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Inclusive pathways to a sustainable bioeconomy: Balancing inclusion and economic feasibility in new bio-based value chains

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ABSTRACT

The transition to a circular bioeconomy, where biological resources replace inputs from fossil fuels, offers a promising pathway to address climate change and sustainability challenges. However, establishing new bio-based value chains (BBVCs) presents substantial challenges, particularly concerning stakeholder inclusion, distributive justice, and context-sensitive implementation. While inclusive strategies have been extensively studied in agri-food systems, their practical application in the bioeconomy remains underexplored. This paper investigates how inclusive business, inclusive value chain, and inclusive development strategies can be applied to BBVCs. Drawing on a comparative analysis of three empirical case studies, olive oil residues in Spain, coffee and cocoa residues in Colombia, and encroacher bush in Namibia, we examine the practical and contextual barriers to inclusion and identify what different stakeholders require to meaningfully engage to create positive social impact and a just transition towards a sustainable bioeconomy.

Our findings underscore the importance of a pluralistic, stepwise approach to inclusion, acknowledging that full inclusion may not be feasible initially in all contexts, particularly where enabling environments are weak. Instead, more modest strategies such as inclusive business can serve as an entry point, providing tangible benefits while laying the groundwork for more ambitious inclusion over time. We argue that inclusive learning and adaptive strategies are essential to balance ideal goals with practical constraints, and that inclusive BBVCs must evolve in response to local realities, stakeholder capacities, and institutional conditions.

1. Introduction

The transition to a bioeconomy, where biomass is converted into energy and materials to substitute fossil fuel inputs, is presented as a solution to address global climate change and sustainability challenges (Lewandowski et al., 2018; Cerca et al., 2022; Siegel et al., 2022). Residues from agriculture or forestry are increasingly used as a basis for this substitution (Carus and Dammer, 2018; Gregg et al., 2020; Stegeman et al., 2020). This contributes to the transition towards a circular bioeconomy where biomass is valorized in integrated, multi-output production chains while also making use of residues and wastes and optimizing the value of biomass via cascading (Stegmann et al., 2020, p.5). However, the circular bioeconomy is often criticized for its potential harmful environmental and social impact (Asveld et al., 2015). Through bio-based value chains (BBVCs), different stakeholders are connected to convert renewable biological resources into valuable products. This presents both opportunities and significant complexities.

While new BBVCs can drive innovation, they also introduce considerable uncertainties and risks. They involve long-term decisions regarding feedstock, suppliers, and location, and require the coordination of diverse stakeholders from various geographical areas, with different backgrounds, needs, and capabilities. This complicates the transition from a fossil-based economy to a bioeconomy (Asveld & Stemerding, 2017; Sadeghzadeh et al., 2025). A successful and sustainable bioeconomy relies not only on technological innovation but also on its integration into social contexts.

While sustainability is the central promise of the circular bioeconomy, what is understood by sustainability for biomass remains contested and has been the subject of ongoing debate involving a wide range of actors. Especially, aspects related to distributive justice and inclusion must be more clearly defined (Asveld et al., 2015). Recent studies emphasize the importance of a just transition to a bioeconomy and explore how, theoretically, a just bioeconomy should be structured. A just bioeconomy transition must address environmental impacts,

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biodiversity preservation, and promote social equity (Ramcilovic-Suominen, 2023; Ruml et al., 2025). However, few studies address the practical implications and complexities of transitioning to a sustainable and just bioeconomy.

A key challenge in building a sustainable and circular bioeconomy is that it demands systemic change, requiring the engagement and commitment of all actors along the value chain (Donner et al., 2020). Therefore, new BBVCs must be inclusive and add value to all stakeholders. Different strategies can be followed to improve and promote inclusion in BBVCs. Defining inclusive strategies within the bioeconomy can benefit from lessons learned in agri-food chains. Although existing literature on inclusion in agri-food systems provides valuable insights (Devaux et al., 2018; Ros-Tonen et al., 2019), the bioeconomy presents different dynamics. It is therefore useful to explore how inclusive strategies applied in agri-food chains can be implemented in the context of the bioeconomy. Additionally, there is little empirical research on the practical implications and complexities of establishing inclusive BBVCs for all stakeholders, and more specifically, private actors such as biofuel producers, technology providers, and end consumers. Consequently, this paper addresses the following research question: *How can different strategies for inclusive value chains be applied in new bio-based value chains?*

We explore this question by first reviewing literature on inclusion in agri-food value chains, especially on inclusive business, inclusive value chains, and inclusive development strategies (Ros-Tonen et al., 2019). We then explore the key differences between agri-food chains and BBVCs. Based on our empirical research in three different contexts, we identify complexities for developing inclusive BBVCs. The three cases involve potential value chains for marine biofuels based on waste biomass, namely olive oil residues in Spain, coffee and cocoa residues in Colombia, and encroacher bush in Namibia. The three cases represent potential global value chains, where different segments and activities of the value chain are carried out in different parts of the world (Gereffi & Fernandez-Stark, 2011). The chosen cases are global value chains because the majority of new BBVCs are global in nature, since a large part of the world's available biomass is produced in the Global South (Lima, 2022). This complicates the development of inclusive value chains, because different actors with various backgrounds, needs, and knowledge who are not used to working together are connected (Asveld & Stemerding, 2017).

We build on the study of van der Veen et al. (2024), who identified design requirements based on upstream stakeholders' needs, perspectives, and capabilities in the three case study locations. In addition, we interviewed downstream stakeholders such as biofuel producers and end-users such as shipping companies. We explore how inclusive business, inclusive value chain, and inclusive development strategies can be shaped in the different contexts to address the identified complexities, and what this requires from the stakeholders involved. We then discuss which strategies are appropriate for specific contexts and reflect on the balance, or trade-offs, between the ideal levels of inclusion and what is practically achievable when establishing new BBVCs.

We conclude that, due to the complexity and diversity of contexts in BBVCs, a range of strategies should be employed. We argue that in contexts where stakeholders are faced with more systemic or structural challenges, it is sometimes more realistic to start with inclusive business strategies, even if ideally the highest form of inclusion (inclusive development) is aimed for. With systemic challenges, we refer to deep-rooted, institutionalized barriers that shape how resources, opportunities, and power are distributed across society. In these contexts, a more modest strategy at least provides some benefits to the most vulnerable stakeholders in the chain. Although inclusive development may not be achievable initially, we argue it should continue to be the long-term objective to provide opportunities for those least well-off.

In the next section, we elaborate on the literature on inclusion in global value chains and present three bodies of literature that conceptualize inclusion in this context (inclusive business, inclusive value chains, and inclusive development). We then address the key differences

between agri-food chains and BBVCs. Second, the methodology is presented, including case study descriptions, case study protocols, and analysis. In the following section, the results are presented. We identify five complexities for developing inclusive BBVCs and illustrate these with examples from the case studies. In the discussion section, we elaborate on the trade-offs and reflect on the three bodies of literature.

