liquidity: worsened (vs. no change) | 0.449 | 0.266 | 1.689 | 0.091 |
| Liquidity: improved (vs. no change) | −0.004 | 0.370 | −0.011 | 0.991 |
| Income: decreased (vs. no change) | −0.204 | 0.254 | −0.802 | 0.422 |
| Income: increased (vs. no change) | 0.405 | 0.335 | 1.208 | 0.227 |
| Investment made in the past 12 months (vs. no) | 0.932 | 0.190 | 4.901 | <0.001*** |
| Financial situation: neutral (vs. Bottom 2 Box) | 1.275 | 0.343 | 3.715 | <0.001*** |
| Financial situation: good/very good (Top 2 Box) (vs. Bottom 2 Box) | 2.072 | 0.373 | 5.549 | <0.001*** |
| Has financial instruments (vs. no) | 1.001 | 0.225 | 4.454 | <0.001*** |
| Applied for financial instrument: unsuccessfully (vs. no) | 0.799 | 0.324 | 2.462 | 0.014* |
| Applied for financial instrument: successfully (vs. no) | −0.045 | 0.209 | −0.217 | 0.828 |
| Plans to apply for funding (vs. no) | 1.510 | 0.194 | 7.770 | <0.001*** |
| Concern about threats to agriculture | −0.179 | 0.069 | −2.601 | 0.009** |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

$\chi^2(23) = 258.6$, $p < 0.001$, Tjur's $R^2 = 0.309$.

Reference categories for categorical variables are indicated in parentheses.
Source: authors' work.

**Table 4.** Logistic regression results for innovativeness of the investments made

| Variable | *B* | *SE* | *z* | *p* |
|---|---|---|---|---|
| Intercept | −0.686 | 0.918 | −0.748 | 0.455 |
| Farm type: plant production (vs. animal) | 1.054 | 0.426 | 2.474 | 0.013* |
| Farm type: mixed production (vs. animal) | 0.275 | 0.516 | 0.533 | 0.594 |
| Macroregion: Southwest (vs. Mazowieckie voivodeship) | −0.517 | 0.838 | −0.617 | 0.537 |
| Macroregion: North (vs. Mazowieckie voivodeship) | −0.277 | 0.688 | −0.403 | 0.687 |
| Macroregion: East (vs. Mazowieckie voivodeship) | −1.270 | 0.588 | −2.158 | 0.031* |

**Table 4.** Logistic regression results for innovativeness of the investments made (cont.)

| Variable | *B* | *SE* | *z* | *p* |
|---|---|---|---|---|
| Macroregion: Northwest (vs. Mazowieckie voivodeship) | −0.360 | 0.810 | −0.445 | 0.656 |
| Macroregion: Central (vs. Mazowieckie voivodeship) | 0.043 | 0.678 | 0.064 | 0.949 |
| Macroregion: South (vs. Mazowieckie voivodeship) | −0.922 | 0.662 | −1.394 | 0.163 |
| Farm size: 5–10 ha (vs. <5 ha) | −0.722 | 0.488 | −1.480 | 0.139 |
| Farm size: 10–20 ha (vs. <5 ha) | −0.128 | 0.421 | −0.305 | 0.761 |
| Farm size: >20 ha (vs. <5 ha) | −0.250 | 0.636 | −0.393 | 0.695 |
| Liquidity: worsened (vs. no change) | 0.327 | 0.438 | 0.747 | 0.455 |
| Liquidity: improved (vs. no change) | −0.344 | 0.556 | −0.618 | 0.537 |
| Income: decreased (vs. no change) | −0.062 | 0.419 | −0.148 | 0.882 |
| Income: increased (vs. no change) | 0.180 | 0.547 | 0.328 | 0.743 |
| Financial situation: neutral (vs. Bottom 2 Box) | 1.367 | 0.588 | 2.327 | 0.020* |
| Financial situation: good/very good (Top 2 Box) (vs. Bottom 2 Box) | 1.630 | 0.641 | 2.541 | 0.01* |
| Has financial instruments (vs. no) | −0.186 | 0.398 | −0.467 | 0.640 |
| Applied for financial instrument: unsuccessfully (vs. no) | 0.221 | 0.522 | 0.423 | 0.672 |
| Applied for financial instrument: successfully (vs. no) | −0.033 | 0.375 | −0.089 | 0.929 |
| Monetary value of investment made in the past 12 months | 0.000 | 0.000 | 1.197 | 0.231 |

*$p < 0.05$.

