Zeszyty Naukowe Uniwersytet Ekonomiczny w Krakowie

3 (1001)
2023

Zesz. Nauk. UEK, 2023, 3(1001): 85–103
ISSN 1898-6447
e-ISSN 2545-3238
https://doi.org/10.15678/ZNUEK.2023.1001.0305

The Limitations of Implementing Environmental Labelling: The Example of Eco-Scoring

Ograniczenia dotyczące wdrażania etykietowania środowiskowego – przykład Eco-Score

Magdalena Muradin[1], **Joanna Katarzyna Banach**[2], **Janusz Turowski**[3], **Magdalena Wojnarowska**[4]

[1] Poznań University of Economics and Business, Department of Quality Management, Niepodległości 10, 61-875 Poznań, e-mail: magdalena.muradin@ue.poznan.pl, ORCID: https://orcid.org/0000-0003-1209-0018

[2] University of Warmia and Mazury in Olsztyn, Institute of Management and Quality Science, Michała Oczapowskiego 2, 10-719 Olsztyn, e-mail: katarzyna.banach@umw.edu.pl, ORCID: https://orcid.org/0000-0001-9178-1540

[3] Studio of Technical Services "Auditor", Juranda ze Spychowa 2/1, 10-064 Olsztyn, e-mail: jot.tur@gmail.com, ORCID: https://orcid.org/0009-0006-0380-4655

[4] Krakow University of Economics, Department of Technology and Ecology of Products, Rakowicka 27, 31-510 Kraków, e-mail: wojnarom@uek.krakow.pl, ORCID: https://orcid.org/0000-0001-7068-1698

Suggested citation: Muradin, M., Banach, J. K., Turowski, J., Wojnarowska, M. (2023), "The Limitations of Implementing Environmental Labelling: The Example of Eco-Scoring", *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie* 3(1001): 85–103, https://doi.org/10.15678/ZNUEK.2023.1001.0305.

ABSTRACT

Objective: To identify potential limitations for the development of Polish enterprises resulting from the need to label dairy products. The focus is on Eco-Score labelling for a selected product from the dairy industry.

Research Design & Methods: The article presents the calculations of the Eco-Score index for Polish mozzarella cheese (125 g) made from cow's milk and produced under a discount store's brand name. On the basis of a case study, an analysis was done with the Eco-Score for mozzarella

cheese produced in France. The Eco-Score is the reference value (benchmark) for calculating the Single Score based on PEF methodology.
Findings: Out of ten mozzarella cheeses available on the Polish market, two of them were classified as category C products (Eco-Score 53 and 58 Pt), indicating that their impact on the environment was moderate. The remaining eight cheeses fell into category D, meaning they had a high impact.
Implications/Recommendations: In the case of Eco-Score, Polish products are assigned a lower category at the outset due to their country of origin and the government's environmental policy. In turn, when it comes to labelling based on product environmental footprint (PEF) rules, the increased environmental burden resulting from the Polish energy mix may pose a challenge when calculating the environmental footprint of a product and comparing it to the designated benchmark.
Contribution: The conclusions from the article may be helpful for industry management in understanding the benefits and limitations of environmental labelling of dairy products and their voluntary use.

Article type: original article.

Keywords: environmental management, product environmental footprint, environmental labelling, Eco-Score.

JEL Classification: L1, L6, L7, Q18, F2, O440, O57.

STRESZCZENIE

Cel: Celem artykułu jest identyfikacja potencjalnych ograniczeń rozwoju polskich przedsiębiorstw, wynikających z konieczności znakowania produktów mleczarskich na przykładzie znakowania Eco-Score dla wybranego produktu z branży mleczarskiej.
Metodyka badań: Przeprowadzono obliczenia dla wskaźnika Eco-Score polskiego sera typu mozzarella z mleka krowiego o gramaturze 125 g, produkowanego pod marką jednego ze sklepów dyskontowych. Na podstawie wybranego przypadku dokonano szacowania w odniesieniu do wartości wskaźnika Eco-Score sera typu mozzarella wyprodukowanego we Francji, stanowiącego wartość referencyjną (benchmark) dla obliczenia wskaźnika Single Score zgodnie z metodyką PEF.
Wyniki badań: Przeprowadzone rozpoznanie wykazało, że na dziesięć dostępnych na polskim rynku serów mozzarella dwa uzyskały kategorię C (Eco-Score 53 i 58 Pt), świadczącą o umiarkowanym wpływie na środowisko, a pozostałe osiem serów sklasyfikowano w kategorii D – dużego wpływu.
Wnioski: W przypadku Eco-Score polskie produkty już na początku mają przypisaną niższą kategorię ze względu na kraj pochodzenia i politykę ekologiczną rządu. Jeśli chodzi natomiast o znakowanie oparte na zasadach PEF, większe obciążenie środowiska wynikające z polskiego miksu energetycznego może stanowić wyzwanie przy obliczaniu śladu środowiskowego produktu i porównywaniu go do wyznaczonego benchmarku.
Wkład w rozwój dyscypliny: Wnioski z artykułu mogą być pomocne dla kadry zarządzającej w poznaniu korzyści i ograniczeń wynikających z etykietowania środowiskowego produktów.

Typ artykułu: oryginalny artykuł naukowy.

Słowa kluczowe: zarządzanie środowiskowe, ślad środowiskowy produktu, etykietowanie środowiskowe, Eco-Score.

