The ecological sustainability of agroecological farming systems in Southern Brazil: an energy-flow analysis

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Abstract

Agroecological farmers often reinvest additional organic matter and labour per output to maintain ecological sustainability. However, most studies overlook these investments in overall assessments, resulting in underestimates of their farm productivity and efficiency. By applying the Agroecological Energy Analysis (AEA) method to 23 farms in Southern Brazil, we observed significant differences in indicators when internal resource reinvestments were included. These findings highlight the need for metrics that incorporate internal resource cycling to accurately assess agroecological approaches in sustaining ecological sustainability and yields.

Introduction and objective

Research suggests that agroecological approaches enhance agricultural ecological sustainability by optimising internal resource cycling, such as organic matter and labour. These resources, intentionally invested by farmers, maintain soil health and natural regenerative capacity without compromising yields (Altieri et al. 2012). However, existing sustainability measures often fail to account for these practices, resulting in an underestimation of the productivity and efficiency of the agroecological farming systems.

Agroecological energy-flow analyses provide a comprehensive ecological sustainability assessment. Such analysis allows the quantification of internal resources in energy terms, which can then be integrated into energy balance indicators (Tello et al. 2015). The objective is to present the preliminary findings from an analysis conducted with 23 agroecological farmers in Southern Brazil. We discuss what insights the indicators provide to assess the ecological sustainability of the farms analysed.

Methods

Primary data were collected between December 2021 and June 2022 using structured questionnaires. The results refer to the farming season from June 2021 to June 2022. We applied the Agroecological Energy Analysis (AEA) (Tello et al. 2015), a multi-EROI approach grounded in the Social Metabolism approach (Fischer-Kowalski and Haberl 2015). This paper focuses on the results of two indicators: External Final EROI (EFEROI) and Agroecological External Final EROI (AE-EFEROI), which measure the energy return on energy invested. EFEROI considers only the final produce, which is the commercialised portion of farm output, whereas AE-EFEROI encompasses the total

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produce, including both the commercialised portion and the resources internally reinvested into the system.

Results and discussion

Figure 1 shows the results for EFEROI and AE-EFEROI indicators (Y-axis) for 23 farms analysed (X-axis). In most cases, EFEROI reveals negative energy balances (values lower than 1). However, when internal resources reinvested by farmers are included in the efficiency assessment, the overall balance turns positive, as indicated by AE-EFEROI. The disparity between EFEROI and AE-EFEROI reflects the proportion of internal resources allocated by farmers, such as green manure and farmyard manure. Larger discrepancies suggest the adoption of regenerative practices to replace or eliminate the need for external inputs.

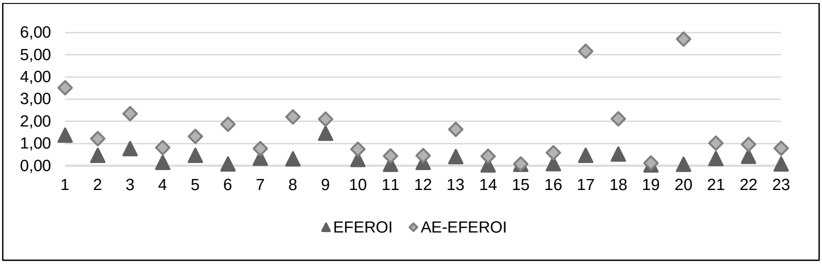

Figure 1: comparative between EFEROI and AE-EFEROI indicators.

Conclusions

Higher values in EFEROI and AE-EFEROI indicators denote greater autonomy and potentially indicate ecologically sustainable farming systems. The findings from this case study highlight the feasibility of employing AEA to evaluate the presence of regenerative practices within farming systems. This approach provides insights into energy balances, moving beyond traditional economic perspectives to encompass biophysical resources essential for maintaining ecological sustainability.

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