

## The energy trap of industrial agriculture in North America and Europe (1830-2012)

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### Abstract

Agricultural energy analyses revealed that behind the greater labour and land productivity of industrial farming there has been a decrease in energy returns, although recent improvements in production and use of inputs have raised them somewhat. Many analyses only consider external inputs at the crop level, regardless of the role of internal biomass flows that livestock and forestry recirculate within agroecosystems. Here we apply a circular bio-economic accounting of different agroecosystems in North America and Europe from 1830 to 2012 that shows a general trend towards lower external and total energy returns, with only small increases or none in internal returns. This energy trap has been driven primarily by dietary and forest transitions to more meat and fewer wood components in agricultural produce. Overcoming this energy trap requires nature-based solutions to increase the circularity and complexity of agroecosystems that reduce the current dependence on external inputs fuelled with fossil fuels.

**Keywords:** Industrial Agriculture; Past Organic Farm Systems; Energy Efficiency; Agroecosystems; Dietary Transition; Animal Bioconversion; Forest Abandonment; Socioecological Transition; Circular Bioeconomy

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