Conservation agriculture as a response to soil degradation in vegetable and crop production

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Abstract

Soil degradation represents one of the most critical challenges in modern vegetable and crop production, largely driven by intensive farming practices, frequent and deep tillage (particularly plowing), and insufficient return of organic matter to the soil. These pressures accelerate the breakdown of soil structure, depletion of soil organic carbon, and disruption of biological activity, resulting in the deterioration of soil physical, chemical, and biological properties. Consequently, soil fertility declines, nutrient cycling becomes less efficient, and the long-term productive capacity of agricultural land is significantly reduced. At the same time, agriculture is a notable source of greenhouse gas emissions, particularly due to the loss of soil organic carbon, which further contributes to climate change and weakens the soil's role as a carbon sink. Under increasing climate variability and growing pressure on natural resources, sustainable soil management is becoming essential. Conservation agriculture has emerged as a key approach to addressing these challenges through practices such as reduced or conservation tillage, permanent soil cover with crop residues or cover crops, and diversified crop rotations. These principles help restore soil structure and function, improve water retention, enhance biodiversity, and increase carbon sequestration. The adoption of such climate-smart and environmentally responsible practices in modern agriculture mitigates soil degradation, restores soil health, strengthens agroecosystem resilience to climatic stress, and supports more stable and sustainable vegetable and arable crop production systems.

Key words: soil degradation, conservation agriculture, carbon sequestration, sustainable soil management, climate change adaptation

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