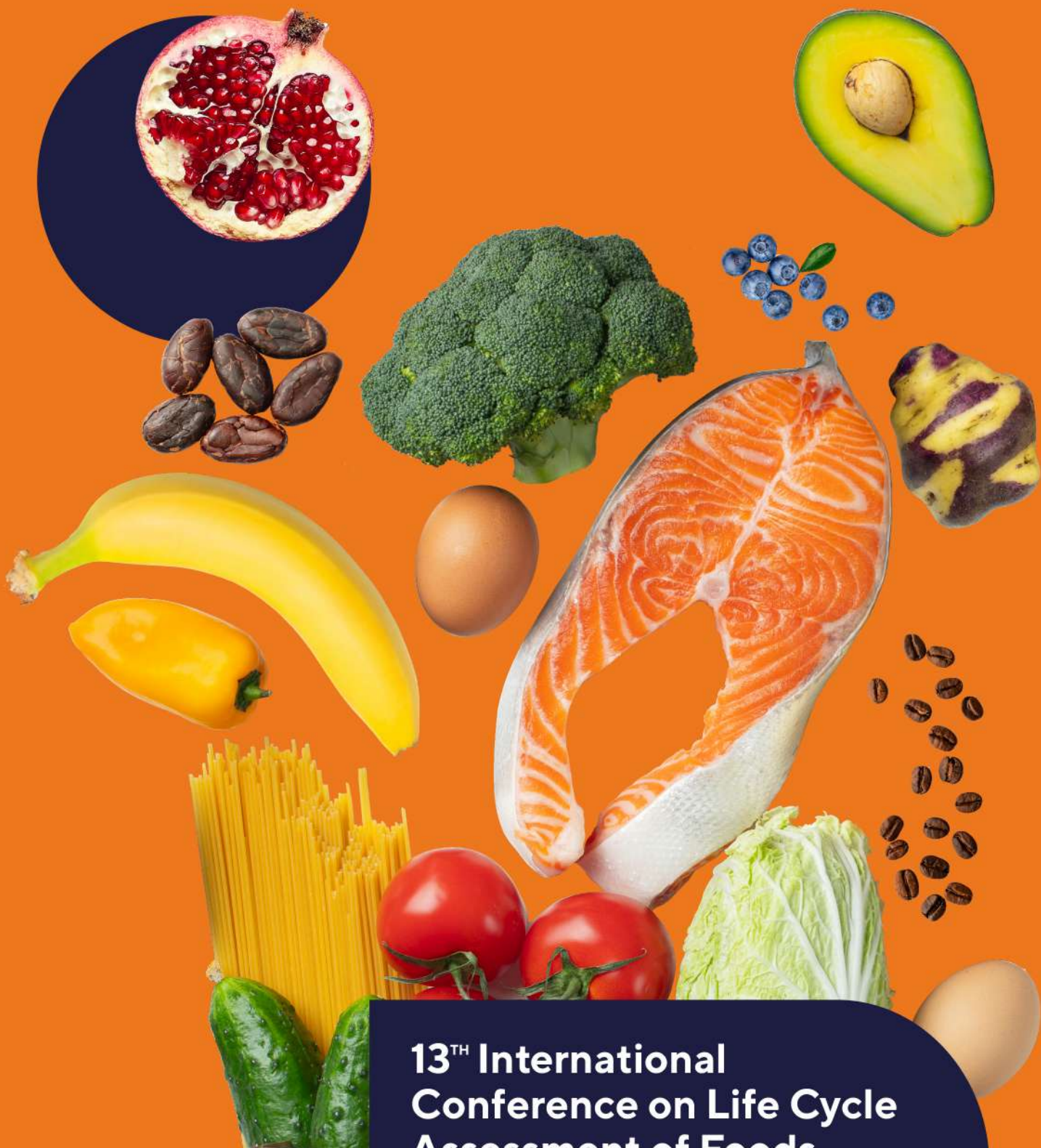


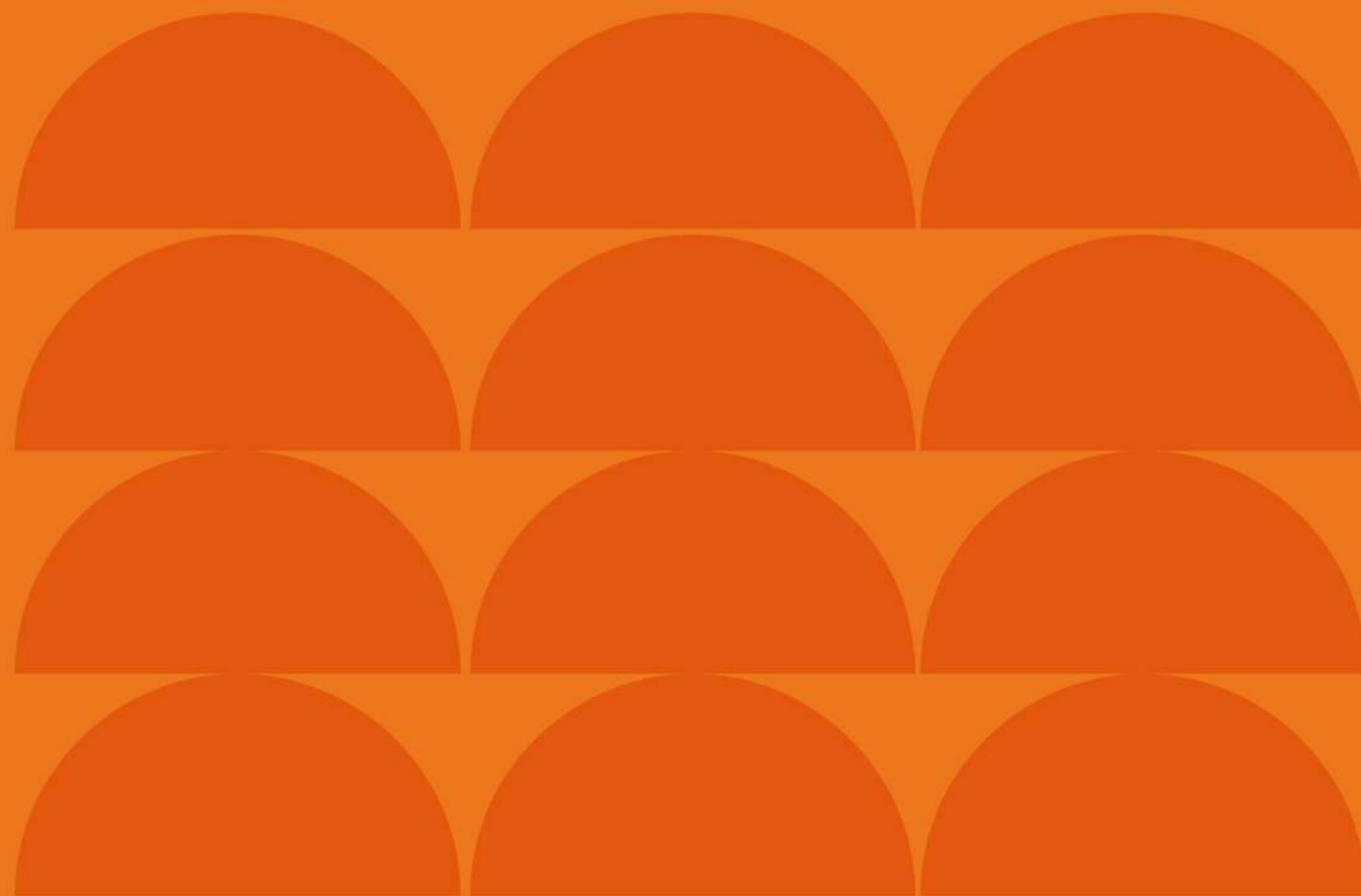
**LCA
FOODS**



**13TH International
Conference on Life Cycle
Assessment of Foods**

11-14 October
Hybrid venue at Open PUCP
Lima, Perú

“The Role of Emerging Economies in Global Food Security”



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Book of proceedings

**13TH INTERNATIONAL CONFERENCE
ON LIFE CYCLE ASSESSEMENT
OF FOOD**

11 - 14 October

Lima, Perú

2022

Editores
*Ian Vázquez Rowe
Ramzy Kahhat Abedrabbo
Eizo Muñoz Sovero*



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WELCOME

¡Bienvenidos a LCA Foods 2022 en Lima, Perú!

Welcome to LCA Foods 2022 in Lima, Peru!