1. Introduction

To force organisations to become more involved with environmental and climate issues, in 2019 the European Green Deal was launched. The goal of this new growth strategy is to build a modern, resource-efficient and competitive economy and achieve net zero greenhouse gas emissions (GHG) in Europe by 2050 (The European Green Deal 2019). The most important task of the Community in this regard is to redirect the economy and society towards sustainable development and to protect the natural capital, health and well-being of EU citizens. When introducing new products onto the market, enterprises should therefore base their decisions on an assessment of the environmental impact of these products, taking specific standards and guidelines into account.

One of the key elements of sustainable production and consumption is the food supply chain, which has had a negative impact on the environment (Tudi *et al*. 2021), and has sped up greenhouse gas emissions and climate change, the destruction of wildlife habitats and biodiversity, water, soil and air pollution and, as a consequence, the production of waste. The amount of input material at each stage of the crop production chain has an impact on GHG as well as emissions, including energy consumption, both on farms (crop cultivation, machine use) and off-farm (transport, refrigeration). Additional sources of emissions include the production and use of fertilisers and pesticides, the production and transportation of raw materials, packaging and disposal. All of these impact the environment in a variety of ways, including through human toxicity, soil toxicity, water toxicity, global warming, and acidification (Alhashim, Deepa & Anandhi 2021). Thus, not only is the agricultural sector itself contributing to climate change and environmental degradation, but so too are the processing, packaging and retail industries (Gerten *et al*. 2020).

Hence, the attempted transformation has focused on implementing the farm-to-fork strategy, a key driver in the transition to sustainable, healthy and inclusive food systems from primary production to consumption (Riccaboni *et al*. 2021). This strategy sets out a number of goals to be achieved by 2030, including halving food waste per capita at both the retail and consumer levels (European Commission 2020). In addition, it points to the need for a more environmentally friendly food system in the European Union, which would make it possible to mitigate climate change and adapt to its consequences (Blanke 2015). However, in order for this strategy to be effective, changes in the behaviour of individual stakeholders are required. Hence, the strategy's main goal is to encourage not only food producers, but also processors and retailers to introduce changes aimed at improving the manufactured products available on the market (European Commission 2020).

Policymakers across the value chain are investing more financial resources than ever in an effort to support sustainable development. However, there is no single standardised and objective way of quantifying the environmental performance of products and services and conveying this information to customers (De Bauw *et al*. 2021). The lack of uniform guidelines means that many different types of tools for calculating the environmental impact of a given product have begun to appear on the market, and each tool is based on a different methodology. This gives rise to information hype and confuses consumers. Labels still do not play a significant role in food selection as they compete with attributes such as price and taste (Truong, Lang & Conroy 2021). Moreover, the variety of existing methodologies for estimating the impact on the environment throughout the product life cycle is perplexing for entrepreneurs and undermines the competitiveness of manufacturing companies. In an effort to be competitive on the European market, food production companies are often forced to use various types of labels.

This article identifies potential limitations for the development of Polish enterprises resulting from the need to label dairy products on the example of "Eco-Score" labelling for selected dairy products.

2. Characteristics of the Dairy Industry in the Context of the Green Deal

The dairy industry, the EU's most important agricultural sector, is the primary focus of the Green Deal strategy aimed at ensuring sustainable food production (EEA 2019). Poland has the third highest stock of dairy cows among the 28 member states of the European Union (Eurostat 2020). In 2010–2019, the milk yield of cows increased significantly, from approx. 4,500 to approx. 5,800 litre / a year (Statistics Poland 2020). Despite the modifications introduced in the concentration of herds and improvements in raw material quality, which is in line with general EU trends, large-scale milk production is considered a potential threat to the environment (Bieńkowski, Baum & Holka 2021).

In accordance with the assumptions of the „from-farm-to-fork" strategy, by 2030 farmers are obliged to reduce their use of plant protection products by 50%, fertilisers by 20%, and antibiotics by 50%, as well as improve the welfare of their livestock. In addition, 10% of all arable land must be set aside for restoring biodiversity and 25% of all food should be harvested using organic farming methods. In spite of these ambitious goals, Polish strategic plans for the Common Agricultural Policy (CAP) for 2023–2027, taking into account the country's capabilities in this area, will be moderate and provide only for a reduction in consumption of 1 kg of pure nitrogen per hectare, an approximate 5% reduction in plant protection products, and a roughly 10% cut in the use of antibiotics (Strategic Plan… 2020).

The high standards set for Green Deal performance indicators may generate additional costs for the entire agri-food sector. If Poland is to convert 25% of its entire agricultural land into organic farming units, in accordance with Resolution of the European Parliament on the European Green Deal (RC-B9-0040/2020), preparing financial support instruments will be required at the national, regional and local levels. These will provide the tools needed to implement the Green Deal, shift to a low-carbon economy, and fight unfair trading practices.

Conscious of the constraints of the market, many Polish dairy companies from the large enterprise and small and medium enterprise (SMEs) sectors are taking substantial steps to translate EU requirements into practice, while ensuring efficient and profitable production of milk and dairy products, taking into account ecological and environmental factors at all stages of the life cycle (Notarnicola *et al.* 2017). They believe that they are able to overcome any constraints of the Green Deal, provided that sustainable products are the preferred choice of consumers (COM 2022). One solution that would enable the Polish dairy industry to survive on the market would be the creation of a truly long-term vision involving sustainable and competitive food systems, while promoting the reciprocity of EU production standards in trade agreements and creating a competitive economy (Commission staff working document executive summary of the impact assessment, SWD/2022/83 final).

