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# PRODUCTIVITY OF RESOURCES AND INPUTS IN ENVIRONMENTALLY SUSTAINABLE AND UNSUSTAINABLE FARMS

*Summary*

*Appropriate management of resources and the most effective use of inputs is a fundamental factor on which production profitability depends. Productivity indicators are one of the measures of using resources and inputs. The paper deals with the analysis of land productivity, technical fixed assets, labour resources, mechanization and power energy inputs in 15 environmentally sustainable farms and 15 farms which are not environmentally sustainable. It was reported that environmentally sustainable farms have higher values of productivity indicators than farms which are not environmentally sustainable. Indicators of land productivity, technical fixed assets and mechanization expenditures differ significantly among the investigated farm groups.*
***Key words**: productivity, resources, expenditures, agricultural farms, sustainability*

# PRODUKTYWNOŚĆ ZASOBÓW I NAKŁADÓW W GOSPODARSTWACH ZRÓWNOWAŻONYCH ŚRODOWISKOWO

*Streszczenie*

*Odpowiednie gospodarowanie zasobami i jak najbardziej efektywne wykorzystanie nakładów jest podstawowym czynnikiem warunkującym opłacalność produkcji. Jednym z mierników wykorzystania zasobów i nakładów są wskaźniki produktywności. W pracy dokonano analizy wskaźników produktywności ziemi, technicznych środków trwałych, zasobów pracy, nakładów mechanizacyjnych i energetycznych w 15 gospodarstwach rolnych zrównoważonych środowiskowo i 15 gospodarstwach niezrównoważonych środowiskowo. Stwierdzono, że gospodarstwa zrównoważone środowiskowo mają większe wartości wskaźników produktywności od gospodarstw niezrównoważonych środowiskowo. Wskaźniki produktywności ziemi, technicznych środków trwałych i nakładów mechanizacyjnych istotnie różnią się między badanymi grupami gospodarstw.*
***Słowa kluczowe:** produktywność, zasoby, nakłady, gospodarstwo rolne, zrównoważenie*

## 1. Introduction

Appropriate management of resources and the most effective use of expenditures is a fundamental factor on which production profitability depends. According to Sawa, the basic task of agricultural activity is to obtain an income by a farmer which ensures means necessary for maintaining a family [11]. However, a farmer in order to obtain a relevant income (often called a parity income) should manage his resources in a proper way so that they bring the best economic effects. The measures which allow comparing the resources management efficiency and effectiveness of the incurred inputs are the productivity indicators. Land productivity is the basic indicator. Except for this measure, the literature often provides for analyses of labour resources or inputs effectiveness [7,9]. All these indicators allow synthetic determination of farms or farm groups which manage resources and expenditures in a more effective way. As a result of frequent over-investment of farms with technical work means, in particular in small farms [1] productivity of the invested capital is an important measure. Labour resources productivity is another measure also significant on account of its low use in the production process. Productivity indicators allow presenting the management effectiveness and constitute the competitiveness measure at the same time [3]. Achieving better productivity by farms is one of the main conditions of competitive advantage [2]. In the times of modernization of Polish farms and their management towards more environmentally friendly processes it is prominent to know the productivity of resources and inputs in environmentally sustainable farms. Therefore, the objective of this paper is to find the answer to the question: whether environmentally sustainable farms obtain greater productivity of the selected resources and expenditures?

The paper covers analysis of 30 family farms for which the basic resources and expenditures were calculated: the area of AL, replacement value of technical fixed assets, mechanization expenditures (mechanization costs), labour resources, energy power inputs. For the investigated farms, the livestock, organic substance balance, intensity of production organization, gross margin and final production were calculated.

## 2. Material and methods

The material used in the paper constitutes a fragment of the research carried out in the years 2009-2012 on the area of the entire country as a part of the scientific project executed by ITP [Institute of Technology and Life Sciences] Warsaw Branch (NCBiR [the National Centre for Research and Development] No 1204306/2009) titled "Technological and ecological modernization of the selected family farms".

