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Organic small scale rice production systems in Java, Indonesia – Comparison of soil management practices

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For more than 90% of Indonesians, rice is the dominant staple food. Rice production needs large amounts of water, especially under conventional rice production systems (CRPS). As the Indonesian population grows, so does the demand for rice and with it, the need for more water to produce this rice. While agriculture is still the largest user of water, the competition with alternative uses of surface and ground water increases. Agricultural production is therefore under pressure to reduce its water consumption.
Recently, the System of Rice Intensification (SRI) is promoted in organic agriculture as an alternative cropland management strategy. SRI aims at sustainably maintaining rice yields through optimizing water and nutrient efficiency. Thereby, the dependency on external inputs and water consumption shall be reduced.

However, there is conflicting literature on how SRI management affects yields, because input parameters are largely neglected. For a more systematic evaluation, management strategies were compared on identical sites (considering soil type and microclimate). In the present study, we examined fields of both rice production systems, in four different villages in Central Java (Sleman, Bantul, Kulonprogo and Gunungkidul). The soil types were classified as Leptosols (clay texture) in Gunungkidul and Kulonprogo, while the soil type in Bantul was a Ferralsol (silty clay) and a Vertisol (loamy clay) in Sleman (WRB, 1967).

In SRI fields, single seedlings were planted and treated with organic fertilizer; in CRPS fields, three to four seedlings were planted and treated with inorganic fertilizer. We determined yields by weighing harvested crops on a beam balance. We took soil samples to analyze soil texture, ultrasound aggregate stability (USAS), total soil organic carbon (TOC), total nitrogen (TN), dissolved organic carbon (DOC) and a fungal biomarker (ergosterol).
We found at all study sites that DOC is significantly more available in soils with SRI management (61.7 ± 7.88 mg L-1 DOC), compared to CRPS (48.8 ± 7.13 mg L-1 DOC). The fungal biomarker ergosterol was significantly more abundant ($p<0.05$) under SRI management strategy (SRI: 1.6 mg/kg, CRPS: 1.1mg/kg). Ultrasound soil aggregate stability is a more integrative indicator of soil processes (i.e. soil genesis) as it is strongly determined by soil type and chemical quality. Leptosols showed significantly more stable aggregates under SRI conditions compared to CRPS.

The above results show, that the determined soil parameters can be used to differentiate the two production systems. Ergosterol is a sensitive indicator for oxidative soil conditions, which are beneficial for nutrient availability and plant uptake efficiency. Ultrasound soil aggregate stability results show a benefit for SRI soils, since more water stable soil aggregates mean better conditions for root penetration, development and higher soil porosity. In conclusion, the investigated soil parameters are valuable proxies for soil health indicators.