The European Green Deal and its accompanying documents present the vision and overall objectives, while the development of specific goals is the responsibility of the Member States and society. The focus of pro-environmental measures in the dairy industry is on increasing resource efficiency in the production cycle. One example is the recycling of whey, a by-product of cheese and casein production, which makes up about 85% of the milk used in these processes (Panesar & Kennedy 2012). Most of the word's whey permeate is treated as dairy wastewater. But it can actually be recovered and reused to produce high-value protein concentrates for special human (Mehra *et al.* 2021) and animal (Zandona, Blažić & Jambrak 2021) consumption as well as for the production of biofuels (Parashar *et al.* 2016). In addition, dairy plants in Poland are investing in renewable energy and cogeneration systems that increase their competitiveness and comply with the objectives of the Green Deal (Fiore *et al.* 2020). The dairy industry is also committed to reducing food waste along the entire value chain from farm to fork, taking into account: its huge share in overall greenhouse gas emissions, the negative environmental impact of packaging and the use of voluntary information systems on packaging (EDA 2019).

3. Product Environmental Labelling

Food labelling that informs consumers about the environmental impact of a product is less common than labelling containing information about the impact of food on health. Hence, when making purchasing decisions, these factors may compete with each other and pose a dilemma for consumers (Hardin 2009). While identifying the health risks / benefits of food has a direct impact on consumer choices (Beattie 2012), the environmental impact of a product has a wider range of effects on many different populations, from local communities to the world as a whole. Consumers' ignorance of the placement of eco-labels on packaging will prevent them from properly interpreting the environmental aspects of a product (Panzone *et al*. 2020).

Eco-labelling is an environmental product management tool that distinguishes products of above-average environmental quality on the market and thus allows consumers to make more informed choices. The food eco-labelling systems currently in use in Poland are voluntary and standardised (ISO 14020:2000) for three types of label: type I is a qualitative label (ISO 14024:2018) while types II and III are quantitative labels (ISO 14021:2016; ISO 14025:2006). Despite the existence of legal regulations in this area, state and EU authorities recommend avoiding the practice of "greening" products, i.e. placing misleading labels on them (greenwashing). They also encourage the use of products with a reduced environmental impact and favour those that are local / seasonal in character and are respectful of biodiversity. In addition, the Resolution of the European Parliament on the European Green Deal calls for improved mandatory country-of-origin labelling and clear information on the environmental footprint of food. It also requires transparent and consumer-friendly labels to be displayed directly on food labels, where digital means of supplying information can complement but not replace them.

To ensure a harmonised visual identity for organic food across the EU, in 2010 the European Commission developed and implemented the EU Organic Farming Logo, which consists of twelve white stars arranged in a pattern of leaves set against a green background (Fig. 1) (Gorton *et al*. 2021).

The detailed requirements regarding the production and labelling of organic products are contained in Regulation (EU) 2018/848 of the European Parliament and the Council of 30 May 2018 (repealing Council Regulation (EC) No. 834/2007), which indicates that organic production is "an overall farm management and food production system combining the best environmental and climate-friendly practices, a high degree of biodiversity, the protection of natural resources and the application of high animal welfare and production standards, meeting the growing number of consumers' demands for products manufactured using natural means and processes". Thus, the main goals of organic farming are to increase system-wide biodiversity, increase the biological activity of soil, maintain long-term soil fertility, recycle plant and animal waste, use renewable resources in locally organised farming systems, promote the healthy use of soil, water and air, and minimise all forms of their contamination that may result from agricultural practices. This translates into a number of specific requirements, including refraining from the use of industrial fertilisers, synthetic pesticides, feed additives, and genetically modified (GM) crops. All these strict and widely-recognised requirements are defined at management level (Sonesson, Berlin & Ziegler 2010, Vives Vallés 2022).

Fig. 1. Certified Organic Farming Logo

Source: Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and the labelling of organic products and repealing Council Regulation (EC) No 834/2007.

Member States are required to implement a control system to properly monitor compliance with the provisions applicable to organic production. EU law requires economic operators to be checked at least once a year. The competent authorities may delegate control to accredited certification bodies, but nevertheless must perform certain supervisory functions themselves (checking the independence of accredited bodies and the effectiveness of their checks and inspections, ensure accurate reporting of irregularities, etc.). In this area, EU activities are not limited only to defining control and certification standards and the principles of ecological activities. They also involve the provision of financial support by the Common Agricultural Policy (CAP) for their promotion and development. The European Agricultural Fund for Rural Development, for example, promotes organic farming through support measures that encourage farms to switch to these organic production methods (Simina & Raluca 2022).

In an effort to standardise the research methodology involved in an environmental life cycle assessment of a product and to communicate these results to consumers, the European Commission introduced the Product Environmental Footprint PEF (Manfredi *et al*. 2012) method of calculation. This tool is based on a multi-criteria assessment of environmental performance throughout the product life cycle (ISO 14040:2006). The assessment covers the flows of elemental material and energy streams at all stages of the life cycle, from raw material extraction, through to processing, distribution, use and end of life (EoL) (Manfredi *et al*. 2015). Figure 2 presents all phases of the PEF study based on LCA methodology (Zampori & Pant 2019).

