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## Energy efficiency on smallholder farms in southern Brazil: An agroecological approach

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### Abstract

Agricultural practices often depend on fossil energy, resulting in adverse socio-economic and environmental impacts. Agroecology offers potential energy-efficient farming practices that maximise output whilst minimising external energy inputs. In Brazil, agroecological farms aim to reduce external energy consumption through internal resource cycling, particularly biomass reuse. However, the impact of these recycling practices on energy efficiency remains unclear, despite extensive Brazilian literature on agroecology. This study addresses this knowledge gap by applying the Agroecological Energy Analysis (AEA) method to a case study of 27 farms in Southern Brazil. The AEA is an energy-flow analysis and multi-EROI (Energy Return on Investment) approach grounded in the social metabolism framework that accounts for biomass reuse in energy balances to measure the impact of such practices on energy efficiency. The results indicate that farms with higher levels of biomass reuse demonstrate reduced reliance on external inputs but do not consistently achieve higher energy efficiency. Although biomass reuse aligns with the principles of agroecology by reducing dependence on external inputs in some cases, it does not uniformly lead to energy savings across the farms studied. The reliance on external inputs, particularly organic fertilisers, is a noticeable pattern in the case study. This indicates that the substitution effect may be minimal or marginal across the analysed farms. This study highlights the importance of considering other factors, such as labour intensity when evaluating energy-saving practices in agroecological farming. It observes the complexity of achieving energy efficiency through biomass reuse and reinforces the need for a broader evaluation framework that encompasses various farm-specific variables.

**Keywords:** Agroecology, energy-flow analysis, multi-EROI, social metabolism