Foundations for Forest-Based Entrepreneurial Ecosystems: An Assessment of a Spanish Region

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Posted Date: 2 July 2025

doi: 10.20944/preprints202507.0148.v1

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 doi:10.20944/preprints202507.0148.v1

Article

Foundations for Forest-Based Entrepreneurial Ecosystems: An Assessment of a Spanish Region

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Abstract

The forest-based bioeconomy (FBB) is increasingly recognized as a key pillar of European bioeconomy strategies, with potential to drive sustainable innovation, rural development, and climate action. However, regional disparities persist, particularly in Southern Europe. This study assesses the development of a FBB entrepreneurial ecosystem located in the Spanish region of Castilla-La Mancha, using an adapted multidimensional framework that considers institutional, supply, and demand-side drivers. Results indicate an incipient and fragmented ecosystem: while initiatives such as UFIL Cuenca foster entrepreneurship and innovation, the region lacks a coherent strategic vision, cluster development, and effective stakeholder coordination. Sectoral roundtables are viewed as critical but currently underutilized governance platforms. The study emphasizes the importance of aligning forest-based resources with supportive entrepreneurial environments—where networks, infrastructure, and institutional mechanisms interact—to enable systemic innovation and sustainable regional development. The findings highlight the need for integrated regional strategies, strengthened governance mechanisms, and expanded entrepreneurship support to advance the FBB ecosystem in CLM.

Keywords: forest-based bioeconomy; entrepreneurial ecosystem; innovation; governance; Castilla-La Mancha

1. Forest-Based Bioeconomy and Entrepreneurial Ecosystems

At the end of the twentieth century, the awareness of the pressure on resources led to a debate and analysis of the depletion of non-renewable resources (mainly those related to fossil resources) and its consequences [1]. Among other factors, the crucial importance of the substitutability of exhaustible resources with renewable ones is highlighted. This substitution would be possible thanks to a technological change that would allow the use of renewable resources at a lower cost than exhaustible ones [2]. The bioeconomy has been positioned as one of the alternatives to mainstream economics in which renewable resources become "the path towards a more innovative, efficient in the use of resources and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes, while guaranteeing the protection of the environment" [3].

The concept of the bioeconomy appeared in the OECD policies in 2009 as a driver of competitiveness and well-being, defining a new economy based on biological knowledge focused on biotechnology [4]. It is based on three fundamental factors: the biotechnological advanced knowledge of genes and complex cell processes, renewable biomass, and the integration of biotechnology applications across sectors [4]. Nevertheless, there is not just a biotechnological vision of the bioeconomy, research argues that it is possible to distinguish also a bio-resource vision and a bio-ecology vision [5]. In this sense, bioeconomy covers all sectors and systems depending on biological resources: primary production, renewable biomass and integration across applications [6,7].

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In this framework, forests and forest sector are important components of a bioeconomy [8] and are one of the pillars of the European bioeconomy [9]. Main products of the forestry sector contributing to economic growth can be grouped as follow: i) Traditional wood products, ii) Non-wood forestry products, iii) Emerging wood-based products with innovation potential for substitution, iv) Biomass, and v) Ecosystemic services [8]. Furthermore, cascading use of forest products, mainly in wood products but not only, aims to increase the efficiency of biomass utilization by reusing, recycling and ultimately generating energy [10].

The forest-based bioeconomy (FBB) brings both opportunities and challenges for Europe's forests: they represent the continent's largest renewable source of energy and materials, yet they also deliver a wide spectrum of additional ecosystem services—from protective functions like soil erosion control to cultural benefits such as recreation—and provide valuable goods like game and mushrooms. It serves not only as a pathway to economic growth but also as a driver of sustainable development and a catalyst for action against climate change. In Europe, the development of FBB has increased in the last few years [11], and several methodologies to measure this development have been proposed [12–14]. To assess the development of the FBB in European regions, Barañano et al. (2022) propose an analytical framework based on the evaluation of ten key drivers, grouped into four categories: institutional, supply, demand, and biomass-related drivers. This framework combines both primary sources (expert interviews) and secondary sources (literature review), following a structured methodology that allows for comparative analysis across regions. The institutional dimension includes government plans and policies, R&D and innovation capacity, training and talent, entrepreneurship ecosystem, green public procurement, and participation in regional networks. The supply dimension addresses entrepreneurial capacities and the presence of clusters, while the demand dimension focuses on market awareness and consumer demand. Finally, the biomass-related driver assesses the availability and sustainability of forest biomass resources [15].

Innovation plays an important role in the development of new products for a FBB, enabling entrepreneurs to creatively extract value from forest biomaterials [16]. Entrepreneurship is identified as a main enabler of the transformation toward an innovative, knowledge-based, and sustainable bioeconomy [16]. In the context of bioeconomy, entrepreneurs are seen as crucial for the transition toward a sustainable bioeconomy, turning environmental degradation caused by economic development into entrepreneurial opportunities [17]. Entrepreneurial activity involves risk, especially when competing with established markets based on fossil resources. Managing this risk often involves "entrepreneurial experimentation", rapidly testing new technologies and developing products, learning quickly from market exposure, and involving consumers early on. Developing innovative business models is a major task of entrepreneurs in the bioeconomy, aiming to change existing models not just by substituting resources but by introducing completely new ways of arranging value creation, potentially organized into different value chains or adopting whole-systems approaches [18].

