# The impact of fixed assets on Polish agricultural production

## Vliv fixního kapitálu na zemědělskou produkci Polska

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**Abstract:** The power function was used to show the dependence of gross, final and sold output on the gross value of total fixed assets and on the ratios of this value to the productivity of these three production categories. Further elaboration included the characteristics of variable features. The system of independent variables employed in the study allowed for the estimation of both extensive and intensive utilisation of fixed assets in Polish agriculture from 2002–2005. The study showed the diminishing impact of the productivity of fixed assets and the decreasing productive efficiency of Polish agriculture from 2002–2005. This situation was caused by the relative stability in the generic structure of fixed assets and by a slow average annual rate of increase in new fixed assets (8.74%).

**Key words:** production, productivity, impact, extensive and intensive utilisation of fixed assets.

**Abstrakt:** Pro vyjádření závislosti hrubé, finální a tržní produkce na hrubé hodnotě fixního kapitálu a poměrových ukazatelů vztahu této hodnoty k produktivitě uvedených tří kategorií produkce byla využita silová funkce. Další zpracování zahrnovalo charakteristiku proměnných. Systém nezávislých proměnných využitých v této studii umožňuje odhad extenzivního i intenzivního využití fixního kapitálu v polském zemědělství v letech 2002–2005. Studie ukazuje klesající vliv produktivity fixního kapitálu a snižující se produkční efektivnost polského zemědělství v uvedeném období. Tato situace byla zapříčiněna relativně stabilní věkovou strukturou fixního kapitálu a nízkou průměrnou roční mírou růstu investic (8,74 %).

**Klíčová slova:** produkce, produktivita, ekonomický dopad, extenzivní a intenzivní využití fixního kapitálu

This paper examines the potential of fixed assets on Polish agriculture during the period 2002–2005. Poland's accession to the EU[1] in May 2004 induced several changes in Polish agricultural development. This study reveals the extent of these changes on the utilisation of fixed assets in agricultural production.

The potential of fixed assets includes information on their quantitative and qualitative impact as well as their utilisation. This makes it possible to use a conventional system of interpretation to explain the changes in the quantitative and qualitative impact of fixed assets in determining the comparative levels of gross, final and sold output in Polish agriculture from 2002–2005.

## RESEARCH METHODOLOGY

The power function was the basic method of deriving the functional model[2] showing the dependence of gross, final and sold output on the gross value of fixed assets and the ratios of this value to the productivity of these three production categories in agriculture during the period 2002–2005. We used the econometric power function models, based on the empirical,

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[1] Compare Lissitsa, Balmann (2003)

[2] Verification of the lowest squares assumptions method was conducted basing on the rests being estimations of random components in econometric model. The survey of random deviations attributes was conducted using tests. Random surveying – test of numbers series. Normality survey – test of Shapiro-Wilk. Auto-correlation survey-test of Durbin-Watson. Survey of homoscedastity – test Goldfeld-Quandt.

non-standardised data, whose regression ratios of non-standardised variables show the co-changeability of increase or of decrease in the independent variable.

Some descriptive statistical measures were also used to describe the variable features as required. Thus, the complex method of evaluation of the impact of

Table 1. Statistical characteristics of the variables under study in Polish agriculture from 2002–2005 (2002 prices)

