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CIRCULAR BIOECONOMY AND SUSTAINABLE RURAL DEVELOPMENT: PATHWAYS AND IMPLEMENTATION CHALLENGES

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Abstract: *The circular bioeconomy offers potential opportunities for sustainable rural development through more efficient use of biological resources and the development of bio-based economic activities. This study examines its main contribution pathways and implementation challenges through a qualitative thematic synthesis of scientific literature and institutional reports. Three interconnected pathways are identified: resource efficiency and biomass valorisation, rural economic diversification, and local value creation. Their potential benefits depend on economic viability, technological capacity, institutional support and stakeholder cooperation. Environmental trade-offs, including competing biomass uses and resource extraction pressures, further influence sustainability outcomes. The findings highlight the importance of context-specific assessment rather than assuming that circular practices automatically generate sustainable rural development.*

• Introduction

The circular bioeconomy integrates biological resource utilisation with circular economy principles, creating potential opportunities for resource efficiency, economic diversification and local value creation. Agriculture and rural areas play an important role in this transition as providers of biological resources and potential locations for bio-based activities.

However, circular practices do not necessarily guarantee sustainable rural development. This study therefore examines the pathways through which the circular bioeconomy may contribute to rural sustainability and the conditions influencing their implementation.

• Material and method

This study adopts a literature-based approach, drawing on ten scientific publications and institutional reports relevant to circular bioeconomy and sustainable rural development. A qualitative thematic synthesis examines three potential contribution pathways: resource efficiency and biomass valorisation, rural economic diversification, and local value creation and retention.

The analysis also considers implementation barriers, enabling conditions and environmental trade-offs.

• Results and discussions

The literature synthesis identifies three interconnected pathways through which the circular bioeconomy may contribute to sustainable rural development: resource efficiency and biomass valorisation, rural economic diversification, and local value creation and retention.

Evidence from 39 agricultural waste and by-product valorisation cases highlights the diversity of circular business initiatives and the factors influencing their implementation. Eight European business cases illustrate opportunities for business model innovation and economic diversification, while research on Danish biogas production examines potential rural employment and income effects.

Regional value creation also depends on cooperation between local actors. A Swedish bioeconomy cluster illustrates the importance of entrepreneurial networks and social capital, while a Finnish case study highlights financial imbalances between participating operators.

However, implementation faces financial, technological, logistical and institutional barriers. Competing biomass uses and environmental pressures introduce further sustainability trade-offs. Consequently, potential benefits depend on local conditions and cannot be assumed to produce sustainable rural development automatically.

These relationships are synthesised in Figure 1.

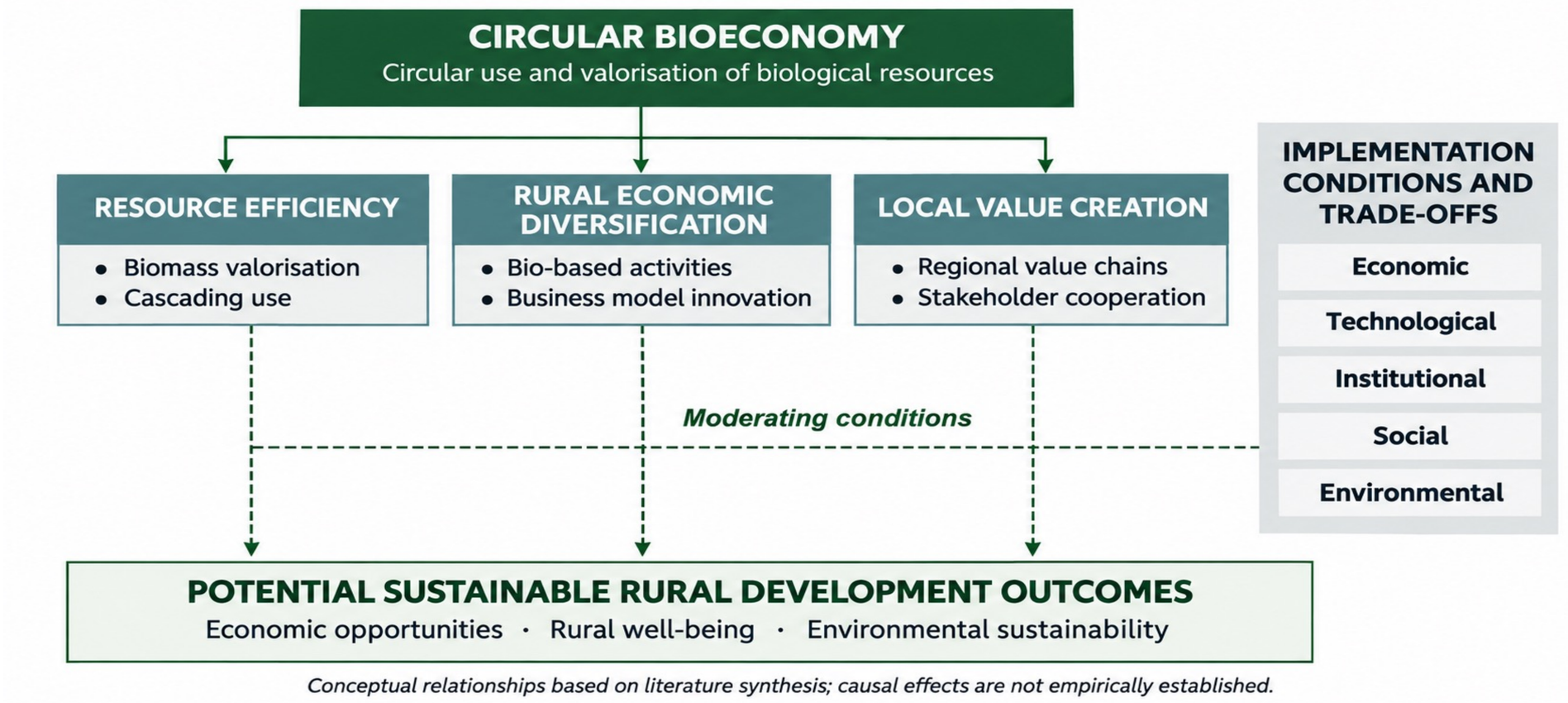


Figure 1. Conceptual framework of circular bioeconomy pathways to sustainable rural development.
Source: Authors' synthesis based on the reviewed literature.

• Conclusions

The circular bioeconomy may support sustainable rural development through improved resource efficiency, economic diversification and local value creation. However, these potential contributions depend on economic viability, technological capacity, institutional support, stakeholder cooperation and environmental limits.

The reviewed evidence highlights opportunities for bio-based activities and regional value chains, but does not establish their broader or long-term impacts on rural well-being. Future research should assess measurable economic, social and environmental outcomes in specific rural contexts, including how benefits are distributed among local stakeholders.