2. Inclusion

2.1. Inclusion in global value chains

To create a positive social impact, it is important to include all stakeholders in the process and outcomes of developing global value chains (Robaey et al., 2022; Asveld et al., 2023). However, it is not always clear what exactly is meant by inclusion. In a broad sense, we define inclusion as interventions focused on those least well off that aim to increase their opportunity to lead a life worth living (Asveld et al., 2023). Different strategies are possible to address or achieve inclusion in global value chains.

Over the past two decades, a substantial body of literature has emerged on inclusive value chains within agri-food systems (Devaux et al., 2017; Ros-Tonen et al., 2019). A key focus has been on integrating small-scale farmers into global value chains, which is seen as a promising strategy for poverty alleviation, economic development, employment creation, gender equity, and enhanced well-being. Particular attention is paid to smallholders, as they are often the most marginalized and least likely to benefit from participation in global value chains. Ros-Tonen et al. (2019) distinguish three bodies of literature dealing with inclusion in this context: inclusive business, value chains, and development, each with its own strategies and dimensions to enhance inclusive collaboration between value chain actors. Inclusive business is a private-sector approach that integrates smallholders (often including women, poor, or marginalized groups) into value chains in a way that is commercially viable while bringing developmental benefits. Inclusive value chain strategies focus not only on involving smallholders but also on improving the fairness of their participation, in terms of access, power, and environmental and social outcomes. Inclusive development is a broader concept that covers more structural aspects, such as policies, institutions, and norms, and encompasses aspects of social justice, equity, and environmental sustainability. Table 1, adopted from Ros-Tonen et al. (2019: 13), shows an overview of how the three bodies of literature define inclusiveness in the context of global value chains.

Both inclusive business and inclusive value chain literature are rooted in sustainability discourses that recognize the role of economic growth and acknowledge that farmers and companies participate in value chains primarily for economic purposes. Inclusive business literature views inclusiveness as a means to advance business objectives. In contrast, inclusive value chain literature more directly engages with issues of inequality and power asymmetries, aiming to address these challenges through inclusive strategies such as social upgrading and empowerment. Inclusive development theory, however, departs from the growth-oriented neoliberal paradigm altogether. While it shares the normative orientation of inclusive value chain literature, it goes further by critically examining the deeper norms, institutional structures, and discourses that drive exclusion and marginalization (Ros-Tonen et al., 2019).

In all three strands of literature, partnerships between value chain actors and beyond, such as governments, NGOs, and civil society organizations, are crucial. Moreover, most literature on inclusion in global value chains views inclusion as a process, instead of an outcome (Ros-Tonen et al., 2019). It's about the criteria of inclusion on both sides of the chain (Schouten & Vellema, 2019). To create these terms of inclusion in new BBVCs, it is helpful to learn from strategies in agrifood value chains and distinguish between the different strands of literature that deal with inclusion in global value chains. This can contribute to a better understanding of how low-income producers can be included in

Table 1
Dimensions of inclusive value chain integration, adopted from Ros-Tonen et al. (2019).

Dimensions of inclusive value chain integration as operationalized in the three bodies of literature (<i>P</i> = process; <i>O</i> = outcome)			
Dimension	Inclusive business	Inclusive value chains	Inclusive development
<i>Economic</i>			
Double or triple bottom-line	Combines profitability targets and economic growth with social and environmental goals (<i>P</i>).		Rejects focus on economic growth (<i>P</i>).
<i>Social</i>			
Concern for wellbeing	Serving the bottom-of-the-pyramid by delivering societal or developmental benefits; include the Base of the Pyramid (BoP) ¹ as entrepreneurs or suppliers (<i>P</i>).	Higher incomes (<i>O</i>) through market integration and upgrading (applying quality and sustainability standards) (<i>P</i>).	Multidimensional wellbeing (material, relational, and cognitive-subjective) for poor and marginalized people (<i>O</i>).
Inclusive learning and innovation	Frugal innovations (affordable, simple, and resource-efficient products and services with high use value (<i>O</i>).		Knowledge co-creation based on recognition of local knowledge, best practices, innovations ‘from below’ and continual learning through participatory monitoring and evaluation (<i>P</i>).
Alignment with smallholders’ realities	Acknowledge survival entrepreneurs and multiple markets (<i>P</i>).		Sensitive to diversity among farmers in terms of opportunities, constraints, and vulnerabilities; alignment with smallholders’ aspirations; accommodating heterogeneity in terms of gender, age, landownership, ethnic/cultural background, and household composition (<i>P</i>).
<i>Relational</i>			
Empowerment	Improving the human rights and dignity of those at the BoP (<i>O</i>).	Strengthening farmers’ autonomy, capacity, and agency vis-à-vis companies, NGOs, and donors, through social upgrading (improved rights and working conditions through VC engagement) and labour agency (<i>P</i>).	Attention to local political economy and constraining structures; enhance the capacity of the poor and marginalized to exert choice (take control over their own life) and voice (demand equitable rights and fair conditions of VC engagement) (<i>P</i>).
Gender equity and responsiveness	Promotes gender aware women’s entrepreneurship by recognizing gendered risks and uncertainties in the BoP community and business environment (gender accommodating) (<i>P</i>).	Addresses gendered bottlenecks to and opportunities for participation and benefits by reforming policies and institutions that constrain women (‘levelling the playing field’) (gender sensitive) (<i>P</i>).	Sensitivity to gender and its intersectionality with age, race, ethnicity, religion, and location, and actively challenging the underlying gender norms, institutional constraints, and power imbalances (gender transformative) (<i>P</i>).
<i>Environmental</i>			
Environmental sustainability	Promotes resource efficiency through frugal innovations (see above) (<i>P</i>).	Upgrading through voluntary certification (<i>P</i>).	Commitment to environmental inclusiveness by avoiding environmental effects; questioning the commitment to growth (<i>P</i>).

(continued on next page)

Table 1 (continued)

Dimensions of inclusive value chain integration as operationalized in the three bodies of literature (P = process; O = outcome)			
Dimension	Inclusive business	Inclusive value chains	Inclusive development
<i>Cross-cutting</i>			
Enabling environment	Government and networks create an enabling environment for inclusive businesses and producers in the global South (P).	Political will, local civil society, and producer organizations are essential for creating inclusive VCs (P).	Governments actively protect people's rights and pursue redistributive policies; multilevel governance addresses interconnected global-to-local challenges (P).

¹ The term “BoP” is adopted from the paper of Ros-Ronen et al. (2019), who discuss literature on inclusive business. In inclusive business literature, BoP is a frequently used term. In the paper of Ros-Tonen et al. (2019), they refer to BoP as ‘Bottom of the Pyramid’, which is a more contested term. We chose to refer to BoP as “Base of the Pyramid” which is more neutral. Nonetheless, there is criticism of this terminology as it is a potentially condescending and oversimplified frame. We chose to still use the term, since it is widely used in inclusive business literature, which we review in the context of bio-based value chains.

new (bio-based) value chains and how partnerships among value chain and non-value chain actors could take shape. Table 1 illustrates how inclusion is operationalized across the three bodies of literature. It distinguishes between different dimensions and highlights the distinct strategies each strand presents.