| Symbol | Units | Arithmetic mean | Range | | Variation coefficient |
| | | | min. | max. | |
|---|---|---|---|---|---|
| **2002** | | | | | |
| Y1 | zl | 3 481 625 000 | 1 106 302 135 | 8 574 057 420 | 61.57 |
| Y2 | zl | 2 531 062 500 | 802 160 910 | 6 406 243 717 | 64.19 |
| Y3 | zl | 2 171 206 250 | 704 927 270 | 5 440 659 976 | 63.90 |
| X1 | zl | 6 904 968 750 | 2 293 274 445 | 14 459 864 729 | 47.46 |
| X2 | zl/zl | 0.485 | 0.364 | 0.648 | 17.57 |
| X3 | zl/zl | 0.351 | 0.241 | 0.476 | 19.53 |
| X4 | zl/zl | 0.301 | 0.200 | 0.404 | 19.68 |
| **2003** | | | | | |
| Y1 | zl | 3 453 772 000 | 938 090 582 | 8 300 424 467 | 62.08 |
| Y2 | zl | 2 594 339 063 | 719 448 152 | 6 412 939 814 | 64.75 |
| Y3 | zl | 2 284 108 975 | 680 013 472 | 5 884 011 509 | 64.95 |
| X1 | zl | 6 822 109 125 | 2 274 689 794 | 14 423 867 848 | 48.01 |
| X2 | zl/zl | 0.484 | 0.365 | 0.621 | 17.18 |
| X3 | zl/zl | 0.362 | 0.251 | 0.480 | 18.52 |
| X4 | zl/zl | 0.319 | 0.204 | 0.440 | 18.98 |
| **2004** | | | | | |
| Y1 | zl | 3 712 804 919 | 1 316 605 280 | 9 122 675 512 | 60.09 |
| Y2 | zl | 2 801 886 188 | 1 038 485 707 | 7 043 273 821 | 62.77 |
| Y3 | zl | 2 359 362 366 | 833 624 865 | 5 988 260 625 | 63.86 |
| X1 | zl | 6 787 998 228 | 2 295 543 011 | 14 332 925 458 | 47.84 |
| X2 | zl/zl | 0.531 | 0.395 | 0.686 | 15.92 |
| X3 | zl/zl | 0.400 | 0.260 | 0.529 | 18.08 |
| X4 | zl/zl | 0.335 | 0.198 | 0.450 | 19.67 |
| **2005** | | | | | |
| Y1 | zl | 3 556 867 094 | 1 264 788 878 | 10 009 618 667 | 66.67 |
| Y2 | zl | 2 681 459 133 | 942 409 907 | 7 846 616 135 | 71.37 |
| Y3 | zl | 2 260 386 219 | 810 895 724 | 6 735 017 060 | 71.59 |
| X1 | zlł | 6 787 998 579 | 2 213 233 586 | 15 832 104 345 | 53.41 |
| X2 | zl/zl | 0.511 | 0.374 | 0.770 | 19.46 |
| X3 | zl/zl | 0.380 | 0.250 | 0.604 | 22.01 |
| X4 | zl/zl | 0.323 | 0.190 | 0.518 | 24.79 |

Y1 – value of gross production; Y2 – value of final production; Y3 – value of sold production; X1 – gross value of total fixed assets; X2 – ratio of the productivity of total fixed assets to gross production; X3 – ratio of the productivity of total fixed assets to final production; X4 – ratio of the productivity of total fixed assets to sold production

Source: Central Statistical Office in Warsaw. The calculations are the researchers' own

a change in the quantitative and qualitative features accompanying the development of fixed assets was applied based whereon their role in the agricultural output growth was shown.

Since the extensive fixed assets category[3] is related to their condition, it demonstrates their quantity. It shows that fixed assets of agricultural output in Poland must be encumbered with gross value. The degree of utilisation of fixed assets is, however, characterised by their productivity (ratio). The category of fixed assets productivity is the measure of qualitative (intensive) utilisation of fixed assets[4]. It is a quantitative measure that is qualitative in character. Since there are no better measures available, the fixed assets productivity ratio

can be used as a qualitative variable (Płudowski, Wierzbicki 1975).

Empirical data were taken from the statistical yearbooks of the Central Statistical Office and the regional Statistical Yearbooks of the Central Statistical Office for the period under investigation. These latter include numerical data from the Central Bureau of the Polish Hunting Union in Warsaw[5]. Data are expressed in 2002 prices.

