

Landscape products for sustainable agricultural landscapes

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Landscape products link to low-input practices and traditional ecological knowledge, and have multiple functions supporting human well-being and sustainability. Here we explore seven landscape products worldwide to identify these multiple functions in the context of food commodification and landscape sustainability. We show that a landscape products lens can improve food systems by fostering sustainability strategies and standards that are place-sensitive, and as such can mitigate conflicts related to food production, social justice and the environment. Co-management strategies and information policies, such as certification, labelling, product information and raising of awareness could accelerate, incentivize and catalyse actions to support landscape products in the context of sustainability strategies.

Replacement of traditional, locally grown agricultural products with mass-market equivalents affects relationships among people, nature and landscapes. Traditional agricultural systems contribute in multiple ways to human well-being and sustainability¹, and their loss poses complex socio-cultural, economic and environmental challenges². Examples include the loss of local crop varieties, diets and ecological knowledge due to land abandonment, the mechanization of farming

practices and the prioritization of more profitable crops as in the Shexian Dryland Terrace System (China)³; decreases in biodiversity and regulating ecosystem services in agroforestry systems in Portugal and Spain due to intensification of livestock production and land use simplification⁴; and increases in health problems from agrochemicals in the United States⁵. Strategies to address these sustainability challenges include labelling to indicate sustainable practices⁶, payments

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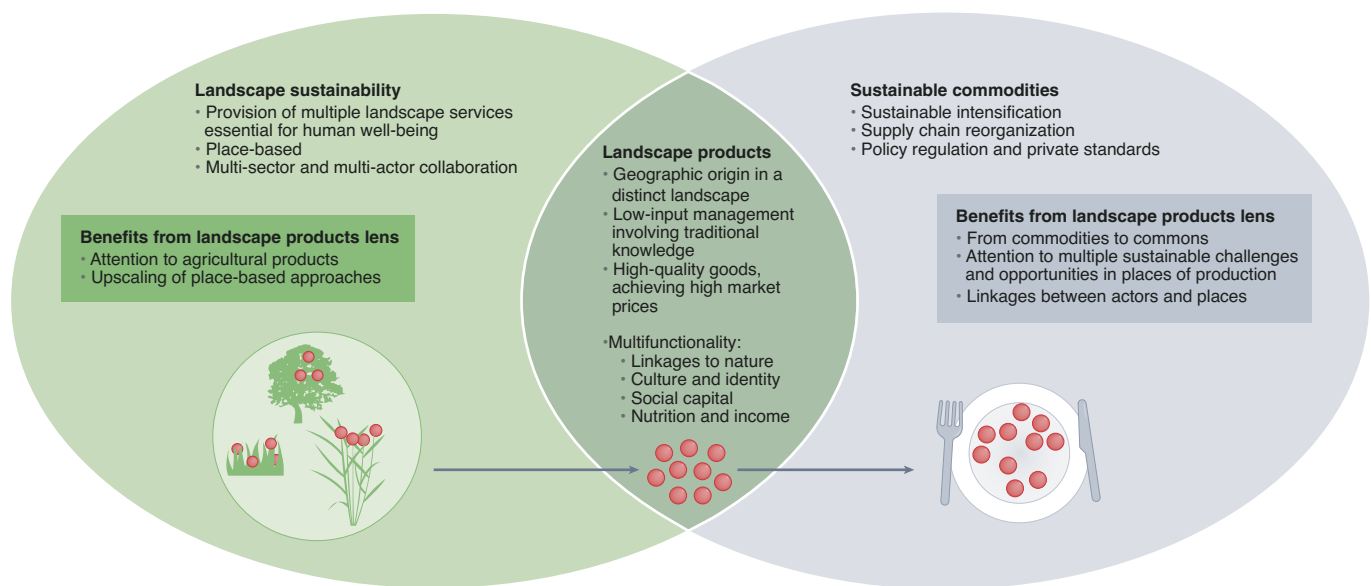


Fig. 1 | Elements of landscape products. The concept of landscape products uniquely links landscape sustainability and sustainable commodities approaches.

for ecosystem services⁷, national food strategies such as the Japanese Sustainable Food Strategy⁸ and community-supported agriculture⁹. System-wide interventions exist where governments, local actors, non-governmental organizations (NGOs) and the business sector strive to foster sustainable global commodities^{10,11}. Yet agriculture and food policy strategies are too often commodity-focused and disregard important non-monetary functions of food systems, lack place-based approaches, neglect full consideration of the broader social-ecological sustainability challenges and do not provide sufficiently for cross-sectoral collaboration, for instance, among food production, local development and nature conservation sectors.