However, innovation and entrepreneurship do not occur in isolation. They are shaped by specific environments known as entrepreneurial ecosystems (EEs)—regional contexts formed by interdependent actors, resources, and institutions that interact to support new venture creation. These ecosystems integrate formal and informal networks, physical infrastructure, and shared cultural outlooks, which collectively influence entrepreneurial capacity and innovation outcomes. EEs provide the systemic conditions (e.g., leadership, talent, finance, knowledge flows, and support services) necessary for productive entrepreneurship to emerge and scale [19,20]. In the bioeconomy, this means that the success of entrepreneurial efforts depends not only on individual initiative but on the structure and strength of the ecosystem that surrounds them.

Despite not having a shared definition for the concept [21], the concept generally refers to the interplay of multiple contextual factors—such as social, political, economic, and cultural conditions—that shape the capacity of a given territory to support entrepreneurship [19]. Building on this understanding, we adopt a perspective that sees EEs as regional environments in which diverse actors, resources, and institutions interact to foster the creation and growth of innovative ventures.

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This includes both formal and informal networks among actors, the availability of physical infrastructure, and the presence of an entrepreneurial culture [22,23]. As Kuckertz et al. (2020) highlight, individual entrepreneurial activity is not sufficient for bioeconomy transformation: the environment in which entrepreneurial activities happen (regions in this case) and dynamic combinations of actors that collectively drive bioeconomic innovation, determine what kind of entrepreneurial activities are available and can be realized.

The bioeconomy offers a plethora of entrepreneurial opportunities [24–26] and entrepreneurs are tasked with creatively extracting value from biomaterials [17,27,28]. This is seen not only in research- and technology-driven startups but also through initiatives like ecotourism or traditional products that can support the economic development of rural and indigenous communities [7].

Despite growing interest in the FBB, much of the existing research has focused on Northern and Central European contexts [29], where institutional conditions, innovation systems, and entrepreneurial dynamics are relatively advanced. In contrast, Southern European regions such as the Spanish region of Castilla-La Mancha (CLM) remain underexplored in terms of their potential to foster forest-based entrepreneurial ecosystems (FBEEs). Moreover, while analytical frameworks such as that of Barañano et al. (2022) provide valuable tools for assessing ecosystem drivers, there is a need to adapt and apply these frameworks to diverse territorial settings to better understand region-specific enabling and constraining factors. This study aims to contribute to this gap by providing both an empirical assessment of the FBB ecosystem in CLM and a conceptual definition of FBEE that can inform future ecosystem-building strategies. In doing so, the research seeks to lay the foundations for advancing FBEEs in Southern European and other underexplored contexts.

In this context, the FBB and EEs are not isolated concepts but interdependent forces that, when aligned, can enable sustainable regional development. The FBB provides a resource base rich in environmental and productive potential, while entrepreneurial ecosystems offer the institutional and relational conditions necessary for innovation to flourish. When embedded within supportive ecosystems, forest-based bioeconomic initiatives can transition from isolated experiments to systemic change. However, the degree to which these ecosystems exist, are coordinated, and effectively mobilize actors around forest-based opportunities remains unclear—particularly in rural and structurally disadvantaged regions. This intersection forms the basis of this research, which explores how entrepreneurial ecosystems can be fostered in support of a regional forest-based bioeconomy, using the case of CLM as an empirical lens.

In this research, we are focused on the CLM, a region in Southern Europe where the 48% of the territory is classified as forest area (3.807.561 ha), being the second largest region of Spain in terms of forest surface [30]. In recent years, the region has witnessed an increasing interest in linking forest resources with innovation and entrepreneurship, particularly in response to structural challenges such as depopulation, low industrial diversification, and underutilization of natural assets. These dynamics make CLM a particularly relevant context to explore the enabling and constraining factors for the emergence of forest-based entrepreneurial ecosystems in rural territories.

Building on the analytical framework of Barañano et al. (2022), the research objectives of this study are: i) To identify the enabling and constraining factors that shape the development of forest-based entrepreneurial ecosystems in Castilla-La Mancha; ii) To examine the extent to which regional strategies and conditions align to foster innovation and entrepreneurship towards a forest-based bioeconomy; iii) To analyse how specific regional initiatives contribute to innovation dynamics and the consolidation of entrepreneurial capacity within the FBEE.

The following sections present the methodological approach, based on a qualitative case study in Castilla-La Mancha, using stakeholder interviews and the analytical framework of Barañano et al. (2022). The results are structured around nine key drivers, offering a grounded assessment of the regional forest-based entrepreneurial ecosystem. The discussion connects these findings with broader literature on entrepreneurial ecosystems and bioeconomy. The paper concludes with strategic insights to strengthen institutional coordination, foster innovation and support entrepreneurship in rural regions.

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2. Methodology

This research is a qualitative study focused on the conditions for the development of a FBEE in CLM with the aim of identifying the enabling factors and barriers for innovation, entrepreneurship and entrepreneurial ecosystem consolidation in the forestry sector of CLM.

To address the current research questions and objectives, this study adopts a qualitative case study approach focused on CLM, with particular attention to the role of UFIL Cuenca within the emerging forest-based entrepreneurial ecosystem. The analysis applies the analytical framework of Barañano et al. (2022), which evaluates ten key drivers of forest-based bioeconomy development across institutional, supply, demand, and biomass-related dimensions. Empirical data were collected through semi-structured expert interviews with key stakeholders in the region, allowing for a systematic assessment of enabling and constraining factors shaping the FBEE in this Southern European context (Table 1).

Table 1. Thematic drivers and guiding questions used in semi-structured interviews to assess FBEE conditions in Castilla-La Mancha. Source: Own elaboration based on Barañano et al. (2022).

