

Title: Is the ‘Protected Designation of Origin’ an indicator for sustainable landscape management? Insights from pasture-based animal husbandry in five EU countries.

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Authors: Lukas Flinzberger^{1*} ([0000-0003-4850-4593](https://orcid.org/0000-0003-4850-4593)), Tobias Plieninger^{1,2} ([0000-0003-1478-2587](https://orcid.org/0000-0003-1478-2587)), Miguel Nuno Bugalho³ ([0000-0002-7081-657X](https://orcid.org/0000-0002-7081-657X)), Yves Zinngrebe⁴ ([0000-0003-1731-2222](https://orcid.org/0000-0003-1731-2222))

¹ Department of Agricultural Economics and Rural Development, University of Göttingen

² Faculty of Organic Agricultural Sciences, University of Kassel

³ Centre for Applied Ecology “Prof. Baeta Neves” (CEABN-InBIO) School of Agriculture, University of Lisbon

⁴ Helmholtz Centre for Environmental Research – UFZ, Leipzig

*corresponding author: lukas.flinzberger@uni-goettingen.de

Abstract

Previous research has shown that products labeled as ‘Protected Designation of Origin’ (PDO) correlate positively with indicators for landscape sustainability. However, specific factors that turn PDO products into sustainable landscape management tools remain vague. We analyze interviews from six European production systems to explore the links between PDO-labeled products and sustainable landscape management. All case studies were linked to extensive and pasture-based animal husbandry. We found that PDO products can contribute to sustainable landscape management if income is supplemented by well-adapted incentives for agri-environmental measures. Successful products are further associated with local networks that use synergies between different stakeholder interests. By introducing eligibility criteria that focus on the various social-ecological goals, PDO labeling could become a sustainability standard. Due to their social-ecological influence at the landscape level, PDO products can be a powerful addition to the EU’s Green Deal and rural development strategy.

Keywords: food labeling, high nature value farmland, phenomenon-centered text analysis, agricultural policy, Farm to Fork strategy

1. Introduction

Sustainable landscape management as a paradigm for European agricultural landscapes

Current agricultural intensification in Europe tends to result in monotonous landscapes with reduced cultural values (Tieskens et al., 2017; van Vliet et al., 2015) and lower biodiversity (Bouwma et al., 2019; Mupepele et al., 2021). The European Union's agriculture is aligned with the Common Agricultural Policy (CAP) of the European Union. Despite various reforms for "greening" the CAP, this extensive set of schemes and rules remains mostly oriented toward an efficient and market-oriented production of food, feed, and biofuels (Pe'er et al., 2019) without fulfilling its environmental goals (Pe'er et al., 2020). The European Commission launched the 'European Green Deal' (European Commission, 2019), which includes the 'Farm to Fork' strategy, aiming to unify the goals of economically viable and ecologically sound agriculture while ensuring a positive development of rural regions (Schebesta & Candel, 2020). Those goals can be pursued in an integrated way by following the concept of 'sustainable landscape management' (SLM), also known as 'integrated landscape management'. Following this concept entails the simultaneous management of food and fiber production, as well as the conservation of biodiversity and other ecosystem services, while fostering human well-being (Plieninger et al., 2020). Researchers have described SLM as a useful concept for achieving sustainable development goals, covering a broad range from ecological sound practices to improved rural livelihoods (Angelstam et al., 2019; Bürgi et al., 2017). A remarkably comprehensive set of principles for SLM was proposed by Scherr et al. (2015). According to them, sustainable/integrated landscape management is defined by 1) agreement among stakeholders on multiple landscape objectives, 2) shared management of synergies and trade-offs among different landscape uses, 3) management practices that contribute to multiple landscape objectives, 4) supportive markets, policies, as well as incentives, and 5) collaborative decision-making for and through the stakeholders. In this paper we used these five principles to evaluate the potential of PDO-producing systems to be a key instrument for SLM.

However, sustainability on the landscape level is not well-defined within the CAP and its subordinated sustainability strategies like 'Farm to Fork'. We need, therefore, a better understanding of the practical issues that farmers, landscape managers, and other stakeholders experience when trying to implement or maintain the principles of SLM. In the context of SLM, the agriculturally productive landscape can be seen as a management unit that comprises many aspects of sustainability, and as a spatial level where challenges can be addressed in an integrated way (Tanentzap et al., 2015). Bringing together production and conservation aims (O'Farrell & Anderson, 2010) makes the SLM concept especially useful for a specific type of agricultural product – the landscape product. It appears sensible to focus on landscape products in this study, as their multifunctional characteristics can be seen as best practice cases for SLM. Landscape products are defined by their distinct geographic origin, low-input management in combination with traditional practices, and their perception as high-quality products leading to high revenues (García-Martín et al., 2022). This study thus addresses the lack of knowledge that presently exists on the potential benefits of geographically distinct products to landscape sustainability.