Food and other products closely connected to unique agricultural landscapes have been termed landscape products¹². Here we develop the concept of landscape products as a lens for analysing the relationships between the multifunctionality of food and the sustainability of agricultural landscapes. Maintaining the benefits from the many functions of agricultural landscapes¹³, and managing the forces that underpin or threaten sustainability, requires a shift in current food system trajectories. Expanding the concept of landscape multifunctionality¹⁴ to provide an alternative to the comparatively narrow concepts of sustainable commodification of agricultural production is important for policy and management initiatives. We argue that a landscape products lens provides such an alternative.

Drawing on recent theoretical advances, empirical evidence and our collective research experience, our aim is to explore the multiple functions of landscape products and how they contribute to landscape sustainability. The empirical evidence comes from seven case studies across the world.

Conceptual framework

How food is framed shapes food policy. A recent study¹⁵ highlights two contrasting food policy and science narratives: food as a commodity, focusing on its economic dimensions, and as a common good, with both economic and non-economic values. Non-economic values critically support both ecological sustainability and human well-being^{16–18}. Transcending the ‘food as a commodity’ view is critical to supporting transition towards more fair, healthy and environmentally sustainable food systems and landscapes¹⁹. To address these narratives, we look into the literature on sustainable commodities¹¹ and landscape sustainability²⁰.

The sustainable commodities literature advocates sustainable intensification of production practices, a reorganization of supply chains to reduce costs, and a mix of public policies and private sector regulations²¹. Sustainability standards and certification schemes typically focus on the mitigation of certain environmental impacts^{10,11}. This approach often targets certification of crops, such as cocoa and coffee along global supply chains¹⁰, and tends to overlook multiple sustainability dimensions at the places of production, including local communities and cultural practices. Instead the focus is on product or industry standards¹¹.

In contrast, landscape sustainability considers ‘place-based’ and ‘multifunctional’ interactions between human well-being and landscape-specific services, and promotes the collaboration of landscape-level actors and institutions^{20,22}. However, a focus on landscape sustainability does not capture the importance of individual agricultural products, and the multiple functions, benefits and values associated with them along their supply chains.

The concept of landscape products highlights the interactions between food products and their landscapes of production. As such, landscape products provide a missing link between sustainable commodities and landscape sustainability approaches (Fig. 1), bringing an embedded systems perspective to sustainable commodities and a product focus to landscape sustainability²³. We define landscape products as products that (1) originate in a distinct landscape, (2) link to low-input practices and traditional ecological knowledge, and (3) typically sell at higher prices than mass-market equivalents¹². Farming practices are adapted to local ecological conditions that help preserve biodiversity, water provisioning and other ecosystem services¹². For instance, there is an established body of literature that has studied how diversified low-input farming practices have shaped structurally and functionally complex landscapes and support high levels of biodiversity, so-called ‘high nature value farming’²⁴. This definition of landscape products does not exclude particular types of producer (for example, small or large farmers) or farming system. Crucially, landscape products are valued, in part, because of their relationships with the landscapes they are embedded in. For example, argan oil is a landscape product. It originates exclusively in a distinct landscape in southwest Morocco where the *Argania spinosa* tree grows; the argan tree is managed traditionally and with few external inputs, and the

