Sicilian Native Wool. From Waste to Resource: A Circular Supply Chain for Made in Sicily

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Abstract
This study focuses on Sicilian native wool, historically excluded from industrial supply chains due to its coarse morphology, and explores its regenerative potential across ecological, economic, and cultural dimensions. Developed within the MICS partnership, the research adopts a systemic and collaborative methodology that enables participatory design processes involving local stakeholders, artisans, and institutions.
In this framework, the Sicilian Wool Production District operates as a strategic coordinator for supply chain activation, while the active integration of artisans in co-design processes allows for the recovery of situated skills essential for generating innovative application scenarios. The findings reveal the capacity of this marginalised material to be reconfigured as a high-value circular resource, capable of activating place-based supply chains, enhancing territorial competences, and fostering new forms of ecological citizenship. The project underscores the role of design for sustainable transitions rooted in proximity, mutualism, and care for place.

Keywords
Sicilian native wool
Circular design
Circular economy
Relationship

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INTRODUCTION

Within the current body of research on circular economy in the agricultural domain, agroecosystems are increasingly recognised as complex productive systems, capable of generating not only primary goods but also substantial volumes of organic residues and by-products that significantly contribute to global waste production (Alan & Köker, 2023). According to the most recent estimates, the environmental burden associated with agricultural waste is rapidly escalating: projections suggest that, in the absence of structural interventions, annual waste generation may reach 27 billion tonnes by 2050, with between 1.3 and 2.1 billion tonnes directly attributable to the agricultural sector, including livestock waste (Midolo et al., 2024). Against the backdrop of the considerable environmental impact of industrial agricultural models, the imperative to reconfigure production systems towards greater environmental and functional sustainability has become increasingly urgent. In this regard, the valorisation of residual flows of both animal and plant origin, among which local fibres stand out, emerges as a particularly relevant strategy. Their reuse can generate ecological benefits and ecosystem services aligned with the principles of the circular bioeconomy (Piotto et al., 2018). This dimension, often overlooked by conventional analyses, has recently gained renewed attention in both scientific and institutional spheres, being considered a potential lever for the ecological transition of agri-food systems. Through the application of advanced technologies for the recovery and reconversion of residual biomass, agricultural waste can be transformed into strategic resources for diverse sectors, thereby promoting sustainable and cross-sectoral integration of production chains (Valenti et al., 2023a; Valenti et al., 2023b). The scientific literature identifies three main categories of waste amenable to valorisation: crop residues, livestock residues, and agro-industrial by-products (Alan & Köker, 2023).

Among the various types of livestock residues, discarded sheep wool represents a significant yet frequently neglected fraction. Wool waste is generated throughout the entire wool production and transformation chain. While the origin and composition of wool waste may vary, raw wool is by far the most critical category, as it negatively impacts the sustainability of the system from the very outset of the supply chain. In the wake of the structural transformations induced by the Green Revolution, raw wool has undergone a progressive devaluation, shifting from a material of high functional, symbolic, and ecological value to a marginal by-product within contemporary agro-livestock cycles. The marginalisation of sheep wool in the Italian productive context stems from a combination of regulatory, infrastructural, and technical-quality factors that hinder its integration into circular economy models. This degradation has occurred in parallel with the rise of production models based on intensification and specialisation, which have systematically reduced the role of multifunctional, small-scale agro-pastoral systems characteristic of traditional rural economies. However, its unsuitability for conventional textile use does not preclude its valorisation. On the contrary, this very condition has spurred numerous scientific studies exploring its application in alternative fields of high ecological and functional value. In recent years, research has increasingly highlighted the potential of sheep wool as a strategic resource for the circular bioeconomy through upcycling practices in agriculture, construction, and artisanal manufacturing. Recent studies have demonstrated its effectiveness in agriculture, for instance through wool-based fertiliser pellets and mulches that increase soil water retention by up to 38% (Camilli et

al., 2025), and in natural building techniques, where the use of coarse fibres in rammed earth construction improves flexural strength and reduces hygrometric shrinkage (Parlato et al., 2023). From an economic perspective, the artisanal processing of wool into knitted garments can significantly reduce the profitability gap between autochthonous and more productive sheep breeds (Sardaro et al., 2021), as shown by the case of the Gentile di Puglia breed, where the gross margin per sheep improved from –57% to –3%, enhancing the viability of marginal rural areas.

In Castronovo di Sicilia (Palermo), a group of women artisans launched the initiative *Arti e mestieri della lana_SiAmo Marcatobianco*, aimed at recovering traditional techniques for processing native Sicilian wool, with the intent to restore value to a material progressively marginalised within contemporary production systems. Rooted in an inner rural context and fuelled by local knowledge, the initiative has taken shape as an active laboratory of cultural regeneration and artisanal experimentation. This research was developed through a direct collaboration with the group, recognising its strategic role within an experimental process dedicated to the valorisation of Sicilian wool from a circular economy perspective.