Driver	Question
Government plans and policies	Is there currently an innovation development strategy in the bioeconomy sector?
Research, development and innovation	What do you think is the current state of innovation - understood as the development of new products/services- in the forest-based bioeconomy in Cuenca/CLM? (Exists / Does not exist) (If it exists---> Level of development: high / medium / low)
Training and talent	Do you think there is a need for more professionalisation in the sector?
Ecosystem for entrepreneurship	Does the ecosystem of CLM the conditions to be innovative or to foster innovation?
Public-private collaboration	Do you think that there is public-private collaboration for the development of the forest bioeconomy?
Regional networks	What role do you think the sectoral roundtables should play in the future development of the sector?
Entrepreneurial capacities	Do you know UFIL Cuenca? Yes / No. What role should UFIL play in the ecosystem? And in the development of innovation?
Existence of clusters	Does a forest-based bioeconomy business ecosystem currently exist in Cuenca/CLM?
Market awareness and demand	What innovations or changes do you expect to see in the forestry sector in the coming years?
Biomass	Not addressed in this phase of the study (as explained in Section 3.2)

2.1. Thematic Focus

In line with the focus of this study on the development of the forest-based entrepreneurial ecosystem (FBEE), the analysis emphasized the institutional, supply, and demand-related drivers of the framework. Some drivers have been adapted to the understanding of the entrepreneurial ecosystems in forest-based bioeconomy.

Although the analytical framework proposed by Barañano et al. (2022) provides a robust basis for evaluating the development of forest-based bioeconomy (FBBE) across European regions, its original formulation is oriented towards systemic assessment of sectoral capacities—particularly in terms of biomass valorization, institutional coordination, and policy implementation. Given that the present study focuses on the enabling and constraining conditions for entrepreneurship and

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innovation in FBBE within Castilla-La Mancha, a selective adaptation of the framework has been applied to align with the specific research objectives and empirical scope.

This adaptation is theoretically grounded in the convergence between regional innovation systems (Cooke et al., 1997) and the entrepreneurial ecosystems perspective (Spigel, 2017; Stam, 2015), both of which emphasize the interplay between institutional, cultural, and relational dimensions in fostering entrepreneurship. In this light, rather than offering a static evaluation of sectoral structures, the analysis seeks to understand how regional configurations—networks, policies, resources, and actors—interact to generate entrepreneurial dynamics, particularly in emerging and structurally disadvantaged territories.

Three main adjustments were introduced:

- The "Green Public Procurement" dimension has been reframed into "Public-Private Collaboration". While public procurement is a relevant mechanism for stimulating innovation, interview data and institutional context in Castilla-La Mancha revealed a more general concern with the effectiveness of collaborative governance and coordination between public and private actors. Therefore, this category was reformulated to capture a broader spectrum of interaction, including informal partnerships, joint initiatives, and institutional co-design mechanisms.
- The "Regional Networks" dimension has been transformed into "Regional Ecosystem Governance". The original framework emphasizes formal regional networks as enablers of system integration. However, empirical evidence pointed to the critical, yet underutilized, role of existing institutional structures—especially sectoral roundtables—in articulating the ecosystem. Accordingly, this driver was adjusted to better assess the operational capacity and strategic function of these coordination arenas.
- Finally, the biomass-related driver, which assesses technical aspects such as resource availability, sustainability, and utilization potential, was not included in this analysis. This decision reflects the study's focus on the institutional and entrepreneurial dynamics rather than the bio-physical dimension of the sector.

Table 3. framework to analyse forest-based entrepreneurial ecosystems. Own elaboration.

Original Driver (Barañano et al., 2022)	Adapted Driver	Description for Adaptation
Government plans and policies	Government plans and policies	
Research, development, and innovation	Research, development, and innovation	
Training and talent	Training and talent	
Ecosystem for entrepreneurship	Ecosystem for entrepreneurship	
Green public procurement	Public-private collaboration	
Regional networks	Regional governance networks	Regional existing structures articulating the value chain and entrepreneurial ecosystem
Entrepreneurial capacities		
Existence of clusters		
Market awareness and demand	Market awareness and demand	Retained to evaluate the extent of demand articulation, market readiness, and perception of forest-based bioeconomic products and services.
Biomass	Not included in this research	Excluded to focus the analysis on institutional and

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		entrepreneurial drivers; the study does not assess technical or biophysical aspects of biomass availability.

[1] Source: Adaptation of Barañano et al. (2022).

This tailored framework remains consistent with the systemic and multidimensional logic proposed by Barañano et al., yet reorients it toward a more actor-centered and innovation-driven analysis. It thereby enhances the framework's applicability to studies concerned with the emergence and consolidation of forest-based entrepreneurial ecosystems in peripheral or transitioning regions.

2.2. Sample Design and Selection

The data were collected through a series of semi-structured interviews that were originally designed to explore the conditions for the development of the FBEE and innovation dynamics in the region.

The sample was purposefully designed to include key stakeholders with in-depth knowledge and direct involvement in institutional and entrepreneurial dynamics shaping the FBEE in Castilla-La Mancha.

Selection criteria included: (1) representing at least one of the main stakeholder groups involved in the regional forestry sector and bioeconomy (public officials, forest managers, companies, entrepreneurs, research centres, associations, etc.); (2) having participated in institutional or innovation-related dynamics in the sector, such as sectoral roundtables, innovation networks, entrepreneurship programs (e.g., UFIL Cuenca), or public-private collaboration spaces; (3) holding a strategic role in national or supranational institutions with potential influence over innovation financing or policy frameworks relevant to the development of the forest-based bioeconomy in Castilla-La Mancha.

This sampling strategy was considered appropriate to capture a diverse range of perspectives on the key enabling and constraining factors for FBEE development in the region, and to ensure relevance to the study's research questions and objectives. The following table presents an overview of the interviewed stakeholders, detailing their institutional affiliations, roles within the forest-based bioeconomy ecosystem, and their participation in relevant innovation or entrepreneurship initiatives.