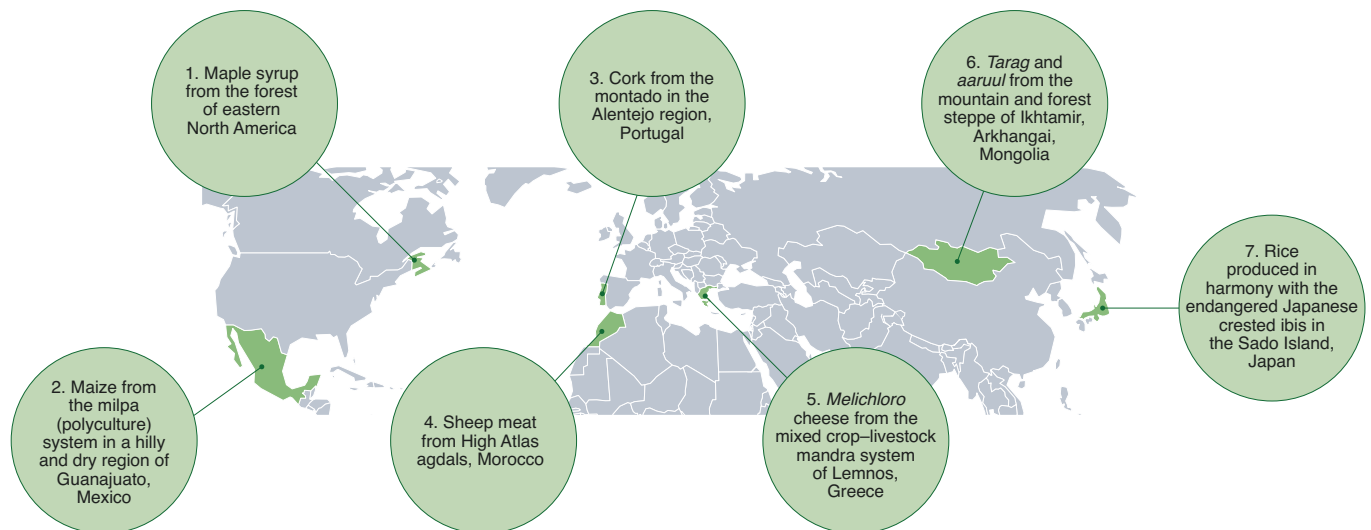


Fig. 2 | Location and description of the seven case studies. The selected case studies offer a diversity of geographical and socio-cultural contexts. Cork is a non-food agricultural product that is closely related to a food product (wine). We highlight one key landscape product and one of the four aspects of landscape product multifunctionality in each landscape, but it is important to note that many other products and functions are part of each production system (for example, vegetables, legumes and backyard animals from the milpa system). Additional details are available in the Supplementary Information. Landscape products descriptions are as follows. 1. Sweet syrup made from the sap of maple trees. Initially produced by Indigenous groups and later also by non-Indigenous family farms. Technological changes are increasingly moving maple-syruping in the direction of more technified, capital-intensive approaches that favour larger producers and investors. It is sold globally. 2. Native maize cultivated together with beans and squash in a traditional family farm polyculture system called milpa. Peasants also raise goats and other backyard animals, and harvest wild crops such as maguey. Maize is kept for self-consumption and surplus of other products sold locally. 3. Made from the bark of cork oak trees, cork is connected with the global wine market. It is grown in large family farms in savannah-like landscapes grazed primarily by cattle, and sometimes sheep and goats. These farms also include a mosaic of vineyards, olive groves, riparian forests and small

orchards. Cork from this region is increasingly Forest Stewardship Council certified and sold globally. 4. Sheep meat, dairy and fibre produced by semi-nomadic communities using the agdals, communal summer highland pastures. Sheep are reared in a mosaic system characterized by small-scale terraced agriculture in the valleys with extensive upland herding and wild food, medicinal and aromatic plant collection. 5. Semi-hard cheese made from a mixture of sheep and goat milk. *Melichloro* is produced in the mandra system, creating a landscape mosaic of grazing lands, cultivated areas (cereals and animal feed) and traditional stone wall structures for farmers' needs. It is sold in local and supralocal markets. 6. Yak-milk yogurt and dried yogurt cheese produced by nomadic pastoral communities that move with their herds among distinct seasonal pastures from valley bottoms (summer) to steppe (autumn) to mountain slopes (winter). Animals are native breeds, naturally bred, live outdoors and subsist on native vegetation. These products are kept for self-consumption, and surplus is sold in local and national markets. 7. High-quality japonica rice from Sado Island produced in the traditional rice cultivation system, a dynamic mosaic of woodlands, plantations, grasslands, paddy fields, wetlands, irrigation ponds and canals. Eco-farming certification ensures that rice is produced in harmony with the endangered Japanese crested ibis. The rice is sold in local and national markets.

oil sells at comparatively high prices, often with organic certification and/or a geographic indication label²⁵. In contrast, Dutch greenhouse tomatoes are not considered landscape products. Similar tomatoes are produced in Spain or Morocco, they require high-input management using fossil energy, pesticides and mineral fertilizers, and they do not cost more than tomatoes from other places²⁶.

