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Full nitrogen balances for different cattle slurry fertilization techniques in a temperate grassland

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Modern slurry application techniques have been shown to reduce ammonia losses, yet a comprehensive evaluation of their nitrogen (N)-related agronomic and ecological impacts is lacking. Therefore, we utilized 15N-labeled cattle slurry to examine traditional and modern application techniques regarding their effects on hydrological and gaseous N losses, plant N uptake, soil organic nitrogen (SON) formation, and total fertilizer N balances. Following the broadcast spreading of slurry, 43 % of fertilizer N was lost as gaseous emissions, regardless of precipitation. In contrast to broadcast spreading, significant total N emission savings were achieved by the broadcast application of diluted slurry combined with a reduced N supply (47 % emission reduction). Open slot injection at depths of 5 cm and 2 cm resulted in even greater emission reductions of 60 % and 74 %, respectively. Recent fertilizer was typically leached in minimal amounts, but applying diluted slurry increased nitrate leaching due to enhanced infiltration. Overall, the high productivity and plant N uptake were hardly affected by the application method, as over 90 % of the plants' N uptake relied on mineralized SON rather than recent fertilizer. The latter led to soil N mining, especially with broadcast spreading and slurry dilution, causing noticeably negative N balances (17–37 kg N ha-1 deficit per fertilization-harvest cycle). Using slurry injection contributed to additional SON formation, effectively offsetting the N deficit and thereby supporting the long-term maintenance of N-related soil functions.

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