The examined variables are characterised by arithmetic mean, range and variation coefficient. These are presented in Table 1.

Table 1 shows that despite the decrease in the range and the average value of variables related to sold production, its variability has been increasing in recent

Table 2. Power regression of gross, final and sold production (Y1, Y2 and Y3) on the gross value of total fixed assets in Polish agriculture from 2002–005

| Year | a | Regression coefficient X1 | Standard error | | $t$-test | | $R^2$ |
|---|---|---|---|---|---|---|---|
| | | | a | X1 | a | X1 | |
| **Gross production** | | | | | | | |
| 2002 | 0.0146 | 1.1548 | 2.0799 | 0.0922 | −2.03 | 12.53 | 0.92 |
| 2003 | 0.0049 | 1.2034 | 1.9102 | 0.0845 | −2.78 | 14.21 | 0.94 |
| 2004 | 0.0179 | 1.1056 | 2.0231 | 0.0897 | −2.05 | 12.32 | 0.92 |
| 2005 | 0.0282 | 1.0569 | 2.0254 | 0.0979 | −2.09 | 10.79 | 0.90 |
| **Final production** | | | | | | | |
| 2002 | 0.0080 | 1.1692 | 2.3386 | 0.1037 | −2.06 | 11.25 | 0.90 |
| 2003 | 0.0029 | 1.2129 | 2.0755 | 0.0920 | −2.81 | 13.18 | 0.93 |
| 2004 | 0.0144 | 1.1023 | 2.3880 | 0.1059 | −2.04 | 10.41 | 0.89 |
| 2005 | 0.0293 | 1.0907 | 2.4793 | 0.1101 | −2.01 | 9.99 | 0.88 |
| **Sold production** | | | | | | | |
| 2002 | 0.0065 | 1.1691 | 2.4158 | 0.1071 | −2.08 | 10.92 | 0.90 |
| 2003 | 0.0037 | 1.1968 | 2.2347 | 0.0991 | −2.50 | 12.08 | 0.91 |
| 2004 | 0.0079 | 1.1341 | 2.4222 | 0.1163 | −2.06 | 9.75 | 0.87 |
| 2005 | 0.0103 | 1.0629 | 2.2673 | 0.1317 | −2.48 | 8.07 | 0.83 |

Significance level alpha < 0.0; a – absolute value (without logarithm)

Other determinations as per Table 1.

Source: Arithmetic calculations

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[3] It includes passive fixed assets (buildings and structures) and active ones (machines, equipment and means of transport) as well as enlivened ones (long-term plantations) and land improvement.

[4] Fixed assets productivity ratio enables an initial, overall evaluation of efficiency (intensity) of their use in manufacturing processes (Borowiecki 1988, p. 58)].

[5] Percentage share of fixed assets gross values in hunting within 1995–2003 fluctuated from 0.01–0.04%. Annex to the letter dated on 08.10.2005 from the Central Bureau of Polish Hunting Union in Warsaw. It shows that their share in fixed assets gross value totally for agriculture had no impact on shaping the surveyed economic occurrences.

years. The growth of dispersion within variables was not high enough to alter their role significantly during the period under investigation. Material differences in dispersion were only observed between quantitative variables and quantitative variables with qualitative features.

## RESEARCH ISSUES

The study attempted to show how the changes in the quantitative and qualitative impact of total fixed assets determined the variability in gross, final and sold production in Polish agriculture from 2002–2005. The study simultaneously attempted to identify that portion of production obtained through the quantitative (extensive) and qualitative (intensive) utilisation of fixed assets in agriculture. Later synthesis of these research issues made it possible to assess the use of fixed assets in agriculture and indicated the directions in which they are developing. The results are presented more accurately in the Conclusions section.

The conventional system of interpreting the role of fixed assets in agriculture was the basis on which these research goals were established.

## PRESENTATION

Table 2 illustrates the functional dependence of gross, final and sold production on the gross value of the total fixed assets.

