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Silicon recycling through rice-residue management does not prevent silicon depletion in paddy rice cultivation

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Silicon (Si) is known to have beneficial effects on plants, in particular on rice, which is a strong Si accumulator. Si helps mitigate environmental stresses and nutrient deficits of plants. In some regions, the limited plant-available Si in soils might have detrimental effects on rice cultivation. Crop-residue recycling can help to maintain the amount of plant-available Si in soils. However, the effect of crop-residue management practices on the soil-plant Si cycle and on Si availability to plants remains largely understudied. Here, we contribute to fill this knowledge gap by reporting a study on the effects of three different rice-residue management practices on Si-depleted paddy rice systems from northern Vietnam. The rice-residue management practices were (1) direct incorporation of rice residues into the soils, (2) burning in the field, and (3) use as fodder for animals, followed by composting of the obtained manure, and subsequent application of the composted manure to the field. We analyzed different Si reservoirs in soils and plant-Si contents under these different practices. Our results show a strong correlation between the different soil Si reservoirs and plant Si contents. We found no significant difference with respect to plant-available Si in soils and plant-Si contents between the different management practices. Moreover, our data suggest that Si-depleted rice-cultivation systems proportionally lose Si through grain harvest faster than less Si-depleted systems, because of enhanced relative Si accumulation in the grains. This loss cannot be mitigated by straw recycling. It may be one of the reasons why straw recycling has only a limited effect in the extremely Si-depleted rice-cultivation systems that were analysed in this study. Such information is critical in finding ways to maintain an appropriate level of plant-available Si in cultivated soils.