Table 2. Profile of interviewed stakeholders involved in the forest-based bioeconomy in Castilla-La Mancha.

Stakeholder group	Entity	Role in the FBEE Ecosystem
Public sector	Junta de Comunidades de Castilla-La Mancha	Regional policy and forest management
Private Company	Cambium Tech	Forest-based products supplier
Private Company	ERTA	Forest-based products supplier
Public Company	Asociación de Maderas de Cuenca	Forest-based products supplier
Association/Foundation	ASEMFO	Forest-services companies representation
Association/Foundation	Forest Stewardship Council Spain (FSC Spain)	Sustainable forest certification
Association/Foundation	CESEFOR	Research, innovation, training and support to sectoral networks
Association/Foundation	COSE	Forest owners representation
Association/Foundation	CEOE	Local companies and business representation

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Association/Foundation	Fundación Gómez-Pintado	Social innovation and construction sector linkages
University	Universidad de Castilla-La Mancha	Research, innovation and training
University	Universidad Politécnica de Madrid	Research, innovation and training

2.3. Interview Process and Data Processing

A total of 15 semi-structured interviews were conducted using the Zoom platform, with informed consent obtained from all participants for the recording and analysis of the interviews. The resulting transcripts were automatically generated and subsequently manually validated by the research team to ensure accuracy.

The interviews were semi-structured, including three control questions and ten thematic questions, organized around key analytical areas derived from an adapted version of the framework of Barañano et al. (2022).

For the analysis, a deductive thematic analysis was conducted, using the analytical framework of Barañano et al. (2022) as the coding structure. Relevant excerpts from the transcripts were identified and organized according to the key drivers of forest-based bioeconomy development proposed in the framework. This process was supported by iterative comparison of responses across stakeholders to enhance consistency and depth of interpretation.

To complement the thematic coding analysis and provide a comparative lens across drivers, an ordinal scoring system was developed and applied. This scoring mechanism, adapted from Barañano et al. (2022), serves as a heuristic tool to synthesize stakeholder perceptions into structured assessments, ranging from 0 (no presence) to 5 (full consolidation). Each score reflects the level of systemic maturity of the ecosystem along each driver and was derived from qualitative indicators such as frequency and depth of references, consensus among stakeholders, and the presence of concrete institutional mechanisms or practices. This hybrid approach combines the depth of qualitative insight with the clarity and comparability of semi-quantitative assessment, enabling a more holistic evaluation of the ecosystem's enabling and constraining conditions. The full scoring framework and methodological rationale are detailed in Appendix A.

3. Results

The interviews reveal a complex and uneven landscape marked by a combination of promising opportunities and systemic constraints that shape the development of a forest-based entrepreneurial ecosystem (FBEE) in Castilla-La Mancha.

One of the most frequently mentioned constraining factors concerns (1) government plans and policies. The interviewees point out the lack of a coherent and strategic regional policy for forest-based innovation and entrepreneurship. While some sectoral initiatives—such as projects in biomass, resin, or essential oils—have emerged, they are perceived as isolated actions, disconnected from a broader vision. The absence of a formal policy framework aligned with long-term goals and stakeholder needs is consistently cited as a critical limitation. This lack of institutional coordination is seen to hinder the activation of latent innovation potential and to reduce the visibility and legitimacy of the forest-based bioeconomy agenda within the region.

In terms of (2) research, development and innovation capacities, though present in some segments, are largely considered incipient and fragmented. Several stakeholders identify the Urban Forest Innovation Lab (UFIL Cuenca) as a promising catalyst, enabling new initiatives and activating local entrepreneurial talent. However, even these efforts are seen as fragile and insufficiently supported by systemic mechanisms. Respondents note the absence of dedicated innovation infrastructures, sustained funding, and inter-institutional collaboration, which prevents the scaling of successful cases. These limitations contribute to a perception that innovation in the sector remains more aspirational than established.

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Regarding (3) training and talent, human capital also represents a major structural constraint. There is widespread concern about the low levels of professionalization within the forestry sector, with critical gaps identified not only in technical forestry skills but also in entrepreneurial competencies, market orientation, and management capabilities. Educational offerings are considered misaligned with the evolving demands of the sector, and the lack of economically viable conditions further weakens retention of skilled professionals. While some interviewees refer to promising initiatives such as microcredential programmes and specialized academies, these are still in early stages and do not yet meet the scale of the challenge.

From the perspective of (4) ecosystem for entrepreneurship, most respondents agree that Castilla-La Mancha does not yet have a functional entrepreneurial ecosystem in the forest-based bioeconomy. Although Cuenca has emerged as a focal point for innovation through projects like UFIL [31,32], the overall picture is one of fragmentation, weak articulation among actors, and poor cross-sectoral collaboration. The region's innovative business fabric is described as embryonic, and there is a general lack of shared platforms or support structures capable of orchestrating collective learning, investment, and strategy.

One of the key enablers identified is the existence of (5) public-private collaboration mechanisms, albeit limited in scope and institutionalization. Interviewees value UFIL Cuenca as a rare example of effective public intervention that has mobilized entrepreneurs and support organizations. However, they also point out that such initiatives are too dependent on specific funding cycles and lack continuity. Broader regional collaboration is often contrasted with more advanced models in other territories, such as Galicia, where institutional frameworks like XERA enable more cohesive and long-term cooperation. Structural barriers—including insufficient public funding, fragmented governance, and a weak collaborative culture—further constrain the scaling of these efforts.