2.2. Inclusion in bio-based value chains

While we can learn from literature on inclusive agrifood value chains, it is important to address some key differences between agrifood and BBVCs.

First, BBVCs are complex and involve multiple actors who are dispersed across different geographical areas, with different backgrounds, needs, and perspectives. Often, these actors are not used to working together. Moreover, the intended end products are more focused on global markets rather than local (food) markets (Asveld & Stermerding, 2017; Robaey et al., 2022). Second, unlike in many agri-food chains, biomass is not a commodity yet and requires advanced processing. BBVCs are built on new and quickly developing technologies, with a broad spectrum of innovation, ranging from bulk to specialty production. This requires an innovative approach and rapid technological progress, as well as sources of financing (Bröring and Vanecker, 2022; Śliwa and Pink, 2025). Third, creating BBVCs requires systemic changes. Different members of the value chain need to adapt for the new technology to succeed (Donner et al., 2020). Fourth, there is a large degree of interdisciplinarity. It is based on complex knowledge from different fields, including process engineering and local knowledge (Bröring & Vanecker, 2022). Last, BBVCs engage with the part of public opinion and civil society, for which reducing negative environmental impact (and social impact) is a key issue. Civil society organizations play an important role in demanding sustainable BBVC and are often the most critical voices (Asveld et al., 2015; Śliwa & Pink, 2025). These aspects make BBVCs stand out from conventional agri-food chains and therefore require a dedicated, tailored approach to address the specific challenges in new BBVCs. Table 2 shows an overview of the key differences between agri-food value chains and BBVCs. In the table, we connect these differences with the relevant dimensions of inclusion as addressed in Table 1.

One of the main challenges to transitioning to an inclusive bioeconomy is the lack of value chain collaboration (Dace et al., 2024). The higher the complexity of an exchange of goods or services, the tighter the required coordination among parties involved (Pascucci et al., 2024). Private actors across emerging BBVCs need to organize upstream as well as downstream activities, particularly if they hold an intermediary position, as is often the situation in bioenergy (Berg et al., 2018). Given the difficulty, partnerships are recognized as crucial for inclusive BBVCs. This addresses the discussion about the roles and responsibilities

Table 2
Overview of the differences between agri-food chains and BBVCs.

Agri-food chains	BBVC	Relevant dimensions
Involve traditional actors like farmers, processors, retailers, and consumers.	Involve a wider range of actors, including farmers, biotechnology companies, and energy providers, who are dispersed among various geographical locations and are not used to working together.	Inclusive learning and innovation (3), Alignment with smallholders' realities (4), Gender equity and responsiveness (6), Enabling environment (8).
Typically involve minimal to moderate processing. Innovation is often incremental.	Biomass is not a commodity yet and requires advanced processing, often built on new and quickly evolving technologies. Innovation is more disruptive and research-intensive.	Double or triple bottom-line (1), Inclusive learning and innovation (3), Enabling environment (8).
Building new agri-food chains requires moderate change.	Building new BBVCs requires systemic change where different value chain actors need to adapt.	Double or triple bottom-line (1), Concern for wellbeing (2), Alignment with smallholders' realities (4), Empowerment (5), Enabling environment (8).
Primarily require knowledge in agriculture, value chain logistics, and food safety.	Built on complex knowledge, characterized by a large degree of interdisciplinarity.	Inclusive learning and innovation (3), Alignment with smallholders' realities (4).
Agri-food chains are mainly influenced by food security, nutrition, and safety guidelines.	Reducing negative environmental impact and preventing societal harm are key issues.	Concern for wellbeing (2), Empowerment (5), Environmental sustainability (7).

*The relevant dimensions are identified according to our own insights.

of various stakeholders, both private and non-private, in ensuring inclusion in new BBVCs. There is a growing expectation for companies to be accountable for the social and environmental consequences of their operations and to actively contribute to societal wellbeing (Scherer and Voegtlin, 2020; De Gelder & Asveld, 2024). However, the specific responsibilities of actors within the bioeconomy remain unclear. This issue is particularly pressing in the context of the bioeconomy, where projects often aim to reduce local poverty (Dawson et al., 2016) but are frequently implemented in regions characterized by deep economic inequalities and cultural diversity (Postal et al., 2020; De Gelder and Asveld, 2024).

3. Methodology

To examine which pathways could be followed to achieve inclusive BBVCs and the implications and complexities for the (private) stakeholders involved, we explore three cases of prospective value chains for marine biofuels based on waste biomass. These cases include olive oil residues in Spain, coffee and cocoa residues in Colombia, and encroacher bush in Namibia. The three cases show a diversity in contexts, with different levels of capabilities, experience, and institutional capacities. We build on the work of van der Veen et al. (2024), who identified design requirements based on upstream stakeholders' needs, perspectives, and capabilities in the three case study locations. In addition, we interviewed downstream stakeholders such as biofuel producers and end-users such as shipping companies, located in the Netherlands.

The cases are part of a multi-stakeholder and multi-disciplinary research project to design inclusive and sustainable biofuels for the marine industry, an industry that is actively looking to source more sustainable fuels (Maritime, 2025). The cases are selected in an iterative process with project partners who represent stakeholders in a biofuel value chain (shipping company, (bio)fuel producers, renewable energy platform, and an NGO).

3.1. Case descriptions

3.1.1. Olive oil residues in Spain

In Jaén, Spain, olive farming is the main economic activity, largely carried out by small-scale farmers using traditional methods. Around 30–40 % of them rely on it for their livelihood. Each year, large amounts of pruning and processing residues are generated, which are poorly managed. Pruning waste is either chipped and left on the field or burned. These are both costly options, with burning posing environmental risks. Olive mills, owned by cooperatives, generate Crude Olive Pomace (COP), made of pulp, pits, peel, and water. COP is currently stored in large open ponds and processed in a secondary industry for further oil extraction and drying into Exhausted Olive Pomace (EOP). EOP is used as energy on-site and sold, but farmers gain no profit from it. In fact, they often bear the cost of transporting and treating COP (La Cal Herrera, 2020). Given the residue volume and supportive bioenergy policies, this presents a strong case for developing a BBVC.

3.1.2. Coffee and cocoa residues in Colombia

In Colombia's coffee axis, residues from coffee and cocoa, mainly grown by smallholders who own less than five hectares, offer potential for new BBVCs. Coffee pulp and cocoa pod husks are often left in piles in the field or used as compost. Poor management of these residues can pollute waterways. Unlike in Spain, most Colombian farmers rely entirely on agriculture, making them more vulnerable to price shifts, low yields, and climate change. To manage this instability, they diversify their income by cultivating different crops. Apart from coffee or cocoa, they often grow bananas and fruits in agroforestry systems, which generate additional residues. Selling the residues from these products could provide a new income stream and enhance their resilience.

3.1.3. Encroacher bush in Namibia

Unlike Spain and Colombia, Namibia's potential biomass for a BBVC comes from encroacher bush, not agricultural residues. Around 45 million hectares are bush encroached, which is the expansion of indigenous bushes like blackthorn at the expense of the Savannah lands. This degrades soil, depletes groundwater, and reduces grazing land. This threatens cattle farming, the main livelihood for over 70 % of Namibians (DAS, 2019). Biomass supply is more diverse and complex compared to the other two cases due to varied land ownership. Large commercial farms are on average 7000 hectares and predominantly managed by European descendants. Communal lands are owned by the government and governed by traditional authorities following customary laws.

