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ELECTRICITY IN ORGANIC AND CONVENTIONAL FARMS – ECONOMIC VALUE OF ENVIRONMENTAL DAMAGE

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ABSTRACT: The aim of this study was to determine the economic value of the environmental impact of electricity used in agricultural production in organic and conventional farms in Poland in relation to cropped area and production value. This study investigated the use of electricity from the grid and that generated using photovoltaic panels. Farm models were constructed based on FADN data. Environmental damage was evaluated by applying the Environmental Prices method with the use of the SimaPro 9.3 program. Results were expressed in prices of 2022. The environmental impact of electricity used in organic farms investigated in this study amounted to 2267 euro/ha and 31.14 euro/1000 euro of production value, while in conventional farms, it was 32.33 euro/ha and 19.27 euro/1000 euro of production value when only energy from the grid was used. In turn, the use of energy generated by photovoltaic panels made it possible to considerably reduce environmental pressure. In the case of organic farms, the recorded indexes were 1.68 euro/ha and 2.31 euro/1000 euro of production value, whereas, in conventional farms, it was 2.72 euro/ha and 1.62 euro/1000 euro of production value. These results indicate that the use of electricity for production in organic farms generates less environmental damage than in the case of conventional farms per unit area, whereas, for the respective figures in relation to production value, an opposite relationship was found.

KEYWORDS: valuation of environmental damage, Environmental Prices method, electricity, agricultural production, photovoltaics

Introduction

Socio-economic changes and the resulting improved quality of life are accompanied by increased degradation of the natural environment and growing energy demand (Owusu & Asumadu-Sarkodie, 2016; Li et al., 2018; Peng et al., 2020; Maśloch et al., 2020). Released pollutants are produced by various sources, both mobile (e.g. vehicles) and stationary (e.g. power plants), anthropogenic (e.g. oil refineries) and natural (such as volcanic activity, wildfires), point (e.g. manufacturing plants) and area sources (e.g. agriculture, cities) (Ukaogo et al., 2020). Awareness of health hazards and environmental hazards resulting from the growing pollution levels, including those generated from fossil fuels used to produce electricity (Samandi, 2017; Solarin, 2020; Perera, 2018), prompts efforts to search for solutions reducing the negative impact of industrialisation, urbanisation or agricultural intensification (Valle et al., 2012; Verbruggen, 2019; Hutchison et al., 2019; Mabon et al., 2019; Szerement et al., 2021; Bukowski et al., 2022).

In response to the need to mitigate climate change and its negative effects, the European Union in 2019 developed the concept of the European Green Deal (Fetting, 2020). It is a roadmap for the EU climate programme, based on which, since 2020, the European Commission has been preparing legislation and strategies (Siddi, 2020). The new package of climate regulations adopted within the Green Deal, named Fit for 55, assumes a 55% reduction of CO2 emissions by 2030 compared to the levels of 1990 and attaining climate neutrality by 2050 (Flam & Hassler, 2023). Reaching these goals will require a considerably increased share of renewable energy sources in energy generation compared to the present level. The development of photovoltaics, which we have been observing for the last decade, indicates that this technology may become crucial for the EU climate and energy goals (Kougias et al., 2021).

Agriculture is a sector of the economy characterised by considerable energy consumption. On the farm level, energy is used directly in plant and animal production, as well as the transport of agricultural products (Rokicki et al., 2021). Agriculture serves an important role in the national economy not only by providing food, income or employment but also by assuring food quality and security, promoting integrated rural development and preserving the social structure (Lichtfouse et al., 2009; Aznar-Sánchez et al., 2019). Intensified agricultural production made it possible to reduce the number of people suffering from malnutrition (Alexandratos & Bruinsma, 2012) and to satisfy needs connected with more resource-intensive diets (Foley et al., 2011; Smith et al., 2010; Tilman et al., 2011). Studies indicate that agriculture contributes to increased output and stimulates regional development of the service sector (Du Pisani, 2006; Loizou et al., 2019). On the other hand, it is also perceived as one of the most significant factors causing environmental changes (Godfray & Garnett, 2014). Among other things, agriculture contributes to the loss of biodiversity (Tscharntke, 2021; Faber & Jarosz, 2023), the greenhouse effect, eutrophication, pollution of water bodies and reservoirs, or depletion of the ozone layer in the stratosphere (Adegbeye, 2020). Organic agriculture is considered to be an alternative to conventional agriculture, making it possible to reduce the negative environmental effects of farming (Le Campion, 2020; Krauss et al., 2020; Durán-Lara et al., 2020). In principle, it attempts to maintain soil fertility and biodiversity; it relies on organic fertilisers and pesticides based on plant extracts while prohibiting the use of synthetic fertilisers and pesticides, as well as genetically modified organisms (Seufert & Ramankutty, 2017; Niggli, 2015).