Previous work has highlighted the ecosystem services on which agricultural production is based and those that are supplied by agro-ecosystems²⁷, and how food can be supportive or harmful to multiple ecosystem services or nature's contributions to people²⁸. Our concept of landscape products goes beyond ecosystem services assessments by focusing on the people who live, cultivate and ultimately shape a particular landscape or place¹⁸. It allows a comprehensive consideration of cultural and non-economic values as defined by local communities²⁹, which have proved difficult to consider in conventional ecosystem services assessments³⁰. It thus considers how sustainability is embedded in the landscape of production holistically, integrating ecological, economic, social and cultural perspectives¹².

Multiple functions of landscape products

Seven case studies illustrate the multifunctionality of landscape products and their contributions to sustainable agricultural systems (Fig. 2). Drawing on recent studies that challenge dominant framings of food as a commodity^{13,15,31}, we focus on four key groups of interrelated

landscape product functions: human links to nature; culture and identity; social capital; and nutritional sustenance and economic income.

Group 1: landscape products as human links to nature

Local ecological knowledge and practices used to produce a landscape product, and human assimilation of plants and animals, connect producers and urban consumers with nature and unique agricultural landscapes^{13,32}. Landscape products result from social-ecological adaptations through which local and regional communities have developed deep connections with ecological processes. For producers, the link to nature encompasses knowledge of natural processes and resources, a sense of land and animal stewardship, and spiritual connections. For consumers, the link happens as they acquire, use and eat meat, grains and other plant parts, for example, when by drinking milk they become aware that they are consuming a natural liquid from mammals. Consumers may also appreciate the ecological functions and biodiversity supporting and supported by the landscape product. For this function, land management and farming practices, and associated rituals and traditions, as well as consumer awareness of product origins, are key. For example, in the Mongolian case, the connection to nature has strong spiritual and symbolic components as local people use landscape products such as milk as spiritual offerings. In Mongolia's Khangai mountain range (Supplementary Box 1), milk's symbolic meaning derives in part from its origins in nature and 'natural' livestock

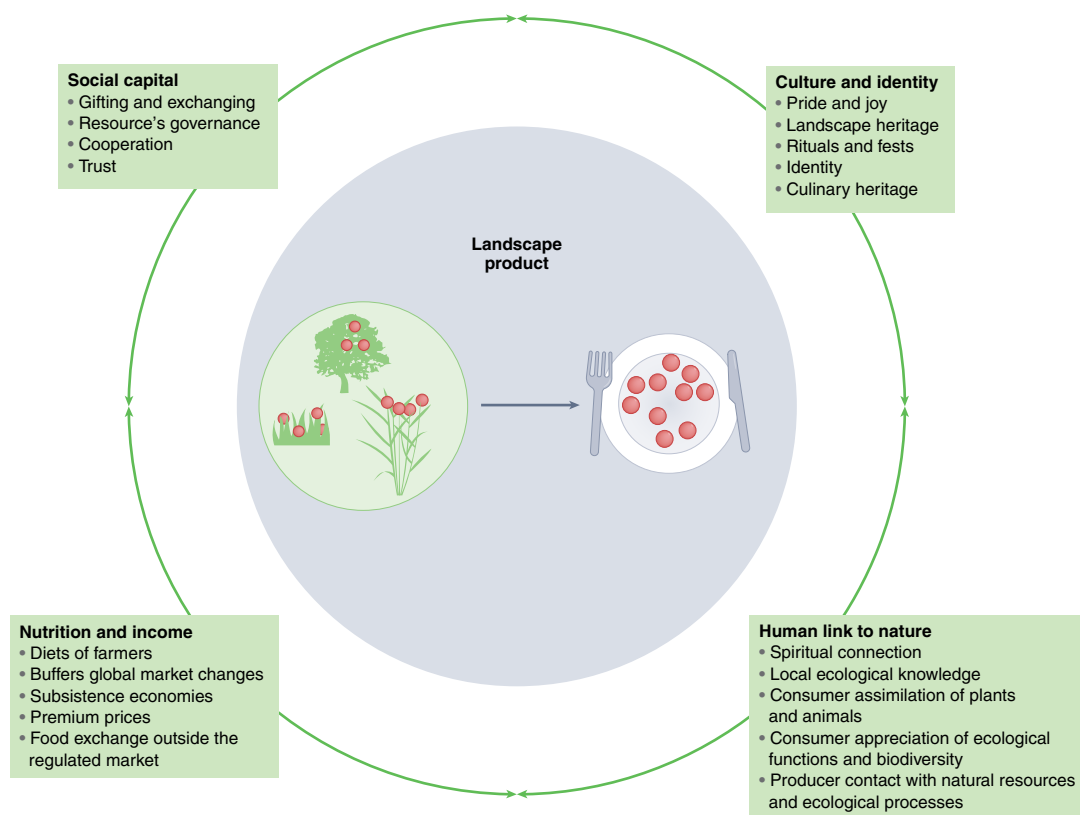


Fig. 3 | Multiple functions of landscape products. Benefits related to social capital, culture and identity, human links to nature, and nutrition and income are based on the seven cases examined. The arrows represent the interrelatedness of the functions.

