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In-Field Biochar Production from Crop Residues: An Approach to Reduce Open Field Burning in Northern Thailand

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Abstract

In recent years, people in northern Thailand have been suffering from severe air pollution. The main sources were found to be forest and field fires. The latter caused by smallholder farmers who burn crop residues in order to clear their land, make nutrients available and presumably improve soil sanitary conditions for the next cropping cycle.

This study compares emissions from open burning of maize stover to the emissions from producing biochar in an experimental kiln. Experiments were carried out at four locations in three provinces in northern Thailand: Mae Hong Son, Chiang Mai and Nan. On each site, the experiments were done in triplicates on 10 m × 10 m plots. Total fresh and dry biomass in the field was measured. Labour requirement for biomass collection and charring was recorded. Temperatures of the open field burning and kiln charring were measured. Production of exhaust gases of open field burning and kiln charring was determined under laboratory conditions at Chiang Mai University.

The results show that during the pyrolysis of corn stover emissions of CO, NO, NO₂ and SO₂ did not occur. This indicates that there was a complete combustion of the synthesis gases, releasing only CO₂ to the environment. In contrast, the open combustion showed elevated emissions and high levels of particulate matter (PM) 10. Burning of residues on the field did not increase soil temperature, while the temperatures 10 cm above ground ascended to 500–700°C, however, for less than two minutes. Thus, the phytosanitary effect of the burning was found to be negligible. An average of 22 % of fresh biomass was converted to biochar, which can be used as a soil amendment. The major disadvantage of charring was the high labour demand of 120 man minutes per 100m² at present state of the art.

This study was the first carried out in cooperation with farmers under field conditions in remote areas of the northern Thai Highlands. It shows that emissions can be reduced substantially by applying pyrolysis instead of open field burning. Further research is needed to optimise the size of the kiln and the ergonomics of biomass collection and biochar handling.

Keywords: Air pollution, combustion, highland, pyrolysis, smoke