Studies conducted to date to compare the environmental effects of organic and conventional farms have primarily focused on comparing these production systems (Tscharntke et al., 2021; Le Campion et al., 2020). Results reported by van Mansvelt et al. (1998) based on an analysis of farms in the Netherlands, Germany and Sweden indicate a greater diversity of landscapes in the case of organic farms. Kuczuk (2015) pointed to a much higher energy consumption of winter wheat in conventional farms compared to organic farms in Poland. A review of literature presented by Mondelaers et al. (2009) showed that the leaching of nitrates and phosphorus, as well as greenhouse gas emissions per unit area in organic farms, are lower than in conventional farms. However, the results are more ambiguous when expressed by unit product. A study by Chabert and Sarthou (2020) indicates that organic farms – at a lower efficiency of provisioning services than conventional farms – are characterised by higher levels of regulating and non-market services. This confirms earlier findings of Sandhu et al. (2010), who, when analysing the situation in New Zealand, stated that conventional agricultural practices may considerably reduce ecosystem services in agriculture. Lower land productivity in

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organic farming (Alvarez, 2022; Chabert & Sarthou, 2020; Kuczuk, 2015) needs to be focused on, particularly considering the need to ensure food security for the constantly growing population. However, some researchers suggest that organic production has sufficient potential to provide food for the global population (Reganold & Wachter, 2016; Badgley & Perfecto, 2007). In turn, Durham and Mizik (2021) conducted a review of the literature in terms of the economic efficiency of various agricultural production systems. Their results indicate that organic farms typically attain better financial results. Nevertheless, there are differences between individual countries. Greater profitability of organic farms was also stressed by Smith et al. (2019). When investigating prospects for the development of organic agriculture in Poland, Kociszewski (2022) stated that many farm owners who changed the farming system to organic production observed no change in their financial results. In turn, Kuczuk (2015) pointed to greater economic efficiency of winter wheat production in conventional farms. In Poland, in regions characterised by greater intensity of agricultural production, farms report higher income levels compared to those from regions with lower production intensity (Sieczko & Koloszko-Chomentowska, 2023).

Farmers deciding to run organic farms frequently are motivated not only by economic factors but also by broadly understood concern for environmental quality (Han et al., 2021; Sapbamrer & Thammachai, 2021). The aim of the analysis presented in this paper was to determine the economic value of the environmental impact of electricity used in agricultural production in organic and conventional farms in Poland. Farms using only energy from the grid and those equipped with photovoltaic systems (PV) were included in the investigations. Research results made it possible to compare negative externalities resulting from the use of electricity depending on the source of its generation in relation to cropped area and production value in conventional and organic farms.

The following research hypotheses were proposed in this study:

- H1: The use of electricity in production operations in organic farms in Poland, when expressed per hectare of utilised agricultural area, generated less environmental damage than is the case with conventional farms.
- H2: Externalities resulting from the use of electricity per unit production in organic farms exceed those in conventional farms.

Materials and Methods

Valuation of environmental damage resulting from the use of electricity in agricultural production was performed by applying the Environmental Prices method using the SimaPro 9.3 programme. Values of the impact included in this valuation are related to the social costs of pollution and indicate a loss of economic welfare as a consequence of additional pollutant loads introduced to the environment (De Bruyn et al., 2018). This method makes it possible to convert the established measures of environmental and social impacts to monetary units (Pizzol et al., 2015). It is one of the possible approaches to be used at the stage of weighing, which facilitates aggregation of impacts expressed using various units of measure within the framework of life cycle assessment (LCA), constituting the analysis of environmental impact over the life cycle of a product (Amadei et al., 2021; Arendt et al., 2020). Monetisation in the LCA analysis due to the application of different physical units in process inventories requires information on the prices of various products. These prices may differ considerably not only between individual supply chains but also between individual levels of the same chains (Jakobs et al., 2021). Thus, price uncertainty significantly affects results obtained in LCA analyses (Jakobs et al., 2021; Yu & Wiedmann, 2018; Thiesen et al., 2008). In turn, Arendt et al. (2020) pointed to the fact that geographic location has a key effect on the level of financial factors. The monetisation of LCA results is a solution facilitating a compromise between various categories of impact. For this purpose, strategies of environmental priorities are applied (Arendt et al., 2020). In this case, weighing requires the inclusion of political, social and ethical values, which is a controversial issue (Eldh & Johansson, 2006). It results from a study by Eldh and Johansson (2006) that in relation to each category, the same pricing needs to be applied. The environmental prices method adopted in this study is based on environmental priorities and prices for goods in the EU.

Results presented in this paper are expressed in prices of 2022. Values originally price expressed in other price levels were updated using the consumer price index (GUS, 2023) and the European

Union Consumer Price Index (CPI) (Trading Economics, 2023). Conversion of values given in PLN to euro was based on the yearly average exchange rates of the National Bank of Poland (NBP) in 2022 (Euro-pln.pl, 2023).