A similar ambivalence is reflected in (6) regional governance networks, particularly the Sectoral Roundtables. These spaces are widely perceived as underutilized and ineffective, with limited convening power and low operational follow-up. Nonetheless, nearly all interviewees see potential in transforming these forums into genuine platforms for strategic coordination, diagnosis, and shared action. This reflects a broader recognition that the region needs not only innovative entrepreneurs but also governance mechanisms that can support and align collective efforts.

The (7) entrepreneurial capacities observed across the region are heterogeneous. Some actors, particularly those with access to research networks or European funding, demonstrate proactive innovation through digitalization, technological traceability, and ecosystem-based business models. These entities often operate as facilitators of innovation for other smaller players, offering services or acting as demonstration projects. In contrast, many other actors express more constrained views, noting that what innovation exists is often "forced" rather than strategic driven by regulatory compliance or market survival rather than by vision or differentiation. Barriers such as lack of skilled labour, limited access to capital, and insufficient support for early-stage ventures are frequently mentioned.

Concerning (8) existence of cluster dynamics, most interviewees identify UFIL Cuenca as the most visible and successful initiative in the region's forest-based bioeconomy. They describe it as a key actor with the potential to act as a cluster nucleus, serving multiple roles: talent incubator, innovation catalyst, platform for inter-institutional collaboration, and conduit between research and market. Stakeholders emphasize its function as a connector and activator of entrepreneurial culture, with the capacity to bridge gaps between isolated actors and domains. However, concerns remain about its limited institutional integration and overreliance on temporary funding schemes. Several interviewees advocate for scaling UFIL into a region-wide innovation hub, comparable to entities like Cesefor in Castilla y León or XERA in Galicia.

Finally, market awareness and demand (9) appear as driven by market-linked innovations that extend beyond technological advances. There is growing interest in mechanisms such as carbon credit markets, ecosystem service compensation, and the creation of transparent trading platforms

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for forest products. Some stakeholders emphasize the need to leverage digital tools—such as blockchain and remote sensing—to provide objective carbon traceability, aligning forest management with climate-related market demands. Others highlight structural changes like the anticipated surge in wood demand, the rise of timber construction, and the integration of forestry with other sectors (e.g., tourism, education, health). These expectations reveal a strategic awareness of market opportunities, yet they also underscore the sector's current limitations in adapting to demand signals. Overall, the responses suggest that increasing market intelligence and demand alignment is essential for unlocking the economic potential of a sustainable forest-based bioeconomy.

The development of a robust FBEE in Castilla-La Mancha is currently shaped by a tension between significant enabling assets (such as existing pilot initiatives, regional entrepreneurial ambition, and underexploited ecological resources) and entrenched structural constraints. The main issues are the lack of a coherent regional strategy, weak institutional coordination, limited human capital and inadequate support mechanisms for entrepreneurship and innovation.

Table 3. Scores between the key drivers of forest bioeconomy development according to Barañano et al. (2022) and the regional ecosystem analysis questionnaire.

Driver	Score	Justification
1. Government plans and policies	1,5	Informal or nascent strategy mentioned by most participants; no structured or widely known plan.
2. Research, development and innovation	2,5	Described as "incipient"; some emerging cases but lack of strategic articulation.
3. Training and talent	2	Strong consensus on the lack of qualified human capital. Frequently mentioned but no structured solutions.
4. Ecosystem for entrepreneurship	2	Most agree no structured ecosystem exists, though early-stage signals are noted.
5. Public-private collaboration	2	Collaboration is weak and not institutionalised, with a few exceptions such as UFIL Cuenca.
6. Regional governance networks	2	Sectoral roundtables are underutilised but have high potential if strategically restructured.
7. Entrepreneurial capacities	2	There are innovative actors, but most face structural barriers that limit their entrepreneurial capacity.
8. Existence of clusters	2,5	UFIL Cuenca is a key node, but there is still a lack of coordination and cohesion within the regional ecosystem.
9. Market awareness and demand	3	Clear anticipation of changes (tech, services, markets), although their effective implementation is yet to be developed.

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4. Discussion

The analysis reveals that the institutional landscape in Castilla-La Mancha does not yet provide the systemic alignment necessary to foster a robust forest-based entrepreneurial ecosystem (FBEE). Despite the growing recognition of the bioeconomy as a driver for sustainable regional development (European Commission, 2012; Verkerk, 2022), the case of Castilla-La Mancha exemplifies a gap between conceptual commitments and institutional praxis. While some enabling initiatives and territorial assets exist, the absence of cohesive policies, fragmented governance structures, and underdeveloped support systems represent significant limitations to the emergence of a dynamic and innovative forest-based economy.

As Barañano et al. (2022) stress, institutional coordination and government strategy are foundational for FBEE development. However, the findings suggest that in Castilla-La Mancha, regional policies remain fragmented and fail to provide an integrated roadmap for forest-based innovation. Sector-specific projects—such as those in resin, biomass, or essential oils—are perceived as isolated and disconnected from broader developmental goals. This disarticulation reduces institutional legitimacy and the ability to mobilize actors around a shared vision. Furthermore, the absence of strategic alignment weakens the region's capacity to activate its latent innovation potential (Kuckertz et al., 2020).

While initiatives such as UFIL Cuenca demonstrate potential as catalysts for innovation, they lack sufficient structural support. Their success remains precarious due to temporary funding and weak institutional embedding. These characteristics contrast sharply with the more consolidated innovation ecosystems in other European regions (e.g., Galicia's XERA). The situation in Castilla-La Mancha exemplifies the limitations of what Spigel (2017) would describe as an "incomplete ecosystem," where critical support infrastructures are underdeveloped or ephemeral.