The experimentation was conducted within the extended partnership *MICS – Made in Italy Circolare e Sostenibile*, funded by the Italian Ministry of University and Research and promoted by the MICS Foundation. The project is among the officially recognised initiatives within the research area dedicated to Circular Made in Italy, supported by the European Union through the NextGeneration EU programme (PNRR). The study took place within *Spoke 2*—one of the eight thematic areas—focused on the development of eco-design strategies ranging from materials to product-service systems (PSS). The objective of this research area is to experiment with a portfolio of eco-design approaches supporting all stages of the design and lifecycle management of PSS, through a cradle-to-cradle approach, and the design of services and communication for social innovation and behavioural change. This paper presents the outcomes of the experimentation, developed through a methodological framework grounded in systemic design and structured through intersectoral co-design processes. The study addresses a dual objective by examining the technical, ecological, and socio-economic feasibility of a regenerative local wool supply chain, while also investigating the role of design as an enabling infrastructure for sustainable transitions, capable of enhancing territorial specificities, mobilising embedded knowledge, reinforcing social resilience, and fostering renewed forms of care for local landscapes.

WOOL AND ITS TERRITORIES OF PRODUCTION

Only a small portion of wool production, represented by the finest fibres, is suitable for textile use and actually enters the market; the remainder is excluded from valorisation circuits due to a combination of production limitations, regulatory constraints, and infrastructural deficiencies that hinder its sustainable reuse. The main challenges are intrinsic and closely linked to the fibre's morphology. Wool classification is based on fineness, defined by the fibre diameter, which varies according to the sheep breed. There are four main categories, but only wool with a diameter below 30 µm meets the standards required by the international textile industry, thereby automatically excluding substantial portions of national production. In particular, coarse

wool obtained from the annual shearing process, necessary for animal welfare and estimated between 1.5 and 3 kg per animal, is difficult to valorise. In the absence of economic outlets and due to the challenges of regulated disposal, it is often illegally dumped on agricultural land along with manure or incinerated, contributing to widespread soil and air pollution. Although raw wool is formally recognised as an agricultural product related to livestock farming under Article 2135 of the Italian Civil Code, current European legislation—particularly Regulation (EC) No. 1069/2009—classifies it as a category 3 by-product, subject to stringent and costly sanitary regulations. This classification, which effectively equates it to special waste, severely limits its integration into circular production cycles, mandating expensive disposal practices such as high-temperature sterilisation (133 °C) and immediate landfill disposal (European Parliament, 2009). This regulatory inconsistency, which places wool in a grey area between product and waste, is further exacerbated by the absence of DOP or IGP recognition, despite the fact that wool is theoretically eligible for protection under Regulation (EC) No. 510/2006.

From an infrastructural perspective, the closure of the last industrial-scale wool-scouring plant in Italy (Gandino, Bergamo, 2018) marked the loss of a strategic node in the supply chain, with a direct impact on competitiveness and access to international markets. The global production of raw wool can only be estimated on the basis of the number of sheep. In terms of global sheep population and wool output, China leads as the top producer of raw (greasy) wool, with an estimated 194 million sheep (FAO, 2024), followed by India and Australia, each with more than 70 million sheep in 2022 (IWTO, 2022). The European Union counted approximately 57 million sheep and generating approximately 89,000 tonnes of wool annually. In Italy, annual production of raw wool is estimated at around 14,000 tonnes, but only about 5% is channelled into economically viable uses, mostly within niche markets such as luxury apparel (Vagnoni et al., 2016; Rajabinejad et al., 2019). According to the latest census data from the Italian National Institute of Statistics (ISTAT), as of 31 December 2023, more than 6 million sheep are reared in Italy, although this figure has sharply declined over the past decade. Sheep farming is practised throughout the country, but certain regions are