The data from Table 2 show that the gross value of the total fixed assets explains 83–94% of the variation in the production categories under investigation. The significance level of 0.00–0.05 was very high. On the other hand, the standard errors in the regression coefficients were less than 50% of their absolute values and the test t values exceeded their critical levels. Fixed assets regression coefficients increased for each of the production categories under investigation during 2002 and 2003 but decreased during 2004 and 2005. However, gross, final and sold production all increased more rapidly than fixed assets between 2002 and

Table 3. Power regression of gross, final and sold production (Y1, Y2 and Y3) on the overall productivity of fixed assets for each production category in Polish agriculture from 2002–2005

| Year | a | Regression ratio X2, X3 and X4 | Standard error | | $t$-test | | $R^2$ |
|---|---|---|---|---|---|---|---|
| | | | a | X2, X3 and X4 | a | X2, X3 and X4 | |
| **Gross from X2** | | | | | | | |
| 2002 | 13 916 823 782 | 2.0828 | 0.4876 | 0.6449 | 47.90 | 3.23 | 0.43 |
| 2003 | 17 830 817 591 | 2.4339 | 0.4526 | 0.5973 | 52.15 | 4.07 | 0.54 |
| 2004 | 10 665 226 947 | 1.8524 | 0.4806 | 0.7243 | 48.04 | 2.56 | 0.30 |
| 2005 | 8 019 361 643 | 1.4138 | 0.5064 | 0.7124 | 45.04 | 1.98 | 0.30 |
| **Final from X3** | | | | | | | |
| 2002 | 16 969 851 338 | 1.9393 | 0.6283 | 0.5814 | 37.49 | 3.33 | 0.44 |
| 2003 | 23 627 660 866 | 2.2988 | 0.5884 | 0.5614 | 40.59 | 4.09 | 0.54 |
| 2004 | 10 883 943 368 | 1.6108 | 0.6011 | 0.6322 | 36.44 | 2.55 | 0.32 |
| 2005 | 9 984 547 778 | 1.5101 | 0.6241 | 0.6189 | 36.89 | 2.44 | 0.30 |
| **Sold from X4** | | | | | | | |
| 2002 | 18 621 712 832 | 1.8941 | 0.6989 | 0.5662 | 33.85 | 3.35 | 0.44 |
| 2003 | 22 552 549 684 | 2.1166 | 0.6605 | 0.5624 | 36.09 | 3.76 | 0.51 |
| 2004 | 12 646 601 421 | 1.6465 | 0.6350 | 0.5609 | 36.63 | 2.93 | 0.38 |
| 2005 | 8 106 845 399 | 1.2549 | 0.6317 | 0.5335 | 36.12 | 2.35 | 0.30 |

Significance level alpha < 0.05; a – absolute value (without logarithm)
Other determinations as per Table 1

Source: Arithmetic calculations

Table 4. The impact of the gross value of the total fixed assets and the ratios of their productivity to gross, final and sold production on the relative growth in production for these three categories in Polish agriculture from 2002–2005 (%)

| Year | X1 | X2 | X1 | X3 | X1 | X4 |
|------|------|------|------|------|------|------|
| | gross | | final | | sold | |
| 2002 | 35.67 | 64.33 | 37.61 | 62.39 | 38.17 | 61.83 |
| 2003 | 33.08 | 66.92 | 34.54 | 65.46 | 36.12 | 63.88 |
| 2004 | 37.38 | 62.62 | 40.63 | 59.37 | 40.79 | 59.21 |
| 2005 | 42.78 | 57.22 | 41.94 | 58.06 | 45.86 | 54.14 |

Source: Derived from Tables 2 and 3. The calculations are the researchers' own.

2005. The absolute values (a) of overall production efficiency exhibited a slight increase[6]. This implies that the application of the gross value of fixed assets was relatively low in Polish agriculture over the period under study (Zwolak 2001, pp. 255–262).