Geographical Indications as instruments for sustainable landscape management

Implementing SLM requires different instruments, policies, and multi-stakeholder governance. A recent instrument that aims to transform European agriculture, considered in the 'Farm to Fork' strategy, is Geographical Indication (GI) labeling (European Commission, 2020). Geographical Indications like the 'Protected Designation of Origin' (PDO) can be seen as prime examples of landscape products. The GI label aims to combine traditional production techniques, unique landscape resources, and high-quality products (Filippo Arfini, 2019). Overall, products labeled as GI have been shown to positively correlate with several social-ecological indicators (Milano & Cazella, 2021). Among the GI labels, the PDO label is the strongest certification that protects agricultural products according to their geographic origin, including their names as intellectual properties. Previous studies have related PDO products to successful agro-ecological practices (Belletti et al., 2015; Owen et al., 2020), or tested specific indicators for their correlation with the numbers of PDO products in a given region (Flinzberger, Zinngrebe et al., 2022). Among those social-ecological indicators was the amount of semi-natural or extensively managed agricultural lands (e.g., agroforestry systems, high nature value farmland), or cultural values based on world heritage sites and tourism indicators (Flinzberger, Zinngrebe et al., 2022). In another study, Flinzberger, Cebrián-Piqueras et al. (2022) revealed connections between PDO products and certain rural landscape typologies in Europe, showing that agricultural landscapes of high environmental value correlate with PDO products across Europe, while the correlation of PDO products and issues of structural change was predominantly found in the Mediterranean region.

For PDO-labeled products (hereafter ‘PDO products’) their whole production process (including growing feed, processing, and packaging), has to take place within the designated geographical region (Belletti & Marescotti, 2011; European Council, 1992). Understanding PDO products as products directly linked to a certain landscape (Brock, 2023; García-Martín et al., 2021), implies recognizing that their production interacts with the social-ecological trends of that geographical area (Allen & Prosperi, 2016; Vakoufaris et al., 2014). That includes considering environmental and biodiversity aspects, traditions, food culture, local identity, rural development, and tourism (Ceï et al., 2021; Lamine et al., 2019). This means that the influence of PDO products reaches beyond productivity and economic aspects, into the arena of landscape governance. The market success of products with an especially regional reputation is influenced by the social-ecological values transmitted through the product and by the marketing (F. Arfini et al., 2011; Barjolle & Sylvander, 1999). Those values are particularly deeply embedded into the product by its place and culture of origin (Filippo Arfini et al., 2019; Raimondi et al., 2018). The statistical and generalizing nature of previous approaches and reviews, however, did not allow the conclusion of direct causal relationships. In this context, PDO products’ potential to promote rural development, counteract rural exodus, and contribute to local livelihoods, as proposed by Dal Ferro and Borin (2017), is worth investigating through a case-based qualitative approach.

Identifying options for developing PDO products through landscape governance

Considering the plurality of stakeholder interests linked to sustainable landscapes, there is a need to analyze synergies and potential trade-offs in specific case-study analyses. In this study, we wanted to uncover how various stakeholders of landscape management (i.e., producers, conservationists, administration, and regional marketing) attribute certain principles of sustainable landscape management to the current production practices of PDO-labeled products. Additionally, we tried to distill the articulated needs of stakeholders for maintaining or implementing those principles within their PDO production systems. By including different types of stakeholders in PDO value chains, we cover multiple perceptions of sustainable landscape management. We selected case studies related to the production of animal-based products, namely cheese and meat, as these are the most relevant product categories of the EU’s geographical indications scheme in terms of registered products and achieved revenues. The selected PDO products are all linked to landscapes whose management includes extensive grazing systems or the use of animals for pasture management. To gain insights into stakeholders’ perceptions of the links between sustainable landscape management and PDO production, we designed our interviews to answer the following research questions:

1. Which characteristics of PDO-producing systems contribute to sustainable landscape management?
2. Which framework conditions enable stakeholders of PDO-producing systems to harness this potential?

Whereas the results section is structured according to the identified phenomena, the research questions are addressed in the discussion, where we reflect on the current state of PDO production and the potential role of PDO products in future support schemes for sustainable landscape management.

2. Methods

The study is based on 46 qualitative interviews with stakeholders collected in six different EU regions in Germany, Portugal, Spain, and Greece. The interviews were carried out between December 2021 and May 2022. To account for the dependencies between different sustainability aspects, we picked a method that focuses on structural overlaps in the interview material. The ‘Phenomenon-Centered Text Analysis’ (PTA) developed by Krikser and Jahnke (2021), which was also used previously in other fields of science (Wagemann et al., 2022), allowed for a focused interpretation of the overlapping content from single categories (codes).

Selecting cases and interview partners

We selected a subset of similar PDO cases that were comparable in terms of landscape management while representing variations of food cultures across different EU regions. We excluded ‘Protected Geographic Indication’ (PGI) products because this label only requires one production step to be carried out within the respective region and thus can be less influential on landscape management. The selected study sites shared two main features: a) PDO-producing systems with animal husbandry in extensive grazing systems, and b) farmlands that can be considered as high nature value farmlands because these correlated particularly well with the production of PDO-labeled foods (Flinzberger, Zinngrebe et al., 2022). Further, we focused on animal-based products (meat and cheese) because some of the most iconic landscapes in Europe are managed with the help of grazing and herding. The cases were situated in the heathlands and bog landscapes of northern Germany, in alpine pasture landscapes of southern Germany, in the Mediterranean oak woodlands of Spain and Portugal, in the semi-

mountainous areas of central Greece, and on the Greek island of Limnos (illustrated in Fig. 1). The production systems include cow, sheep, and goat cheeses, as well as beef, ham, lamb, and goat meat (Table 1). For each of the six production systems with a distinctive landscape, we interviewed a minimum of five PDO actors to represent a diversity among relevant stakeholder groups: PDO-registering organizations, local producers, processing or marketing companies, tourism agencies, and landscape management or conservation experts.