Communal land is inhabited by different tribes, who share the land and the resources from that land. Last, resettlement farmers are previously disadvantaged and are placed on land sold by commercial farmers. The challenge of bush encroachment affects all land tenure systems. However, the capabilities and challenges faced are different for the three types of farmers. While small-scale value chains like charcoal exist, they use only 1 % of the biomass, leaving major potential for new BBVCs. Turning encroacher bush into value-added products could address environmental issues and support rural livelihoods (van der Veen et al., 2025).

3.2. Case study approach

Field studies have been carried out in the three countries (Spain: 18–10–2021 – 27–11–2021, Colombia: 20–06–2022 – 29–07–2022, Namibia: 16–01–2023 – 17–02–2023) and consisted of semi-structured interviews, observations, and multi-stakeholder workshops. In addition, interviews were carried out with downstream stakeholders in the Netherlands. Fig. 1 shows an overview of the steps taken in the methodology.

Interviews were conducted with stakeholders who could play a role in the potential BBVC. Questions were asked about the current system, challenges, potential role in a new BBVC, as well as opportunities, hurdles, potential harms, and their relation to other stakeholders. In addition, in-depth interviews were conducted with small-scale farmers about the current use of biomass and their challenges. Participants were selected using purposeful sampling to select a representative sample of stakeholders with distinct characteristics (age, gender, type of farm, region). The selection of participants was done in close collaboration with our local partners (local universities and a multi-stakeholder platform), who are well-informed about the sector and the relevant stakeholders.

Multi-stakeholder workshops were organized to discuss different design choices and necessary policies, and local development needs. Workshop participants were selected from the interview participants, using purposeful sampling to ensure representation of all stakeholder groups. Participants were divided into three groups and did a forecasting and backcasting exercise. First, they discussed ideal scenarios for a new BBVC in the region, and made choices on crucial design choices (type of feedstock, feedstock processing and transport, contracts, biomass conversion, biorefinery products, biorefinery ownership, location, and setup). Next, they made a roadmap and identified necessary steps to be taken in 5, 10, and 20 years to achieve the ideal scenario. More information on the interviews and workshops can be found in the case study protocol in Appendix A.

Downstream stakeholders, such as shipping companies and biofuel suppliers, were interviewed in the Netherlands to understand the drivers and barriers for establishing inclusive BBVCs from their perspectives. These participants were partners in the research project. Table 3 shows an overview of the interview and workshop participants. Interviews and workshop discussions were recorded with participants' consent, transcribed verbatim, and coded using MAXQDA 2012 software. General themes were identified from the data through inductive coding. First, initial labels were created from the data, and then these codes were iteratively redefined and grouped into themes (Chandra & Shang, 2019). The themes were related to challenges and complexities for developing inclusive BBVCs in the three case study locations.

Informed consent was obtained in written form, or in case participants had trouble reading and writing, verbally. Participants were assured confidentiality and data protection. Anonymized data is stored in the data repository of the TU Delft. The fieldwork protocol was approved by the ethics committee of the TU Delft.

4. Complexities for inclusive bio-based value chains

Based on the three case studies, we identified five complexities for

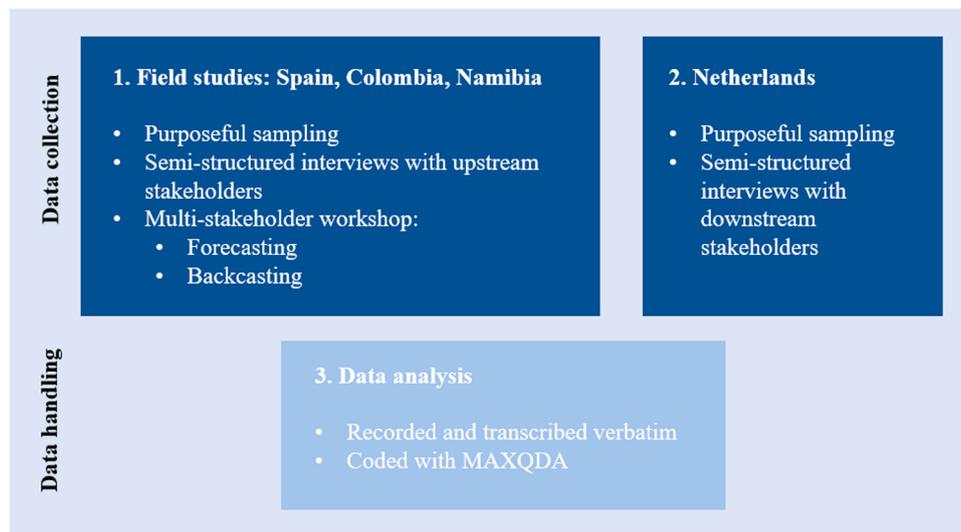


Fig. 1. Overview of the steps in the methodology.

Table 3

Overview of interviews and workshop participants.

Type of stakeholder	Spain (S)		Colombia (C)		Namibia (N)		Netherlands (NL)
	Interview	Workshop	Interview	Workshop	Interview	Workshop	Interview
Farmers (F)	27	2	24	-	8	-	
Farmer cooperative/association(C)	8	8	8	4	1	3	
(Farm) workers (W)	-	-	4	-	8	-	
Farmer union/federation (FU)	2	1	5	2	3	2	
(Secondary) industry (I)	1	1	1	1	3	1	
Entrepreneurs (E)	-	-	2	1	1	1	
Logistics (L)	1	-	3	3	1	-	
Government (G)	1	4	4	3	5	5	
Technology developers (T)	2	2	-	-	-	-	
Academia/knowledge institute (A)	3	3	10	7	2	1	
NGO (N)	-	-	2	1	3	3	
Bioenergy association (B)	1	4	-	-	1	4	1
Energy company (EC)							1
Biofuel supplier (BS)							2
Shipping company (S)							2
Total	44	25	63	21	36	20	6

*We use abbreviations to refer to interview participants. For example, the code S-F3 refers to farmer #3 in Spain.

developing inclusive BBVCs. The complexities were derived after inductive coding of the interviews and workshop discussions, and recognizing general themes across the three different cases. The complexities include inequalities, lack of capacity, lack of an intermediary party, logistics, and the importance of maintaining self-determination. In this section, we will present the complexities and explore how the different inclusive value chain strategies from Table 1 could be applied in BBVCs to deal with these complexities. We also reflect on what this entails and what the trade-offs are for the different stakeholders. We show that, given the complexity and varied contexts of BBVCs, more modest inclusion strategies, such as those outlined in the inclusive business and inclusive value chain literature, are often the most realistic.

