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Research Article

Cooperativism and Bioeconomy in the Amazon

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Abstract

This article analyzes rural cooperativism as an organizational model for an inclusive bioeconomy in the Amazon, articulating environmental conservation, income generation, and community strengthening. The research adopts a quantitative and qualitative approach, applying the Ambitec-Biocoop module to 13 cooperatives in the state of Amazonas that work with sociobiodiversity products, complemented by interviews, field observations, and analysis of management data. The results indicate positive ecological impacts, such as the recovery of degraded areas, the expansion of agroforestry systems, and biodiversity conservation, as well as relevant socioeconomic effects, including increased and diversified income, food security, and the strengthening of social capital. Nevertheless, challenges remain regarding infrastructure, technology, and innovation, which highlights that the consolidation of these initiatives depends on institutional strengthening, public policies, and continuous technical assistance.

Introduction

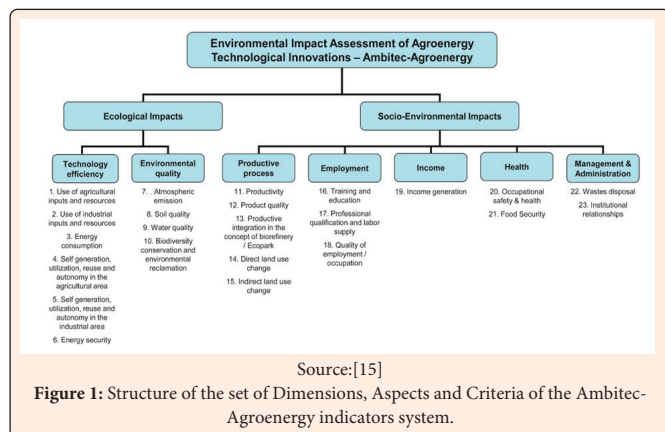
The bioeconomy has been consolidating itself as one of the main paradigms for thinking about the future of the Amazon, especially in the context of COP30 and the formulation of the National Plan for the Development of the Bioeconomy (PNDBio), which presents it as a strategy to articulate nature conservation, innovation, the sustainable use of sociobiodiversity, and socio-environmental justice [1,2,3]. In this scenario, cooperativism gains centrality by enabling family farmers, Indigenous peoples, riverside communities, quilombolas, extractivists, and other social groups to expand their economic and political participation in Amazonian production chains. The study results from a project supported by CNPq/SESCOOP and seeks to analyze the stage and conditions of 13 cooperatives in the state of Amazonas that work with products such as açaí, guaraná, cassava, and other sociobiodiversity goods. To this end, it adapts the Ambitec-Agro system into the Ambitec-Biocoop module, allowing for the integrated assessment of ecological, economic, and social impacts. The results show that cooperativism is a relevant instrument for adding value, generating income, strengthening food security, and conserving ecosystems, although it still faces limitations linked to infrastructure, energy, innovation, and access to public policies.

Theoretical Framework

The bioeconomy is a contested concept, taking on different meanings according to institutional and territorial contexts. Broadly, the OECD defines the bioeconomy based on the use of advanced knowledge, renewable biomass, and efficient bioprocesses to promote sustainable production [4], while the FAO understands it as the use, conservation, and regeneration of biological resources associated with science, technology, and innovation for sustainable solutions across various economic sectors [5]. In the Amazonian case, authors advocate for a territorialized and bioecological approach. [6] argue that the bioeconomy in the Amazon must be rooted in the region and promote local bio-industries, value addition, jobs, and social inclusion [7]. [7] reinforce this perspective by defending a bioeconomy guided by biodiversity conservation, the valorization of biological, cultural, and social diversity, and the preservation of the integrity of the biome, in dialogue with [8], who demonstrate the plurality of meanings attributed to the concept of bioeconomy. Within this debate, cooperativism emerges as a strategic element for consolidating an inclusive bioeconomy. [9] understands the cooperative as a way of combining capacities in contexts of social and economic fragility, while [10] distinguishes traditional cooperativism from that linked to social resistance, highlighting its economic, social, and political dimensions. For [11], cooperatives also have a strong capacity for collective mobilization. In the Amazonian context, the article shows that these organizations are fundamental for structuring sociobiodiversity chains, reducing dependence on intermediaries, strengthening community leadership, and expanding access to public policies, technical assistance, and differentiated markets [12,13,14].

Methodology

The analysis was based on 13 cooperatives located in different territories of the state of Amazonas, drawing on individual and collective interviews with managers and cooperative members, conducted during field visits between May 2024 and 2025, within the scope of a project funded by CNPq/SESCOOP. The Ambitec-Agro system was adopted as the methodological framework, adapted to the research context as Ambitec-Biocoop, comprising 164 indicators distributed across 29 criteria and seven analytical dimensions, allowing for the integrated assessment of ecological and socioeconomic impacts. The change coefficients were defined based on empirical evidence and information provided by the cooperatives, involving interviews with managers and members, considering the direction of changes and their spatial scale. The application of the method took place in three stages: selection of the units, field data collection using weighting matrices, and analysis of performance indices. The results were classified into five levels, enabling a systematic assessment of the cooperatives' contribution to the Amazonian bioeconomy. The results were grouped by indicator and classified into five levels of impact - Very Low, Low, Medium, High, and Very High - according to the frequency of responses and the Ambitec-Biocoop scale (± 15).