Table 1 Study regions, their geography, and the included PDO products in these regions.

Country & region	Geography and landscape characteristics	Product names	Product type	
GER Allgäu region	- pre-alpine pastures in Bavaria and Baden-Württemberg - temperate conditions with high summer precipitation - pastures used for grazing / meadows for feed production - maintenance of open meadows for milk production	Allgäuer Emmentaler / Allgäuer Bergkäse	cow cheese (hard)	
	- flat heath and peatland pastures under Atlantic climate - shrub vegetation on partly drained peatlands	Lüneburger Heidschnucke	sheep meat	
	- level of vegetation maintained by grazing sheep - little economic income from meat products	Diepholzer Moorschnucke	sheep meat	
GR Ellassona municipality	- mountainous plains in hot conditions - close to Olympus national parc - sheep and goat grazing mountainous shrubs - altitudes from 250 – 2,500 m.a.s.l.	Arnaki Ellassonas	sheep meat	
	Lemnos Island	- small island in north of the Aegen sea (Greece) - rocky and hilly shrublands in hot-dry conditions - sheep and goat utilizing herbs otherwise considered useless shrubs	Katsikaki Ellassonas	goat meat
		Kalathaki Limnou	sheep cheese (soft)	
PT Alentejo	- hilly cork oak woodlands in central Portugal - climatic region of Mediterranean-Atlantic influence with extremely hot and dry summers - iconic cork oak forests mixed with shrub vegetation - most remote and least inhabited region of Portugal	Carne Alentejana	beef	
		Presunto do Alentejo	ham	
		Queijo de Évora	sheep cheese (hard)	
ES Extremadura (Badajoz and Cáceres provinces)	- hilly to semi-mountainous area in western Spain - partly arid conditions under Mediterranean climate - iconic cork oak forest mixed with shrub vegetation - bird protection areas	Torta del Casar	sheep cheese (soft)	
		Queso Ibores	goat cheese (hard)	
		Dehesa de Extremadura	ham	



Fig. 1 Typical views on extensively managed landscapes from our six case study regions. a) Cattle in Ribatejo region, Portugal (photo by Conceição Caldeira); b) Terraced fields mixed with oak trees in Extremadura, Spain; c) Sheep in the heath meadows around Lüneburg, Germany (photo by Willow on Wikimedia Commons [CC-BY 2.5]); d) Semi-mountainous pastures in the Lemnos region close to Mt. Olympus national park, Greece (photo by Vasileios Deligiannis); e) Meagre pastures with goats on Lemnos island, Greece (photo by Danae Sfakianou); f) Cattle in touristically used alpine pastures in Allgäu region, Germany (photo by Marlene Haiberger on Unsplash).

Interviews, transcriptions, and coding

The interviews were conducted as semi-structured interviews, using guiding questions to stimulate the narrative process. The interview guideline is available within the supplementary material (Annex 1). Two open-ended questions at the beginning asked what the interviewees associated with the landscapes. The second interview section focused on relations between the PDO product and landscape management practices, as well as cultural and economic trends within the region. In the final interview section, respondents could talk about political, cultural, and economic framework conditions that support or hinder PDO systems' success and their ideas on how to make PDO products a more successful instrument for sustainable landscape management. Because of the semi-structured style of the interviews, the context of answers was comparable enough to use a statement-oriented transcription, noting key statements and relevant information during the interviews, and refining it based on the audio recordings afterward (Clausen, 2012). The refined transcriptions were translated into English before being processed with MAXQDA software (VERBI – Software, 2010).

While coding the raw interview material, we assigned separate codes to all emerging aspects of sustainable landscape management under the PDO regime. Landscape management practices as well as management outcomes were both considered, accompanied by remarks on the landscape-product relationships, and statements about current and potential PDO policies. In the first step of structural reduction, codes referring to landscape management were grouped into nine coding categories (Table 2). This simplification was done because the phenomenon-centered text analysis (PTA) method required more generalized coding categories. Those nine codes (listed under 'Social-ecological aspects' in Table 2) were used for the PTA as described below. Text segments coded with 'Associations' and 'PDO-plus' were analyzed separately, without being part of the PTA, yielding background information on the cases.

Table 2 Codes used for structuring the interview material with a detailed description of each code.