4.1. Inequalities

The first complexity is the inequalities between stakeholders in new BBVCs. We discern two types of inequalities: those between different actors in the value chains and those between different biomass producers. Each of these inequalities may have more or less systemic causes. We conclude it is more feasible for private actors to build a truly inclusive value chain if the causes for inequality are not deeply rooted in structural, systemic causes.

First, inequalities exist in the position of the different value chain actors. In Spain and Colombia, small-scale farmers are identified as the most vulnerable stakeholders in the value chain. While the Spanish olive farmers cannot be defined as Base of the Pyramid (BoP) because they are relatively well off and meet their basic needs, the farmers are the most vulnerable actors in the chain because of their small scale and traditional, manual cultivation practices. Farmers reported that they struggle to receive a stable income, and in some years, even produce at a loss, due to fluctuating olive oil prices and input costs. This vulnerability is more severe in Colombia because the majority of the coffee and cocoa farmers depend on agriculture for their livelihoods, making them more vulnerable to price fluctuations and climate change. According to a coffee farmer, coffee production is just enough to make a living: “I depend on just the coffee. Well, and a little cattle. I have little, so the profits are few. Yes, it is enough because, as I work on the property myself, the revenues are for me. But if you have to pay for everything, you have nothing left. Coffee is enough for one to survive, to live, and to survive through time.” (C-F22).

Moreover, the average age of the farmers in Colombia is over 50 years old, and the majority of the farmers have only received primary education. These factors also make it more difficult to access and supply to a new BBVC, because it requires (time) investments and changes in practices. An inclusive business case should align with the local needs

and realities of small-scale farmers by making it easy and straightforward to participate and build on the existing structures, such as the cooperative system in Spain.

Second, inequalities among biomass producers exist in the biomass production regions, causing differences in opportunities to supply and benefit from the new BBVC. In Colombia, this difference is primarily due to the type of farmers' organization to which they belong. There are significant differences between the level of organization among farmers and the type of services they receive from that organization. Some associations are well-organized and capable of acquiring (international) funds for their projects. An example is a coffee association that set up a centralized collection system for the unprocessed coffee cherries. Post-harvesting processes are carried out centrally, instead of on individual plots, which is the main practice in the area. This makes the post-harvest process more uniform and standardized. This association would be a good starting point for a new BBVC because the coffee pulp is collected in one location. However, this would not increase the access of other farmers to the value chain. More interventions, such as strengthening the farmers' organizations and offering education and capacity building to farmers, are needed to include less well-off farmers as suppliers in the BBVC. So in this case, inclusive value chain strategies may be more appropriate than inclusive business strategies.

In Namibia, inequalities between biomass suppliers are deeper and caused by more structural issues related to land ownership, historical processes, and government policies. While bush encroachment is most severe in communal areas, communal farmers are currently prohibited from participating in commercial value chains from the bush due to a moratorium placed by the government. This is a result of concerns about unequal benefit sharing in the communal areas and unsustainable harvesting, which would result in even worse bush encroachment (van der Veen et al., 2025).

According to a civil society representative in Namibia: *"On the biomass side. It's a lot more difficult in the communal areas. Because you've got, well, a common pool resource, and our government hasn't quite found the right way to manage it because it tends to become elite capture."* (N—N1).

While in Colombia, less organized or less well-off farmers could be included through inclusive value chain strategies, such as capacity building, in Namibia, more structural issues are causing these inequalities. Addressing those requires interventions from many stakeholders, most notably the national and local government and civil society organizations. This requires time and commitment from different actors to set up the required local organizational structures in the communal areas, test them with pilot projects, and change government policies. It is not impossible, however, to establish a new BBVC is already complex for value chain actors. It is even more complex in a context where more structural issues are faced, such as in the case of Namibia. While inclusive development strategies are most desired, in this case, inclusive business strategies might be more feasible and can at least bring some benefits to more marginalized actors, such as communal farmers, by including them as consumers or as workers in the chain. BBVCs could, for example, produce animal feed, which is needed in communal areas. Moreover, communal farmers are currently included in the charcoal value chain as workers. A new BBVC could offer better and cleaner working conditions compared to the charcoal industry. However, this should not be considered the end goal. It could be a first step towards further inclusion.

4.2. Lack of capacity

A second complexity is a lack of capacity, especially of farmers' organizations. Farmers' organizations play a crucial role in strengthening the position of small-scale farmers vis-à-vis other value chain actors. They can also play an essential role in the mobilization of biomass. This is a complex task, especially when involving a large group of diverse, small-scale farmers.

Currently, farmers' organizations lack the capacity to play this role.

Even in Spain, the case where farmers' cooperatives are best organized and where value is already added in olive mills owned by cooperatives, the level of professionalization is a major bottleneck. Based on the interviews and workshop discussions, this was identified as one of the main obstacles to establishing new BBVCs from olive oil residues. This is due to the education levels of the cooperative managers and the low (paid) personnel capacity of the cooperatives. As a local researcher explains: *"I think the main challenge we have is to professionalize the sector. In a lot of cooperatives, there are not enough professionals to manage it. In some, there are, but in others no."* (S-A1). They specialize in producing and marketing olive oil, and supplying a biofuel value chain requires different knowledge and skills. For this, more commitment and investments are needed from other actors in the chain and beyond, such as the local government. In Colombia, even more capacity building is needed, especially for less well-organized associations, as described above. In the communal areas of Namibia, some organizational structures exist. They are, however, highly diverse and much less established than the organization of commercial farmers. Moreover, a structure that can organize sustainable harvesting and equal benefit sharing in communal areas is lacking, and pilot projects so far have failed. According to a civil society representative involved in these pilots: *"We've been struggling to get that structure in place, also with the communal areas because it is, you know, millions of hectares belonging to hundreds of thousands of people equally. They all get the same benefit out of the land. Getting a structure in place where one guy does not have a bigger benefit than the other. Other than just the time that he's putting in, is very difficult."* (N—N2).

Failing to address this issue or not strengthening farmers' organizations can hinder effective biomass mobilization (such as in Spain), exclude farmers from less well-organized associations or cooperatives, risking elite capture (such as in Colombia), or risk excluding whole groups from participating or benefiting from the new BBVC (such as in Namibia). So in all three cases, some form of empowerment and capacity building is needed. In comparison, in agri-food chains, strengthening farmers' organizations is also an important strategy to empower small-scale farmers. However, different from agri-food chains are the new knowledge and skills that are required to supply a bioeconomy, which are out of the scope of the current knowledge present in these farmers' organizations.

4.3. Lack of intermediary party

Related to the issue of lacking capacity is the lack of an intermediary party. In agri-food chains, the link between farmers and processors is much clearer and established. In new BBVCs, especially those value chains based on residual biomass, this connection between biomass suppliers and the biorefinery does not exist. Yet, that intermediary is the most complex position because it needs to organize upstream as well as downstream processes. A representative of a shipping company states: *"A new stakeholder, the biorefinery, comes into place. This is the place where risks are created. For the rest of the value chain, there are not a lot of changes, so they don't increase their risks. The biorefinery is the stakeholder that incurs costs and buys the residues, but is not sure whether it can be sold and sold for enough money to cover all costs. Therefore, they are at risk."* (NL-S1). Biorefinery operators need to be sensitive to the realities and complexities of biomass producers. They also need to respond to market demands to adhere to the required technical specifications, uniform production quality and quantity, and a competitive price. So far, these intermediary parties don't exist, but they are essential for a new bioeconomy. Operating in Global South contexts where other, more structural issues are faced, such as inequalities, a lack of political will or corruption, lower education levels, and a lack of infrastructure, makes establishing a biorefinery even more complex and risky. So far, one of the main bottlenecks identified in field studies and interviews with downstream stakeholders is finding a party that is both able and willing to take on those initial risks.