The analysis was based on information coming from organic and conventional farms included in the system, collecting and utilising accounting data within the framework of the Polish FADN. In accordance with the assumptions of the farming accountancy data system FADN, investigations covered only commercial farms (Goraj & Mańko, 2009), i.e. those whose agricultural market output comprises mainly products for sale (Józwiak & Kagan, 2008). The population of farms keeping the accounting books comprises approx. Twelve thousand farms constitute a statistically representative sample in terms of their agricultural type (production specialisation), economic size (potential production capacity of the farm) and regional location of commercial farms, which were included in the Polish FADN (Pawłowska-Tyszko et al., 2023). In accordance with the guidelines, in order to classify a farm to the FADN field of observation, the minimal economic size threshold is set at 4,000 euros. The field of observation for the Polish FADN, established based on the above-mentioned criterion, covers approx. 750,000 commercial farms from the total number of 1,410,732 farms in Poland. Although the number of farms in the field of observation of FADN accounts for slightly over half of all the farms, this set of farms produces approx. 95% value of the standard production in Polish agriculture (Floriańczyk et al., 2024). For this reason, data from the FADN sample farms may be broadly applied in various types of analyses concerning farms and agricultural production.

Using information coming from 11 923 farms located throughout the country the models were constructed depending on the adopted production system (conventional, organic) and the source of electricity used. Data from the FADN network indicate that for the needs of their agricultural production, farms used electricity from the grid and energy generated by photovoltaic systems. A comparative analysis of the value of externalities resulting from the use of electricity in agricultural production was conducted for four types of farms. The distinguished farms included conventional farms using only electric energy from the grid and conventional farms equipped with photovoltaic systems, as well as analogous organic farms based on electric energy from the grid and organic farms using electricity generated by photovoltaic panels.

Characteristics of investigated farms

The average utilised agricultural area (UAA) for the analysed groups of farms varied considerably. Organic farms were smaller in area, as their mean UAA was 24.6 ha, whereas for conventional farms, it was 32.9 ha.

Organic farms are characterised by an extensive range of grown crops, which, in combination with appropriate crop rotation, makes it possible to maintain soil fertility as well as reduce the incidence of plant diseases and pests (Runowski, 2012; Łuczka, 2021). In the agriculturally utilised area in the organic farms compared to conventional farms cereals covered less area, while more area was cropped to legumes, orchards, vegetables and fodder crops, including permanent grassland.

Since animal rearing in organic farms needs to provide them with natural living conditions in terms of nutrition, stocking and housing, including access to open runs and pasture (Tyburski & Żakowska-Biemans, 2007), stocking of animals kept on organic farms was markedly lower than it was in conventional farms. In turn, due to more labour-intensive production technologies applied in organic farms, in which no chemical plant protection products are admissible, and animal feeds are produced mainly on the farm, labour intensity of production measured based on total labour inputs is greater in those farms, despite much smaller numbers of kept animals (Table 1).

Potential factors of production in the case of farms include fixed and current assets, whose value is given as total assets. Total assets per 1 ha UAA indicate capital intensity of production. It was greater in conventional farms, which was connected, e.g. with higher animal stocking rates. The level of production intensity was markedly lower (almost 2-fold) in organic farms, which was manifested in the respectively lower levels of output and economic outcomes of those farms.

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Table 1. Production potential and production intensity in the compared groups of farms

Specification	Farms	
	organic	conventional
Average agricultural area, in ha	26.4	32.9
Animals per 100 ha of UAA, in LU[1]	45.3	68.3
Total labour input per 100 ha of UAA, in AWU[2]	6.4	5.2
Total assets per ha of UAA, in euro	7277	9789
Total input per ha of UAA, in euro	665	1322
Volume of electricity consumption for agricultural production, in kWh per year	2007	3564

[1] – Livestock Unit (LU), according to FADN, equivalent to 1 dairy cow or culled cow, or bull aged min. 2 years.
[2] – Annual Work Unit (AWU) of labour input per 1 person gainfully employed for a year: 1 AWU = 2200 total work hours/year.
Source: authors' calculations based on European Commission (n.d.).

Table 2. Production value and productivity of factors of production in investigated farms

Specification	Farms	
	organic	conventional
Total production, in euro	19 208	55 106
Productivity of agricultural land, in euro per ha	728	1 675
Productivity of labour, in euro per AWU	11 366	32 226
Productivity of capital, in euro per 100 euro of total assets	10.0	17.1

Source: authors' calculations based on European Commission (n.d.).

Since organic farms ran markedly less intensive production (they used smaller inputs of factors of production) and had lower UAA, their outputs were almost 3-fold lower than those of conventional farms (Table 2). Reference of the outputs to the input of factors of production involved in their production shows the productivity of land, labour input and capital assets (Józwiak, 1998). Indicators of productivity, similarly to outputs, were much lower in organic farms, particularly for labour productivity (over 3-fold lower).

Analysed organic and conventional farms used various sources of electricity in their production activity. In most cases, it was energy coming from the grid. Some farms used photovoltaic systems. In such a situation, organic farms obtain all the energy used in agricultural production from these systems. In contrast, conventional farms – despite using energy generated by PV systems – additionally purchased electricity from the grid to meet their needs.