husbandry. In the Sado Island rice case (Supplementary Box 2), the link to nature is reinforced by certification that rice has been produced in traditional ways that protect wildlife. By buying certified rice, distant consumers can connect to Sado's rich biodiversity while contributing to its protection. Such landscape products help strengthen the emotional, cognitive, experimental and material components of human–nature connections³³, which are crucial for well-being and sustainability^{34,35}.

Group 2: landscape products as part of culture and identity

Traditions and culinary and landscape heritage associated with farming, processing and consuming landscape products provide identity, a sense of belonging to a community and culture, and enjoyment^{16,32,36}, meeting emotional needs³⁷. This includes the pride of farmers and food processors, and the appreciation and enjoyment of their products and recipes by local communities and distant consumers. Rituals and feasts are an expression of this, being associated with a unique taste and culinary heritage. This function also has tangible expression in a rich landscape heritage that local communities identify with, including landscape structure, seeds, crops and breeds. For example, Sado Island rice production is connected to Noh theatrical performance and agricultural shrine rituals. Mongolian traditionally made *tarag* and *aaruul* enable herders to meet cultural expectations of hospitality. Any visitor to a herder home can expect to be served salty milk tea, a large plate of *aaruul* and other dairy delicacies. In Greece, Lemnos *melichloro* is a living part of *Kehaghias* (local farmer) identity. It requires time, effort and resources to make, demonstrating craftsmanship and the ability to husband a healthy herd, a source of pride and identity. It is also celebrated through traditional dances; it is an everyday food for locals and essential in restaurants and taverns (Supplementary Box 3). As such, landscape products support socio-cultural aspects of sustainability³⁸.

Group 3: landscape products as social capital

Networks of social ties among local actors and along the value chain, and the embedded relationships of trust, reciprocity and shared norms, constitute social capital. Social capital is key in resource governance, especially for common pool resources, as it lowers the transaction costs of reaching agreement among users and community members^{39,40}. Landscape products play a role in mediating relationships among both local and extra-local actors in the food system and landscapes of production, for example, among producers, processors, retailers, local communities, tourists, consumers and government agencies. The Moroccan agdal exemplifies how social capital linked to mutton, lamb and dairy products supports governance of a grazing commons (Supplementary Box 4). The Greek mandra system illustrates cooperation built around certification mechanisms to make *melichloro*, a protected designation of origin (PDO) product, while the Japanese Sado rice case showcases management strategies co-designed between producers and the local government for adapting agroecological farming practices. Both the Mexican milpa system and Mongolian Khangai Mountains dairy products demonstrate how trust can be built between consumers and producers from a specific landscape or cooperative. Gifting and exchanging food at home and at local festivals, very common in our cases, strengthens social ties. Landscape products can therefore strengthen social capital, a key component of sustainability⁴¹.

Group 4: landscape products as nutritional sustenance and economic income

Local food and other landscape products support rural livelihoods through sustenance, income, employment and business opportunities⁴², meeting basic health and economic security needs³⁷. Often, landscape products are integrated into polyculture or agroforestry systems, where a portion is consumed by producers and surplus is

BOX 1

Examples of collaborative interventions that contribute to sustainability

The following examples showcase collaborative interventions building on interdependent landscape product functions that reinforce shared values, community identity and trust.

Example 1. Establishment of a women's cooperative in the milpa case. A cooperative brought together women producers and strengthened their connections to one another, helping to keep the system alive despite male outmigration to cities. The cooperative protects farmers from inequitable value chains and establishes links between landscapes, producers and consumers. Products are sold directly to consumers or restaurants. Fewer intermediaries mean earnings are more fairly distributed through the food chain, a contribution to social justice.