This misalignment also reflects the lack of dedicated innovation infrastructures, including incubators, accelerators, and sustained funding channels. As Kuckertz et al. (2020) note, innovation in the bioeconomy requires not only individual entrepreneurial agency but also enabling environments that reduce risk and encourage experimentation. In Castilla-La Mancha, such environments remain under construction.

Despite efforts to promote specialized training (e.g., microcredentials or planned academies), the forestry sector still suffers from low levels of professionalization. As highlighted in the interviews, technical and managerial competencies are insufficiently addressed in current educational frameworks. This divergence limits both the entrepreneurial and absorptive capacities of the territory (Stam, 2015), weakening its ability to adapt to new value chains and market opportunities.

Moreover, without economically viable prospects in the forestry sector, talent retention remains a key challenge. This reveals a vicious cycle in which limited profitability undermines the development of human capital, which in turn constrains innovation and entrepreneurship.

Institutional arrangements such as Sectoral Roundtables, while formally in place, are widely regarded as ineffective. Their limited operational capacity and lack of follow-up mechanisms prevent them from becoming true platforms for strategic coordination. This finding is consistent with Theodoraki & Messeghem's (2017) assertion that governance structures must go beyond formal existence and exhibit functionality and legitimacy.

Some interviewees recognized the potential of these forums to evolve into governance hubs, but this would require a cultural shift towards institutionalized collaboration and co-design. Currently, collaboration depends more on individual relationships than on durable inter-organizational mechanisms.

Although the region does not yet possess a fully consolidated forest-based business ecosystem, the data point to the existence of initiatives with catalytic potential, such as UFIL Cuenca. According to interviewees, this program has acted as a bridge between entrepreneurs, public administration, and knowledge centers, helping to articulate projects and develop entrepreneurial skills. While its reach remains limited and localized, it is recognized for its potential to catalyze collaborative

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networks and facilitate knowledge transfer in the absence of structured governance and innovation mechanisms.

Additionally, the region benefits from underutilized forest resources, a growing awareness of ecosystem service markets (e.g., carbon credits), and interest in new value chains such as biomaterials or wood construction. These conditions offer potential for strategic innovation, but without institutional mechanisms to coordinate investment, knowledge transfer, and regulatory alignment, these assets remain underexploited.

5. Conclusions

This study provides an empirical assessment of the state of the forest-based bioeconomy ecosystem in Cuenca and Castilla-La Mancha, applying a variation of the analytical framework developed by Barañano et al. (2022).

The case of Castilla-La Mancha illustrates the complex interplay between territorial potential and systemic institutional limitations in the development of a forest-based entrepreneurial ecosystem. While the region possesses valuable ecological assets, emerging initiatives such as UFIL Cuenca, and increasing interest in bioeconomic innovation, these elements are not yet embedded within a coherent strategic framework. The absence of an integrated regional policy, coupled with weak institutional coordination and underdeveloped support infrastructures, significantly constrains the capacity of the region to transition from isolated efforts to a mature and resilient ecosystem.

The findings underscore that entrepreneurship and innovation in the bioeconomy cannot thrive solely on individual initiative. As emphasized by Barañano et al. (2022), Kuckertz et al. (2020), and Stam (2015), the consolidation of a FBEE requires systemic alignment across government strategy, human capital development, institutional governance, and public-private collaboration. Castilla-La Mancha's current configuration reflects a low-maturity ecosystem, in which structural fragmentation and a lack of institutional embeddedness hinder the full realization of its bioeconomic potential.

By applying the Barañano et al. (2022) framework to a Southern European context, this research contributes to the growing body of literature on bioeconomy transitions and demonstrates the framework's utility for ecosystem diagnosis in diverse territorial settings. The results underscore that achieving a mature forest-based bioeconomy in CLM will require synchronized progress across institutional, supply, demand, and resource dimensions.

Future research should further explore effective governance models for emerging FBB ecosystems in peripheral and rural regions and examine how initiatives like UFIL Cuenca can be scaled or replicated to drive systemic transformation. Additionally, more attention should be paid to the role of entrepreneurial ecosystems as critical enablers of the forest-based bioeconomy, particularly in Southern European and Mediterranean contexts that remain underrepresented in current scholarship.

These findings not only contribute to the academic understanding of forest-based bioeconomy transitions in Southern European contexts but also highlight practical implications for policymakers and stakeholders. The following section outlines specific policy recommendations to support the development of a more cohesive and dynamic forest-based entrepreneurial ecosystem in Castilla-La Mancha.

6. Recommendations

Based on the findings of this study, several recommendations can be proposed to foster the development of a more cohesive and dynamic forest-based entrepreneurial ecosystem in Castilla-La Mancha.

First, it is critical to develop a comprehensive regional strategy for the forest-based bioeconomy, aligned with European and national bioeconomy frameworks. This strategy should articulate clear objectives, priority areas for innovation, and coordination mechanisms to overcome current fragmentation and provide long-term guidance to both public and private actors. In this regard,

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strengthening public-private collaboration and supporting cluster formation would be key to enhance entrepreneurial capacities in the sector.

Second, existing sectoral roundtables should be reinforced and professionalized as core platforms for stakeholder coordination and strategic governance. As highlighted by interviewees, these spaces must evolve beyond their current consultative role to become operational forums for shared diagnosis, co-creation, and policy influence. Their composition should be inclusive, with representation from administration, businesses, forest owners, research institutions, and civil society. Regular meetings, actionable agendas, and robust monitoring systems are needed to ensure their effectiveness and impact.

Finally, initiatives such as UFIL Cuenca demonstrate the value of entrepreneurship support programs in catalysing innovation and talent development in the forest sector. Scaling such models regionally—through replication, networking, and integration with sectoral governance structures—would amplify their transformative potential. Additionally, targeted investments in training and capacity building, particularly for young entrepreneurs and rural stakeholders, are needed to bridge current human capital gaps and foster a vibrant and inclusive FBEE in CLM.