Externalities of the use of electricity in agricultural production

The use of electricity in economic activity is responsible for a considerable share of pollutants released to the environment (Omer, 2008). Their impact varied depending on the energy source. This analysis took into consideration the value of environmental damage in Poland resulting from the consumption of energy from the grid and from PV systems. The results indicate a considerably lower value of environmental damage for the use of electricity generated by PV panels compared to that from the grid (Figure 1). The estimated value of environmental impact for energy from the grid was 26.42 euros per 100 kWh, while for energy from the PV systems, it was 1.96 euros per 100 kWh. The greatest differences in the advantage of PV panels, as high as 20- to 34-fold value of the impact, were recorded in the following categories: land occupation, eutrophication and terrestrial acidification. Only in the case of ecotoxicity the value of environmental damage caused by electricity consumption was 28% lower for the use of energy coming from the grid.

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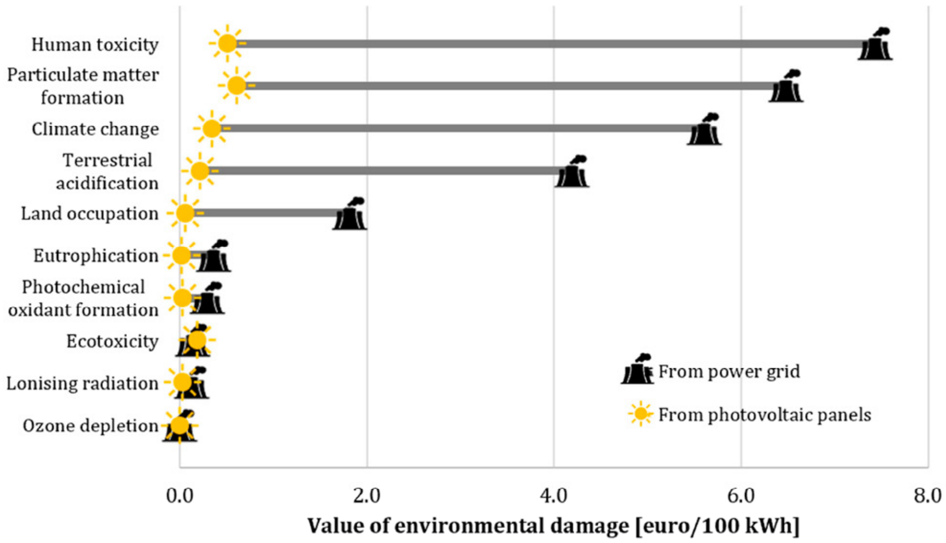

Figure 1. Environmental impact of electricity consumption depending on the source, in euro/100 kWh

When analysing the structure of environmental damage depending on the source of electricity, a difference may be observed between energy from the grid and that generated by photovoltaic panels (Figure 2). In the case of energy from the grid, the greatest losses were found for human toxicity (28.1%), particulate matter formation (24.5%) and climate change (21.2%), as well as terrestrial acidification (15.9%). In turn, in the structure of losses caused by the consumption of energy produced using photovoltaic panels, the dominant categories include particulate matter formation (31.0%), human toxicity (25.6%), climate change (17.2%) and terrestrial acidification (10.7%). Consumption of energy produced by photovoltaic systems also leads to considerable damage related to the category of ecotoxicity with a 9.2% share in the total environmental damage. In contrast, the share of this category in the total environmental damage generated by the consumption of energy from the grid is as low as 0.5%.

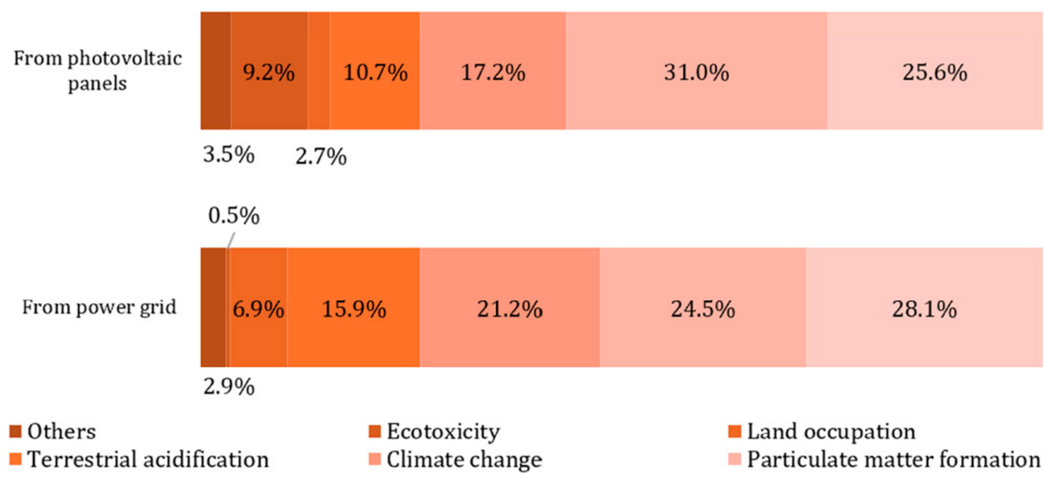

Figure 2. Structure of environmental damage caused by consumption of electricity depending on the source

