CUT-AND-CARRY GREEN MANURE: OPPORTUNITIES FOR PLANT-BASED NUTRIENT MANAGEMENT IN POTATO SYSTEMS

Summary

Cut-and-carry green manure systems are increasingly promoted as plant-based alternatives to chemical fertilizers in nutrient management strategies. This study evaluates the impacts of such systems on seed potato yield, soil health, and nutrient cycling in Northern Netherlands. Despite short-term improvements in soil structure and microbial diversity, long-term results reveal challenges in maintaining nutrient availability for crops.

The need

There is growing pressure to reduce chemical fertilizer use due to environmental risks and resource scarcity. Nature-based solutions (NBS), such as plant-based manures, can support more circular nutrient flows, especially where animal manure is unavailable. However, it remains unclear how complete substitution with green manure affects soil function and crop yield, especially under nutrient-deficient conditions.

This long-term field trial tested a system relying entirely on cut- and carry-green manure and crop rotation. Results were compared to conventional systems using chemical or animal manure-based fertilization. We assessed soil nutrient profiles, microbial dynamics, and calculated soil health scores.

The benefits

Cut-and-carry green manure systems can contribute to more circular and plant-based nutrient management, especially in areas where animal manure isn't available. In our field trials, applying clover silage improved soil structure early in the growing season and boosted microbial diversity. The system also showed potential for carbon and nitrogen fixation, which are important for building long-term soil fertility.

However, the full replacement of chemical fertilizer with plant-based inputs brought some challenges. Nutrients were not always available when the potato crop needed them most, and competition between soil microbes and plants likely reduced nutrient uptake. As a result, yields were lower and soil health declined by the end of the season.

While these systems can support soil biology and reduce reliance on external inputs, our results suggest that extra steps—like combining with compost or adjusting the timing of application—are needed to maintain productivity. This approach has potential, but it needs careful management to work well in practice.

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trans4num solution

Our research pilot explored whether a fully plant-based fertilization system could match or replace conventional methods in terms of soil health and crop yield. The trial was carried out on long-term organic seed potato fields in the north of the Netherlands (Munnikenzijl) and included four systems:

- A conventional system using chemical fertilizers (CF),
- An organic system with goat manure and cattle slurry (COF),
- A plant-based system using only cut-and-carry clover (POF), and
- The same plant-based system with additional compost (POFC).

Over one year with two time points (before planting and just before harvest), we measured yield, soil nutrient availability, microbial activity, and soil structure. The plant-based systems performed well in some areas: they improved microbial diversity and showed higher potential for nitrogen fixation. They also enhanced early soil aggregation. However, nutrient availability during crop growth was a challenge, especially for phosphorus.

The full replacement of chemical or animal-based fertilizer resulted in lower potato yields and lower soil health scores after harvest. Compost helped improve outcomes slightly but didn't fully close the gap. These findings suggest that while cut-and-carry green manure can support nature-based nutrient strategies, they may not be sufficient on their own—especially in nutrient-poor soils.

What were the challenges / limitations in the implementation process?

- Nutrient release didn't match crop demand, especially during the later growth stages when tubers were developing. This limited nutrient availability when the crop needed it most.
- Timing of application was difficult to optimize, as organic inputs decomposed quickly in early spring, releasing nutrients before the crop could use them — especially during wet periods.
- Different potato varieties were used in conventional and organic systems, which is realistic for practice but complicates direct comparisons of outcomes.

What kind of resources do you need to implement the proposed solution?

Land for dedicated cut-and-carry green manure production.
Access to high-quality compost to balance nutrient supply.
Equipment to apply and incorporate organic material efficiently.
Soil and weather monitoring to better time applications.
Possibly microbial inoculants to boost nutrient mineralisation and availability.

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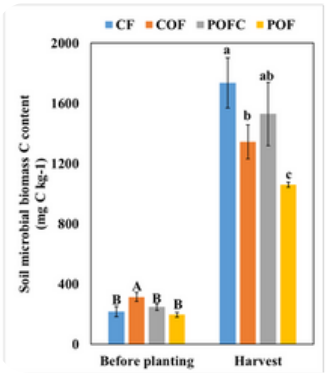
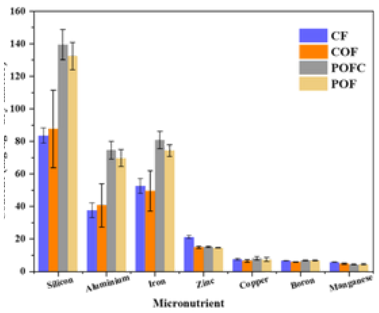
More information

- Giller et al. (2021) "Regenerative Agriculture: An agronomic perspective"
- Moebius-Clune et al. (2016) "Cornell Soil Health Assessment Manual"
- Kuzyakov & Xu (2013) "Competition between roots and microorganisms for nitrogen"
- Sorensen & Grevsen (2016) "Strategies for cut-and-carry green manure production"

Lead study:
WU & SPNA





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