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"Development on the margin"

Life Cycle Assessment on the Substitution of Dung Combustion by Biogas Systems in Ethiopia

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Abstract

The utilisation of dried dung cakes as a fuel for household cooking stoves is very common in rural areas of developing countries. The greenhouse gases thereby emitted contribute to the global warming potential (GWP) and endanger the human health of the local people. In industrialised countries, biogas production by anaerobic digestion is assessed as an efficient way to reduce greenhouse gas emissions from dung management and to preserve nutrients for plant production.

The objective of this study was to assess the environmental impacts of biogas systems used for the provision of cooking heat in rural areas of Ethiopia. Two scenarios for the provision of thermal household energy were taken into consideration. The first one describes the situation at present, where cattle dung was dried and used in household cooking stoves. The second scenario was the usage of the fresh dung as a substrate for anaerobic digestion to produce biogas and combustion in a biogas stove.

The method of Life Cycle Assessment was used according to the ISO 14040 and 14044 standards. A model was built with the GaBi-software and system expansion was used to deal with additional functions of the system. The life cycle inventory was based on literature values *e.g.* for emissions of dung cake combustion, methane losses of the biogas plants and methane conversion factors. Impact assessment was done using the CML 2001 method in the version of 2007 for the impact categories GWP, acidification potential, eutrophication potential and human toxicity potential (HTP).

The production of biogas leads to several environmental advantages compared to the dung combustion system. The results indicate that the GWP can be reduced about 1.36 kg CO_2 equivalents MJ^{-1} heat delivered to pot. The fertiliser value is increased due to a higher nitrogen content of the biogas plants effluent compared with the ash of dung combustion. Furthermore, emergence of cooking smoke in households is reduced considerably which results in a saving of 32 g DCB equivalents MJ^{-1} heat delivered to pot concerning HTP.

Keywords: Biogas, dung combustion, Eastern Africa, Ethiopia, lCA

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