Consumption of electricity from the grid has a greater effect on the soil surface than energy generated by photovoltaic panels. The share of environmental damage resulting from the impact on the soil surface in the case of the grid was 22.7% (the joint share of damage in the categories of land occupation and terrestrial acidification). In contrast, for energy generated in photovoltaic systems, this share amounted to 13.4%. A greater impact on the soil surface in the case of the consumption of energy from the grid results from the land surface being occupied by transmission lines and from soil acidification caused by compounds produced during coal combustion, primarily sulphur and nitric

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oxides. In contrast, for the production of electricity using photovoltaic panels, a greater share of damage related to toxicity is observed. The total share of losses in the categories of human toxicity and ecotoxicity for energy generated in photovoltaic systems was 34.8%, while for energy from the grid, it was 28.6% (Fig. 3). In the case of the two other aggregated categories of environmental impact, i.e. impact on the quality of the atmosphere and the quality of waters, their share in the total value of losses is comparable for the consumption of energy generated by photovoltaic panels and that coming from the grid.

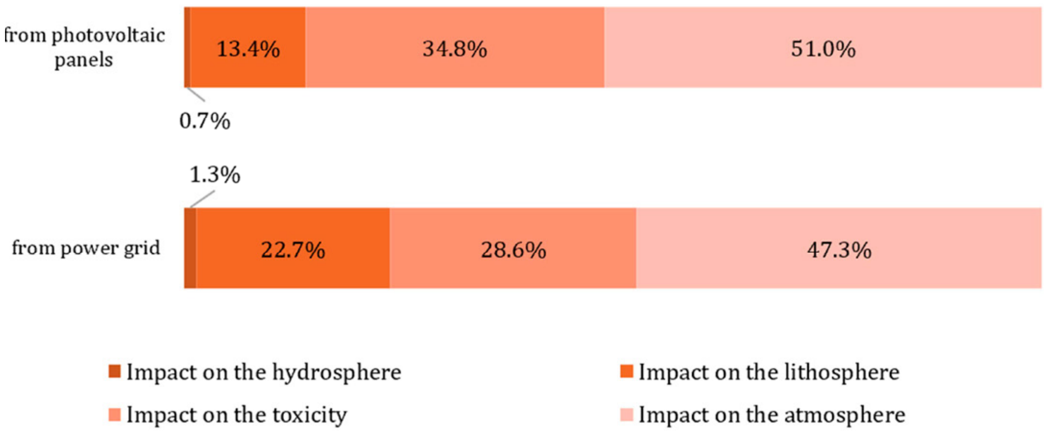

Figure 3. Structure of environmental damage caused by consumption of electricity within 4 aggregated environmental impact categories depending on the source

Obtained values of environmental damage referred to the amount of electricity consumed for agricultural production in the analysed types of farms. These results indicate that in conventional farms the value of environmental damage per 1 hectare of UAA was much greater than it was in organic farms (Figure 4). Observed differences result, first of all, from the greater animal stocking rates and production intensity in conventional farms compared to organic farms.

When energy used came only from the grid, the total value of losses caused by electricity consumption in conventional farms was 9.66 euro/ha higher than in conventional farms (43% greater impact than in organic farms). An even larger percentage difference between these impacts is observed when analysing farms using energy generated by PV panels. In such a case, environmental losses in conventional farms were 62% greater than in organic farms (in absolute values, this difference is 1.04 euro/ha). Higher losses in the case of conventional farms using electricity generated in photovoltaic systems compared to organic farms using the same source of energy result from a greater impact in the category of land occupation (impact greater by 93%), eutrophication (impact greater by 78%) and terrestrial acidification (impact greater by 71%). The observed difference results from the fact that in the case of conventional farms using energy produced by PV panels, it is necessary to purchase additional energy from the grid. This, in turn, increases the environmental impact of conventional farms, particularly in the case of these categories, where the difference in the environmental impact between energy from the grid and energy generated by PV panels is the greatest.

When comparing the same types of farms using different sources of energy, it may be stated that in the case of conventional farms using energy from the grid, the total value of environmental damage was almost 12-fold greater than in the same type of farms using energy generated by photovoltaic panels. In turn, when analysing environmental losses caused by the consumption of energy by organic farms depending on its source, we may observe 13.5-fold losses by farms using energy from the grid. A smaller difference in the case of conventional farms results from the above-mentioned need to purchase additional energy from the grid despite having a photovoltaic system. Categories to the greatest extent influencing the described differences in the level of the environmental impact of farms depending on the energy source include land occupation (over 34-fold greater impact for energy from the grid for organic farms and 25-fold greater impact for conventional farms), eutrophication (24.5-fold greater impact in the case of organic farms and almost 20-fold greater impact for conven-