“The Role of Emerging Economies in Global Food Security”

Lima is hosting in October 2022 the world’s leading scientific and technical forum on Life Cycle Assessment linked to the food sector. The 13th edition of the conference arrives as the first fully hybrid edition of the event, after the forceful virtual conference that had to be held in Berlin in 2020 during the COVID-19 pandemic. Despite the setbacks due to the pandemic, Berlin provided a high quality conference in which the number of attendees was comparable to past events. Two years later, distancing is no longer an obligation as it was in the first months of the pandemic. Hence, we are now hosting an edition in which many of us are eager to meet up in-person after 4 full years since we last met in Bangkok for the 11th edition of the conference; however, the virtualization of conferences worldwide showed us that another way of interacting with our colleagues is possible without having to travel thousands of miles to meet those experts that we wish to discuss science with. This led to the conundrum regarding what Lima, the gastronomic capital of the Americas, should offer participants in this edition. The thirst for in-person interaction, offering a low-carbon event in line with what should be expected in a environmentally-centered conference, the need for

countries like Peru to participate in the global flow of scientific knowledge and discussion or the fact that the conference travels for the first time to Latin America and the Caribbean were all aspects that we discussed for the past two years in order to determine what type of conference we should offer.

Finally, we have managed to offer a hybrid conference in which we are happy to share an online platform through which we will all unite for 4 full days. When this proceedings book was sent out for publication, over 210 participants had confirmed their attendance from approximately 40 countries worldwide. Approximately 45% will also be joining us physically at Open PUCP in Lima.

Life Cycle Assessment (LCA) is currently one of the most commonly used and scientifically robust environmental management methodologies to determine the environmental profile of products and services. Although its applicability is vast, with notable research in most productive sectors, the agri-food sector has benefited undoubtedly thanks to LCA-related research. In this context, the aim of the 13th edition of the LCA of Foods Conference is to continue with the work done in previous editions of the confe-

rence by creating a space for the LCA community to share and discuss about their advancements, foster networking between research groups and industries on a global scale and provide a space for LCA practitioners and developers to exchange ideas on methodological developments. Moreover, in this case we want to introduce policy-makers and industries in the Latin America – Caribbean region to the world of LCA, allowing them to meet the LCA community.

The consolidation of LCA methodologies in the agri-food sector coincides with food security arising as one of the major global challenges for the 21st century. Objectives such as zero hunger and the reduction of poverty and extreme poverty will only be attained if humanity is capable of improving the sustainability of diets, combining environmental issues with social and health needs. For this to be possible, dietary patterns should continue their transition to low carbon choices in the developed world, but changes are also needed in developing and emerging nations. This implies that improvements in terms of environmental impact mitigation must be attained in a number of sectors, including livestock, fisheries, aquaculture and agriculture, but also in the increasingly complex processing and freighting supply chains that have developed through globalization.

We expect that these and other topics will be presented and discussed in Lima for three full days. The workshops planned for Day Zero (11 October) should also be a nice complement to the activities in the main programme. We have also prepared a Special Issue in the International Journal of Life Cycle Assessment. Approximately 20 oral presentations linked to the main topic of the conference have been invited to submit a manuscript to this call, although submission is also open for other manuscripts.

Finally, on behalf of the Organizing Committee, I would like to thank the authors for their presentations and posters. We are also very grateful to the 24 members of our Scientific Committee for their efforts in reviewing the abstracts and selecting the papers for oral presentations. We warmly thank our sponsors for supporting the conference. Last but not least, I would like to thank all those from the PUCP community, especially the members of the Peruvian LCA & Industrial Ecology Network (PEL-CAN), for their essential contribution to the success of the conference.

We hope that you all have a lovely experience in Lima and Peru during the conference. For those of you who will be traveling around the country in the days before or after the conference, you will visit some of the most beautiful places in Latin America. We hope that the small taste of the Peruvian cuisine that you will get in lunches and the Gala Dinner at the conference will complement this experience.



IAN VÁZQUEZ ROWE
LCA Foods 2022 Chair



Environmental schemes for the dairy sheep sector. Category rules for hard cheese from sheep milk developed within the Product Environmental Footprint EU initiative.