Code	Code description
Social-ecological aspects	
1) Animal welfare	Remarks on animal welfare practices related to traditional methods and consumer demands
2) Culture	Local identity, traditions, and regionality regarding production, diets, customs, etc.
3) Diversification	Economic diversification on farm level and regional level, including tourism and gastronomic tourism
4) Environment	Environmental issues, ecological sustainability, biodiversity, climate change aspects, and resourcefulness.
5) Governance	Policies related to labeling or agriculture in general, incl. subsidies/incentives, and administration of label
6) Income	Individual and regional income; economic viability of the business models, including remarks on value chains
7) Landscape	Landscape maintenance and practices that link animals with the landscape and its aesthetics
8) Legacy	Generational renewal and quality of rural life connected to maintaining the legacy of the product
9) Quality	Remarks covering taste, healthiness, nutrients, purity, etc. of the product
Associations	Professional relations and personal associations with products, regarding the social-ecological context
PDO-plus	Sentiment towards theoretical PDO+ label, combining regionality and sustainability through specific criteria

Phenomenon-centered text analysis

Combining aspects of quantitative and qualitative text analysis, the phenomenon-centered text analysis (PTA) helped us to uncover six social-ecological phenomena within the interview material by pointing out connections between single coding categories. Based on the transcribed and translated interview material we assigned codes to each text segment like for any common qualitative text analysis. We continued with a content analysis for each code separately (Annex 2), which later helped with the qualitative descriptions of how the codes are linked within the phenomena. Using the MAXQDA code-matrix browser, we calculated the number of text segments per code and per interview within each stakeholder group (Annex 3.1 and 3.2). We found that the different codes appeared relatively even throughout all actors and regions. The only major differences occurred for the 'Animal welfare' code which was often used in the interviews from Allgäu and barely used in the interviews from Extremadura, and the 'Quality' coding, which was used relatively often in the context of Extremadura, but barely in the interviews from Lower-Saxony.

The PTA method follows the assumption that codes that frequently appear in proximity also share a common underlying concept or cause and form a contextual phenomenon. We defined proximity as interview segments overlapping or lying directly next to each other. Subsequently, we counted the overlaps, using the MAXQDA code-relations browser with the 'near' function enabled and the maximum distance set to zero (VERBI, 2020). According to Krikser and Jahnke (2021), we considered all relations between codes as relevant which counted more than half of the maximum overlaps. In our case, the maximum number of overlaps was 38 and thus all relations with 19 or more overlaps were considered. In total we identified six relationships between codes, the so-

called ‘phenomena’. The codes ‘Animal welfare’ and ‘Quality’ were not related to any phenomenon. The final step of the PTA was an in-depth qualitative analysis of every text segment related to a phenomenon to describe how the overlapping aspects interact on a landscape scale. The description of these so-called phenomena is also called ‘micro-theories’ (Krikser & Jahnke, 2021). The codes for ‘Landscape’ and ‘Income’ were most prevalent within the different phenomena and thus, they are discussed as cross-sectoral aspects.

3. Results

The following section shows how different aspects of sustainable landscape management are related to each other within the PDO-producing systems. The six phenomena (identified through the PTA method) each represent one set of overlapping sustainability aspects (Table 3). Each phenomenon is summarized and illustrated with direct quotes from the interviews. Based on those findings, commonalities and variations across different product types and case study regions regarding PDO implementation are highlighted. A full list of quotes (including additional quotes and extended statements) is available in the supplementary material, as are the summaries of the phenomenon-unrelated codes ‘Animal welfare’ and ‘Quality’ (Annex 4). The quotes are numbered sequentially in their order of appearance, including the quotes from the annex.

Table 3 Result from the ‘Code-Relations-Browser’ from MAXQDA showing the number of overlapping and nearby coded text segments among the nine codes used for the PTA. All codes that have equal to or more than half of the maximum overlaps (38) are emphasized by bold-italic numbers. In the lower half, the six identified phenomena are listed with the number of overlaps given in brackets.

	1)	2)	3)	4)	5)	6)	7)	8)	9)
1) Animal welfare		3	1	6	1	5	3	0	5
2) Culture			10	16	12	20	18	8	17
3) Diversification				18	7	14	23	4	5
4) Environment					19	16	38	26	10
5) Governance						28	15	23	12
6) Income							19	18	11
7) Landscape								18	14
8) Legacy									5
9) Quality									

maximum overlaps = 38
relevant overlaps $\geq 38/2 \geq 19$

Phenomenon 1 – Landscape-Environment (38)
Phenomenon 2 – Landscape-Income (19)
Phenomenon 3 – Landscape-Diversification (23)
Phenomenon 4 – Environment-Governance-Legacy (26; 23; 19)
Phenomenon 5 – Income-Governance (28)
Phenomenon 6 – Income-Culture (20)

Social-ecological phenomena of PDO production

P1 – Landscape-Environment: PDO production landscapes support biodiversity and ecosystem services

In all regions, the presence of livestock and traditional farming practices were perceived as a crucial element for maintaining landscape aesthetics with fewer trees (e.g., Dehesa or Montado) or no trees at all (e.g., heath- or peatlands). Producers or breeders insisted on the grazing animals as the keepers of the landscape aesthetics and stressed the animals’ suitability for grazing on less-productive or difficult-to-farm land. This comes along with high biodiversity values, such as habitats for threatened bird species, that were maintained through grazing or herding and complemented by diverse structures like trees, shrubs, or ponds:

Q1: “The land [...] is only suitable for grazing [...] and the ‘Heidschnucke’ [local sheep breed] is especially suitable for transferring nutrients from the heathland to the pastures. It is a totally extensive form of grazing, where no fertilization is used. [...] many flowers and plants, birds, and reptiles live here – that means high biodiversity.” (R9: producer from Lower Saxony)

There was a major difference between milk and meat production in Extremadura. While grazing sheep and goats, which are kept mainly for milk production, contribute to maintaining the open landscapes, pigs raised for ham production almost entirely forage on acorns. In this case, the maintenance of the open landscape with holm oak

forests must be supported by manual labor. That also means that large parts of the iconic mosaic-like agroforestry systems in the Spanish Dehesa and the Portuguese Montado need human maintenance:

Q2: "The Dehesa is not a natural landscape; it is human-made. Instead of having a closed canopy, the open landscape supports a strong ecological diversity" (R22: conservation expert from Extremadura)

This mix of grazing animals and human maintenance also helps to mitigate large wildfires, which is perceived as a key benefit of those open landscapes that would be lost in case of abandonment.