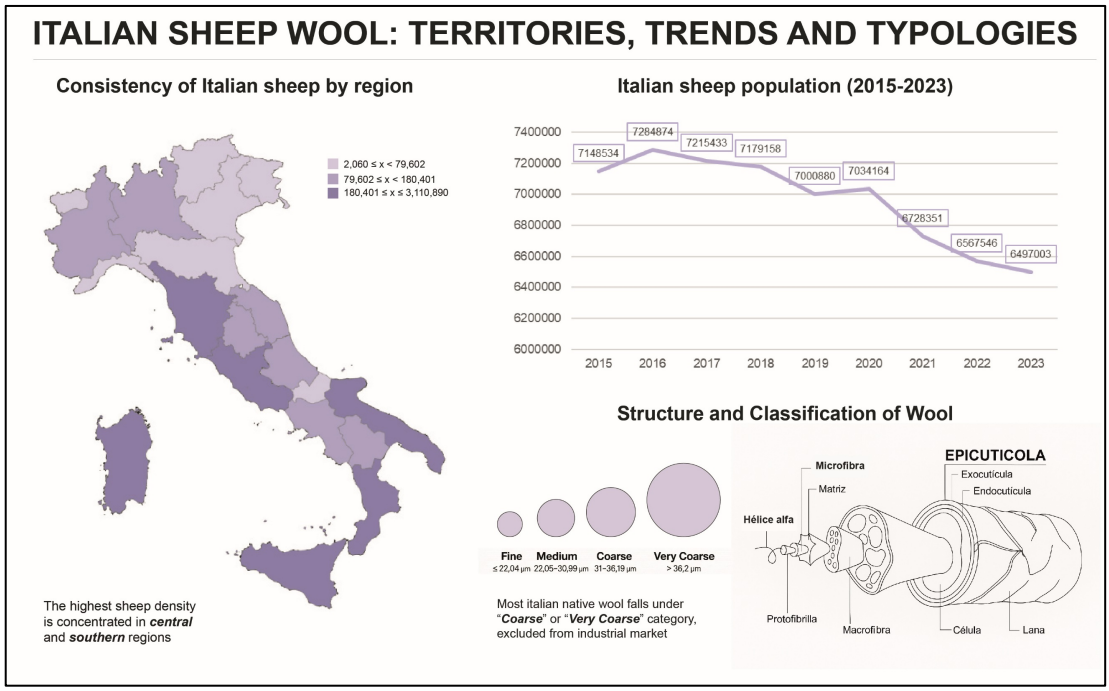

Fig. 1
Overview of Italian sheep wool by region, population trends (2015–2023) and fibre typologies.

particularly prominent. Sardinia and Sicily are home to the largest sheep populations, with 3,074,452 and 738,800 head respectively **Fig. 1**.

This concentration makes the need for circular economy solutions particularly urgent, in alignment with the European Green Deal objective to reduce greenhouse gas emissions by 55% by 2030 (European Commission, 2019). According to data from the National Zootechnical Registry (Anagrafe Nazionale Zootecnica), Sicily ranks as the second Italian region in terms of sheep population, with approximately 700,000 head distributed across more than 8,000 farms. The annual production of raw wool is estimated at around 900,000 kilograms. The National Zootechnical Register of the Ministry of Health (IZS) highlights the predominance of mixed breeds in Sicily, resulting from crossbreeding strategies aimed at improving productivity and resistance to both climatic conditions and diseases. The most widespread breeds include Valle del Belice, Sarda, Pinzirita, and Comisana. Despite their differences in morphology, adaptability, and productivity, the wool produced by these breeds is generally classified as "low quality". As Sicilian sheep farming is primarily geared towards milk and meat production, wool is often treated as a by-product with limited value, resulting in high management costs for farmers. The current management of Sicilian sheep wool represents a critical junction where environmental, economic, and socio-cultural issues converge (Ganci et al., 2022). The fleece of local dairy breeds, whose fibres have an average diameter of approximately 70 µm, does not meet the standards of the international textile industry (< 30 µm). This generates a structural surplus on the island, with over 7,000 tonnes of raw fibre produced annually, particularly concentrated in the Sicani Mountains and the Nebrodi range (Midolo et al., 2024). In the absence of regional scouring and storage facilities, the logistics costs associated with transporting the material outside Sicily frequently exceed its commercial value, often resulting in irregular disposal practices (Parlato et al., 2023).

The progressive accumulation of unvalorised shorn wool, increasing regulatory pressure on the management of agricultural waste, and the advancement of upcycling technologies prompted the Sicilian Region, in 2021, to formally establish the Sicilian Wool Production District (*Distretto Produttivo Laniero Siciliano*), headquartered in Cammarata (AG), in the heart of the Sicani Mountains. Recognised as one of the twenty-three official production districts at the regional level, the district was conceived as a strategic infrastructure for the activation of a regional wool supply chain, with the aim of supporting the local sheep farming sector and reintegrating native wool into new production cycles capable of generating economic, environmental, and socio-occupational value. The district has been assigned the role of coordinating investments for the establishment of local scouring facilities, promoting high value-added products, and structuring collaborative territorial platforms. Its activities are articulated through a series of strategic interventions: the activation of a combined textile and museum workshop in the hamlet of Borgo Marcatobianco; the development of experimental projects funded under the Rural Development Programme for Sicily 2014–2020 (sub-measure 16.1); the production of innovative materials such as biochar, bioplastics, and wool-based thermal insulation; the expansion of training initiatives aimed at farmers; and the creation of a transdisciplinary operational group for the integrated management of the wool resource.