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Keywords: *Product Environmental Footprint; eco-schemes; category rules; dairy sheep sector; hard cheese.*

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Introduction

Within the general debate and effort to improve agrifood systems sustainability, which resulted in the development of multiple frameworks, conceptual approaches and methods to capture the complexity of this challenge, environmental schemes for food products play a relevant role supporting the properly ecolabelling and reward of green products by the market (McLaren et al., 2021). In fact, the misleading communication of environmental performance causes asymmetric distribution of information that affects both producers, generating in addition economic barriers for accessing to competing labels and certification schemes, and consumers, which, often disoriented by the excess of environmental schemes and labels, tend to lose trust in these claims (Delmas and Burbano, 2011). Therefore, in 2013 the European Commission, with the Recommendation 2013/179/EC, launched the Product Environmental Footprint (PEF) scheme, aimed to harmonize the assessment and communication of the environmental impacts of products using a life-cycle approach. Italy is a leading global agri-food products exporter, with Made in Italy, Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) labels recognized worldwide as high-quality standards with elevated reputation profile (Bonaiuto et al., 2021). This paper presents the elaboration process and main results of the product environmental footprint category rules (PEFCR) for the hard sheep milk cheeses, developed within the PEF scheme. In particular, the paper is focused on the preliminary PEF study (screening study) implemented on the Pecorino Romano PDO, which is considered the most representative product of the whole hard sheep milk cheese category. Pecorino Romano is a sheep milk cheese among the most exported in the world (Pirisi and Pes, 2011).

Methodology

The PEFCR for hard sheep's milk cheeses were developed within the LIFE MAGIS - Made Green in Italy Scheme (LIFE18 GIE/IT/000735) project, aimed at launching and disseminating the PEF method and the recently introduced PEF-based “Made Green in Italy” scheme. The PEFCR were intended as an integration to the already existing “PEFCR for Dairy Products” v1.0 (EDA, 2018). In particular, the integration consisted in the inclusion of the product sub-category “hard cheese from sheep milk”, and the related representative product. The structure and content of these PEFCR have been developed in line with the “PEFCR for Dairy Products” but it differs in those parts characterizing sheep milk production and processing and which are not covered by the existing PEFCR that only includes raw milk (and its derived dairy products) produced by cattle. In general,

sheep milk farming is characterized by more extensive and pasture-based farming techniques, with lower animal productivity levels, compared to the dairy cow sector. Therefore, a specific LCA model is required. The representative product was defined as "Pecorino Romano PDO" (the second exported Italian cheeses in the world and the best-known Italian dairy product obtained from sheep milk) which is cooked, made with fresh or thermised whole sheep's milk, derived exclusively from farms located in the regions of Lazio, Sardinia and the province of Grosseto in Tuscany. A preliminary PEF study was carried out on the representative product with the aim of identifying the most relevant life cycle stages, processes, elementary flows, impact categories and data quality needs to derive the preliminary indication about the definition of the benchmark for the sub-categories in scope, and any other major requirement to be part of the final PEFCR. This screening study involved 18 sheep farms (data refer to 2016/2017) representing the main Italian sheep farming systems and 4 dairy sheep plants producing 23% of the total "Pecorino Romano PDO" production (data refer to 2019/2020). LCA calculations were made using EF version 2 (Fazio et al., 2018) impact assessment method. The following main limitations that are particularly relevant to the sheep dairy sector were considered: i) The benchmark is related to a representative product produced in Italy. Therefore, it can be used to compare PEF study results of products in the PEFCR scope. In particular, the profile of sheep milk production is representative of the Italian conditions in terms climate, soil, and technology, and differences could be expected from sheep farming systems of other geographic areas; ii) This benchmark is intended to be used by other companies belonging to the Pecorino Romano Consortia as reference to the PEF profile of their products; iii) Sheep milk production datasets were specifically developed based on background data from Ecoinvent Centre v3.6 (Moreno Ruiz et al., 2019) and Agri-footprint 4.0 (2017).

Results and discussion

The functional unit and its reference flow (Figure 1) was defined as 10 g dry matter equivalent of cheese, fit for human consumption and considered from milking to consumption up to the expiration date. The system boundaries include 7 life cycle stages: a) "Raw milk", b) "Dairy processing", c) "Packaging", d) "Distribution", e) "Use" and f) "End-of-life", and the main cut-off rules concern i) cleaning agents and refrigerants at farm, ii) transportation of input products to the dairy unit accounting for less than 1% in mass and solid waste at dairy plant stage, and iii) capital goods.