$\chi^2(21) = 34.03$, $p = 0.034$, Tjur's $R^2 = 0.109$.

Reference categories for categorical variables are indicated in parentheses.
Source: authors' work.

factors, and remain consistent with findings in the existing literature on the subject [Wieliczko et al., 2019, Bórawski et al. 2020, Zielonka et al. 2021, Zmyślona and Barczak 2025, Zmyślona et al. 2025].

Our findings indicate that farms specializing in plant production tend to invest less than those focused on livestock production. This may be due to the need for significant technological investments, which are relatively more demanding for livestock farms. In contrast, plant production farms less frequently incur investment outlays due to the specificity of production, which is more dependent on natural conditions and characterized by a lower level of mechanization than farms focused on animal production.

Clear regional differences have been identified, especially lower investment activity in the northwestern macroregion of the country compared with Mazowieckie voivodeship. These findings contribute to the literature highlighting the role of local conditions, such as the level of infrastructure development, agrarian structure, and availability of support measures in investment activity [Bórawski et al. 2020, Kiryluk-Dryjska et al. 2021, Kozera et al. 2021]. Combining the results of our research with findings from Grzelak and Kiełbasa [2014], Bórawski et al. [2020], Kozera et al. [2021], and Sadowski et al. [2021], it becomes evident that regional differences in investment activity are significant and dynamic, with no single region maintaining permanent dominance over time. This is beneficial from the point of view of the development of the country and the objectives of the "Strategy for Sustainable Development of Rural Areas, Agriculture and Fisheries 2030" [MRiRW 2023].

The significant impact of farm size on the propensity to invest is confirmed by the literature reviewed. Medium-sized farms show higher investment activity than smaller farms, which is the result of their greater financial potential and easier access to support pro-

grams [Lorencowicz and Cupiał 2013, Wicki 2019, Wieliczko et al. 2019], access to loans and grants, and their potential to recover their costs more quickly.

The study results also clearly indicate the importance of the farm's economic situation. Both income growth in the last year and a neutral or positive subjective assessment of the financial situation were significant predictors of investment activity, which is consistent with the theory of the rationality of investment decisions and previous analyses of the effect of direct subsidies, equity on investment capacity [Zielonka et al. 2021, Zmyślona et al. 2025] and generally the possibility of greater use of financial leverage [Wieliczko et al. 2019]. Greater equity and financial optimism encourage thoughtful development activities.

Finally, it was noted that farms that applied for external funds – both successfully and unsuccessfully – were more likely to declare making an investment. This is an interesting observation, since the very attempt to apply for financing is associated with a higher likelihood of investment. The application process involves needs analysis and the preparation of a business plan, so it requires strategic planning and activity from the farmers applying for the funds. Thus, those entrepreneurial farmers who have a legitimate investment need seek another source of financing their investment. Once incurred, the expense of preparing an application for funds can pay off in the future, as the application itself can serve as the basis for other proceedings [Grzelak and Kiełbasa 2014, Czubak et al. 2021].

### Predictors of investment plans

Our research shows that farms that invested in the past 12 months were more likely to plan further investments. This may be due to the fact that investment-active farms, already having both infrastructure, experience, and competence, continue to expand.

Financial stability increases the willingness to take investment risks. This is supported by the finding that farms with a neutral or positive assessment of their financial situation and access to financing were significantly more likely to plan investments than those with a negative assessment and no access to investment funding. Interestingly, even farms that unsuccessfully applied for financing were more likely to plan investments, which was also observed in previous periods.

Farms intending to apply for financing in the following year were more likely to plan investments. This result is not surprising, as investment plans are often linked to plans to obtain financing.

Heightened concern about agriculture's future tends to reduce investment planning. Pessimism and uncertainty about the future of the agricultural sector can effectively discourage investment. This result can be explained by the real options approach (ROA), according to which, in a situation of unfavorable economic conditions, investments are suspended or delayed in order to obtain more information about future conditions. As noted by Dessart et al. [2019], when faced with sunk costs and uncertainty about the future benefits of adopting new sustainable practices, farmers may prefer to delay investment decisions in order to maintain flexibility and adapt to changing conditions.