WOOL AS A CULTURAL MEDIUM AND RELATIONAL HERITAGE

The processing of wool has accompanied Italian agro-pastoral history since the earliest times, as evidenced by numerous archaeological discoveries. The presence of woollen textile artefacts, found in contexts dating back to the Bronze Age, such as at the site of Castione dei Marchesi (PR), attests to the extensive and structured use of this fibre already in the earliest forms of agricultural settlement (Piotto et al., 2018). The employment of the vertical weight loom technique in the production of textiles reveals not only an advanced knowledge of spinning and weaving processes, but also a social organisation in which these activities were closely linked to the female domestic sphere. In protohistoric and archaic times, the figure of the mater familias assumed a central role in the management of textile activities, as demonstrated by significant iconographies such as the throne from Verucchio (8th-7th century BC) or the *tintinnabulo di Bologna* (7th century BC), which accurately depict the stages of wool production (Piotto et al., 2018).
In Sicily, the indigenous sheep breeds are selected primarily for their high dairy yield. These breeds provide a large-diameter fibre that is unsuitable for fine yarns, but optimal for the production of blankets, carpets and padding. As early as Roman times, the fullonicae established a standardised method of fulling, whereby cloths were immersed in hot water and smectic clay, followed by prolonged compression. This process resulted in the creation of compact and strong fabrics. This proto-industrial infrastructure underwent an evolution during the medieval period, resulting in the establishment of continuity in the "*paraturi" mills,* hydraulic fulling mills, which are still in operation in certain regions of the island (Pizzuto Antinoro, 2002). *Paraturi* are technically equivalent to gualchiere machines, which were utilised for the purpose of felting and waterproofing fabrics through the processes of beating and compressing. The verb "parare" denotes the degreasing and compacting of orbace, a traditional cloth of raw, non-carded wool.
Records from the "G. Pitrè" Ethnographic Museum in Palermo confirm that, even in the twentieth century, the wool supply chain maintained a domestic and intergenerational dimension: spinning, weaving, and sewing were primarily learned within the family, especially among women, and the resulting artefacts—blankets, rugs, sacks—responded to everyday needs grounded in proximity, care, and use. The symbolic significance of wool is powerfully articulated in Ignazio Buttitta's poem *Lingua e Dialettu*, where the act of *arripezzare a tela camuluta* (mending a moth-eaten fabric) woven "with the wool of Sicilian sheep" evokes a material expression of collective memory and cultural continuity. Seen as a metaphor, repair becomes more than a functional operation: it is a regenerative act that reactivates the relational bond between fibre, territory, and shared identity. Wool thus emerges as a semiotic infrastructure, capable of interweaving memory, material knowledge, and situated belonging within a design dispositive oriented toward care and the reactivation of local systems.
While this heritage testifies to a layered artisanal wisdom, the present offers examples of rediscovery and regeneration. In the rural hamlet of Marcatobianco, part of Castronovo di Sicilia (Palermo), a group of female artisans has established a textile workshop where local sheep wool is processed manually along the entire supply chain, from carding to the making of felt and woven goods. Adjacent to the workshop, a Wool Museum has been created, preserving historical looms, spinning wheels, dyeing tools, and

pastoral utensils, thus functioning as an integrated educational and exhibition device. The project, supported by the municipal administration as part of the Wool District, aims both to foster the intergenerational transmission of skills through training activities and on-site demonstrations, and to establish a cultural attractor oriented towards experiential tourism, interweaving museum visits, the observation of production practices, and itineraries through the surrounding pastoral landscapes. This model underscores the transformative potential of community networks in sustaining the continuity of local textile knowledge and in activating economic circuits based on short supply chains and the valorisation of both tangible and intangible heritage.

In Sardinia, the high fibre density of Sardinian wool lends itself to applications requiring durability, such as loom-woven artisanal rugs, which are now featured in contemporary design collections. A notable example of the valorisation of Sardinian wool is the work of textile designer Eugenia Pinna, originally from Nule. Her creations reinterpret traditional local blankets using a modular visual language and double-face weaving techniques, producing artefacts with low energy input and high symbolic density. Projects such as *B'Estes* and *Manta* combine textile sculpture, morphological customisation, and technical experimentation, exemplifying a post-industrial design ethos that blends art, craft, and sustainability. In particular, *Manta*, made entirely from native wool, demonstrates the transformative potential of raw fibre: the overtwisting of the yarn produces a dynamic, non-deterministic texture (Besana, 2010; 2012). This approach reflects a logic of "correspondence" (Ingold, 2021), wherein the material acts as co-author of the process, in a relational and situated perspective that recognises wool as an active agent (Bennett, 2023). Within the international panorama of design research dedicated to material cultures, the work of Dutch designer Christien Meindertsma represents a fundamental reference point for her capacity to investigate the raw material through a forensic and systemic lens, as evidenced by her extensive exploration of wool culminating in the exhibition *Christien Meindertsma: Beyond the Surface* presented at the Vitra Design Museum in 2019. Her approach dissects the production cycle to reveal the invisible links between the animal source and the finished artefact, transforming the concept of traceability into a narrative tool capable of restoring dignity to the fibre and challenging the anonymity of industrial standardization through projects that document the individuality of the single animal and the specific qualities of the fleece.