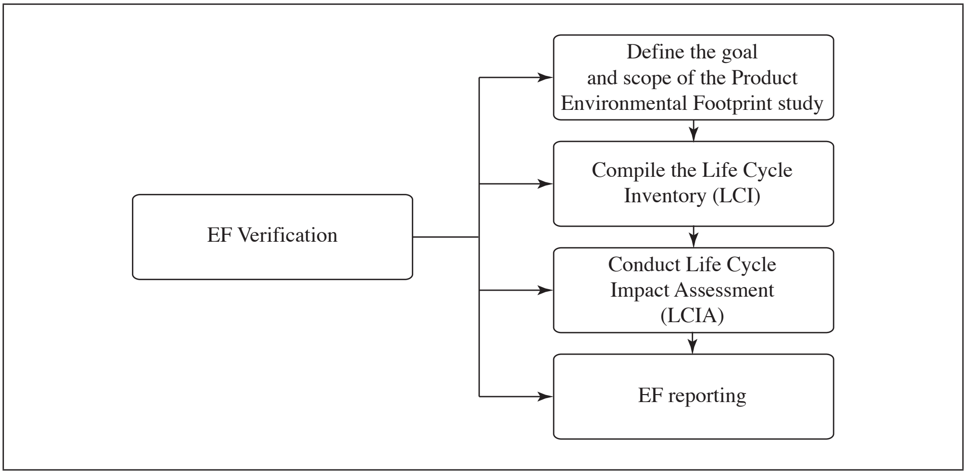

Fig. 2. Phases of a Product Environmental Footprint Study
Source: (Zampori & Pant 2019).

The purpose of PEF is to develop a standardised, uniform procedure for comparing and communicating the effects of the environmental impact of products in order to help consumers recognise to what extent a given product or company is environmentally friendly. A high degree of reproducibility and comparability of studies within the same product category can be achieved based on specific methodological requirements established for selected categories in the Product Environmental Footprint Category Rules PEFCR. In the pilot phase in 2013–2018, PEFCRs were developed for 19 different product categories, including dairy products. Each document is prepared by a group of experts supported by the Technical Advisory Committee, which includes entrepreneurs from various sectors.

Currently, calculating the PEF is not mandatory. However, according to the recommendations of the European Commission, Member States should include the PEF in their voluntary policies for measuring or communicating to consumers the environmental and ecological performance of products or organisations throughout the life cycle (European Commission 2021). It is also still unclear how the PEF will be used in communications with external stakeholders (Minkov, Lehmann & Finkbeiner 2020). Because consistent communication and monitoring of eco-labels was one of the justifications for launching the PEF, the option favoured was that of combining eco-labelling with the PEF label. Potential technical options for informing consumers about a product's PEF were investigated as part of a pilot

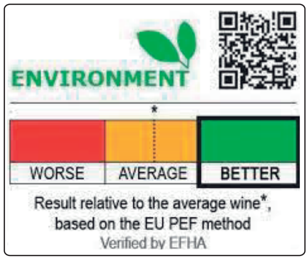

Fig. 3. A Simplified Example of a Potential PEF Label
Source: (Elsen *et al*. 2019).

phase. Nine different labels have been proposed in online eye-tracking interviews to assess the effectiveness of attracting consumer attention (Elsen *et al*. 2019). One example of a simplified proposal is shown in Figure 3.

4. The Example of Eco-Score Mozzarella Cheese

4.1. Methodology

In January 2021, a group of French organisations introduced a new environmental food labelling system on the European market called „Eco-Score", based on the PEF methodology. This label provides information for customers ("front of pack" information) on the environmental footprint of products along the entire supply chain "from farm to fork". The Eco-Score environmental food labelling system is supported by the Open Food Facts portal (https://world.openfoodfacts.org/, accessed: 29.03.2023). The portal has the most extensive database of products from around the world assigned Nutriscore and Eco-Score labels. The platform's base contains 2,392,926 products, of which 8,220 are from Poland (as of June 19, 2022).

According to Osman and Thornton (2019), the use of Eco-Score labels is an easy, intuitive and effective tool for communicating environmental performance. Researchers have also noted their beneficial effect on the development of consumer awareness and making consumers more motivated to make favourable environmental choices (Panzone *et al*. 2020). Currently, the system only functions on a small scale. Steps to introduce Eco-Score environmental labelling for private label products have been undertaken by such retail chains as Carrefour, REWE, Lidl and the Belgian retailer Colruyt.

The Eco-Score is calculated using the aggregated Environmental Footprint Index and takes into account the different stages in the product life cycle. Its value is determined on the basis of two components:

– Single Score – the result of quantified environmental impact data calculated on the basis of a product's PEFCR concerning a specific category of product,

– additional quality criteria that take into account environmental benefits / losses not included in the PEF methodology concerning an individual product.

To identify the potential limitations for the development of Polish enterprises resulting from the need to label dairy products, the Eco-Score example was discussed using the secondary data for selected products from the dairy industry taken from the Open Food Facts portal and AGRYBALISE 3.0.

An overview of the Polish market for mozzarella cheese made from cow's milk was conducted. Ten different kinds of cheese of 125 g produced under the brand name of discount stores, and with Eco-Scores already awarded, were selected for the study. A new estimation was made with reference to the French benchmark in the scope of additional quality criteria used in Eco-Score methodology. Single Score results (Table 1) for the French benchmark of mozzarella cheese were taken from the AGRIBALYSE 3.0 database, which was designed by the French Environmental Protection Agency (ADEME 2023) on the basis of a product's PEFCR. This approach was used because there is currently no sufficient data on the environmental impact of individual Polish dairy products. Moreover, Polish dairy producers have shown little interest in the Eco-Score, so there is limited access to the inventory data of elementary flow of the mozzarella cheese production stage for the selected discount stores in Poland. These data correspond to the life cycle analysis (LCA) of the product including agriculture, processing, packaging, transportation, distribution and consumption of mozzarella cheese. However, additional quality criteria not included in the PEF methodology are the determining component of the overall Eco-Score value (which is why the paper focuses only on this scope of the study).

The Single Score benchmark presented for mozzarella cheese was calculated by ADAME (Auberger *et al*. 2022) using the AGRIBALYSE 3.0 database according to the European „PEF" (Product Environmental Footprint) methodology based on values for 16 normalised, weighted environmental impact indicators (EDA 2018), thereby allowing us to assign an aggregated „Single Score" index (Table 1).