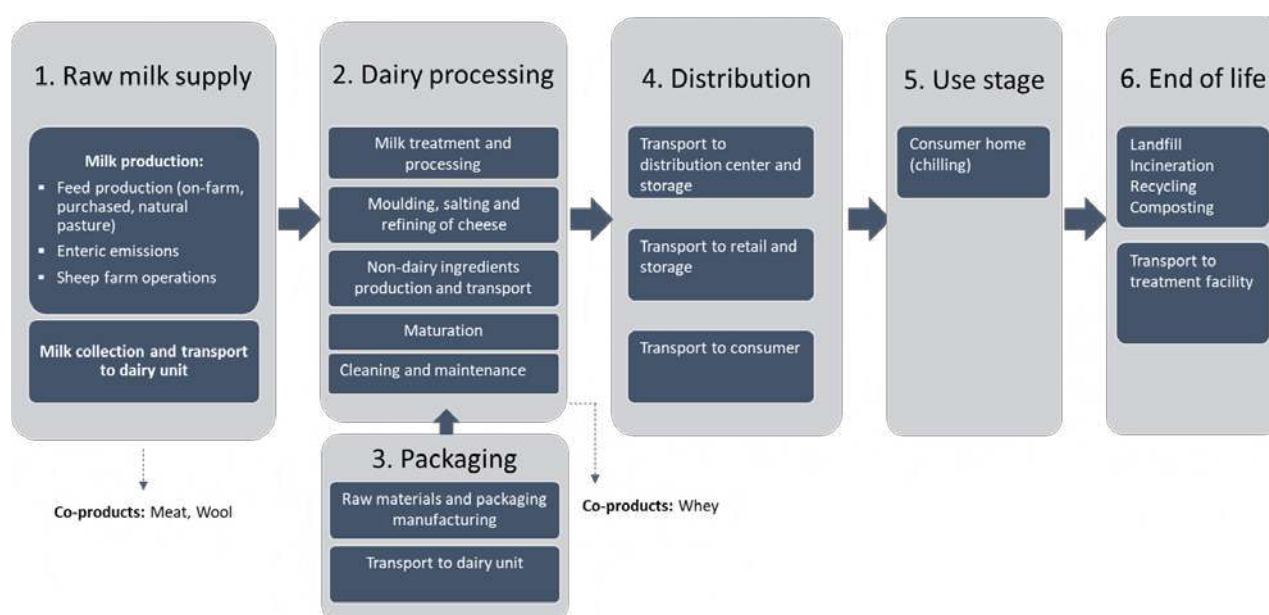


Figure 1. System boundaries diagram for hard cheese from sheep milk.

The most relevant impact categories, identified considering those that cumulatively contributed to at least 80% of the total environmental impact (excluding toxicity-related impact categories), were 1) Climate change (CC) (25.2%), 2) Water scarcity (WS) (23.3%), 3) Land use (LU) (22.3%) and 4) Resource use mineral and metals (RU m&m) (10.2%). For all the most relevant impact categories, raw milk supply was the most relevant life cycle stage (contribution above 94%), followed by dairy processing as additional relevant life cycle stage (Table 1).

<i>Impact category</i>	<i>Raw milk</i>	<i>Dairy processing</i>	<i>Packaging</i>	<i>Distribution</i>	<i>Use</i>	<i>End-of-Life</i>
Climate change	95.51%	2.93%	1.17%	0.01%	0.01%	0.37%
Land use	99.45%	0.09%	0.16%	0.29%	0.00%	0.01%
Water scarcity	99.21%	0.37%	0.21%	0.13%	0.00%	0.08%
Resource use, mineral and metals	94.95%	2.22%	1.62%	1.06%	0.01%	0.14%

Table 1. The most relevant life cycle stages of hard sheep's milk cheese, calculated as the life cycle stages that together contribute to at least 80% of any of the most relevant impact categories previously identified. Functional unit: 10 g dry matter; impact assessment method: EF v.2 (Fazio et al., 2018).

Impact categories as Eutrophication and Acidification, considered among the most relevant in PEFRCR dairy, do not appear very significant in Pecorino Romano PDO manufacturing. That is probably due to less critical issues related to manure storage and disposal and feed production and supply in sheep farming systems compared to dairy cattle ones.