In the project *Oltre Terra. Why Wool Matters*, presented at the National Museum of Oslo in 2023, the design collective *Formafantasma* develops a systemic inquiry into wool as a critical junction between ecology, production, and material culture. The etymology of the title, which references the Latin root of "transhumance" (from *trans*, "beyond," and *humus*, "earth"), reflects an intention to explore wool not merely as a material resource but as a vector of complex interactions between living beings, environments, and local technologies. Wool is thus approached not as a passive resource, but as a threshold for interpreting the ecological, historical, and symbolic relations that constitute material ecosystems. The exhibition proposes an expansion of the concept of matter towards a relational ecology in which boundaries between culture and nature, human and animal, become porous and dynamic. The project calls for the overcoming of the epistemological divide between biological evolution and cultural production, proposing an integrated reading of domestication, herding, and textile transformation. In this perspective, the cooperative symbiosis between species and environments becomes a

foundational principle for design, recalling a systemic vision of production based on interdependence and co-evolution between forms of life and forms of making.
At the European level, initiatives such as the *Circular Wool* project (funded by the EU ELIIT programme) further demonstrate growing interest in innovation in this domain. *Circular Wool* brings together an Italian textile innovation centre (Lottozero, in Prato) and a Belgian specialised company, aiming to develop high value-added design products, such as modular rugs, using coarse European wools. The project leverages automation and creativity to make the raw wool supply chain economically viable. In this context as well, a key factor that has been identified is the active construction of relationships with local shepherds and the collective awareness-building around the idea that enhanced animal welfare practices, such as regular and high-quality shearing, can generate higher-quality fibres and, consequently, increased value. The focus on local supply chains thus emerges as a transversal strategic dimension: strengthening the relationship between those who raise sheep and those who process wool represents a foundational condition for ensuring traceability, quality, and an equitable distribution of added value across the entire chain. This highlights how, when a network of textile knowledge and skills is rooted in the territory, so-called "poor" wool can be reconfigured into a high-added-value resource, capable of sustaining a durable presence within economically rewarding market segments.

SICILIAN WOOL: TOWARDS A CIRCULAR SUPPLY CHAIN FOR MADE IN SICILY

Over the past two years of work within the extended MICS partnership, the Design for Agri-Food Laboratory at the University of Palermo has established a research environment aimed at exploring native Sicilian wool as a material, cultural, and ecological threshold through which to develop a systemic reflection on the transformative potential of design. This contribution presents the outcomes of the experimental activities carried out in the Laboratory during the academic year 2023/2024, within the framework of the research project *Sicilian Native Wool. From Waste to Resource: A Circular Supply Chain for Made in Sicily*. The activities were developed according to a cradle-to-cradle paradigm (McDonough & Braungart, 2010), implemented through systemic design methodologies (Bistagnino, 2012; Sevaldson, 2013; Barbero, 2022) and supported by a community-centered approach capable of enhancing the relational dimension between design and territory (Villari, 2021), with the aim of investigating the regenerative potential of native sheep wool from ecological, economic, and cultural perspectives. In terms of expected impacts, the study aimed to recover and enhance the value of wool both as a raw material for processes, artisanal/industrial products, and services in the fields of furniture, textiles, and packaging, and as a cultural asset rooted in local knowledge and manual skills, with the objective of identifying place-based micro-economies within the Sicilian territory. A key feature of the laboratory was the active participation of the Sicilian Wool Production District, which was engaged as both an institutional and operational interlocutor. Students had the opportunity to interact directly with the district's president through dedicated meetings that enabled a dialogue centred on the motivations, challenges, and strategic perspectives associated with the regeneration of the regional wool supply chain. This moment of

exchange proved fundamental in gaining an in-depth understanding of the actual conditions of the sector, allowing the integration of concrete needs and context-specific knowledge into the design process. The activities were carried out in synergy with the group of artisans involved in the *Arti e mestieri della lana_SiAmo Marcatobianco* initiative and with the Mythos Fashion District, recognised as a Productive District by the Sicilian Regional Government. The laboratory functioned as a collaborative learning space in which students developed project scenarios aimed at valorising native Sicilian wool as a circular resource, integrating technical-productive, relational, and communicative dimensions. The design approach was oriented towards fostering fertile relationships among diverse actors, reinforcing the principle of shared responsibility as the foundation of sustainable long-term project development, in line with the notion of design as a catalyst for systemic change through iterative and participatory processes (Brown & Katz, 2011). Each proposal sought to outline supply chain configurations geared towards sustainability, territorial diversification, and the recognition of wool not as waste, but as a common good of high ecological and cultural value. Based on this interpretative framework, collaborative design tools (Sanders & Stappers, 2008) were activated to construct valorisation scenarios capable of integrating agriculture, craftsmanship, sustainable building practices, and education.

