LEGUME RESIDUE RECOVERY AND RHIZODEPOSITION: AN UNDERESTIMATED SOURCE OF SOIL NITROGEN

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Research problem

The contribution of legumes, especially red clover, to the nitrogen (N) cycle is greater than typically assumed based on handbooks and popular science information. Legume crop residues (straw and roots) contain large amounts of N compared to cereals and oil crops, which can be utilized by subsequent crops. However, these residues also increase nitrogen leaching and volatilization. Additionally, an often underestimated source of N is rhizodeposition from legumes, which results from root and rhizobial exudates. To enhance N use efficiency, it is essential to precisely understand the nitrogen turnover in the soil, including the nitrogen inputs and outputs, and their magnitude, which constitutes the nitrogen balance.

Materials and methods

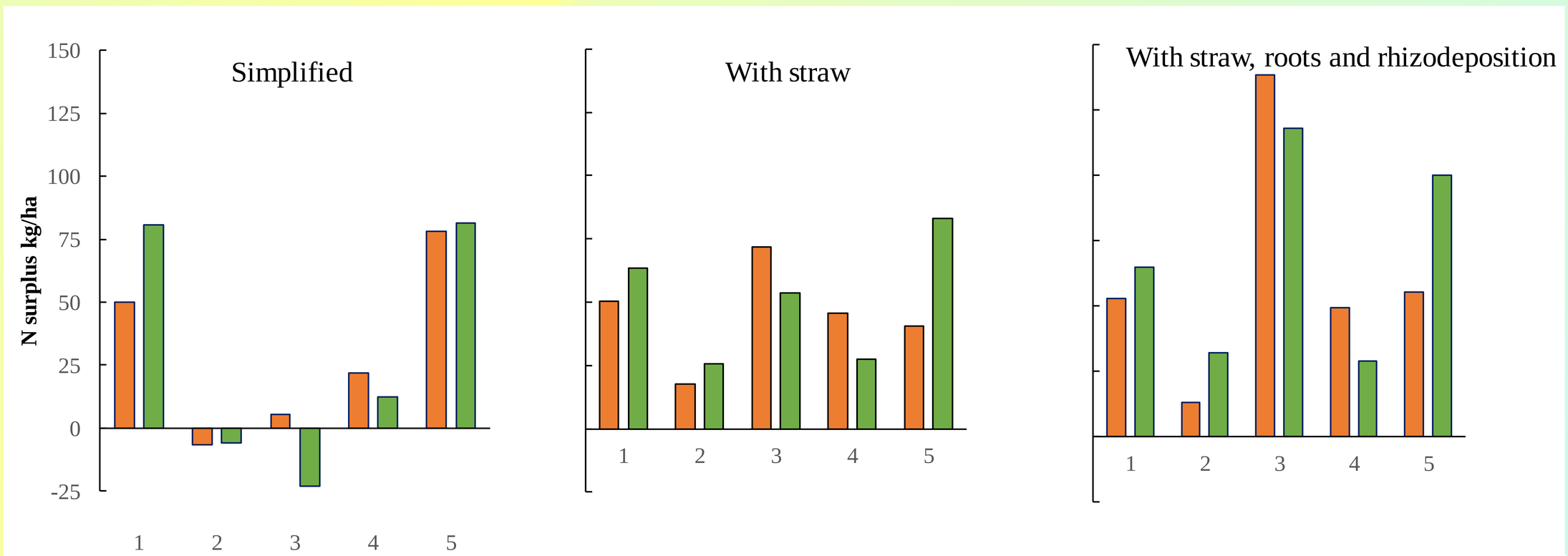
We compared three different N balance calculation methods and their impact on N surplus. The volumes of N inputs and outputs for the year 2023 were considered from a long-term experiment in Tartu County, Estonia. Two cropping systems were compared in a five-field crop rotation as follows: barley with undersown red clover, red clover, winter wheat, field pea, and winter oilseed rape. In the conventional cropping system (N100), barley, winter wheat, and oilseed rape received 100 kg/ha of N, 25 kg/ha of P, and 95 kg/ha of K. In the Organic cropping system, cover crops and cattle manure were used as additional sources of N. The soil type was Stagnic Luvisol (sandy loam surface texture, C 1.38%, N 0.13%, pH KCl 6.0).

Three different N-balance calculation methods, N-inputs and N-outputs

	Simplified		With straw		With straw, roots and rhizodeposition	
	Input	Output	Input	Output	Input	Output
Mineral fertilizer	X		X		X	
Organic fertilizer	X		X		X	
Field pea and red clover N2, ground parts	X		X		X	
Field pea and red clover N2, below ground parts					X	
Atmospheric deposition	X		X		X	
Crop seed	X		X		X	
Crop yield		X		X		X
Red clover as green manure		X		X		X
Mineralized red clover			X		X	
Sereals and rape seed straw and roots				X		X
Mineralized sereals and rape seed straw and roots			X		X	
Cover crops		X		X		X
Mineralized cover crops	X		X		X	

Results and conclusions

The mean N surplus for the five crops, i.e., N input minus N output (see figure below), was 30 kg/ha (N100) and 29 kg/ha (Organic) using the simplified calculation method. The N surplus increased to 45 kg/ha (N100) and 51 kg/ha (Organic) with the straw calculation method, and further increased to 62 kg/ha (N100) and 69 kg/ha (Organic) with the straw, roots, and rhizodeposition method, respectively.



N surplus of different calculations methods: simplified; with straw; with straw, roots and rhizodeposition. Crop rotation: 1-barley with undersown red clover, 2- red clover, 3- winter wheat, 4- field pea, 5- winter rape seed. Two cropping systems: red columns- conventional N100, green columns- organic with cattle manure and cover crops.

The N balance method, which includes straw, roots, and rhizodeposition, is more reliable for identifying N surplus in crop rotations. This method also indicates where the N surplus accumulates, forming ‘hot spots’. In our case, the N surplus accumulates in the winter wheat field (3, figure above) due to the residues and rhizodeposition from the preceding red clover crop.

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