Example 2. Collaboration between the government and the farmers' cooperative in the Sado rice case. Certification with support from the city government has helped farmers to get a fairer price for landscape products while incentivizing maintaining the ecological and cultural functions of the system and recognizing the work of farmers as landscape stewards. In addition, Sado was designated one of Japan's first Globally Important Agricultural Heritage Systems (GIAHS) in 2011. The GIAHS programme advocates for the safeguarding of the multiple functions that agricultural heritage systems provide (social, cultural, economic and environmental) to farmers and local communities.

Example 3. Joint action towards acquiring a PDO certification in the Lemnos *melichloro* case. There is an ongoing process to acquire a Protected Designation of Origin (PDO) certification for *melichloro* cheese, driven by Anemoessa (a local NGO) with the support of the Terra Lemnia project, which involves local and international NGOs, research centres and local producers, and under the aegis of the administrative region of the North Aegean. Local cheesemakers support the initiative, which should help valorize and promote *melichloro* cheese based on its high nutritional value and exquisite taste, and its importance for keeping the cultural and environmental values associated with the mandra production system.

Example 4. Adherence of the Portuguese cork and wine industry to sustainability standards to preserve the montado landscape. Certification for Alentejo cork through the Portuguese Cork Association of Producers affects both the cork product itself and the wider montado landscape. The Wine Sustainability Program of Alentejo also links the sustainability of the final product (wine) to the multifunctional landscapes of the region. It defines the use of sustainably certified cork from the montado that is achieved following a bottom-up strategy as one key requirement for wine sustainability standards.

sold in local markets, providing diversified nutrition for producers and local communities (milpa, agdal and mandra systems, and Ikhtamir dairy production), and contributing to farmer diets and to subsistence economies (Supplementary Box 5). In the mandra system, for example, most milk is sold to local dairy factories. Farmers retain some to sell in the informal local market as unpasteurized, because officially it cannot be sold, or to produce cheese for use as rent payments or for barter. Revenues obtained from local markets may be lower than

those from national or international markets, but fluctuate less from market volatility and value appropriation by big players, reducing producers' vulnerability. In contrast, in the maple syrup and cork cases (Supplementary Boxes 6 and 7), far-reaching exports sold at premium prices are more important economically to local livelihoods than local consumption or use. Yet cork and maple syrup still fulfil functions from all four groups. Landscape products therefore directly impact livelihoods across the value chain.

Interrelated functions and shared appreciation across value chain actors

The multiple functions of landscape products are strongly interconnected and by that reinforce each other (Fig. 3). Culture and identity are underpinned by ecological functions, both symbolically and spiritually, and reflect adaptation to and celebration of the natural environment, as in the case of the Moroccan agdal. Culture is also connected to social capital linked to governance of common resources such as pastoral lands, or to local knowledge necessary to extract products such as cork. Social capital builds on shared identity and pride that bonds the local community and on shared appreciation of culinary heritage with actors far from the landscape of production, such as in the Lemnos *melichloro* case, as well as from the sharing and gifting of products among community members, as illustrated by the role of dairy products among Mongolian herders. The nutrition and income function depends on all the others, as we see from the premium prices that producers can obtain for some products when the links to nature and culture are acknowledged by consumers, as in the Sado rice case.

In our cases, myriad complex and interacting social, economic and environmental challenges, along with ongoing technological and economic intensification, hamper the sustainability of agricultural landscapes. Nevertheless, we observed collaborative interventions that contribute to sustainability by building on interdependent landscape product functions (Box 1). These interventions include establishment of farmers' cooperatives, product certification schemes, labels of origin and designations such as Globally Important Agricultural Heritage Systems (GIAHS). In common is a shared appreciation of the socio-cultural and ecological contributions of landscape products, and enhanced market access and improved financial returns, both strengthening the livelihood functions of landscape products.

The multiple functions of landscape products, when embedded in communication and exchange networks across production and value chain actors, may help to stabilize landscapes of production. The ability of landscape products to engage actors along the value chain from beyond the landscapes of production through the shared appreciation of their cultural and ecological values provides access to economic resources and knowledge, and to a larger community for burden and benefit sharing. Landscape product culture and identity functions that are lived and shared with tourists and consumers are key in reinforcing these relationships^{16,32,36,43}. However, collaborative interventions alone are dwarfed by the power of agri-business and agricultural subsidies that frequently neglect the diversity and interrelatedness of multiple functions of food^{44–46}. Global food and agricultural policies and strategies that recognize and protect landscape product functions are therefore needed.