TOWARDS VISIONS AND SCENARIOS

The projects presented should be understood as cognitive devices through which the role of design has been investigated in constructing new supply chain models, strengthening territorial specificities, and experimenting with circular regeneration practices grounded in the collective intelligence of local contexts. Each project contributed to the development of an operational lexicon rooted in the concepts of proximity and regeneration.
Proximity, understood as both a methodological and relational principle (Manzini, 2021), guided design choices towards configurations capable of fostering ties of care (Puig de la Bellacasa, 2017) among materials, territories, and communities. This led to a specific focus on the localisation of processes, the activation of multi-actor alliances, and the valorisation of contextual knowledge. Regeneration, conceived as the systemic reactivation of marginalised resources, oriented the intervention on native Sicilian wool supply chains, contributing to the rehabilitation of their productive, symbolic, and relational value. The systemic approach adopted in the laboratory enabled the consolidation of a design practice aimed at constructing circular filtrations, in which design operates as an infrastructure for interconnecting disciplinary domains (agronomy, archaeology, circular economy, pedagogy), operational dimensions (production, communication, distribution, education), and levels of governance (local, district, regional). Native Sicilian wool, traditionally excluded from formalised production circuits, thus acquired strategic centrality as a connective material capable of generating new relations among actors, valorising latent resources, and triggering cooperative practices.

Fig. 2

UI concept for Rewoolution, a platform promoting the reuse of Sicilian native wool through geolocated services, community engagement, and circular fashion practices. (Source: Project by Marco Barilà and Giorgia Bonaccorso)

This trajectory gave rise to lightweight infrastructures capable of supporting the recomposition of local productive systems through mobile devices, community-based micro-services, and integrated educational actions, as exemplified by the *Rewoolution* experiment **Fig. 2**. The project articulates an adaptive system based on itinerant collection, shared transformation spaces, and targeted educational programmes. The connection between shepherds, artisans, schools, and community organisations enables the restoration of value to raw wool, transforming it from a residual material into a catalyst for citizenship, intergenerational exchange, and situated learning. *Rewoolution* also functions as an integrated platform for promoting sustainable practices through regenerated wool, weaving together storytelling, territorial mapping, community engagement, and individual impact tracking.
Alongside the regeneration of supply chains, the research also explored the pedagogical and cognitive dimension of design, proposing educational and communicative devices capable of rendering the complexity of the wool system accessible through practices of manipulation, storytelling, and symbolic construction. The material was approached as a medium for situated learning, capable of activating ecological imaginaries and forms of embodied knowledge in dialogue with bodies, gestures, and local ecologies. Educational kits, narrative modules, and play-based tools enabled a horizontal transmission of knowledge, oriented towards fostering environmental, emotional, and cultural awareness within educational contexts. Within this perspective, the BeeeCreative project in **Fig. 3** proposes a multisensory educational interface designed for early childhood and primary school settings. The kit is composed of natural materials (carded wool, felt balls, copper wire, non-woven fabric) and an illustrated A5 booklet introducing the wool cycle through accessible language and affective storytelling. At the core of the kit is a flexible metal wire coated in wool, freely shapeable, conceived to stimulate creativity, tactile exploration, and symbolic expression. Activities are differentiated by age group: for younger children, storytelling, sensory recognition, and association games; for older children, professional encounters, scientific experiments, and measurement exercises. The system also includes a series of learning cards designed in OpenDyslexic typeface to ensure accessibility and inclusive support for teaching. Within this context, wool emerges as an enabling medium for the activation of rooted, transformative, and participatory educational practices.
The research also explored the functional potential of native wool by investigating its physical and material properties within systems oriented towards sustainability, efficiency of use, and local traceability. A particularly representative example is the *Nodo* project, which applies eco-design principles by enhancing the keratinous structure of the fibre **Fig. 4**.

Designed for domestic use as a reusable laundry accessory, the device leverages the thermo-hygroscopic properties of raw wool to reduce residual moisture in garments, optimise drying times, and minimise the need for chemical additives. The design intervention integrates technical performance, raw material traceability, and artisanal production processes, thus constituting a micro product-service system based on reuse, circularity, and the valorisation of local resources. The *Five* project, on the other hand, investigates the application of native Sicilian wool in the field of sustainable packaging, through the development of a modular system inspired by the archetype of the number five **Fig. 5**.