The Single Score is calculated by dividing the individual impact data by relevant normalisation factors (i.e. the impact per capita) and the normalised values are then multiplied by relevant weighting factors. The values obtained are finally expressed in mPts per functional unit (kg). They are then added, yielding the Single Score. The normalisation factors have an objective statistical character (per capita for a given region), while the weighting factors are subjective and have to be agreed by experts competent for a given manufacturing sector taking into account their significance for human health, the environment and resources.

A full LCA analysis for an individual product can be avoided because the environmental impact based on the PEF methodology was performed as a benchmark,

Table 1. The Environmental Impact Indicators for a French Benchmark – Cow's Milk Mozzarella

No.	Impact indicator	Unit	Value
1	Climate change (CF)	CO_2 eq/kg	4.66
2	Water resource depletion	m^3/kg	1.77
3	Ozone depletion	10^{-6} kg CVC11 eq/kg	0.199
4	Ionizing radiation	kg Bq U-235 eq/kg	0.57
5	Photochemical ozone formation	10^{-2} kg NMVOC eq/kg	0.823
6	Particulate matter	10^{-6} disease incidence/kg	0.326
7	Acidification of land and freshwater	10^{-2} mol H^+ eq/kg	4.67
8	Eutrophication of land	mol N eq/kg	0.197
9	Freshwater eutrophication	10^{-3} mol P eq/kg	0.697
10	Marine eutrophication	10^{-2} mol N eq/kg	1.57
11	Land use	Pt/kg	242.00
12	Ecotoxicity of freshwater ecosystems	CTUe/kg	46.8
13	Mineral resource depletion	10^{-5} kg Sb eq/kg	1.29
14	Depletion of energy resources	MJ/kg	27.8
15	Toxicological effects on human health: non-carcinogens	10^{-8} kg Sb eq/kg	9.92
16	Toxicological effects on human health: carcinogens	10^{-9} kg Sb eq/kg	2.81
Single score		mPt/kg	0.446

Source: (ADEME 2023).

taking into account specific requirements and limitations of LCA methodology (ISO 14040, 14044 standards). The reference Single Score (mPt) for a given product category is linearised in order to obtain the values from 0 to 100 Pt (Single Score 0–100) according to the appropriate dependencies, separately for solid and liquid products. For solid products, the following linearisation algorithm is used:

$$\textit{Single Score}\,(0-100\,\textit{Pt}) = 100 - \frac{\ln(10x+1)}{\ln\left(2+\frac{1}{100x^4}\right)}\cdot 20, \quad (1)$$

where: x – Single base score (mPt).

The linearisation based on (1) is done because, from the consumer's point of view, the Single Score values give no simple information on the products' environmental impact, and thus they cannot be directly used for eco-labelling. The final Eco-Score value is obtained taking into account specific quality criteria that are relevant for an individual product but not included in the environmental life cycle assessment. Scoring is modulated by bonus points or penalties and awarded to products depending on the following:

1) the method of production – the possessions of a specific ecological or quality certificate, e.g. Bio, Fairtrade, Rainforest, Demeter, Label Rouge, UTZ, MSC/ASC (max. 20 Pt);

2) the ingridients' country of origin – this criterion takes into account the impact on transport on a particular consumer market (max. 15 Pt), as well as the environmental policy of each producer country (from –5 to +5 Pt);

3) the share of ingredients in products that have a significant impact on biodiversity and ecosystems and endangered species (max. –10 Pt). One example here is palm oil, the production of which has resulted in massive deforestation (Pye 2019);

4) the type of packaging – this factor considers the type of packaging and the principle of circularity. If precise information on the type of plastics used is not indicated on the packaging, the product's final Eco-Score will be lower, with consumers viewing the product in a less positive light (max. –15 Pt).

The maximum bonus that can be obtained is +25 Pt. Finally, the result is calculated using the following formula:

$$\textit{Eco-Score} = \textit{Single score}\,(0\text{–}100) + \textit{bonus/malus}\,(\text{from } -15 \text{ to} + 20)\,. \qquad (2)$$

The Eco-Score value can then be used to create the eco-label for a given product. The shape of a "front of pack" label has not yet been decided. At present, it is proposed to classify products, based on a score from 0–100, into one of five colour-coded categories according to the extent of its environmental impact (Fig. 4). Category A – low impact, B – medium impact, C – average impact, D – high impact, and E – very high environment impact. The final classification of a product is largely influenced by the discretionary bonus and penalty points awarded. More important from a technical point of view, however, is the fact that an increase in the Single Score by 20 Pt (on a scale of 0–100) corresponds to a two-fold decrease in the value of the base Single Score (mPt) – that is, a two-fold decrease in the environmental footprint.

Fig. 4. Food Environmental Impact, Eco-Score

Source: Eco-Score, https://docs.score-environnemental.com/implementation/affichag (accessed: 29.03.2023).

4.2. Results

The findings showed that out of ten different discount store mozzarella cheeses available on the Polish market, two of them were classified as category C products (Eco-Score of 53 and 58 Pts), indicating an average impact on the environment. The remaining eight cheeses were classified as category D – a high impact. For all products (mozzarella) produced in Europe the benchmark is the same according to the environmental impact assessment results. With these results in hand, we set out to determine the overall Eco-Score category for a Polish mozzarella cheese on the basis of a benchmark equal to 0.446 mPt per kg of mozzarella cheese produced (Table 1).

A Single Score of 0.446 mPt for the product category „mozzarella cheese" was linearised according to formula (1), so the baseline Eco-Score was 59 Pt (on a scale of 0–100), making it a category C product (average environmental impact). The baseline can then be corrected according to formula (2), depending on the additional criteria.

