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Are perennial crops more adapted to maintain long-term relationships with soils and, therefore, to sustainable production systems, soil restoration and conservation?

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Abstract

Most major food and feed crops in the world have been derived from annual early successional plant species. Traits that characterize early successional plant species are ephemeralism, preference for disturbed sites, low nutrient use efficiency, and pathogen sensitivity however, such trait combinations in crops require crop rotation, land tillage, fertilization, and biocide use to control belowground and aboveground pests and pathogens. These requirements are a major constraint for sustainable agriculture, as they result in production of greenhouse gasses, loss of organic matter, nutrient leaching to ground- and surface water, and pollution of the environment with toxic biocides. Developing perennial crops could be a solution for circumventing intensive soil disturbance. However, early successional perennials could also have adverse trait combinations that require intensive management practices. The question is what may be learned from nature when aiming at producing sustainable perennial crop production systems. I will discuss some research highlights on secondary succession following land abandonment in order to elucidate how soil food webs and soil ecosystem processes may respond to both change in management and plant trait characteristics of early, mid, and late successional annual and perennial plant species. In short, reducing land tillage and fertilization results in a development of the soil biodiversity and soil food web composition, which affects the mineralization and cycling of nutrients in ecosystems. Such ecosystems could also be more resistant to extreme events, such as drought stress during the growing season. Changes in soil food web composition and functioning are to some extent related to the presence of plant species with specific traits, whereas in part they are due to successional developments that are the result of reduced intensity of land use practices. I propose that insights from (semi-) natural ecosystems may stimulate thinking about how perennial crops could be developed in such a way that they will further enhance the sustainability of agriculture.

Key words: Learning from nature, succession, plant traits, soil food webs, pathogens, ecosystem processes