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Using biochar in animal farming to recycle nutrients and reduce greenhouse gas emissions

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Charcoal has been used to treat digestive disorder in animals since several thousand years. But only since about 2010 biochar has increasingly been used as regular feed additive in animal farming usually mixed with standard feed at approximately 1% of the daily feed intake. The use of biochar as feed additive has the potential to improve animal health, feed efficiency and the animal-stable environment; to reduce nutrient losses and GHG emissions; and to increase soil organic mater and thus soil fertility. The evaluation of more than 150 scientific papers on feeding (activated) biochar showed in most of the studies and for all investigated livestock species positive effects on parameters like toxin adsorption, digestion, blood values, feed use efficiency and livestock weight gain, meat quality and GHG emissions. The facilitation of direct electron transfers between different species of bacteria or microbial consortia via the biochar mediator in the animal digestion tract is hypothesized to be the main reason for a more energy efficient digestion and thus higher feed efficiency, for its selective probiotic effect, for reduced N-losses and eventually for less GHG emissions.

While chicken, pigs, fish and other omnivore animals provoke GHG-emissions (mainly NH3, CH4, N2O) when their liquid and solid excretions decompose anaerobically, ruminants cause direct methane emissions through flatulence and burps (eructation). Preliminary studies demonstrated that feeding high temperature biochars might reduce ruminant CH4 emissions though more systematic research is needed. It is likely that microbial decomposition of manure containing digested biochar produces less ammonia, less methane and thus retain more nitrogen, as seen when manure was composted with and without biochar or when biochar is used as bedding or manure treatment additive. Laboratory adsorption trials estimated that using biochar for liquid manure treatment could safe 57,000 t NH4 and 4,600 t P2O5 fertilizer per year in California alone. It was further shown that feeding 0.3 to 1% biochar could replace antibiotic treatment in chicken and ducks, respectively. Feeding biochar could thus have an indirect effect on GHG emissions when it is able to replace regular antibiotic "feeding" that produces high indirect GHG emissions after soil application of antibiotic contaminated manure. Moreover, it was demonstrated that feeding biochar to grazing cows had positive secondary effects on soil fertility and fertilizer efficiency reducing mineral N-fertilizing requirements which could be another indirect biochar GHG mitigation effect.

Considering an average C-content of fed biochar of 80% and produced at recommended temperatures above 500°C resulting in H/Corg ratios below 0.4, at least 56% of the dry weight of the fed and manure-applied biochar would persist as stable carbon in soil for at least 100 years. If the global livestock would receive 1% of their feed in form of such a biochar, a total of about 400 Mt of CO_2eq or 1.2 % of the global CO_2 emissions could be compensated.

The apparent potential for improving animal health and nutrient efficiency, for reducing enteric methane emissions as well as GHG emissions from manure management and for sequestering carbon with soil fertility improvements makes it compelling to increase the scientific effort to investigate, measure and optimize the GHG reduction potential of biochar use in animal farming systems. The main results from literature and own experiments will be presented to illustrate and calculate this potential.