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Exploring factors influencing grain As concentration and speciation in U.S. rice

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Rice is typically grown in flooded soil conditions that favor the growth of Fe- and As-reducing microoorganisms that mobilize mineral-bound inorganic As. These reducing conditions also promote the methylation of inorganic As to organic forms, including dimethylarsinic acid (DMA) and dimethylmonothioarsenate (DMMTA). Inorganic As, DMA, and DMMTA can be found in rice grain; however, the prevalence of DMMTA in U.S. rice is currently unknown. This is because the common speciation techniques that had been previously employed to speciate inorganic As and organic forms led to the conversion of DMMTA to DMA. Thus, DMMTA has been misidentified as DMA in much of the literature. In recent years, pioneering work by Dr. Britta Planer-Friedrich and colleagues proved that DMMTA exists in rice grain, and it is not wise to assume that all organic forms of As are safer than inorganic forms due to the unknown amount of DMMTA in rice. Thus, a closer look at the factors controlling grain concentrations of different As species is warranted.

Here, we explore the factors that influence grain As and speciation in U.S. rice using both experimental and field-collected data. Field-collected data include samples from variable water-managed production-scale fields in Arkansas, the leading rice-producing state in the U.S. These data show that higher concentrations of grain As (both inorganic and organic forms) occur in fields managed under conventional flooded conditions. However, climate-smart irrigation practices like alternate wetting and drying (AWD) or furrow-irrigation (‘row rice’) that save water and limit emissions of methane also decrease both inorganic and organic As in rice grain to levels lower than regulatory limits. We also show through a pot study using three contrasting Arkansas soils how the addition and timing of sulfur amendments influence As mobility and grain As concentration and speciation. Elemental S additions correlated with As mobilization in one silt loam soil but had no impact on finer texture soils with higher pH, and overall soil characteristics had more of an impact on grain As species than sulfur amendments.