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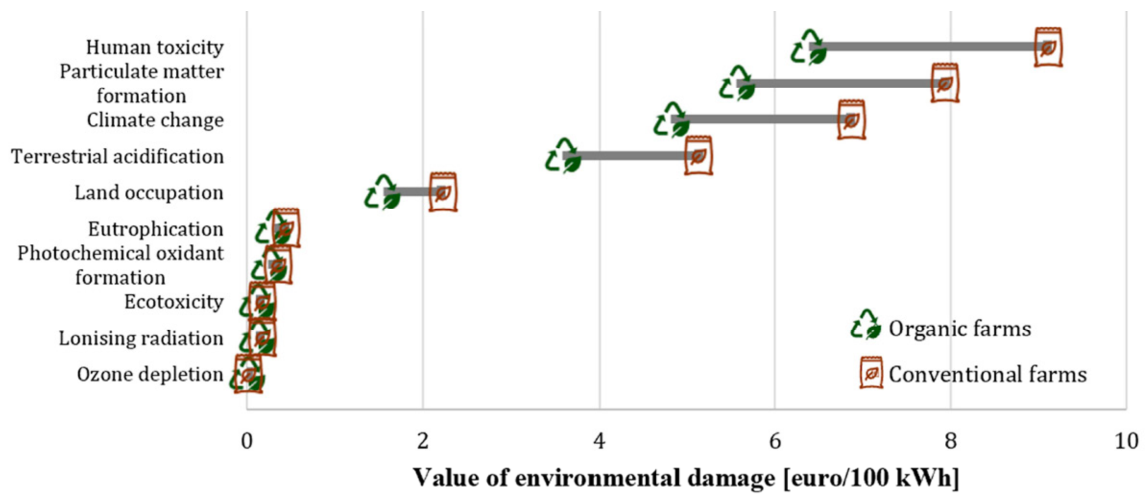
tional farms) and terrestrial acidification (almost 20-fold greater impact in the case of organic farms and 16.5-fold greater impact for conventional farms). Differences in the level of environmental losses caused by energy consumption in the same type of farms result directly from the difference in the environmental impact of energy production depending on its source.

a) electricity from the power grid



b) electricity from the photovoltaic panels

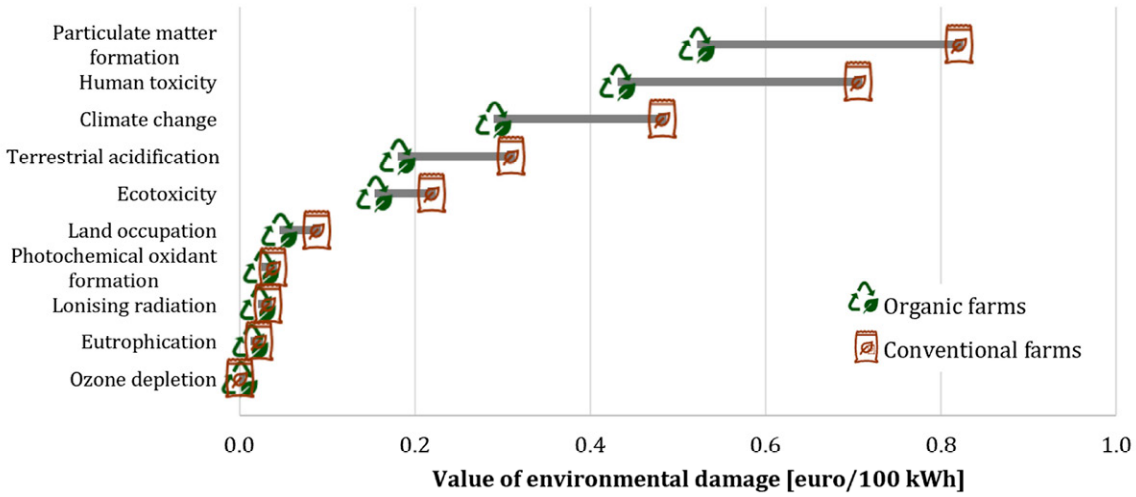
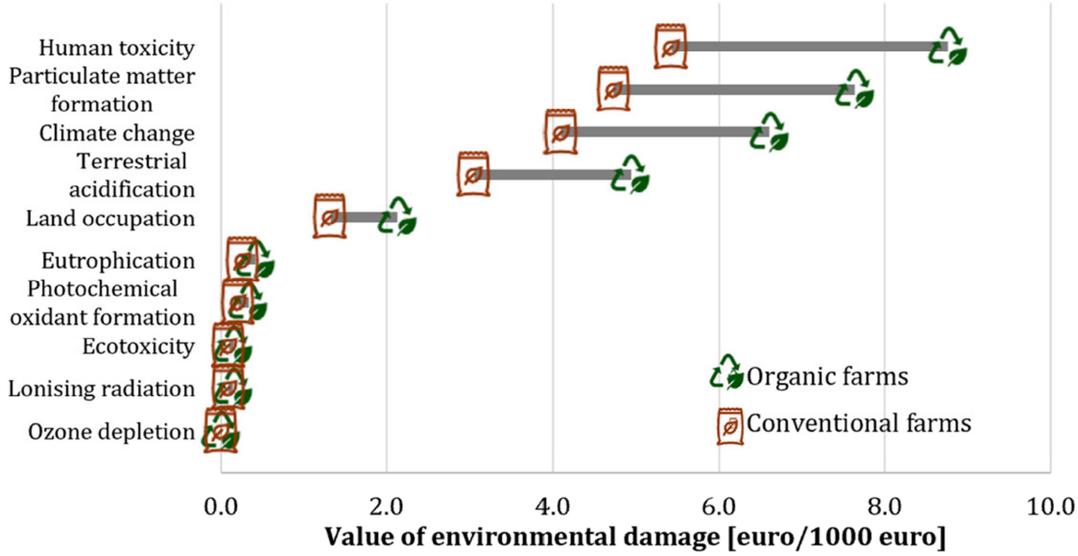