### Predictors of innovative investments

Important factors correlating with the innovativeness of farmers' investments are the type of production, the macroregion, and the assessment of the financial situation. Farms engaged in plant production are more open to modern technologies, which is perhaps partly correlated with the arrangements of the European Green Deal [EC 2019], but not only. An increase in the share of organic and precision farming, in accordance with the provisions of the European Green Deal, may require innovation in crop production and plant protection, especially in terms of technology.

The greatest impact on innovation in crop farms may be exerted by mechanisms related to small-scale trialing, which helps with gradual implementation of technological practices, followed by full-scale or partial-scale adoption of innovative technologies, lower investment irreversibility, and a shorter return on investment horizon than in livestock farms. In animal breeding, many innovations are infrastructural and irreversible, with a high capital threshold and lower trialability, i.e., slower, incremental adoption [Sunding and Zilberman 2001].

Farms in the eastern macroregion also declared less innovative investments compared to the Mazowieckie voivodeship. This may be due to more difficult access to financing than in the Mazowieckie voivodeship.

Farms with a neutral or positive assessment of their financial situation were more likely to report

innovative investments. This can be explained by the fact that the sense of financial stability increases the propensity for innovative, and therefore perhaps riskier, investments.

### Future drivers and challenges for agricultural investment

Looking ahead, the future of agricultural investment will increasingly be shaped by broader policy frameworks and systemic challenges, among which it is worth mentioning climate change adaptation, ESG requirements [Leite de Almeida et al. 2024], and the European Green Deal [EC 2019].

The results of this study indicate a high share of innovative investments among active farms. However, an important question emerges: is this observed innovativeness a proactive market response or a regulatory adaptation? Future research should seek to disentangle whether farm-level innovation is being driven primarily by external policy incentives or by endogenous, entrepreneurial motivations. Understanding this distinction may help policymakers refine their support mechanisms.

### Structural inequalities and risks of uneven development

While investment activity is generally rising, our data confirm that it is concentrated in specific regions and farm types. Larger farms and those located in well-developed regions such as Mazowieckie voivodeship are significantly more likely to invest, particularly in innovation. This spatial and structural polarization may exacerbate inequalities between rural areas, limiting the potential for inclusive development [Prus et al. 2021]. Without targeted support for smaller farms and undercapitalized regions, the investment gap may deepen, reinforcing cycles of stagnation in less developed areas of the country.

## CONCLUSIONS AND RECOMMENDATIONS

The analysis confirms that both structural and financial determinants strongly shape investment behavior in Polish agriculture. Larger farms, economically stronger units, and those located in more developed regions exhibit significantly higher investment activity, whereas farms facing financial constraints or operating in structurally disadvantaged areas demonstrate lower investment readiness. These patterns will become even more relevant as agriculture adapts to emerging regulatory frameworks, including environmental compliance, ESG requirements, and the transition toward climate-smart production.

Addressing structural disparities requires targeted support instruments. Simplified grant procedures and tailored financial tools dedicated to small and medium-sized farms, particularly in less developed regions, could help mitigate the uneven distribution of investment activity. Strengthening advisory and educational services remains essential for increasing farmers' capacity to design effective investment plans and navigate funding opportunities. In parallel, policy measures that promote climate-smart and digital technologies may enhance both productivity and resilience, supporting the sector's transition toward sustainable production.

The empirical results allow for several evidence-based recommendations. First, farms with neutral or good financial standing show the highest responsiveness to external support instruments, suggesting that credit guarantees and preferential loans would substantially stimulate investment activity in this group. Second, the analysis demonstrates that the mere act of applying for funding (regardless of the outcome) is strongly associated with investment propensity, indicating that simplifying application procedures and expanding advisory support could meaningfully increase the number of farms entering the investment process. Third, medium-sized farms (10–20 ha) exhibit the strongest likelihood of investing, highlighting them as a strategically important group for modernization policies. Fourth, crop farms invest less frequently but show higher innovativeness when they do, which implies that tailored instruments should simultaneously stimulate basic investment activity and support innovative technologies in plant production. Fifth, regional differences in innovative investment (particularly the lower propensity in the eastern macroregion) point to the need for region-specific financial instruments aimed at reducing structural disparities. Finally, ele-

vated concern about future sectoral risks is negatively associated with investment planning, suggesting that risk-mitigation tools such as investment insurance, guarantee schemes, or stabilization mechanisms may be critical for sustaining long-term investment activity.