At the same time, PDO-producing landscapes were described as threatened by more profitable and water-intensive crops such as vegetables or pineapples. Statements about the competition for land and water also highlighted the environmental harm that these intensive systems can inflict.

Q3: "The cork oak forest [montado] does not need to be watered, the montado lives well with the climatic conditions that exist and feeds that ecosystem without any disruption. These new agricultural practices that threaten the montado are highly predatory of the water resource." (R45: tourism representative from Alentejo).

Similarly, the Greek producers from Elassona stressed the importance of keeping the landscape and its bio-physical resources intact to maintain the current system and keep the PDO certification.

P2 – Landscape-Income: Market incentives and support measures can strengthen sustainable landscape management in PDO production systems

Landscape management practices across the case study regions, such as breeding and raising grazing livestock, have a common goal: to generate income. This happens through selling products, receiving financial support, or payment for ecosystem services (i.e., rewarding land managers for the conservation of biodiversity). We found regional differences regarding the main motives for landscape management depending on the dominant type of income. In regions with economically successful PDO products, such as Allgäu or Extremadura, landscape management was more production-oriented while still relying on traditional farming systems. In cases where more of the income came from financial support measures or nature conservation funds, such as in the peat and heath landscapes of northern Germany ('Lüneburger Heide' and 'Diepholzer Moor'), landscape management decisions were guided by nature protection goals. Economically barely viable value chains led to a high degree of dependency on financial support or contractual nature conservation:

Q8: "One would have to communicate that sheep have a high value for landscape maintenance, [...] It needs higher prices but you do something good for climate and biodiversity. [...] but in the background the land care association sponsors it." (R10: conservation expert from Lower Saxony)

While most respondents highlighted the importance of financial support for the maintenance of PDO-producing landscapes, the suggestions were quite different. Wherever the products were sold along relatively stable value chains (e.g., Extremadura, or Allgäu), the respondents demanded support through product marketing or agriculture policies.

Q9: "What we do should work in the long term, and for this, there must be a certain economic viability. This includes subsidies and support measures of the agricultural policy, but also income from the products is central. Production is only sustainable over time if there is profitability through production" (R1: conservationist from Allgaeu)

In regions where the PDO products were less profitable (e.g., 'Diepholz Moorschnucke' or 'Kalathaki Limnou'), respondents asked for more direct forms of income support to improve local livelihoods and sustainable landscape management practices:

Q10: "Support for the regional economy is needed very much. The island has a very large percentage of people engaged in animal husbandry and agriculture in general, so products like the Kalathaki help the economy a lot." (R36: producer on Lemnos)

P3 – Landscape-Diversification: Traditional landscapes are central to tourism activities

The landscape-diversification phenomenon represents the specific relationship between landscape and tourism because tourism was the single most important aspect of economic diversification and thus regional income in all our study regions. This includes the coexistence of different services that landscapes offer. Respondents mentioned for example landscape as aesthetic spaces, wildlife experience, tranquility, and possibilities for recreation as important factors for tourism:

Q12: “The extensive areas further away from the farms represent the Allgäu in terms of tourism and aesthetics. There are those beautiful alpine areas below the tree line with open meadows that blossom so beautifully.” (R1: conservation expert from Allgäu).

Many primary producers were too occupied with agricultural work to add diversification to their portfolio. Logically, regions with an integrated landscape-tourism strategy and active governance bodies did much better in this relationship. Especially the Allgäu and Extremadura regions developed regional brands entailing environmental tourism, and gastronomic specialties:

Q13: “In Extremadura, there are many shops geared towards tourism. We sell our cheese there. [...] Tourists come from Madrid at Easter and buy local products in the shops that they can't buy in a large supermarket. Here they come to eat more traditional and organic products.” (R19: producer from Extremadura)

In the north German study area, the extensively managed landscape attracts recreational tourism as well, but the productive aspect of the PDO was rather small. In this context, we found the statement that ‘sustainability’ should not be used for tourism marketing. The Spanish ‘regulatory councils’, which were considered very supportive regarding advertising the PDO products as landscape products, mainly focus on products as regional and gastronomic specialties and not so much on the sustainability aspect too. Although the income from tourism seemed almost unrelated to the PDO production itself, it heavily depends on landscapes, culture, and gastronomy in all investigated regions:

Q14: “As a hotel professional with restaurants [...], our relation with kalathaki [local cheese] has absolute relevance because we believe that [...] the local product should be supported. Regionality in general, as a basis for promotion and the touristic development on the island, has an absolute relation to the primary sector.” (R34: Tourism stakeholder from Lemnos)