Figure 4. Environmental impact of electricity consumption in agricultural production depending on the type of farms and energy source, in euro/ha UR

The scale/value of production was the factor differentiating the amount of electricity consumed on a farm. The value of the environmental impact of electricity consumption in agricultural production in relation to the agricultural production value was greater in organic farms than in conventional farms (Figure 5). The total value of environmental damage caused by organic farms consuming electricity from the grid was 31.14 euro/1000 euro of production value. In contrast, in the case of conventional farms, it was 19.27 euro/1000 euro of production value. In the case of farms using energy generated by photovoltaic systems, these values amounted to 2.31 euro/1000 euro of production value in the case of organic farms and 1.62 euro/1000 euro of production value for conventional farms, respectively.

Thus, differences between the investigated types of farms amounted to 62% for farms using energy from the grid and 43% for farms using photovoltaic systems. Higher values of the environmental impact in the case of organic farms result from low productivity of factors of production in organic farms compared to conventional farms. Total production value per 1 farm was almost 3-fold lower in organic farms in comparison to conventional farms (compare values in Table 2). In order to obtain their production value, conventional farms have to consume only 78% more energy than organic farms.

a) electricity from the power grid



b) electricity from the photovoltaic panels

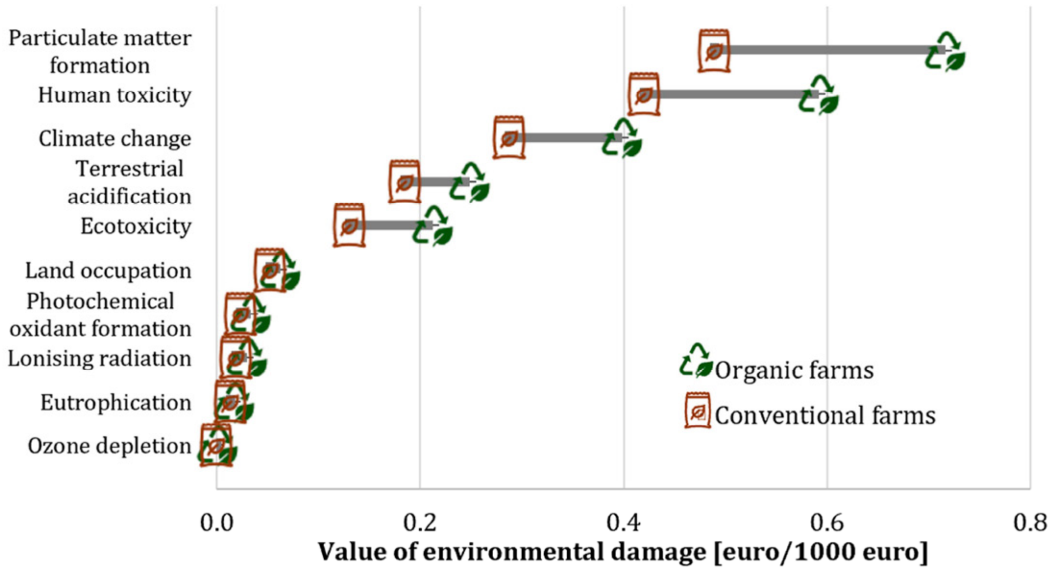


Figure 5. Environmental impact of electricity consumption in agricultural production depending on the type of farms and energy source, in euro/1000 euro of agricultural production value

Conclusions

The use of energy in economic activity is connected with a negative environmental impact. A greater share of energy from renewable sources makes it possible to reduce anthropopressure (Hertwich et al., 2015; Laurent & Espinosa, 2015). Results presented in this paper indicate a much greater value of environmental damage for the use of energy from the grid compared to energy generated by photovoltaic systems. Only in the category of ecotoxicity an opposite relationship was observed. This is consistent with the findings presented in their studies by Arvesen and Hertwich (2012) as well as Laurent et al. (2018). Electricity consumption in farms, to the greatest extent, influ-

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ences such categories of environmental changes as human toxicity, particulate matter formation and climate change. These categories, both in the case of energy from the grid and that generated by photovoltaic panels, are responsible for almost ¾ of the total value of environmental damage caused by energy consumption in farms.

Recorded results confirm the hypotheses presented in this paper. The use of electricity in production in conventional farms per hectare UAA showed a greater value of pressure on the environment – by 43% in the case of farms using only energy from the grid and by 62% in farms using solar energy (H1). In turn, referring to the value of environmental impact to the production value of the studied farms, an opposite relationship was obtained, i.e. environmental damage resulting from the use of electricity in organic farms was greater than in conventional farms (H2). This difference results from the lower productivity of organic farms, which was not offset by the lower electricity consumption by this type of farm. Crop productivity in organic farming, depending on crop type, is 5-58% lower compared to conventional agriculture (Aulakh et al., 2022).