Taken together, these findings indicate that financial determinants primarily shape the capacity to invest, while structural determinants shape the direction and intensity of investment behavior. Effective policy should therefore combine improved access to capital with instruments that strengthen adaptive capacity, particularly in regions and production systems with lower investment potential.

Our study is based on one-year cross-sectional data, which limits the possibility of analyzing investment trends over time. While the results identify key structural and financial determinants of investment activity, longitudinal or panel data would be required to capture dynamic adjustment processes and temporal changes in farmers' investment behavior. Future studies should therefore extend the analytical framework to multi-year observations.

Future research should additionally explore behavioral and institutional barriers to accessing investment support, particularly through qualitative studies that examine why some farmers refrain from applying for public funds and how institutional frameworks might be improved to address this. A deeper analysis of how digital transformation, precision farming, and automation influence both the scale and efficiency of investments would also provide valuable insights for policy and practice. Ultimately, policy that supports balanced, inclusive, and forward-looking investment will be crucial for sustaining the resilience, competitiveness, and ecological responsibility of Polish agriculture.

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## INWESTYCJE W ROLNICTWIE: STRUKTURALNE I FINANSOWE UWARUNKOWANIA AKTYWNOŚCI INWESTYCYJNEJ GOSPODARSTW ROLNYCH W POLSCE

### STRESZCZENIE

**Cel:** Badanie dotyczy strukturalnych i finansowych czynników determinujących działalność inwestycyjną polskich gospodarstw rolnych z uwzględnieniem skłonności do inwestowania, planowanych inwestycji oraz innowacyjnych inicjatyw inwestycyjnych. **Metody:** Badanie opiera się na danych zebranych w ramach reprezentatywnej dla całego kraju ankiety CATI przeprowadzonej wśród 800 właścicieli lub współwłaścicieli gospodarstw rolnych w okresie od końca 2024 r. do początku 2025 r. Wykorzystując modele regresji logistycznej, identyfikujemy kluczowe czynniki prognostyczne dotyczące przeszłych inwestycji, przyszłych planów inwestycyjnych oraz innowacyjności ostatnich inwestycji. **Wyniki:** Wyniki podkreślają znaczącą rolę wielkości gospodarstwa, kondycji finansowej, wcześniejszej działalności inwestycyjnej oraz wykorzystania zewnętrznego finansowania w kształtowaniu decyzji inwestycyjnych. Na skłonność do inwestowania i wdrażanie innowacji wpływają również różnice regionalne i rodzaj produkcji (roślinna kontra zwierzęca). Gospodarstwa, które ubiegały się o finansowanie, niezależnie od wyniku procesu, były bardziej skłonne do inwestowania, co sugeruje, że samo planowanie strategiczne koreluje z działalnością inwestycyjną. **Wnioski:** Badanie stanowi wkład w literaturę dotyczącą modernizacji rolnictwa, a jego wyniki dostarczają praktycznych zaleceń dla decydentów politycznych dążących do promowania rozwoju obszarów wiejskich poprzez ukierunkowane wsparcie inwestycyjne. Sektor rolniczy w Polsce przechodzi znaczącą transformację spowodowaną wprowadzeniem przepisów dotyczących ochrony środowiska przyrodniczego, ramami ESG oraz przejściem na produkcję zrównoważoną. Te zmiany wymagają nie tylko kapitału finansowego, lecz także zdolności adaptacyjnych, planowania strategicznego i wsparcia instytucjonalnego, aby zapewnić

rozwój zrównoważony i inkluzywny. Ukierunkowane różne rodzaje polityki poświęcone małym i średnim gospodarstwom rolnym, zwłaszcza tym działającym w regionach znajdujących się w niekorzystnej sytuacji i mającym ograniczony dostęp do kapitału, mają zasadnicze znaczenie dla wzmocnienia ich wydajności i konkurencyjności. Poprawa jakości usług edukacyjnych i doradczych mogłaby pomóc rolnikom w opracowaniu skuteczniejszych strategii inwestycyjnych i uzyskaniu lepszego dostępu do możliwości finansowania, zwłaszcza na obszarach o niższym poziomie aktywności inwestycyjnej.

**Słowa kluczowe:** inwestycje w rolnictwie, wielkość gospodarstwa, innowacje, finansowanie publiczne, Polska, regresja logistyczna