30 family farms were analysed and those which meet the criteria of the environmental sustainability defined after Sawa and Kocira [12] and those which do not meet these criteria were selected.

Environmental sustainability is:

– organic substance balance (BSO) 0.4–1.5 t·ha$^{-1}$GO [6],
– intensity of farms' organization 450-800 points.

For all farms the following productivity indicators were calculated: land, technical labour means, mechanization expenditures, labour resources and power energy inputs.

Particular productivity indicators were calculated with the use of the following formulas:

Land resources productivity ($P_s$):

$P_s = P_k \cdot S^{-1}$ (PLN·ha$^{-1}$),

where: $P_k$ – final productivity (PLN),
S – agricultural land area (ha).

Productivity of technical fixed assets ($P_t$):

$P_t = P_k \cdot W_{ot}^{-1}$ (PLN·PLN$^{-1}$)

where: $W_{ot}$ – gross replacement value of technical fixed assets (PLN).

Productivity of mechanization expenditures ($P_{Km}$):

$P_{Km} = P_k \cdot K_m^{-1}$ (PLN·PLN$^{-1}$),

where: $K_m$ – mechanisation costs (PLN).

Productivity of labour resources ($P_R$):

$P_R = P_k \cdot R^{-1}$ (PLN·ftw$^{-1}$),

where: $R$ – number of full-time workers (ftw).

Productivity of energy inputs ($P_{Ne}$):

$P_{Ne} = P_k \cdot N_e^{-1}$ (PLN·GJ$^{-1}$),

where: $N_e$ – energy inputs (GJ).

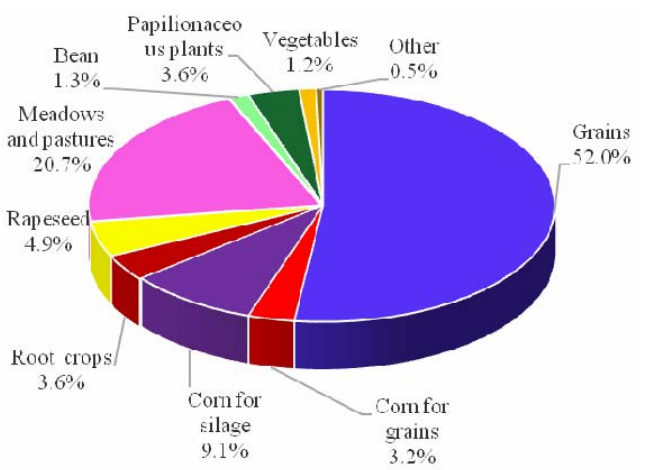
Statistical analysis was carried out in Statistica 12 PL. Significance of differences between the investigated groups of farms was tested with Tukey's test at $\alpha = 0.05$. Regularity of distribution of the analysed variables was determined with Shapiro-Wilk's test.

## 3. Results and discussion

The crops structure of the investigated farms included a dominant part of grains which covered 52% of the AL area. The fodder area for cattle took 33.3% of AL (meadows, pastures, papilionaceous plants and corn for silage) (fig. 1).

In the analysed group of 30 farms, 15 met the criteria of environmental sustainability [ES] and the same number of farms did not meet these criteria [NES]. All farms used the arable land (table 1). Some farms both from the ES and NES group did not have permanent pastures in their structure (PP).

In the environmentally sustainable farms higher livestock was reported which was on average 1.31 LSU·ha$^{-1}$ AL than in the farms which were not environmentally sustainable where the livestock was over 2 times lower and it was 0.59 LSU·ha$^{-1}$ AL. Higher livestock in ES farms had a more favourable impact on the balance of organic substance which was from 0.59 to 149 t·ha$^{-1}$ AL. Such level is acceptable for the sustainable farming. Livestock also influenced the intensity of production organization which in ES farms was on average higher by 74% than in the NES farms. Also in environmentally sustainable farms higher final production and higher gross margin than in the remaining investigated farms were reported.