In studies covering the entire agricultural production, it is stressed that the environmental impact of organic farms is smaller than that of conventional farms per unit area of the farm, whereas in relation to a production unit of production value, an opposite relationship was found (Meemken & Qaim, 2018; Seufert & Ramankutty, 2017). Results concerning the environmental impact of organic farms may be different when specific farms of applied production methods are investigated. For example, Aguilera et al. (2015) indicated that organic fruit and nut orchards produce fewer greenhouse gases per unit product in comparison to conventional orchards, whereas investigations conducted by Venkata (2012) showed an opposite dependence.

In the context of challenges posed by the EU climate policy, we also need to stress the fact that organic agriculture counters the adverse effects of climate change by increasing resilience to fluctuations in temperatures and drought. Technologies applied in organic agriculture make it possible at the level of production to reduce greenhouse gas emissions, such as methane and nitrous oxide (Gamage et al., 2023). These factors need to be taken into consideration in the assessment of the total volume of the impact of agricultural production in organic farms on climate change.

The results of analyses presented in this paper confirm the dependence of the level of environmental pressure on the source of electricity used in agricultural production. A method to limit the negative environmental impact is connected with the utilisation of energy generated by renewable sources, including photovoltaics. Increasing the share of renewable energy sources in the production of electricity used in agriculture may contribute to reaching the adopted goals of the European climate and energy policy. Studies conducted to date concerning the economic efficiency of electricity generation using photovoltaic panels in farms in Poland (Bukowski et al., 2021; Bukowski et al., 2020) indicate that such installations attain greater efficiency in the social accounting terms compared to microeconomic accounts. However, a condition for economic efficiency is to apply mechanisms of financial support in the form of subsidies to PV installations as well as an appropriate mechanism for settling accounts for produced electricity. Adoption of such solutions is justified in view of the fact that social benefits resulting from the replacement of coal in the production of electricity exceed the level of support which owners of PV installations receive from public funds. In view of the costs of photovoltaic installations, maintenance of such support is necessary in view of the goals specified in the European climate policy.

It is advisable to conduct further research concerning the environmental impact both for different systems and elements of agricultural production. This may facilitate the optimisation of production processes in agriculture, including the minimisation of environmental costs.

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The contribution of the authors

Conceptualization, A.S., J.M. and D.K.; literature review, A.S. and J.M.; methodology, A.S., J.M. and M.B.; formal analysis, A.S., J.M., M.B. and D.K.; writing, A.S., J.M., M.B. and D.K.; conclusions, A.S., M.B. and J.M.

The authors have read and agreed to the published version of the manuscript.

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ENERGIA ELEKTRYCZNA W GOSPODARSTWACH EKOLOGICZNYCH I KONWENCJONALNYCH – EKONOMICZNA WARTOŚĆ SZKÓD ŚRODOWISKOWYCH

STRESZCZENIE: Celem badań było określenie wartości ekonomicznej oddziaływania na środowisko energii elektrycznej wykorzystywanej w produkcji rolnej gospodarstw ekologicznych i konwencjonalnych w Polsce w odniesieniu do powierzchni upraw i wartości produkcji. W pracy uwzględniono wykorzystanie energii elektrycznej z sieci energetycznej i paneli fotowoltaicznych. Modele gospodarstw zbudowano w oparciu o dane z FADN. Wycenę szkód środowiskowych przeprowadzono metodą cen środowiskowych, wykorzystując program SimaPro 9.3. Wyniki wyrażono w cenach z 2022 r. Oddziaływanie na środowisko energii elektrycznej wykorzystanej w objętych badaniem gospodarstwach ekologicznych wyniosło 22,67 euro/ha i 31,14 euro/1000 euro wartości produkcji, natomiast w gospodarstwach konwencjonalnych 32,33 euro/ha i 19,27 euro/1000 euro wartości produkcji, w przypadku, gdy korzystano tylko z energii z sieci energetycznej. Wykorzystanie energii z paneli fotowoltaicznych pozwoliło na znaczne ograniczenie presji środowiskowej. W przypadku gospodarstw ekologicznych uzyskane wskaźniki wynosiły 1,68 euro/ha i 2,31 euro/1000 euro wartości produkcji, a w gospodarstwach konwencjonalnych 2,72 euro/ha i 1,62 euro/1000 euro wartości produkcji. Uzyskane wyniki wskazują, że wykorzystanie energii elektrycznej do produkcji w gospodarstwach ekologicznych wywołuje mniejsze szkody środowiskowe niż w gospodarstwach konwencjonalnych w przeliczeniu na jednostkę powierzchni, natomiast w odniesieniu do wartości produkcji zależność jest odwrotna.

SŁOWA KLUCZOWE: wycena szkód środowiskowych, metoda cen środowiskowych, energia elektryczna, produkcja rolna, fotowoltaika

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