P4 – Environment-Governance-Legacy: Framework conditions for continued PDO existence

According to our respondents, governance plays an important role in both protecting environmental values, and the future of the products, hence the legacy of traditional production and landscapes. Overall, it was stated that more support from the CAP would be necessary to keep up traditional production and that the CAP payments should be more targeted towards provisioning and cultural services. Especially in the case of PDO products with a lower production volume, supportive instruments and a better integration of environmental and agricultural regulations were demanded to keep the systems alive:

Q18: “Depending on the leasing contract, different agri-environmental measures are counted as double subsidies. Those who don't know correctly make contracts that are unfavorable for shepherds.” (R10: conservation expert from Lower Saxony)

Regarding the governance aspect of their products’ legacy, many respondents reported about problematic regulations for livestock production and demanded financial incentives for adopting innovations. In parallel, provisioning ecosystem services (provision of hay, grass, acorns, etc.) was called crucial for the continued existence and ensuring certain quality traits of the products:

Q19: “Having animals grazing directly in natural pastures and sown pastures in well-managed cork oak forest improves the milk quality for cheese production.” (R42: producer from Alentejo)

Respondents also referred to cultural ecosystem services, in the form of recreational areas, touristic attractiveness, and aesthetic values. They stressed that cultural services have their foundations in the historically grown landscape management practices, such as herding, grazing, or mountain agriculture:

Q20: "People want to buy immersive experiences in nature, that are harmless to nature, they want to fully enjoy it, they want to take with them the products that the cork oak forest (montado) produces." (R45: tourism representative from Alentejo)

P5 – Income-Governance: A high demand for political and financial support

Respondents stated that political and financial support measures are necessary to keep up traditional production. They demanded that politics should do more to generate or stimulate income from PDO products. From the producers' views in particular, the CAP should provide more support for low-intensity and less profitable animal systems. Further, they demanded reduced administrative efforts and streamlined conservation regulations with agricultural support policies, as illustrated by a response from Germany:

Q24: "Lower Saxony guideline demands annual grazing, which then qualifies for grazing premium. Nature conservation administration demands however three times grazing per year. [...] there are contradictions between nature conservation administration and commercial management." (R13: producer from Lower Saxony)

Many respondents demanded more targeted payments for the ecosystem services they produce or deliver to the public. Respondents from northern Germany in particular demanded long-term commitments regarding land access rights for maintaining livestock systems without economic risks. Further, respondents expressed the need for administrations to bear additional management expenses, for example, costs stemming from new food safety regulations, or costs for offsetting damages done by wolves:

Q25: "Five years is a short period [for contractual nature conservation] and a loss of the funding afterwards would threaten the existence of shepherds. Longer funding periods would be needed for such livestock projects." (R11: producer from Lower Saxony)

Also, regional administrations could support the producers by bearing the costs of centralized marketing efforts. In general, Mediterranean products appeared to be better represented by centralized PDO administration. Interviewees in Extremadura stressed that the economic success of their products is largely based on network structures that connect different PDO products as well as gastronomy and tourism:

Q26: "The offices promoting the labels and certified products do an incredible job. We are doing just fine in this regard. [...] Political investments into structures and marketing are essential to maintain the production system." (R25: producer from Extremadura)

Other governance measures can have positive effects on rural livelihoods, for example by offering and maintaining affordable infrastructure (e.g., internet, commuting). In the remote areas of Extremadura and Ellassona, this was seen as important as income to counteract rural exodus.

P6 – Income-Culture: Traditions around food culture and management practices make PDO production financially viable

This phenomenon highlights the fact that income for rural communities was connected to the traditional management practices and the resulting products by many respondents. Whether the food culture or the food-related income evolved first, was seen differently among the respondents. They however agreed, that maintaining the traditional low-intensity management practices would be necessary to maintain the uniqueness of the PDO-landscapes, but also that despite traditional aspects, they need to adapt to modern requirements of food production:

Q30: The breeder is a Businessman, [...] so the first thing we need to see is whether traditional techniques can be financially viable. Also, [...] traditional techniques must keep pace with modern food hygiene requirements. (R37: conservationist from Lemnos)

While local identity was an aspect related to PDO production everywhere, gastronomy was more important in the Mediterranean countries. The gastronomy-related aspects help to turn PDO-labeled products into flagships which leads to higher incomes from traditionally produced food. Thus, the stakeholders of the PDO value chain saw themselves as guardians of local heritage:

Q31: "The name of the ham is directed towards marketing – an egoistic motivation – because certification makes the production more visible. [...] It creates a joint image of local identity, traditional landscapes, biodiversity, and local resources." (R14: producer from Ellassona)

In turn, the traditional management practices were culturally more important in Germany, where the income from landscape tourism is just as important, or even more important than the income from agricultural production.

