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How can we reduce post-harvest nitrogen losses on agricultural land? Evaluating the potential of easily degradable, nitrogen-free organic soil additives

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One of the most pressing issues in intensive agriculture is how we can reduce post-harvest losses of nitrogen (N) on agricultural land. In terms of N use efficiency, the focus so far has been on optimizing the amount and timing of N fertilization, including spatially targeted application (precision agriculture). However, we must be aware that this will not be sufficient to solve the problem of N surplus. The mineralization of crop residues and soil organic matter, especially after harvest, can lead to very high mineral N concentrations in the soil, which ultimately result in high N losses, mainly in the form of nitrate leaching, but also as nitrous oxide (N_2O) if the excess N is not immobilized before winter. In crop rotations that do not allow the cultivation of a catch crop, e.g. before winter cereals, the N immobilization potential is by far not high enough to immobilize the available mineral N. In this case, a different approach than plant N immobilization is required to immobilize the excess N before winter.

Here, we present results from laboratory incubations and field trials with different soils under a wide range of conditions based on the stimulation of microbial biomass growth by readily available organic soil amendments. They show that effective immobilization of mineral N in large quantities (almost 100 % reduction of nitrate concentration in the soil) is possible for several months, even under winter conditions. A consistent picture emerges from the results, suggesting that the optimal and longest-lasting effect of N immobilization can be achieved with nitrogen-free organic compounds that are moderately available to microorganisms (i.e., within several weeks rather than a few days). If the microorganisms are offered compounds that are too readily available (extreme case: glucose), a rapid stimulating effect can be triggered, which, however, does not last long enough to immobilize N for several months due to too early remineralization. If too recalcitrant organic compounds are introduced into the soil, the utilization of the additional carbon source takes too long to lead to effective N immobilization. We can therefore say that we have taken a significant step forward in understanding the mechanisms and timing of microbial N immobilization and remobilization, which may prove key to solving the N surplus problem in agriculture. However, the extent to which such management measures can be implemented in agricultural practice also depends on the political framework conditions that make them economically feasible.