Benchmarks were provided as characterised results (Table 2), normalised results and weighted results (Figure 2).

<i>Impact category</i>	<i>Unit</i>	<i>Life cycle excl. use stage</i>	<i>Use stage</i>	<i>Total</i>
Climate change	kg CO ₂ eq	1.64E-01	2.03E-05	1.64E-01
Land use	Pt	6.75E+01	2.99E-04	6.75E+01
Water scarcity	m ³ depriv.	5.52E-01	1.61E-05	5.52E-01
Resource use, mineral and metals	kg Sb eq	1.36E-06	9.12E-11	1.36E-06

Table 2. Characterised benchmark values (most relevant impact categories) for hard sheep's milk cheese. Functional unit: 10 g dry matter; impact assessment method: EF v.2 (Fazio et al., 2018).

Normalized and weighted impact values for CC, LU, WS and RU m&m in Pecorino Romano PDO were higher than the corresponding values reported in PEFRCR dairy for cheeses (EDA, 2018). This result has been widely expected and can be easily explained considering the above mentioned technological and management differences between dairy cattle and sheep milk production systems.

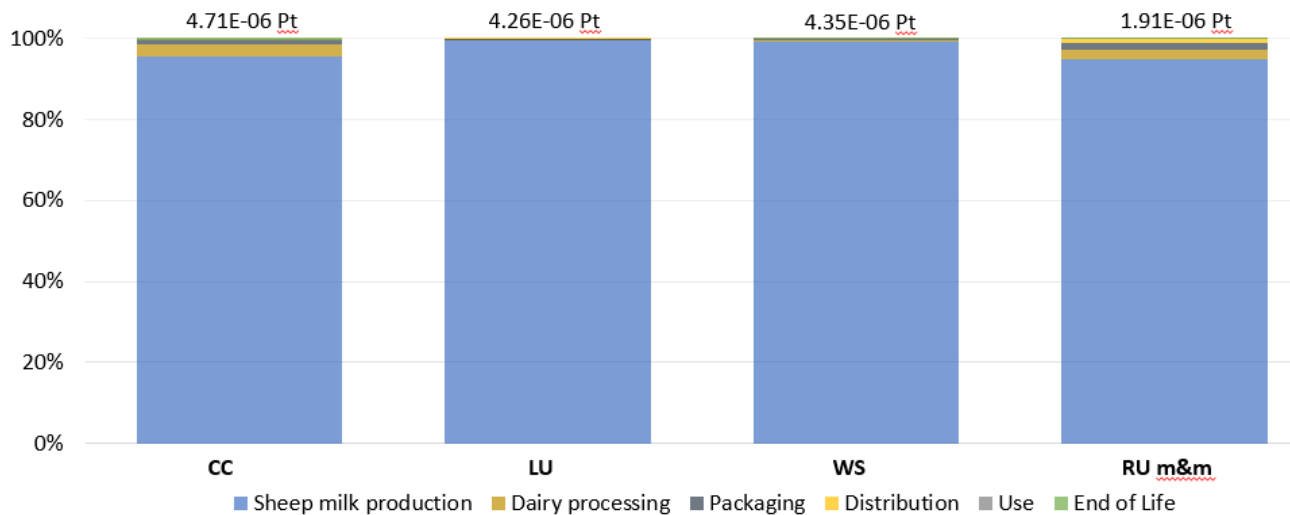


Figure 2: Normalized and weighted values (Pt, points) and life cycle phases contribution of Climate Change (CC), Land Use (LU), Water Scarcity (WS) and Resource Use mineral and metal depletion (RU m&m) for 10 g dry matter equivalent of Pecorino Romano PDO cheese, calculated using the EF method 2.0 (adapted) (Fazio et al., 2018).

Conclusions

PEFCR for hard sheep’s milk cheeses were developed as an integration of the already existing “PEFCR for Dairy Products”. In particular, specific rules for sheep milk production modelling were included (production systems of sheep and cattle differ largely for both productivity levels and animal nutrition management). Screening study indicated Climate change, Land use, Water scarcity, Resource use minerals and metals as the most relevant impact categories of the environmental footprint of Pecorino Romano PDO supply chain, with a very large contribution (around 94%) derived from milk production phase. The main differences among cattle and sheep systems’ PEFCR consist in the most relevant impact categories list and in the benchmark values.

Acknowledgments

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