Q32: "Allgäu lives from tourism, cheese dairies live from tourism [...] tourism needs the traditional production process and the cheese dairies need tourism." (R8: producer from Allgäu)

4. Discussion

This study investigated stakeholders' perceptions of the relationship between PDO-labeled products and sustainable landscape management (SLM) using case studies from six pasture systems in the EU. We found that from stakeholders' perspectives, the success and persistence of PDO-labeled products is largely influenced by two factors: landscape maintenance, and income opportunities. Five of the six identified phenomena included either the code 'Landscape' or the code 'Income'. We claim that phenomenon two (landscape-income) touches all of the SLM principles proposed by Scherr et al. (2015), at least indirectly, but looking at the other five phenomena as well provides a more detailed picture. By indicating their numbers, we refer to relevant quotes from the interviews of which some are placed in Annex 4. Drawing on the principles of SLM, we propose three central findings:

1) The commercialization of PDO-labeled products puts stakeholders in a position to maintain landscape management practices that contribute to several landscape objectives at once (**SLM principles one and three**), such as biodiversity conservation (*Q2; Q6*), cultural values (*Q31; Q32*), touristic attractiveness (*Q13 - Q15*), and maintenance of aesthetically beautiful landscapes (*Q4; Q12*). Looking into the phenomena that include landscape management, environmental benefits, and the legacy of PDO production, it becomes clear that the current state of PDO management already fulfills the SLM principles one and three, obviously with minor regional differences.

2) The interviews revealed that central marketing agencies or network hubs enable a more integrated approach to landscape management (**SLM principles two and five**). This was prominently displayed in the cases of Extremadura and Allgaeu, where centralized marketing makes traditional landscape management economically more viable through diversification (*Q14; Q26*). The regional differences regarding successful collaborative management are described in the phenomena that feature culture, diversification, and governance.

3) Stakeholders from all case study areas criticized the poorly adapted policies and support measures (**SLM principle four**) which often are not suitable for multifunctional livestock systems (*Q18; Q22; Q28*), do not reward landscape management that produces multiple benefits (*Q8; Q9; Q29*) or collide with rules of nature conservation (*Q24; Q25*). Because income is related to policies in many ways, stakeholders have strong opinions and demands but only little control over the issues described in the governance-income phenomenon.

Which characteristics of PDO-producing systems contribute to sustainable landscape management?

We found that key stakeholders of PDO production relate environmental (*Q1; Q5*) and cultural values (*Q33*) to sustainable landscape management. Aspects such as biodiversity conservation (*Q2; Q6*) and reduced wildfire risk (Silva et al., 2020), or the maintenance of aesthetic landscape fostering touristic attractiveness (La Millán-Vazquez de Torre et al., 2017) were linked to the traditional (*Q12*) and less-intensive practices (*Q11*) which are promoted and supported by the PDO label. Those benefits were assigned to low-input management practices like herding, grazing, and grassland production, which in turn led to mosaic-like, multifunctional landscapes. Structurally rich landscapes are often perceived as aesthetically valuable (*Q4*), where both domesticated animals and wildlife may contribute to economic diversification (*Q3*), mainly through tourism (Batista et al., 2017; Folgado-Fernández et al., 2019). Working towards multiple objectives at the same time, as observed in the case study areas, aligns with **SLM principle number three**. Although sustainable landscape management is the reason for the inherent sustainability of many agricultural systems from which PDO products emerge, also PDO production can be intensified to a point where overgrazing leads to a loss of traditional landscape elements.

In our case study regions, we found two main ways of generating income from landscape management. There was income generation from the landscape product itself, making the characteristic landscape a production factor and using it as a marketing instrument (*Q13*). Farmers involved in related activities can be seen as part-time landscape conservationists. On the other hand, income can also be sourced from tourism (*Q15; Q16*) or environmental protection funds (*Q9*). For example, the well-maintained heathland areas around Lüneburg (northern Germany) are used as recreational sites and promoted as tourism destinations, while at the same time, herders can receive money for contractual nature conservation (*Q18*). The Portuguese "goats as firefighters" program is another neat example of compensating land managers for their provision of public services like fire prevention. In the landscapes related to our case studies, livestock turned out to be a powerful tool to combine sustainable landscape

management and a continuous and sustainable stream of income. In accordance with **SLM principle number one**, stakeholders must agree on the multiple objectives of landscape management.

We found evidence that local networks for geographically protected products are key for supporting the products and integrating them into regional brand strategies, which is in line with the more theoretical work of Jansujwicz et al. (2021). The uptake of sustainable landscape management approaches works best when various actors collaboratively decide on management practices, value chains, and regulations (Zinngrebe et al. 2020), thus combining **SLM principles number one and three**. As observed particularly in Extremadura and Allgäu, centralized marketing and brand building for the entire region helps to integrate these functions and thus appears to be more promising than promoting single products (Q26). In general, the marketing for PDO products from the Mediterranean region seems to focus a little more on the socio-economic outcomes than the environmental ones, which is also supported by other studies (Cozzi et al., 2019; Ferrer-Pérez & Gil, 2019).

Which framework conditions enable stakeholders of PDO-producing systems to harness this potential?

Understanding PDO products as landscape products and acknowledging their importance within these complex systems makes them a key element for sustainable landscape management (Turner et al., 2020). By the nature of their environmental and socio-economic embeddedness, they can help to close the gap between food as a commodity and landscape management for social-ecological conservation and human well-being (García-Martín et al., 2022). While some PDO products are economically very successful, most PDO-related agricultural systems are characterized by low-input management which mostly is a trade-off for income unless there is a compensation scheme (e.g., agro-environmental subsidies). In the case of subsidies or economic incentives for PDO production, which were demanded by many respondents (Q27 – Q29), governance bodies should ensure that those are not environmentally harmful as underlined by **SLM principle number two**. Because environmental policies require baselines and indicators (Asioli et al., 2020; Borrello et al., 2022) the sustainability of PDO products would benefit from clear environmental standards in this sense.