Table 2. Scenarios for a Mozzarella Produced in Poland

Scenario	Eco-Score result (Pt)	Eco-Score category	Impact
Baseline scenario	59	C	average
The worst possible scenario	39 (–20 Pt)	D	high
The best possible scenario	84 (+25 Pt)	A	low

Source: the authors.

In the example of the mozzarella produced in Poland, the final result must be adjusted to include bonus points for the production method used – no certificates (0 pt) as well as penalty points resulting from Poland's environmental protection policy (–5 Pt) and the lack of information regarding packaging type and ingredients (–15 Pt). By reducing the result by 20 Pt, an overall Eco-Score of 39 Pt was obtained, placing Polish mozzarella as a D category product with a high environmental impact. If the maximum number of bonus points (+25 pts) were awarded, a comparable mozzarella cheese could be classified in a higher category, i.e. A – low environmental impact (Table 2).

5. Discussion and Conclusions

As Pink *et al*. (2022) note, current food consumption patterns are damaging to our health and the environment, so consumers need to make conscious changes to their diet. Labels on products informing about the environmental impact and nutritional quality of the product can help consumers make the right choice

(Plamondon *et al*. 2022). According to Potter (Potter *et al*. 2021), environmental labels can effectively encourage more sustainable purchases, especially when combined with nutrition labels. This confirms the effectiveness of product labelling as an important means to changing eating behaviour to improve the health of the planet (Potter *et al*. 2021).

From the point of view of dairy industry producers, the multitude of different environmental labels and symbols has created a degree of information noise (Kontogeorgos 2012). In addition, voluntary eco-labelling does not have a positive effect on production management because it is not obligatory, though specific retail chains may require it of contractors, as may dairy industry producers for these networks' private labels. In the case of the environmental labels considered here, the country of origin is not a factor only when a product is certified organic. This would appear to make organic the most favourable choice for entrepreneurs. The organic symbol is issued when determining the origin of the raw materials and the method of rearing and feeding dairy cows (in the case of the dairy industry), and not at the dairy processing stage.

For producers, a major disadvantage of using the Eco-Score is that the data can be incomplete, leading to an overreliance on averaged reference data. Many businesses and governmental organisations therefore forego these labelling systems in their current food evaluation mechanisms. The only way to change manufacturers' approach to the use of environmental labelling would appear to be through the adoption of standardised testing methodology for assessing the environmental impact of products as well as the introduction of mandatory labelling.

We have achieved our aims with this case study and can now formulate the following conclusions:

1. Thanks to the widening application of the environmental labelling system, the Eco-Score is seen as a solution that can be implemented in all European Union countries. However, a citizens' initiative is critical of the current lack of harmonisation of calculation methods in the law, as well as the fact that most Eco-Score products have only been available online and in French.

2. In terms of production management, in the interests of producers it is very important to provide up-to-date and complete data on the production method for a product and its resulting environmental impacts, and to lobby for appropriate policy and specific pro-environmental actions in the country. This will ensure that products are awarded bonus points and do not incur penalty points.

3. For the Eco-Score label, the values used for bonuses and penalties determine the final value of the indicator and may raise doubts as to the accuracy of their allocation, e.g., in terms of country of origin. Therefore, the introduction of any environmental labelling system requires the use of as uniform and objective criteria as possible throughout the EU.

4. None of the indicators presented above take into account all the environmental damage (pesticide or antibiotic use and their impact on health, soil, air or water quality) that has been done to sustainable livestock farming or the benefits of organic or free-range farming for biodiversity and animal welfare. This has led to the development of a more advanced visual food tagging system called Planet-Score.

5. It would be wise to develop a single sustainable indicator (nLCA) that harmonises voluntary green declarations for products and to create a labelling framework that, in synergy with other relevant initiatives, will cover the nutritional, climatic, environmental and social aspects of food products.

6. This analysis could supplement the knowledge for management in understanding the benefits and limitations of using the Eco-Score label.

7. In the case of Eco-Score, Polish products are assigned a lower category at the outset due to their country of origin and their government's environmental policy. In turn, when it comes to labelling based on PEF rules, the increased environmental burden resulting from the Polish energy mix may pose a challenge when calculating the environmental footprint of a product and comparing it to the designated benchmark.

8. When it came to establishing the PEFCR for selected product baskets, representatives of the industry with the highest market share were invited to sit on technical committees. Due to their production volumes, large enterprises are major stakeholders contributing to a given industry's overall impact on the environment. This means that they can lobby for solutions that are inconsistent with measures that favour the development of enterprises from the SME sector, which rules out a fair transformation process in line with the Green Deal Strategy.

Financial Disclosure

This project has been financed by the Minister of Education and Science within the "Regional Initiative of Excellence" Programme for 2019–2022. Project no.: 021/RID/2018/19. Total financing: 11,897,131.40 PLN.

References

ADEME (2023), *Wyniki bazy danych Agribalyse dla sera mozzarella z mleka krowiego, według wskaźników LCA*, https://agribalyse.ademe.fr/app/aliments/19590#Mozzarella_au_lait_de_vache (accessed: 29.03.2023).

Alhashim R., Deepa R., Anandhi A. (2021), *Environmental Impact Assessment of Agricultural Production Using LCA: A Review*, "Climate", vol. 9(11), https://doi.org/10.3390/cli9110164.