*Source:* own work based on research carried out in years 2009-2012 as part of the project
*Źródło:* Opracowanie własne na podstawie badań realizowanych w latach 2009-2012 w ramach realizowanego projektu

Fig. 1. The crop structure in the investigated farm group
*Rys. 1. Struktura upraw w badanej grupie gospodarstw*

Land resources in the analysed farm groups were at a similar level and for the environmentally sustainable farms they were 37.89 ha·farm$^{-1}$ and for the non-environmentally sustainable farms they were 39.74 ha·farm$^{-1}$. The average gross replacement value of technical labour means in environmentally sustainable farms was higher (about how many %, add value) than in non-environmentally sustainable farms. Also mechanization costs, number of full-time workers and energy inputs were higher in the environmentally sustainable farms than in the second analysed group (table 2).

Table 1. General characteristic of the investigated farms
*Tab. 1. Ogólna charakterystyka badanych gospodarstw*

| Specification | Units | Environmentally sustainable (ES) | | | Non-environmentally sustainable (NES) | | |
|---|---|---|---|---|---|---|---|
| | | Minimum value | Maximum value | Average | Minimum value | Maximum value | Average |
| Arable land | ha·farm$^{-1}$ | 9.40 | 57.31 | 30.46 | 5.00 | 61.00 | 29.73 |
| Permanent pastures | ha·farm$^{-1}$ | - | 19.00 | 7.53 | - | 47.55 | 9.91 |
| Livestock | LSU·ha$^{-1}$ AL | 0.59 | 1.49 | 1.31 | - | 1.05 | 0.59 |
| Renewability of organic substance | t·ha$^{-1}$ AL | 0.41 | 1.27 | 0.89 | -0.59 | 0.36 | -0.01 |
| Intensity of production organization | pt·farm$^{-1}$ | 339 | 954 | 602 | 117 | 426 | 347 |
| Final production | PLN thousand | 63.560 | 613.780 | 321.947 | 75.900 | 472.370 | 213.305 |
| Gross margin | PLN thousand·ha$^{-1}$ AL | 3.342 | 10.465 | 5.943 | 1.531 | 11.522 | 4.642 |

*Source:* own work based on research carried out in years 2009-2012 as part of the project
*Źródło:* Opracowanie własne na podstawie badań realizowanych w latach 2009-2012 w ramach realizowanego projektu

Table 2. Resources and inputs in the investigated farms
*Tab. 2. Zasoby i nakłady w badanych gospodarstwach*

| Specification | Units | Environmentally sustainable (ES) | | | Non-environmentally sustainable (NES) | | |
|---|---|---|---|---|---|---|---|
| | | Minimum value | Maximum value | Average | Minimum value | Maximum value | Average |
| Agricultural land area | ha·farm$^{-1}$ | 12.10 | 71.27 | 3798 | 24.11 | 85.00 | 39.64 |
| Gross replacement value of technical fixed assets | thousand PLN·farm$^{-1}$ | 342.100 | 1838.300 | 1041.054 | 576.240 | 1772.900 | 979.672 |
| Mechanization costs | PLN thousand·farm$^{-1}$ | 30.893 | 187.523 | 96.408 | 52.088 | 158.693 | 88.470 |
| Number of full-time workers | person·farm$^{-1}$ | 1.4 | 3.4 | 2.6 | 1.3 | 3.5 | 2.4 |
| Energy inputs | GJ·farm$^{-1}$ | 101.368 | 689.753 | 311.781 | 94.838 | 484.196 | 232.471 |

*Source:* own work based on research carried out in years 2009-2012 as part of the project
*Źródło:* Opracowanie własne na podstawie badań realizowanych w latach 2009-2012 w ramach realizowanego projektu