Results and Discussion

The Ambitec-Biocoop results, as shown in Table 1, indicate that the cooperatives in Amazonas present positive socio-environmental impacts, although with different intensities across the criteria evaluated. On the ecological axis, advances stand out in direct land use, with the recovery of anthropized areas, the strengthening of agroforestry systems, and an increase in carbon stock, which contributes to soil fertility, biodiversity conservation, and food security. Regarding indirect land use, the results are more heterogeneous, reflecting different levels of technification and pressure on productive areas, with no significant evidence of land conflict or interference with the tenure of local communities. In the technological efficiency criteria, water consumption was predominantly low, with reduced use of agricultural inputs in a significant portion of the cooperatives and the absence of relevant use of veterinary inputs, due to the predominance of agricultural and extractive activities. On the other hand, energy consumption showed greater concentration at higher levels, indicating dependence on external sources and the need to improve strategies for energy autonomy, reuse, and self-generation. Regarding environmental quality, the results indicate low impacts on soil and water and a positive performance in the conservation and recovery of natural habitats. The cooperatives contribute to reducing emissions, restoring degraded areas, and maintaining forest cover, especially through intercropping, more qualified management, and the incorporation of practices compatible with the Amazonian bioeconomy. In the socioeconomic dimension, the most significant impacts are concentrated in income generation, the diversification of revenue sources, the strengthening of social capital, and the expansion of food security. Advances are also observed in training, equity among genders, generations, and ethnicities, marketing conditions, and institutional relationships. Nevertheless, challenges persist regarding job quality, waste management, the use of chemical inputs, access to public policies, and greater efficiency in the use of water, energy, and inputs. Overall, the study indicates that cooperativism constitutes a relevant instrument for promoting sustainable territorial development, social inclusion, and the strengthening of the bioeconomy in the Amazon. In summary, the study shows that Amazonian cooperativism is strategic for strengthening an inclusive bioeconomy, by articulating income generation, food security, social capital, and environmental conservation. Despite challenges such as access to energy, productive autonomy, qualification of work, and public policies, the cooperatives expand territorial leadership and drive sustainable development.

Table 1: Classification of the criteria based on the Ambitec indices.

Criteria	Classification based on the Ambitec indices*				
	Very Low	Low	Medium	High	Very High
Direct land use	17%	0	41%	25%	17%
Indirect land use	33%	17%	25%	8%	17%
Water consumption	17%	58%	25%	0%	0%
Use of agricultural inputs	42%	8%	0%	33%	17%
Use of veterinary inputs and raw materials	0%	0%	0%	0%	0%
Energy consumption	16%	0%	17%	17%	50%

Self-generation, reuse, and autonomy	8%	51%	8%	25%	8%
Atmospheric emissions	25%	25%	42%	0%	8%
Soil quality	92%	8%	0	0%	0%
Water quality	83%	0%	17%	0%	0%
Biodiversity conservation and recovery	25%	16%	42%	17%	0%
Product quality	25%	17%	17%	24%	17%
Social capital	17%	25%	0	41%	17%
Animal welfare and animal health	92%	0%	8%	0%	0%
Education/training	0%	25%	42%	16%	17%
Quality and supply of work	8%	58%	8%	17%	9%
Quality of employment/ occupation	42%	42%	16%	0%	0%
Gender, generational, and ethnic equity	8%	0%	0%	25%	67%
Income generation	0%	0%	0%	8%	92%
Diversification of income sources	0%	17%	17%	33%	33%
Heritage and territorial valorization	0%	8%	25%	33%	34%
Occupational safety and health	8%	33%	42%	9%	8%
Food and nutritional sovereignty and security	0%	0%	33%	50%	17%
Dedication and profile of the manager	0%	25%	8%	33%	34%
Marketing conditions	0%	8%	25%	67%	0%
Waste disposal	25%	16%	25%	17%	17%
Management of chemical inputs	42%	25%	17%	8%	8%
Institutional relationship	0%	25%	33%	8%	34%
Access to public policies and rural programs	17%	50%	33%	0%	0%
Environmental Impact Index	75%	25%	0%	0%	0%
Economic Impact Index	0%	0%	25%	67%	8%
Social Impact Index	8%	58%	34%	0%	0%
General Technology Impact Index	0%	83%	17%	0%	0%

*The classification corresponds to the Ambitec index: Very Low (-1.5 to 0 / 0 to 1.5); Low (-4.5 to -1.6 / 1.6 to 4.5); Medium (-7.5 to -4.6 / 4.6 to 7.5); High (-10.5 to -7.6 / 7.6 to 10.5); and Very High (-15.0 to -10.6 / 10.6 to 15).

Source: Data organized by the authors, 2026.

Conclusion

The results show that rural cooperativism in Amazonas, anchored in sociobiodiversity products, constitutes a strategic instrument for an inclusive bioeconomy, by articulating market access, income generation and diversification, food security, the strengthening of social capital, and environmental conservation. The application of Ambitec-Biocoop showed that cooperatives can raise technological efficiency and environmental quality, with the recovery of degraded areas, productive diversification, and the expansion of ecosystem services, without intensifying pressure on the territory. Although the environmental impacts are generally positive, albeit of low intensity, the economic and social effects are more significant, especially regarding income, financial stability, health, and community organization. Challenges persist concerning the use of energy, water,



and inputs, waste management, the qualification of work, and access to public policies, reinforcing the need for investment in technical assistance, innovation, and institutional strengthening.

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