Farmers' organizations, such as the cooperatives in Spain, are in a

good position to play an intermediary role between small-scale farmers and the biorefinery. However, they are in no position to take on the (financial) risks of establishing a new biorefinery or pilot project. The decentralized nature of biomass sourcing adds complexity to the value chain, making risk management and sharing more challenging. According to a representative of a renewable energy platform: *“If you keep your thinking on the linear business cases we have currently, this can’t be just translated to the new ones we need. This has to do with risk sharing. You need to have far, much more risk sharing in the value chain, and that is the one big challenge we face.”* (NL-B1). The parties that do have the means to take on financial risks, such as oil companies, are reluctant or unwilling to invest in smaller-scale pilot projects. Moreover, while some public funds are available to fund these types of pilot projects, such as from the HORIZON program of the European Union, these funds are limited.

To attract investors, it is important to have one anchor product and a clear market outlet. This was one of the key takeaways from the workshop in Namibia, where a comparable project aimed at sustainably and inclusively valorizing encroacher bush ultimately failed to take off. While multiple factors contributed, a major issue was the project’s complexity, trying to achieve too many goals and producing a diversity of products from the bush. Workshop participants concluded that a more effective approach would be to start with a simple, small-scale project focused on a single marketable product, supported by a business model built on a stable supply, and then scale up gradually. In Colombia, similar conclusions were drawn. In these contexts, where the entire value chain, including infrastructure, biorefinery, and logistics, still needs to be developed, it is more realistic and feasible to start with well-established farmers’ associations that already have a solid infrastructure in place. While this approach may limit the inclusion of more marginalized stakeholders initially, attempting to achieve full inclusivity from the beginning could undermine the successful establishment of the value chain altogether.

4.4. Logistics

Fourth, logistics were identified as a key issue in the three case studies. Logistics are a key aspect of the economic feasibility of the value chain. According to a biofuel supplier: *“Logistics optimization is an important aspect. You need to look into the variables that you have in the process, like which kinds of transport modes you have and where the collection and delivery points are. So then you would mitigate the changes in the transport. You would avoid making too many nodes in the value chain because then you mitigate cost, you reduce the lead time as well.”* (NL-BS1). This is a challenge for including smallholders in new BBVCs, especially when the residues are generated in the field. Organizing the mobilization of the residues is a logistical challenge, since it requires transport in remote, rural areas, sometimes on poor tertiary roads and/or steep hills, both are time-consuming and costly. It is also a social challenge as it affects the agricultural practices of the small-scale farmers. The most efficient option is not always the most effective or accepted one.

This is especially true for sectors with more traditional practices, such as olive cultivation and coffee and cocoa production in Colombia. For example, in Spain, olive trees are pruned every two years, and this generates millions of tonnes of field residues, which are currently chipped or burned in the field. Collecting these pruning rests is a logistical challenge because they are spread over multiple smaller-scale plots. Outsourcing pruning, collection, and transportation to a single service provider would be the most efficient approach for handling pruning residues. However, this model is unlikely to gain acceptance among farmers, who are accustomed to their own established practices. Some prefer to carry out pruning themselves, while others rely on trusted employees who perform the task annually. Maintaining control and autonomy over their plots is a priority for them. A previous initiative by a local cooperative to collectively organize on-farm agricultural activities failed for this reason. A similar issue was encountered in Colombia, where the majority of the coffee and cocoa farmers carry out

the post-harvesting processes on their individual plots. Although centralizing collection and post-harvest processing would improve efficiency, most farmers are hesitant to adopt new practices due to a lack of trust and a strong preference for familiar methods. A cooperative leader explains: *“With coffee, I think we have a serious problem with cultural individualism. In Colombia, you’ll see at the coffee farms that almost every coffee grower has their own processing plant. Other countries have places where everyone takes their coffee and there, they process it, so it’s easier to manage waste because everything is centralized, processes are standardized, costs are reduced. But here everyone wants to have their own processing plants, even the smallest farms.”* (C-F4).

So, logistics are a bottleneck for establishing new BBVCs based on agricultural residues. While economic efficiency is important, logistics must be designed to align with the realities of smallholders to ensure social acceptance.

4.5. Maintaining self-determination

The last complexity is the importance of maintaining self-determination. The three cases in this study are based on traditional agricultural sectors, olive oil in Spain, coffee and cocoa in Colombia, and cattle farming in Namibia. Agricultural practices are passed on from generation to generation, and farmers value their known practices. While participation in new BBVCs can bring multiple benefits to them, economic and non-economic, producing for new BBVCs is not their core business. Most farmers identify as olive farmers or coffee farmers, not as bioenergy producers. Supplying new BBVCs means changing their agricultural practices and sometimes interventions that influence the work on their plots. For example, centralizing post-harvesting processes in Colombia or collectively organizing olive tree pruning in Spain, as described above. Another example comes from bush harvesting in Namibia, which is predominantly done manually due to the hard and thorny properties of the bush, making mechanical harvesting a challenge. Manual harvesting requires a group of workers, often migrant workers, to perform the work on the farm. Many commercial farmers expressed reluctance to engage in bush valorization because they don’t want a group of workers on their plots that they need to manage. Language and cultural barriers make that more complicated, but also concerns about illegal poaching.

Engaging small-scale farmers as suppliers in a new BBVC requires changes in practices. This can be challenging, especially for producers in more traditional sectors such as the coffee or olive oil sectors. A cooperative leader in Spain states: *“Olive cultivation is not just a business, it is also tradition and culture, in a culture that is very reluctant to change, because they have always done it in a certain way. So in the first place, you’ll receive rejection.”* (S-C3). There needs to be a clear benefit for their participation and (time) investments. That is also in the best interest of downstream stakeholders. Making sure (small-scale) farmers are motivated and capable of supplying the BBVC is important for the security of supply. Farmers occupy a different and potentially more influential position in BBVCs compared to conventional agri-food chains. Since supplying biomass to a BBVC is typically not their primary activity, farmers may be in a stronger position to negotiate terms and demand benefits. Their participation is therefore not only valuable but also conditional, making their empowerment and alignment with the BBVC goals a key factor for success. Balancing efficiency with the desires of many farmers to maintain control over their plots and practices is important. This can sometimes compromise the economic outcomes, but when not addressed or taken seriously, it can result in failed projects.

5. Discussion

5.1. Trade-offs and strategies

The identified complexities are intertwined and show the dilemmas and trade-offs that are encountered when establishing inclusive BBVCs.