Auberger J., Ayari N., Ceccaldi M., Cornelus M., Geneste C. (2022), *Agribalyse Change Report 3.0/3.1*, Written by INRAE teams – MEANS Platform, EVEA. ADEME 2022 Edition, https://3613321239-files.gitbook.io/~/files/v0/b/gitbook-x-prod.appspot.com/o/spaces

%2F-M7H-JTDnDsswmNDPy-z%2Fuploads%2FI5Kr1AJBSxaoEUMtnRdT%2F-ChangeReport_oct2022.pdf?alt=media&token=654009df-db4e-4d0c-874d-97c0f76a9741 (accessed: 29.03.2023).

Beattie G. (2012), *Psychological Effectiveness of Carbon Labelling*, "Nature Climate Change", vol. 2, https://doi.org/10.1038/nclimate1468.

Bieńkowski J., Baum R., Holka M. (2021), *Eco-efficiency of Milk Production in Poland Using the Life Cycle Assessment Methodologies*, "European Research Studies Journal", vol. 24(1).

Blanke M. (2015), *Challenges of Reducing Fresh Produce Waste in Europe – from Farm to Fork*, "Agriculture", vol. 5(3), https://doi.org/10.3390/agriculture5030389.

COM (2022), Wniosek Rozporządzenie Parlamentu Europejskiego i Rady ustanawiające ramy ustalania wymogów dotyczących ekoprojektu dla zrównoważonych produktów i uchylające dyrektywę 2009/125/WE, COM/2022/142 final.

Commission staff working document executive summary of the impact assessment (SWD/2022/83 final), Accompanying the document Proposal for a Regulation of the European Parliament and of the Council establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC.

De Bauw M., Matthys C., Poppe V., Franssens S., Vranken L. (2021), *A Combined Nutri-Score and 'Eco-Score' Approach for More Nutritious and More Environmentally Friendly Food Choices? Evidence from a Consumer Experiment in Belgium*, "Food Quality and Preference", vol. 93, https://doi.org/10.1016/j.foodqual.2021.104276.

EDA (2018), *Product Environmental Footprint Category Rules for Dairy Products*, European Dairy Association, Brussels, Belgium.

EDA (2019), *The Dairy Sector & the Green Deal*, European Dairy Association, Brussels, Belgium.

EEA (2019), *Climate Change Adaptation in the Agriculture Sector in Europe*, EEA Report No 4/2019, Publications Office of the European Union, Luxembourg.

Elsen M., Giesen R. van, Akker K. van den, Dunne A. (2019), *Consumer Testing of Alternatives for Communicating the Environmental, Footprint Profile of Products – Final Report*, European Commission.

European Commission (2020), *Farm to Fork Strategy for a Fair, Healthy and Environmentally-friendly Food System*, European Commission, https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en (accessed: 29.03.2023).

European Commission (2021), Commission Recommendation of 16.12.2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations, C(2021) 9332 final.

The European Green Deal, 640 (2019) (testimony of European Commission).

Eurostat (2020), Number of Dairy Cows, https://ec.europa.eu/eurostat/web/products-datasets/product?code=tag00014 (accessed: 29.03.2023).

Fiore M., Galati A., Gołębiewski J., Drejerska N. (2020), *Stakeholders' Involvement in Establishing Sustainable Business Models*, "British Food Journal", vol. 122(5), https://doi.org/10.1108/BFJ-04-2019-0263.

Gerten D., Heck V., Jägermeyr J., Bodirsky B., Fetzer I., Jalava M., Kummu M., Lucht W., Rockström J., Schaphoff S., Schellnhuber H. (2020), *Feeding Ten Billion People Is Possible within Four Terrestrial Planetary Boundaries*, "Nature Sustainability", vol. 3, https://doi.org/10.1038/s41893-019-0465-1.

Gorton M., Tocco B., Yeh C.-H., Hartmann M. (2021), *What Determines Consumers' Use of Eco-Labels? Taking a Close Look at Label Trust*, "Ecological Economics", vol. 189, https://doi.org/10.1016/j.ecolecon.2021.107173.

Hardin G. (2009), *The Tragedy of the Commons*, "Journal of Natural Resources Policy Research", vol. 1(3), https://doi.org/10.1080/19390450903037302.

ISO 14020:2000, Environmental Labels and Declarations – General Principles, Geneva, Switzerland.

ISO 14025:2006, Environmental Labels and Declarations – Type III Environmental Declarations – Principles and Procedures, Geneva, Switzerland.

ISO 14040:2006, Environmental Management – Life Cycle Assessment – Principles and Framework, Geneva, Switzerland.

ISO 14021:2016, Environmental Labels and Declarations – Self-declared Environmental Claims (Type II Environmental Labelling), Geneva, Switzerland.

ISO 14024:2018, Environmental Labels and Declarations – Type I Environmental Labelling – Principles and Procedures, Geneva, Switzerland.

Kontogeorgos A. (2012), *Brands, Quality Badges and Agricultural Cooperatives: How Can They Co-Exist?*, "The TQM Journal", vol. 24(1), https://doi.org/10.1108/17542731211191230.

Manfredi S., Allacker K., Pelletier N., Chomkhamsri K., Souza D. M. de (2012), *Product Environmental Footprint (PEF) Guide*, European Commission, Ispra, Italy.

Manfredi S., Allacker K., Pelletier N., Schau E., Chomkhamsri K., Pant R., Pennington D. (2015), *Comparing the European Commission Product Environmental Footprint Method with Other Environmental Accounting Methods*, "The International Journal of Life Cycle Assessment", vol. 20(3), https://doi.org/10.1007/s11367-014-0839-6.

Mehra R., Kumar H., Kumar N., Ranvir S., Jana A., Buttar H. S., Telessy I. G., Awuchi C. G., Okpala C. O. R., Korzeniowska M., Guine R. P. F. (2021), *Whey Proteins Processing and Emergent Derivatives: An Insight Perspective from Constituents, Bioactivities, Functionalities to Therapeutic Applications*, "Journal of Functional Foods", vol. 87.