Landscape products in policy and practice

Based on the empirical evidence from our cases, we propose that a landscape products lens can improve food systems and landscape policies by addressing three key needs: (1) reinforcement of the shared appreciation for landscape products; (2) context-dependent and place-sensitive sustainability standards and food policies; and (3) multi-sector collaboration that capitalizes on landscape product multifunctionality (Fig. 4).

First, reinforcement of the shared appreciation and recognition of the multiple functions of landscape products by different actors is

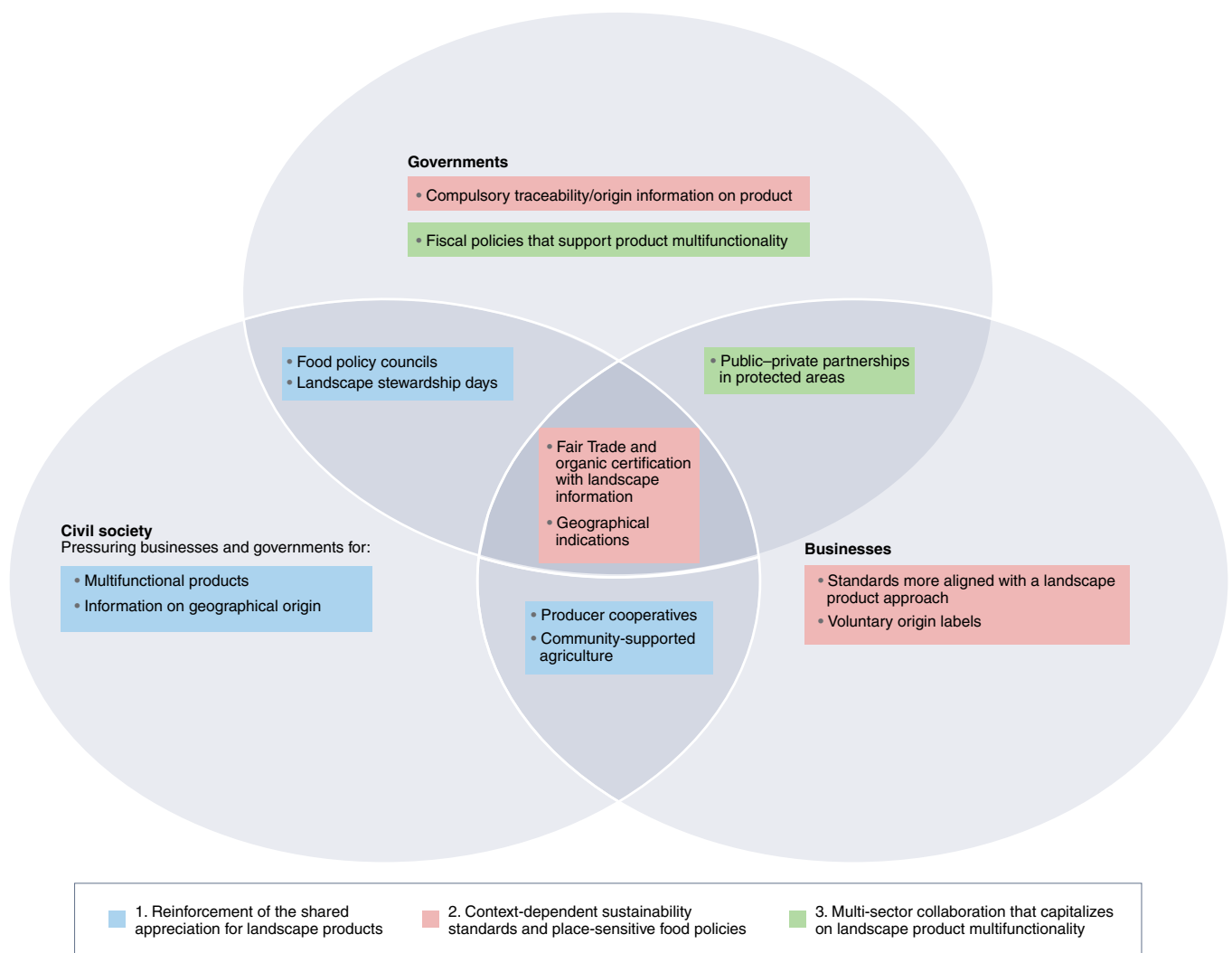


Fig. 4 | Key needs and actions for policy and practice. Actions to be taken by governments, businesses and the civil society to improve food systems and landscape sustainability from a landscape products lens. Such actions respond

to the three needs identified in the seven cases examined: reinforcement of the shared appreciation for landscape products, context-dependent sustainability standards and policies, and multi-sector collaboration.