Table 3 illustrates the dependence of gross, final and sold production on the overall productivity of fixed assets for each of these three production categories.

The data from Table 3 show that the degree to which the variation in the examined variables could be explained was a relatively low 0.00–0.05. The standard errors in the regression coefficients were less than 50% of their absolute values and the test t values exceeded their critical levels. Fixed assets productivity regression coefficients increased for each of the production categories under investigation during 2002 and 2003 but decreased in 2004 and 2005[7]. This mirrors the changes in the fixed assets regression coefficients between 2002–2005 (refer Table 2). Comparing the fixed assets productivity regression coefficients reveals that both fixed assets and the production categories under investigation were increasing more rapidly than fixed assets productivity from 2002–005. The changes in the fixed assets productivity regression coefficients correlated to the changes in production efficiency for the period under investigation[8]. This decreasing elasticity in the production categories under investigation relative to the productivity of fixed assets explains the decrease in production efficiency independently of the production category for the period under investigation.

Table 4 illustrates the synthesis of the research.

The data from Table 4 show that refining gross production in the direction of sold production brought about a growth in the quantitative share (extensive) of fixed assets utilised in agriculture. Similar types of changes took place during the period under investigation. The extensive utilisation of fixed assets was increasing while their intensive utilisation was decreasing. The relatively stable structure of fixed assets can explain this[9] as their gross value decreased by only about 1.69% between 2002 and 2004 and remained constant in 2004 and 2005 (2002 prices) (Zwolak 2005, pp. 5–15). But their amortisation between 2002 and 2005 rose by 2.1 percentage points while the average annual rate of increase in new fixed assets was 8.74%[10]. This is three times lower than "normal" in agriculture. This inevitably led to a loss of both features and functions in fixed assets which in turn brought about a decrease in their intensive utilisation in Polish agriculture.

**CONCLUSIONS**

The foregoing enables the following conclusions to be drawn.

The gross value of the total fixed assets explained 83–94% of the variation in gross, final and sold pro-

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[6] Compare Vizvari, Bacsi (2002).

[7] Procedures estimating research effectiveness ratio towards productivity from function presented by Oehmke, Schimmelpfennig (2004).

[8] Compare Carlaw, Lipscy (2003).

[9] Fixed assets structure in 2002, 2003, 2004 and 2005 amounted like follows; farm buildings 61%, machines technical equipment and tools 13%, transport means 12% and other fixed assets 14%.

[10] Regarding prices from 2002, one counted the share of new fixed assets values in total fixed assets in surveyed years, and next the dynamics towards previous year and estimated their average annual growth rate (Statistical Yearbook of the Central Statistical Office – respective years).

duction in Polish agriculture from 2002–2005. But the overall productivity of fixed assets only explained 30–54% of the variation in these three categories of production. This was reflected in the greater dispersion within the gross values of fixed assets than their productivity in agriculture for the period under investigation. The impact of productivity of gross fixed assets was 1.5 times higher than of the gross value of the total fixed assets. Therefore, productivity of gross fixed assets limited considerably the decline in work performance in the Polish farming in the years 2002–2005. It is also an intensive driver of work performance growth in farming.

Decreases in the impact of fixed assets productivity were found to correspond with the decreasing productive efficiency in Polish agriculture from 2002–2005. This can be explained by the stability in the state and generic structure of fixed assets in 2004 and 2005. These were partially replaced by new fixed assets. The rate of increase in new fixed assets within this stable situation was three times lower than "normal" (8.74%).

Taking 50% as a basis for the elementary intensive and extensive utilisation of fixed assets, it has to be said that the utilisation of intensive fixed assets was only about 10 percentage points higher and was decreasing over time. This was a result of the inability to intensively engage fixed assets in Polish agricultural production. This makes the need to accelerate the renewal of fixed assets in Polish agriculture all the more urgent.

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