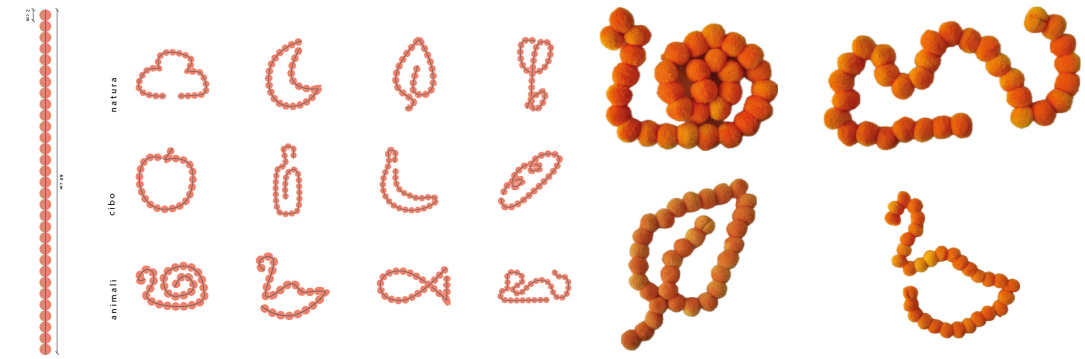

Fig. 3
BeeeCreative is a sensory-based educational kit fostering creativity, embodied learning, and material exploration. (Source: Project by Federica Lucido and Giuseppe Alotto)

Fig. 4
Nodo, wool dryer balls with thermo-hygroscopic and antistatic function. (Source: Project by Marco Barilà. Prototype by artisan Patrizia Scocco, Arti e mestieri della lana _ SiAmo mercatobianco)

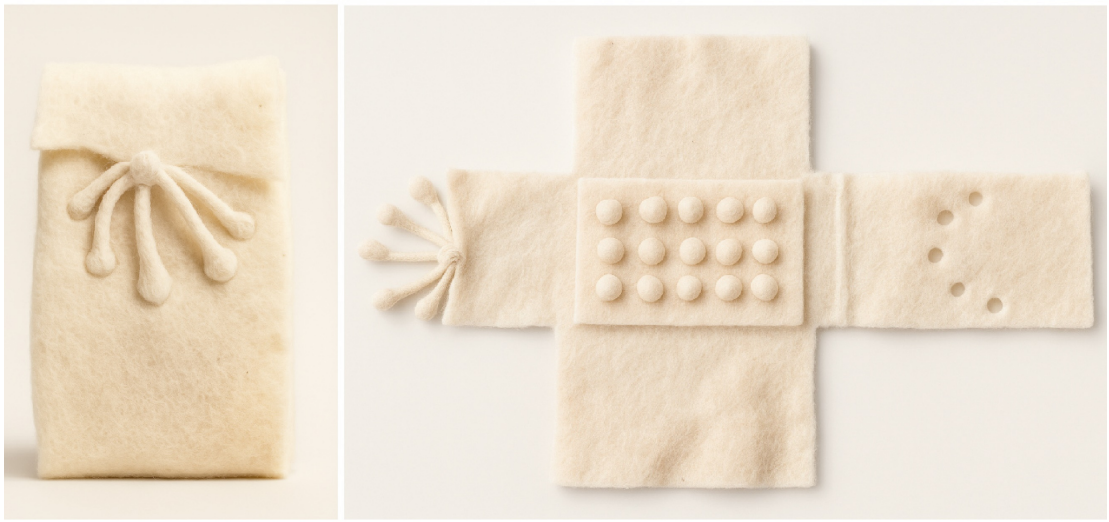

Fig. 5
Five, modular wool felt packaging inspired by the number five. Designed for jewelry, it integrates material tactility, reuse, and symbolic geometry. (Source: Project by Federica Lucido and Giuseppe Alotto. Prototype by artisan Patrizia Scocco, Arti e mestieri della lana _ SiAmo mercatobianco)

The symbolic reference to the human body, composed of five extremities and five senses, and to the penta-symmetric structures found in nature (flowers, elements, geometries) informs the packaging design, shaping it into a