Another enabling condition we identified was a well-adapted incentive system. Because landscape management is always a question of economics (Plieninger et al., 2015) the producers among our interviewees saw financial support measures as a natural part of their cash flow. They were aware of the additional ecosystem services, which they are maintaining through their landscape management (Q2; Q5), and logically, they want to get compensated for their service to society (Peterson et al., 2014), which is also in line with **SLM principle number four**. Among our respondents, we found the common perception that CAP payments are too focused on intensive monoculture (Q3) systems. They claimed that the CAP payments do not reward the multiple societal values and environmental outputs that stem from PDO-related agricultural systems (Q28). The stakeholders' statements align with research findings indicating that, despite expressing support for sustainability and multifunctionality, a significant portion of the CAP funds are still allocated to payments rooted in the productivist discourse (Erjavec & Erjavec, 2015). Instead, CAP funds should be redirected toward management approaches that deliver multiple benefits at once through conserving multifunctional landscapes, including the biodiversity values and ecosystem services they provide.

Economic diversification in the investigated PDO-producing landscapes almost exclusively focused on tourism, which was managed in a particularly professional manner by networking agencies. For example, achieving touristic attractiveness based on a certain landscape is almost impossible for a single producer (Q16). It needs coordinated efforts by several institutions (Q13; Q26), which was also found in other studies (Parga-Dans et al., 2020; Tieskens et al., 2017) and is reflected in **SLM principle number five**. In the case study regions, we identified local networks and regional marketing agencies as useful actors and entry points for supportive measures. Promoting PDO products as a part of the landscape identity and cultural heritage paves the way for future strategies to support rural development in those landscapes.

5. Conclusion

PDO products are catalysts for a positive social-ecological development of rural areas, but they can rarely initiate or drive a positive trend on their own. Stakeholders of PDO production reported that PDO-labeled products are the main reasons for the continuation of extensive management in traditional landscapes and thereby help to generate various social-ecological benefits. The success and persistence of PDO products, however, are tightly

linked to several framework conditions. Among those necessary conditions are successful regional marketing and brand-building, integration with tourism, maintenance of regional value chains, the attractiveness of rural areas and related professions, as well as targeted support measures for all those elements. However, it needs further investigation of how landscape connectedness and regional characteristics of value chains influence the values attached to the PDO products, also for other categories than milk or meat products.

We conclude that wherever PDO products should continue to exist, the income either must come from a certain food culture (e.g., Torta del Casar) or the attractiveness of sustainably managed landscapes (e.g., Diepholzer Moorschnucke). In the best case, both are combined in a balanced way (e.g., Allgäu cheese, Dehesa de Extremadura, or Lemnos cheese). From the interviews, we learned, that this combination of having a successful food product but also a diversified income through nature tourism, is best reached by local or regional marketing networks. Both, traditional landscape management and regional food culture seem to play a crucial role in the success of PDO marketing. While food culture is easier to communicate to distant places, the value of sustainable landscape management can almost only be perceived within the PDO products' regions. From this finding, we distinguish two major development strategies for different types of PDO products, both of which can support the underlying sustainable landscape management:

- i) PDO products with a unique and well-known food heritage can better transmit social-ecological values through the product itself. Thus, they are better suited for reaching a wider audience and serving geographically distant markets. It must be ensured that marketing success does not undermine environmental integrity.
- ii) PDO products that draw their main value from representing a unique and iconic form of landscape management may be better marketed within the region. They probably can draw more benefits from any kind of nature-based tourism integrated with the gastronomic experience, and from being paid for environmental services or nature protection.

For both options, supportive governance should try to stimulate PDO-producing systems in two ways. On the one hand, through offering incentives or financial support as a reward for providing ecosystem services to the public. On the other hand, governance can support PDO production through beneficial regulations and cultural valorization of the products. To ensure context-sensitive implementation, those measures appear to be better administered on a regional or local level while responding and reporting to national and European targets. Above all, the support measure should be aligned along the key principles of sustainable landscape management with its multiple environmental and cultural objectives. While the cultural aspect is already part of the PDO legislation regarding production and landscape management, the environmental aspect could be added by introducing basic sustainability standards to the label. Those could be voluntary first, and later become mandatory, or be the starting point for a sustainable regionality label. By doing so, the agenda to use the Geographical Indications scheme for a sustainable transformation of Europe's agriculture – following the 'Farm to Fork' strategy – could be brought forward substantially.

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Ethical statement: We enabled the recipients to participate by informed consent in the following way: (i) During the introduction, we described the objectives of the interview and clarified that the survey is part of a research project. (ii) We pointed out that participation in the interview is voluntary and that the analysis will be conducted anonymously. (iii) We left contact information to address any arising questions or concerns of the participants.

Data availability: The interview guideline, the summarized interview results, the coding frequencies needed for the phenomenon-centered text analysis, and direct quotes from the interviews that illustrate the topic will be made available via the publisher's platform once the manuscript is published as a peer-reviewed article.

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