needed. The sustainable commodification literature often calls for top-down monitoring, surveillance and accountability, and for sustainable intensification and a reorganization of supply chains where bigger players enter to increase efficiency²¹. Yet top-down approaches can “undermine voluntary cooperation, the development of shared meaning, and reciprocal relationships of trust and trustworthiness”¹¹. Top-down strategies need to be complemented with grounding in an appreciation of a product’s multiple functions and a shared goal of preserving them, as we observe in the women’s cooperative of the milpa case (Box 1). This could include food policy councils helping to prioritize between multiple functions, local stewardship days involving citizens in landscape products’ cultivation or manufacturing, and community-supported agriculture systems strengthening producer and consumer relationships. Citizens pressuring businesses and governments for landscape products can also have a strong impact.

Second, there is need for context-dependent sustainability standards and place-sensitive food policies. Most sustainability standards lack attention to place- and community-specific challenges¹¹. A sustainability transition is the goal of several recent food policy initiatives, such as the EU Farm to Fork Strategy⁴⁷, the Japanese Sustainable Food Strategy⁸ or the Moroccan Green Generation Strategy⁴⁸. They

recognize the links among healthy people, societies and the planet, but continue to conceptualize food as a ‘place-less’ commodity¹⁹ and centre on individual and mostly technical aspects of food sustainability. Besides making place of production information on packaging compulsory, there could be soft regulations. For instance, Fair Trade or organic labels could mention the production place. Place-sensitive food policies such as protected geographical indications or collective trademarks with a focus on socio-cultural and ecological standards allow producers to collaborate to communicate the social-ecological context of their products⁴⁹, as in the Sado rice and *melichloro* cases (Box 1). The business sector can incorporate voluntary origin labels and landscape approaches that promote local cultural and ecological values in their sustainability standards, as piloted in the case of cork and wine certification in Portugal (Box 1). The differentiation of landscape products based on their links to the social-ecological context of production landscapes can capture consumer willingness to support such places.

Third, multi-sector collaboration is necessary to capitalize on the multiple functions of landscape products. Landscape sustainability and environmental conservation approaches often neglect food production as support for nature conservation. Efforts to integrate food policies and biodiversity conservation should draw on landscape products

for support of both nature conservation and sustainable development. Landscape products can market conservation, generating additional income from conservation areas and fostering landscape biocultural diversity⁵⁰. Public–private partnerships in protected areas can help address this need, as we have seen in the Sado rice case where rice is produced in harmony with the endangered Japanese crested ibis (Box 1). Fiscal policies can further support aligning food production, nature conservation and cultural heritage promotion goals through landscape products.

To sum up, co-management strategies and information policies, such as certification, labelling, product information and raising of awareness could accelerate, incentivize and catalyse actions to support landscape product multifunctionality in the context of sustainability strategies.

Conclusions

The concept of landscape products bridges contrasting food narratives by recognizing the commodity value of food and also its social, cultural and ecological values. It provides a lens for merging perspectives on sustainable commodities and landscape sustainability that can better inform policy and practice, and guide research.

We conceptualized landscape products as agricultural products originating in distinct landscapes, using low-input farming practices and typically sold at higher market prices than mass-market equivalents. They provide multiple and interrelated functions important for human well-being and landscape sustainability that we grouped into: human links to nature; culture and identity; social capital; and nutritional sustenance and economic income. When appreciated and shared by different actors along the value chain, this multifunctionality supports collaborative interventions that promote the sustainability of the agricultural landscapes of production.

Sustainability standards developed with a landscape products lens go beyond mitigation of environmental damage to foster a wider interpretation of sustainability that incorporates the four landscape product functions presented here. Food sustainability policy strategies with a landscape products lens recognize the importance of place-based foods. Landscape-product-informed sustainability standards and policies bring together actors across the value chain through shared appreciation of landscape product multifunctionality, going beyond top-down monitoring and accountability approaches. Different sectors involved in the management of agricultural landscapes capitalize on the multiple functions of landscape products. Landscape products help all actors, from producers to consumers, to connect to and support socio-cultural and environmental sustainability in the landscapes of production.

Data availability

All data related to the seven cases used as empirical evidence in this Perspective can be found in the Supplementary Information.

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Competing interests

The authors declare no competing interests.

Additional information

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