From our interview and workshop findings, we conclude that for all stakeholders, upstream and downstream, inclusion and adding local value are important, for both normative and instrumental reasons. This value can be economic, social, and/or environmental. However, as demonstrated, building inclusive BBVCs is a complex process that requires carefully balancing inclusion with practical feasibility. Compared to agri-food chains, building new, inclusive value chains is even more complex due to the required technological innovation, new actors, and initial investments and risks that need to be taken, often in a context marked by inequalities and structural issues (Postal et al., 2020; De Gelder & Asveld, 2024). We have addressed several complexities for establishing inclusive BBVCs, drawing on examples from our three case studies, and explored the three inclusive strategies (inclusive business, inclusive value chains, and inclusive development). The three cases studied in this research reflect different contexts. The case in Spain represents a context with a relatively strong enabling environment. In Colombia, more structural issues are experienced by small-scale farmers, and in Namibia, these structural issues are more severe. We conclude that, due to the complexity and diversity of contexts in BBVCs, it is often most realistic to apply more modest strategies towards inclusion, such as those described in inclusive business and inclusive value chain literature. A key bottleneck remains: which party will take up the initial risks of establishing a new value chain? Even though important sectors such as the shipping industry have ambitious targets to become net zero in 2050 (IMO, 2025), and biomass is an important element in achieving those targets, large-scale end users like shipping companies or oil companies are not taking up this role. While smaller-scale start-ups are interested in doing so, they often lack the financial means to take up the initial risks.

While inclusive strategies can strengthen feedstock security by increasing the motivation and engagement of biomass suppliers, they can also give rise to conflicting interests and trade-offs that must be navigated thoughtfully. Moreover, it raises questions about roles and responsibilities, specifically about what type of inclusion is being pursued, what is realistically achievable, and how to manage potential conflicts or trade-offs. In the following section, we reflect on the different dimensions mentioned in Table 1 and address potential conflicts and trade-offs.

The first dimension is economic, concerning the extent to which economic growth is prioritized. Rejecting a focus on economic growth, such as in inclusive development literature, is not desirable for establishing new BBVCs. While participation in new BBVCs can have multiple benefits for small-scale farmers, farmers in this study identified receiving more economic stability as one of the main reasons to engage as a supplier in a BBVC. Moreover, to establish the value chain, a robust business model with a secure supply is necessary to attract investors. However, economic growth should not be the primary or only focus of the new BBVC. As demonstrated, a more holistic approach to wellbeing is essential to avoid undermining other important dimensions, such as self-determination, that may at times take precedence over economic efficiency. Next to economic opportunities, environmental sustainability (dimension 7) is the central promise of the bioeconomy. The potential BBVCs in the study all have the potential to positively contribute to environmental sustainability by improving residue management or addressing the ecological issue of bush encroachment, which, in the current situation, causes environmental harm.

Concern for wellbeing (dimension 2) highlights a central tension in developing inclusive BBVCs between improving wellbeing for those least well-off and the practical constraints of setting up new BBVCs. At a minimum, concern for wellbeing entails creating meaningful opportunities for local vulnerable communities to participate in the new value chain, either as suppliers, workers, or consumers (inclusive business). Alignment with smallholders' realities (dimension 4) is vital, accounting for the diversity of farmers and the varying levels of resources and constraints. While inclusive business approaches can support smaller-scale farmers, challenges arise when this diversity is rooted in

entrenched structural inequalities that cannot be addressed solely by market actors, at least in the short term. This also includes gender equity and responsiveness (dimension 6). Market actors can, for example, actively include women's associations, such as those present in Colombia, in their business model, or be sensitive to the specific roles carried out by women in the production process and provide job opportunities for women, as currently done in the charcoal industry in Namibia.

However, in contexts marked by deep-rooted structural inequalities related to land ownership and ethnicity, such as in Namibia, more comprehensive interventions are needed to include the most marginalized farmers. These interventions go beyond market mechanisms and require coordinated efforts from multiple stakeholders, including local and national governments and civil society organizations. Yet, such an inclusive approach could compromise efficiency or reliability of supply, factors that are critical for downstream stakeholders in the chain. While residue valorization and inclusive value chain strategies can lead to higher incomes for smallholders, truly inclusive development is not always feasible. Especially when infrastructure is lacking and farmers' organizations have limited capacity. Attempting to address too many issues simultaneously can be overwhelming and ineffective. Moreover, inclusive development requires commitment and interventions from the state. Addressing structural inequalities exceeds the responsibilities of private actors, and can even be undesirable because outside interference from commercial actors in local political structures may impose external norms on local contexts (De Gelder & Asveld, 2024).

Concern for wellbeing is closely related to the level of empowerment to be aimed for (dimension 5) and the enabling environment (dimension 8). Ideally, there should be attention to the local political economy and constraining structures, and a government that actively protects people's rights and pursues redistributive policies (inclusive development). When this enabling environment is lacking, ideally, a higher level of empowerment is required. This is especially needed in contexts where more structural issues cause inequalities. However, when the government is not able or willing to take up this role, the question remains, who should? This relates to the responsibility of private sector actors to deliver societal goals, 'do good', with their business operations. Yet, in the context of the emerging bioeconomy, it remains unclear what 'doing good' entails. De Gelder & Asveld (2024) argue that, at least, companies have the responsibility to offer a perspective on a stable market offtake. The valorization of the residues produced by small-scale farmers is a way to offer more market outlets and can be seen as a type of upgrading, as discussed in inclusive value chain literature. In addition, apart from 'doing good', it is important for companies to 'do no harm'. Voluntary certification schemes can be mechanisms for private actors to avoid doing harm with their operations, especially in contexts where 'hard laws' that protect people's rights are absent (Voegtlin and Scherer, 2017). However, 'soft laws' like voluntary certification schemes can be partially ineffective, especially when monitoring and enforcement capacities are lacking. This was, for example, encountered in the case study in Namibia, where the charcoal value chain is FSC certified. This offers multiple benefits, such as clear policies on workers' conditions, safety, and sustainable harvesting. However, due to a lack of monitoring and enforcement capacities, these policies were not always adhered to. Moreover, certification schemes do not address underlying structural inequalities. To address these, state policies and capacities play a crucial role.

We conclude that in those contexts where this enabling environment is lacking, it is neither feasible nor desirable for value chain actors to simultaneously set up a whole new infrastructure and system, and address structural inequalities. While ideally, a higher form of empowerment is required that can address these structural issues, it may not be achievable in the short term. In these cases, inclusive business strategies that integrate vulnerable groups as consumers can still provide tangible benefits, even if they fall short of full inclusion. A step-by-step approach that recognizes limitations while striving for broader inclusion over time

is more realistic and sustainable.