Minkov N., Lehmann A., Finkbeiner M. (2020), *The Product Environmental Footprint Communication at the Crossroad: Integration into or Co-existence with the European Ecolabel?*, "The International Journal of Life Cycle Assessment", vol. 25(3), https://doi.org/10.1007/s11367-019-01715-6.

Notarnicola B., Sala S., Anton A., McLaren S. J., Saouter E., Sonesson U. (2017), *The Role of Life Cycle Assessment in Supporting Sustainable Agri-food Systems: A Review of the*

Challenges, "Journal of Cleaner Production", vol. 140, part 2, https://doi.org/10.1016/j.jclepro.2016.06.071.

Osman M., Thornton K. (2019), *Traffic Light Labelling of Meals to Promote Sustainable Consumption and Healthy Eating*, "Appetite", vol. 138, https://doi.org/10.1016/j.appet.2019.03.015.

Panesar P. S., Kennedy J. F. (2012), *Biotechnological Approaches for the Value Addition of Whey*, "Critical Reviews in Biotechnology", vol. 32(4), https://doi.org/10.3109/07388551.2011.640624.

Panzone L. A., Sniehotta F. F., Comber R., Lemke F. (2020), *The Effect of Traffic-light Labels and Time Pressure on Estimating Kilocalories and Carbon Footprint of Food*, "Appetite", vol. 155, https://doi.org/10.1016/j.appet.2020.104794.

Parashar A., Jin Y., Mason B., Chae M., Bressler D. C. (2016), *Incorporation of Whey Permeate, a Dairy Effluent, in Ethanol Fermentation to Provide a Zero Waste Solution for the Dairy Industry*, "Journal of Dairy Science", vol. 99(3), https://doi.org/10.3168/jds.2015-10059.

Pink A. E., Stylianou K. S., Ling Lee L., Jolliet O., Cheon B. K. (2022), *The Effects of Presenting Health and Environmental Impacts of Food on Consumption Intentions*, "Food Quality and Preference", vol. 98, https://doi.org/10.1016/j.foodqual.2021.104501.

Plamondon G., Labonté M.-È., Pomerleau S., Vézina S., Mikhaylin S., Laberee L., Provencher V. (2022), *The Influence of Information about Nutritional Quality, Environmental Impact and Eco-Efficiency of Menu Items on Consumer Perceptions and Behaviors*, "Food Quality and Preference", vol. 102, https://doi.org/10.1016/j.foodqual.2022.104683.

Potter C., Bastounis A., Hartmann-Boyce J., Stewart C., Frie K., Tudor K., Bianchi F., Cartwright E., Cook B., Rayner M., Jebb S. A. (2021), *The Effects of Environmental Sustainability Labels on Selection, Purchase, and Consumption of Food and Drink Products: A Systematic Review*, "Environment and Behavior", vol. 53(8), https://doi.org/10.1177/0013916521995473.

Pye O. (2019), *Commodifying Sustainability: Development, Nature and Politics in the Palm Oil Industry*, "World Development", vol. 121, https://doi.org/10.1016/j.worlddev.2018.02.014.

Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007.

Riccaboni A., Neri E., Trovarelli F., Pulselli R. M. (2021), *Sustainability-oriented Research and Innovation in 'Farm to Fork' Value Chains*, "Current Opinion in Food Science", vol. 42, https://doi.org/10.1016/j.cofs.2021.04.006.

Simina P. A., Raluca C. (2022), *A Perspective on the Management Processes Specific to Organic Farming*, "Journal of Contemporary Issues in Business and Government", vol. 28(2).

Sonesson U., Berlin J., Ziegler F. (2010), *Environmental Assessment and Management in the Food Industry Life Cycle Assessment and Related Approaches* (in:) *Environmental*

Assessment and Management in the Food Industry, Life Cycle Assessment and Related Approaches, U. Sonesson, J. Berlin, F. Ziegler (eds), Woodhead, Oxford.

Statistics Poland (2020), *Statistical Yearbook of Agriculture 2019*, Statistics Poland, Warsaw.

Strategic Plan for the CAP for 2023–2027 (2020), version 4.0 – draft.

Truong V. A., Lang B., Conroy D. M. (2021), *Are Trust and Consumption Values Important for Buyers of Organic Food? A Comparison of Regular Buyers, Occasional Buyers, and Non-Buyers*, "Appetite", vol. 161, https://doi.org/10.1016/j.appet.2021.105123.

Tudi M., Daniel Ruan H., Wang L., Lyu J., Sadler R., Connell D., Chu C., Phung D. T. (2021), *Agriculture Development, Pesticide Application and Its Impact on the Environment*, "International Journal of Environmental Research and Public Health", vol. 18(3), https://doi.org/10.3390/ijerph18031112.

Vives Vallés J. A. (2022), *Organic Varieties under Regulation (EU) 2018/848: Analysis of the Concept and Proposal to Make Them Compatible with Plant Breeders' Rights*, "SSRN Electronic Journal", https://doi.org/10.2139/ssrn.4104575.

Zampori L., Pant R. (2019), *Suggestions for Updating the Product Environmental Footprint* (*PEF*) *Method*, European Commission, Publications Office of the European Union, Luxembourg, https://doi.org/10.2760/424613.

Zandona E., Blažić M., Jambrak A. R. (2021), *Whey Utilisation: Sustainable Uses and Environmental Approach*, "Food Technology & Biotechnology", vol. 59(2), https://doi.org/10.17113/ftb.59.02.21.6968.