Table 3. Productivity of resources and inputs in the investigated farms
*Tab. 3. Produktywność zasobów i nakładów w badanych gospodarstwach*

| Specification | Units | Environmentally sustainable (ES) | | | Non-environmentally sustainable (NES) | | |
|---|---|---|---|---|---|---|---|
| | | Minimum value | Maximum value | Average* | Minimum value | Maximum value | Average* |
| Productivity of land resources | PLN·ha$^{-1}$ | 5110 | 26991 | 8712b | 2299 | 12112 | 5483 a |
| Productivity of technical fixed assets | PLN·PLN$^{-1}$ | 0.10 | 0.48 | 0.30b | 0.10 | 0.39 | 0.21 a |
| Productivity of mechanization inputs | PLN·PLN$^{-1}$ | 1.23 | 6.34 | 3.29b | 1.33 | 4.43 | 2.35 a |
| Productivity of labour resources | PLN·ftw$^{-1}$ | 32045 | 252231 | 117947a | 31416 | 197228 | 92113 a |
| Productivity of energy inputs | PLN·GJ$^{-1}$ | 326.6 | 2191.4 | 1062.5a | 553.9 | 2140.5 | 971.0 a |

* values determined with the same letter do not differ significantly at $\alpha = 0.05$

*Source:* own work based on research carried out in years 2009-2012 as part of the project
*Źródło:* Opracowanie własne na podstawie badań realizowanych w latach 2009-2012 w ramach realizowanego projektu

The calculations of land resources productivity proved that environmentally sustainable farms obtained higher productivity in the amount of 8,712 PLN·ha$^{-1}$ than the non-environmentally sustainable ones 5,483 PLN·ha$^{-1}$ (table 3). Land productivity at the level of 8 thousand hectares of agricultural land was obtained by Malaga-Toboła et al. in their research when investigating organic farms [8]. Kulikowski investigated the land productivity in stated that on average it was 4.9 thousand PLN·ha$^{-1}$ in 2009. Also, productivity of technical fixed assets and productivity of mechanization inputs was higher in ES farms than in NES farms [5]. Both land and technical fixed assets productivity and mechanization inputs in the environmentally sustainable farms differs significantly from the adequate productivity in the non-environmentally sustainable farms. Average values of productivity of mechanization inputs were in the ES farm group 3.29 PLN·PLN$^{-1}$, and in the NES farms it was 2.35 PLN·PLN$^{-1}$. Similar values were obtained in the research by Kowalczyk [4] when analysing orchard farms and it was found out that the gross value of the farm family income exceeds on average from 2.19 to 3.51 of the amount of costs incurred on mechanization in orchard farms. On the other hand Sawa when analysing the performance of agricultural production mechanization in various conditions of management stated that farms with the average intensity of production organization are low-effective [10]. Although the productivity of labour resources, despite the fact that it was higher in environmentally sustainable farms than in non-environmentally sustainable farms, the statistical analysis which was carried out did not prove significant differences between those two farm groups in the value of this indicator. Moreover, energy inputs on productivity did not differ significantly between the investigated farm groups and it was at the average in the ES farms 1062.5 PLN·GJ$^{-1}$ and in the NES farms it was 971.0 PLN·GJ$^{-1}$.

Higher productivity of the selected resources and inputs in the environmentally sustainable farms may result from more developed animal production which is proved by livestock expressed in livestock units and intensity of production organization related thereto and the obtained gross margin.

## 4. Conclusions

Analysis of the research leads to the conclusions that:
1. Farms in Poland should develop towards compliance with environmental criteria and also produce the greatest amount of high-quality food. This is confirmed by economic results obtained by environmentally sustainable farms compared to the results obtained for environmentally unsustainable farms.
2. The environmentally sustainable farms manage the land resources more effectively which results in higher land productivity in those farms than the one obtained in the non-environmentally sustainable farms.
3. Productivity of technical labour means and mechanization inputs is higher in the environmentally sustainable farms than in the non-environmentally sustainable farms.
4. Productivity of labour resources and energy inputs in both farm groups is similar.
5. Land, technical fixed assets and mechanization inputs productivity in the environmentally sustainable farms differs significantly than in adequate productivity in the non-environmentally sustainable farms.

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