Moreover, what ‘doing good’ means can differ per context and stakeholder. Therefore, inclusive learning and innovation (dimension 3) is essential. Co-creating solutions with local stakeholders allows for context-sensitive decision-making and ongoing impact assessment. Full inclusivity may not be feasible from the outset, but inclusive innovation can guide incremental progress (Bouchaut & Asveld, 2021). For instance, when establishing a BBVC requires new infrastructure (e.g., biorefineries), initial efforts may need to focus on relatively better-off farmer groups, which was a consensus across all three workshops. These groups can participate in pilot projects, forming a foundation for gradually expanding inclusion to more marginalized farmers. Establishing strong multi-stakeholder networks is crucial here. Participating in such multi-stakeholder platforms can accommodate economic as well as non-economic incentives for private actors (Voegtlin and Scherer, 2017). On the economic side, participation can yield indirect benefits such as enhanced reputation, stronger relationships with key stakeholders, and competitive advantages through resource sharing and greater opportunities for innovation through access to broader knowledge networks. Non-economic incentives include the chance to learn from diverse actors, align with institutional or societal expectations, and derive intrinsic satisfaction from contributing to environmental and social well-being. Collaborating with NGOs, in particular, can help companies gain legitimacy, improve product distribution, and access specific markets more effectively (ibid). Table 4 shows an overview of the dimensions of inclusion, the trade-offs we encountered, and preferred strategies to deal with them.

Table 4
Summary of trade-offs and preferred strategies.

Dimension	Trade-off	Preferred strategy
<i>Economic</i>		
Double or triple line	Balancing economic growth with broader wellbeing.	Stepwise inclusion via inclusive business/value chain models; focus on stable market offtake, not solely on economic growth.
<i>Social</i>		
Concern for wellbeing	Inclusion vs. feasibility; addressing structural inequalities vs. operational constraints.	Start with modest, realistic inclusive business/value chain strategies; avoid overwhelming scope.
Inclusive learning	Uniform solutions vs. context-sensitive approaches.	Co-creation with local actors; iterative learning and innovation.
Alignment with smallholders' realities	Diversity of farmers vs. market efficiency.	Tailor to smallholder diversity, but acknowledge limits of private actors.
<i>Relational</i>		
Empowerment	High-level empowerment vs. lack of enabling environment.	When state support is weak, adopt incremental empowerment via inclusive business; realistic short-term goals.
Gender equity and responsiveness	Gender inclusion vs. traditional roles/market priorities.	Proactively include women's groups; recognize and support women's roles in value chains.
<i>Environmental</i>		
Environmental sustainability	Long-term sustainability vs. short-term costs and feasibility.	Focus on residue valorization solutions; emphasize dual ecological-economic value; aim for circularity/nutrient recycling to guarantee soil maintenance.
<i>Cross-cutting</i>		
Enabling environment	Ambitious inclusion vs. weak governance and infrastructure.	Recognize limitations; avoid burdening private actors with systemic change; advocate for state involvement.

5.2. Implications for policy and practice

Besides contributions to the academic debate about the transition towards a sustainable and just bioeconomy, this research also has implications for policy and practice. We have highlighted the complexities of building new and inclusive BBVCs and addressed the trade-offs and dilemmas encountered for the various stakeholders involved. We concluded that the enabling and institutional environment is important for achieving inclusive development. Policymakers can take specific actions to strengthen this enabling environment. An action they can undertake is de-risking the early investments by allocating public funds for pilot projects that have potential economic, environmental, and social impact. Moreover, policymakers can address the structural barriers towards participation of vulnerable stakeholders, such as the land rights policy in Namibia and the moratorium that is currently preventing communal farmers from participating in commercial bush-based value chains. These actions support the goals of the governments in the Global North and in the Global South, such as the European Green Deal and the bioeconomy strategies of the African Union.

Companies can use the insights from this study by taking a step-wise approach towards deeper levels of inclusion as know-how and infrastructure grow. Moreover, companies can create stability for biomass suppliers by offering a stable market offtake. In addition, they can invest in co-creation and continuous learning to improve inclusive practices in the longer term. Finally, alliances between private, public, and civil society actors can strengthen the inclusion of marginalized stakeholders in new BBVCs.

5.3. Limitations

While this study provides valuable insights into the pathways for developing inclusive BBVCs, several limitations should be acknowledged. First, this research is based on three cases. Although these cases capture diverse contexts, they cannot represent the full range of socio-economic, environmental, and institutional conditions under which new BBVCs can emerge. As such, the findings are exploratory and context-specific and limit the possibilities for generalization. Second, the study relies on purposeful sampling of upstream and downstream stakeholders, conducted in close collaboration with local partners. While this approach ensured access to relevant actors, it may have favored those who are more visible or organized, potentially under-representing marginalized groups or informal actors. Furthermore, downstream stakeholders were primarily project partners based in the Netherlands, which may have constrained the diversity of perspectives from the wider shipping and biofuel industries.

5.4. Recommendations for future research

Future research could build on our work by researching the complexities of establishing new BBVCs in various other contexts. This can contribute to identifying more limiting and enabling factors. In addition, studies can focus on the perspective of companies to gain more insight into the challenges they face in building new BBVCs and what they need to support this transition. Lastly, future research can build on the trade-offs and strategies we identified and could build decision-making tools for various stakeholders to support the transition towards an inclusive bioeconomy.

6. Conclusion

Establishing inclusive BBVCs is a highly complex but essential component of a sustainable and just transition to a circular bioeconomy. While many studies underscore the importance of balancing environmental impacts, biodiversity preservation, and social equity, few studies address the practical complexities of establishing new BBVCs. We addressed these challenges by studying three cases of potential BBVCs

based on waste biomass in different contexts, by interviewing different stakeholders along these potential value chains. Based on the case studies, we identified five complexities for establishing inclusive BBVCs, namely inequalities, lack of capacity, lack of an intermediary party, logistics, and the importance of maintaining self-determination. We then explored different inclusive strategies that can be followed and the trade-offs that are encountered.

We argue that while the ultimate goal for new BBVCs may be inclusive development that addresses structural inequalities and promotes long-term wellbeing for all stakeholders, especially the most marginalized, this is often not immediately feasible in many settings. In such cases, more pragmatic approaches, such as inclusive business and inclusive value chain strategies, can serve as critical stepping stones. These strategies allow for the engagement of upstream stakeholders, particularly smallholder farmers, by offering them tangible benefits and pathways toward greater empowerment, without overwhelming the new value chain with unrealistic expectations. However, the success of even these incremental strategies depends on their alignment with local contexts and the willingness of downstream stakeholders to invest in socially responsible practices.

Ultimately, while inclusive development may not be immediately attainable, it should remain the long-term goal. A phased, flexible approach, grounded in the principles of inclusion and adjusted to local realities, offers a realistic and constructive path forward. Co-creation with local stakeholders, continuous learning, and adaptive governance are crucial to managing trade-offs, building trust, and navigating conflicting interests. As our case studies show, beginning with relatively stronger stakeholder groups and gradually expanding inclusion through iterative learning can provide a more resilient foundation for BBVCs. Such an approach allows BBVCs to evolve over time into systems that are not only economically viable and environmentally sustainable but also socially just, ultimately offering a significantly improved alternative to fossil-based value chains, particularly in terms of their social impact

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CRedit authorship contribution statement

Susan van der Veen: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Lotte Asveld:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Formal analysis, Conceptualization. **Patricia Osseweijer:** Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

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Data availability

Data will be made available on request.

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