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Socio-technical challenges and opportunities for forest-protecting bioeconomies in the Brazilian Amazon: An integrated assessment of rede terra do meio

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Abstract

Bioeconomies in the Terra do Meio region of Pará rely on traditional, community-based, and seasonal livelihood systems, including the extraction of Brazil nuts, rubber, and babassu, as well as fishing and small-scale agriculture (roça) for self-consumption. As climate events and market instability intensify, traditional communities face economic constraints and an urgent need to increase local income retention and reduce dependence on external intermediaries by diversifying and adding value to local products while conserving the multifunctionality of landscapes and cultural diversity.

In this context, public and private initiatives to develop technological solutions have emerged to support these goals and improve livelihoods. However, understanding traditional knowledge systems, practices, and technologies remains essential to building on community strengths and co-developing culturally appropriate, sustainable alternatives.

Using a bottom-up socio-technical systems framework and a qualitative approach, including semi-structured interviews, focus groups, and participant observation, this study assessed the complexity of local interplay between social and organisational factors and technical systems, evaluating how potential co-developed technological elements may enhance production performance while ensuring the feasibility and appropriateness of community needs are met.

The assessment finds that the socio-technical systems of bioeconomies in Amazonian regions, such as Terra do Meio, are embedded in traditional community knowledge systems and depend heavily on collective practices, often combined with modern infrastructure such as miniusinas and community cantinas. In addition, it identifies critical challenges, including climate-driven production risks, logistical barriers, and the need for improved access to clean water and reliable energy to support feasible technological upgrades.

The study also concludes that effective technological interventions should not be treated as isolated, top-down technical upgrades. Instead, solutions must be incremental, territorially adapted, and focused on strengthening locally understood socio-technical systems rather than introducing complex new equipment. Moreover, aligning technology with long-term institutional support, fair market access, and community governance is essential for sustainable adoption and resilient local sociobioeconomies.

In sum, technological interventions must be understood as elements influencing production relations, labour dynamics, and resource access and use. Neglecting these interactions often results in underutilised or abandoned technologies, especially in resource- and logistics-constrained Amazonian settings, such as those under consideration in this study.

Keywords: Bieconomy, Brazilian Amazon, socio-technical systems, sustainable livelihoods