Author Contributions: Conceptualization, C.M.A. and C.A.P.; C.M.A.; validation, C.A.P.; formal analysis, C.MA.; investigation, C.M.A.; resources, C.M.A.; data curation, C.M.A.; writing—original draft preparation, C.M.A.; writing—review and editing, C.A.P.; supervision, C.A.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Data Availability Statement: Not applicable

Acknowledgments: In this section, you can acknowledge any support given which is not covered by the author contribution or funding sections. This may include administrative and technical support, or donations in kind (e.g., materials used for experiments). Where GenAI has been used for purposes such as generating text, data, or graphics, or for study design, data collection, analysis, or interpretation of data, please add "During the preparation of this manuscript/study, the author(s) used [tool name, version information] for the purposes of [description of use]. The authors have reviewed and edited the output and take full responsibility for the content of this publication."

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CLM	Castilla-La Mancha
FBB	Forest-based bioeconomy
FBEE	Forest-based entrepreneurial ecosystem
UFIL	Urban Forest Innovation Lab

Appendix A

To complement the qualitative coding analysis, we developed an ordinal scoring system to evaluate stakeholder perceptions across the ten key drivers of forest-based bioeconomy development in Castilla-La Mancha. This methodological approach aims to combine the depth of qualitative inquiry with the comparability and clarity of a structured ordinal assessment.

A.1. Conceptual Rationale

The scoring framework is adapted from the regional bioeconomy evaluation model proposed by Barañano et al. (2022) and methodologically grounded in qualitative content analysis and institutional maturity models. This system was designed to synthesize semi-structured interview

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data into a structured comparative format, allowing for inter-driver analysis and visualization of systemic gaps and strengths.

A.2. Scoring Scale and Criteria

Each driver was assigned a score ranging from 0 (absence) to 5 (consolidation) according to the following ordinal interpretive framework:

A.3. Operationalization

Scores were assigned based on five qualitative indicators extracted from the coded interview data:

- Frequency of mentions across the sample.
- Consensus or divergence in stakeholder responses.
- Linguistic tone (positive, negative, neutral).
- Conceptual depth in response narratives.
- Concrete examples of implementation or impact.

Each driver was scored independently by the research team, with results cross-validated through team discussions and supported by direct quotes in the analytical matrix. This triangulation ensures methodological transparency and guards against individual researcher bias.

The use of ordinal scoring in qualitative research is intended not as quantification, but as a heuristic device to structure complex perceptions, guide comparative analysis, and enhance communicability of findings for policy-making and strategic design in innovation ecosystems.

Table A1. Scoring scale and criteria.

Score	Interpretive Criteria
1	Absence or marginal presence.
2	Incipient presence, sporadic or uncoordinated activities.
3	Operational presence with partial articulation or limited scale.
4	Partial consolidation, recognized functionality across stakeholders.
5	Full consolidation, mature integration, and systemic impact.

References

1. Meadows, D.H.; Meadows, D.L.; Randers, J.; Behrens, W.W. *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*; Universe Books, 1972; ISBN 978-0-87663-165-2.
2. Dasgupta, P.; Heal, G. The Optimal Depletion of Exhaustible Resources12. *The Review of Economic Studies* **1974**, *41*, 3–28, doi:10.2307/2296369.
3. Directorate-General for Research and Innovation (European Commission) *Innovating for Sustainable Growth: A Bioeconomy for Europe*; Publications Office of the European Union, 2012; ISBN 978-92-79-25376-8.
4. OECD *The Bioeconomy to 2030: Designing a Policy Agenda*; OECD, 2009; ISBN 978-92-64-03853-0.
5. Bugge, M.M.; Hansen, T.; Klitkou, A. What Is the Bioeconomy? A Review of the Literature. *Sustainability* **2016**, *8*, 691, doi:10.3390/su8070691.
6. European Commission A Sustainable Bioeconomy for Europe: Strengthening the Connection between Economy, Society and the Environment Available online: https://op.europa.eu/en/publication-detail/-/publication/4999712a-cd5f-11e8-9424-01aa75ed71a1/language-en (accessed on 30 October 2024).
7. Rinn, R.; Kalábová, M.; Jarský, V. Bioeconomy-Based Tourism: A New Concept Responding to the Support of Bioeconomy. *Front. Environ. Sci.* **2023**, *11*, doi:10.3389/fenvs.2023.1122440.
8. Verkerk, P.J. *Forest Products in the Global Bioeconomy*; FAO ;, 2022; ISBN 978-92-5-135151-2.

