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"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Trade-offs between nitrogen fixation and heavy metal(loid)s accumulation in a cassava-legume intercropping system on post-tin mining soils amended with local organic amendments

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Abstract

Mining activities severely affect local ecosystems and threaten food security. In particular soils after tin mining on Bangka Island are highly nutrient deficient and characterised by low pH value. Remediation practices, however, are a viable way of reducing the negative impacts on post-mining lands.

In this study, we aimed to investigate the effect of locally available resources on heavy metal(loid)s (HMs) concentrations in crops and soil on a post-tin-mining site located on Bangka Island, Indonesia. Plots with five different soil amendments: (1) dolomite; (2) compost; (3) charcoal; combinations of (4) charcoal + compost; and (5) charcoal + sawdust; and control were established. An intercropping system with cassava and centrosema was employed, and HM concentrations in crops and soils were determined. In addition, the effects of different locally available soil amendments on the percentage of nitrogen derived from the atmosphere (%NDFA) and the amount of nitrogen fixation (N_2-fixation) in the cassava-legume intercropping system were investigated.

The highest amounts of N_2-fixation in centrosema were observed in combined treatment (charcoal + compost), which was influenced more by high shoot biomass production than %NDFA. Improved soil physicochemical properties had a positive impact on the shoot biomass of centrosema, resulting in a higher amount of N_2-fixation and N uptake values. Crop Pb, As, and Cd concentrations exceeded the international standard for maximum levels in food. The edible parts of cassava showed the highest Pb and As concentrations in the charcoal-only treatment. Furthermore, high Pb, As, and Cd concentrations in centrosema vegetative organs indicate a high risk for contamination of the human food supply chain, as these are used as cattle fodder.

Locally available organic soil amendments offer a potential solution for remediating post-tin mining soils by increasing N_2-fixation in centrosema when intercropped with cassava. However, due to the inherent high HM concentrations from their local origin, crop HMs

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can become accumulated in the edible parts of crops. In this study, the combined treatment of charcoal and compost showed the best compromise between improved nitrogen fixation and HMs concentration in a cassava-centrosema intercropping system on remediated post-tin mining soils.

Keywords: Bioaccumulation, crop, local resources, nutrient, remediation, soil