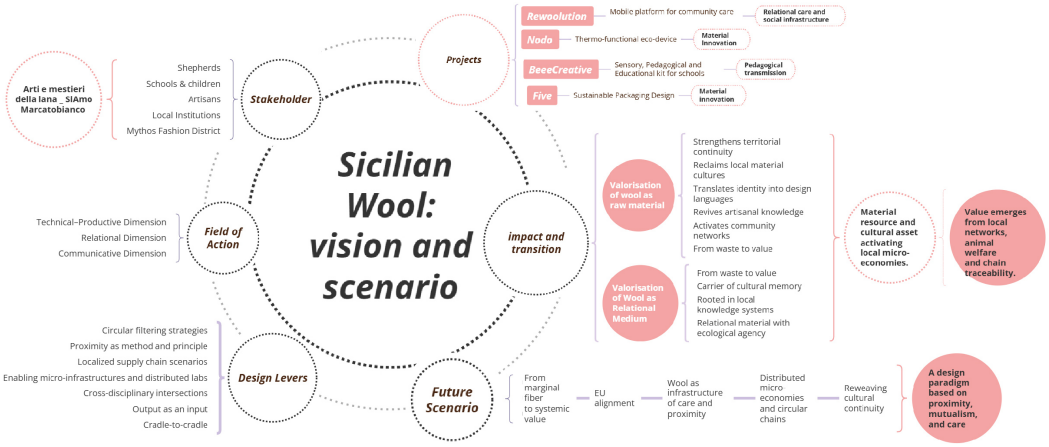

Fig. 6
Concept map illustrating the vision, design levers, and future scenarios related to the reconfiguration of Sicilian native wool as both a material and cultural infrastructure.

compact, foldable form rooted in the cultural logic of the gift. The object functions as a multifunctional micro-device designed for jewellery packaging, capable of integrating form, function, and material storytelling. The prototypes are made entirely of 100% wool felt, shaped without the use of adhesives or composite materials. The material used falls within the scope of Proof of Concept (POC 2 – TRL 3) research on the development of biocomposite fabrics and filaments made from natural fibres, specifically, non-woven fabric (TNT) and felt derived from virgin and/or recovered raw wool. From a technical perspective, the packaging meets key requirements of environmental sustainability (absence of adhesives, single-material components, recyclability), functional usability (flexibility, strength, modularity), and raw material traceability.

The set of experimental practices gave rise to a design model grounded in systemic activation, the construction of shared meaning, and the valorisation of interactions among material resources, distributed knowledge, and relational networks. Through these processes, native wool acted as a transformative vector, capable of reconfiguring roles, reactivating dormant economies, and generating new forms of territorial belonging. Design emerged as a practice of both cultural and operational orchestration, integrating productive ecologies, educational devices, and aesthetic codes within a regenerative design vision. In this context, wool is not merely a resource to be valorised, but a cultural infrastructure to be inhabited, redefined, and returned **Fig. 6**.

DESIGN PERSPECTIVES AND FUTURE SCENARIOS

The reconfiguration of wool as a generative resource acquires significance within a broader trajectory of territorial regeneration. In a context shaped by the decline of rural economies and the marginalisation of artisanal practices,

the rediscovery of this local fibre does not arise from nostalgic impulses. Rather, it opens spaces for experimentation with circular production models that are ecologically responsible and deeply rooted in place. The transition from discarded material to shared resource coincides with the emergence of a design paradigm grounded in proximity, mutualism, and care. Relations is the term that most effectively encapsulates the complexity encountered throughout the research process. The experimental work with native Sicilian wool has not merely investigated a material, but explored the entire ecosystem of relationships that sustain, traverse, and transform it. In this perspective, wool reveals itself as a relational material: the generation of value lies not solely in the final product, but in the network of connections activated through processes of collection, transformation, narration, and restitution. As part of this relational ecology, design operates as an enabling practice which, in line with the mediation skills of the Community Designer (Symbola, 2024), connects material flows, embedded knowledge, and local alliances, configuring lightweight infrastructures that support regenerative, place-based trajectories while reducing energy consumption and environmental impact. The systemic orientation adopted enables the integration of tradition and innovation, local knowledge and design tools, reinforcing an economy of relation that restores meaning to production as a situated and cooperative act. Recovering both the material and immaterial memory of wool thus entails a transformation in the very meanings attributed to the fibre: from by-product to pedagogical medium, from invisible residue to catalyst for sustainable practices.

The relational quality of the activated processes translates into environmental benefits (waste reduction, ecosystem regeneration), social benefits (valorisation of local knowledge, intergenerational cohesion), and economic benefits (emergence of micro-economies, development of high-value territorial products). This vision aligns with the strategic orientations outlined in European frameworks for the circular bioeconomy and ecological transition, which advocate for solutions capable of linking the local scale with systemic thinking, and innovation with social equity. Within this context, Sicily emerges not simply as the geographical site of experimentation, but as a critical laboratory in which new forms of territorial production are made visible—forms capable of integrating local resources, contextual knowledge, and transformative trajectories. In this configuration, native wool positions itself as a potential vector of eco-social transition, revealing how sustainability extends beyond technical parameters and is constituted within the relational density that binds materials, cultures, and territories. Looking ahead, the research invites a broader reflection that, starting from the Sicilian case, looks towards other similar experiences currently developing across Italy and Europe, envisioning the possibility of weaving a trans-territorial dialogue capable of enriching local specificities through a shared exchange of knowledge and practices regarding coarse wool valorisation.

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