 doi:10.20944/preprints202507.0148.v1

9. Lovrić, M.; Lovrić, N.; Mavsar, R. Mapping Forest-Based Bioeconomy Research in Europe. *Forest Policy and Economics* **2020**, *110*, 101874, doi:10.1016/j.forpol.2019.01.019.
10. Jarre, M.; Petit-Boix, A.; Priefer, C.; Meyer, R.; Leipold, S. Transforming the Bio-Based Sector towards a Circular Economy - What Can We Learn from Wood Cascading? *Forest Policy and Economics* **2020**, *110*, 101872, doi:10.1016/j.forpol.2019.01.017.
11. Mougenot, B.; Doussoulin, J.-P. Conceptual Evolution of the Bioeconomy: A Bibliometric Analysis. *Environment Development and Sustainability* **2022**, *24*, doi:10.1007/s10668-021-01481-2.
12. Arnould, M.; Morel, L.; Fournier, M. Embedding Non-Industrial Private Forest Owners in Forest Policy and Bioeconomy Issues Using a Living Lab Concept. *Forest Policy and Economics* **2022**, *139*, 102716, doi:10.1016/j.forpol.2022.102716.
13. Blumberga, D.; Muizniece, I.; Zihare, L.; Sniega, L. Bioeconomy Mapping Indicators and Methodology. Case Study about Forest Sector in Latvia. *Energy Procedia* **2017**, *128*, 363–367, doi:10.1016/j.egypro.2017.09.053.
14. Lovrić, N.; Lovrić, M.; Mavsar, R. Factors behind Development of Innovations in European Forest-Based Bioeconomy. *Forest Policy and Economics* **2020**, *111*, 102079, doi:10.1016/j.forpol.2019.102079.
15. Barañano, L.; Unamunzaga, O.; Garbisu, N.; Briers, S.; Orfanidou, T.; Schmid, B.; Martínez de Arano, I.; Araujo, A.; Garbisu, C. Assessment of the Development of Forest-Based Bioeconomy in European Regions. *Sustainability* **2022**, *14*, 4747, doi:10.3390/su14084747.
16. Kuckertz, A.; Berger, E.S.C.; Brändle, L. Entrepreneurship and the Sustainable Bioeconomy Transformation. *Environmental Innovation and Societal Transitions* **2020**, *37*, 332–344, doi:10.1016/j.eist.2020.10.003.
17. Dean, T.J.; McMullen, J.S. Toward a Theory of Sustainable Entrepreneurship: Reducing Environmental Degradation through Entrepreneurial Action. *Journal of Business Venturing* **2007**, *22*, 50–76, doi:10.1016/j.jbusvent.2005.09.003.
18. Stegmann, P.; Londo, M.; Junginger, M. The Circular Bioeconomy: Its Elements and Role in European Bioeconomy Clusters. *Resources, Conservation & Recycling: X* **2020**, *6*, 100029, doi:10.1016/j.rcrx.2019.100029.
19. Malecki, E.J. Entrepreneurship and Entrepreneurial Ecosystems. *Geography Compass* **2018**, *12*, e12359, doi:10.1111/gec3.12359.
20. Theodoraki, C.; Dana, L.-P.; Caputo, A. Building Sustainable Entrepreneurial Ecosystems: A Holistic Approach. *Journal of Business Research* **2022**, *140*, 346–360, doi:10.1016/j.jbusres.2021.11.005.
21. Stam, E. Entrepreneurial Ecosystems and Regional Policy: A Sympathetic Critique. *European Planning Studies* **2015**, *23*, 1759–1769, doi:10.1080/09654313.2015.1061484.
22. Spigel, B. The Relational Organization of Entrepreneurial Ecosystems. *Entrepreneurship Theory and Practice* **2017**, *41*, 49–72, doi:10.1111/etap.12167.
23. Theodoraki, C.; Messeghem, K. Exploring the Entrepreneurial Ecosystem in the Field of Entrepreneurial Support: A Multi-Level Approach. *International Journal of Entrepreneurship and Small Business* **2017**.
24. D'Amato, D.; Veijonaho, S.; Toppinen, A. Towards Sustainability? Forest-Based Circular Bioeconomy Business Models in Finnish SMEs. *Forest Policy and Economics* **2020**, *110*, 101848, doi:10.1016/j.forpol.2018.12.004.
25. Laktuka, K.; Kubule, A.; Vamza, I.; Rozakis, S.; Blumberga, D. Strategic Pathways for a Bioeconomy with High Value-Added Products: Lessons Learnt from the Latvian Forest Sector. *Biomass and Bioenergy* **2024**, *190*, 107400, doi:10.1016/j.biombioe.2024.107400.
26. McCormick, K.; Kautto, N. The Bioeconomy in Europe: An Overview. *Sustainability* **2013**, *5*, 2589–2608, doi:10.3390/su5062589.
27. Birch, K. Knowledge, Place, and Power: Geographies of Value in the Bioeconomy. *New Genetics and Society* **2012**, *31*, 183–201, doi:10.1080/14636778.2012.662051.
28. Hinderer, S.; Kuckertz, A. The Bioeconomy Transformation as an External Enabler of Sustainable Entrepreneurship. *Business Strategy and the Environment* **2022**, *31*, 2947–2963, doi:10.1002/bse.3056.
29. Di Letizia, G.; De Lucia, C.; Pazienza, P.; Cappelletti, G.M. Forest Bioeconomy at Regional Scale: A Systematic Literature Review and Future Policy Perspectives. *Forest Policy and Economics* **2023**, *155*, 103052, doi:10.1016/j.forpol.2023.103052.
30. MITECO *Cuarto Inventario Forestal Nacional En La C.A. Castilla-La Mancha*; Madrid, 2023;

 doi:10.20944/preprints202507.0148.v1

31. Muñoz Arenas, C.; Avilés Palacios, C.; Morillas Guerrero, J.J. Bioeconomy Ecosystem to Boost Entrepreneurship: The Urban Forest Innovation Lab Cuenca (UFIL Cuenca) Case. In Proceedings of the Organizational Engineering, Coping with Complexity; Carrasco-Gallego, R., Moreno-Serna, J., Gutierrez, M., Avilés-Palacios, C., Eds.; Springer Nature Switzerland: Cham, 2025; pp. 605–609.
32. Avilés Palacios, C.; Muñoz-Arenas, C.; García-Alfonso, J. Ecosistemas Emergentes Para El Fomento de La Bioeconomía Forestal En España–El Caso UFIL Cuenca. In Proceedings of the Actas del Noveno Congreso Forestal Español; Sociedad Española de Ciencias Forestales, 2025.