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The Effect of Biogas Production induced Land Use Changes on Soil Organic Carbon Stocks – Case Study and Modelling Approach with CANDY

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With the revision of the German Renewable Energy Law in 2004 and the following biogas boom, land use management is undergoing major changes. Narrow energy crop rotations, fertilized with biogas plant digestates, are substituting the traditional crop rotations. Concerns are that these land use changes may have a negative effect on soil quality, especially on soil organic carbon stocks. Objective of this study is to model the impacts of land use change induced by biogas production on sandy soils in north-west Germany. The soil process model CANDY seems to be an appropriate tool to describe carbon and nitrogen dynamics in arable soils on the basis of soil, management, and climate data. Such data were recorded from long-term soil monitoring sites on arable land in north-west Germany established in the early 1990s. The basic soil and climate data recorded continuously at the monitoring sites were used to describe the development of soil organic carbon stocks for two different land use scenarios: The traditional crop rotations are compared with a narrow energy crop rotation. To both crop rotations, three different organic fertilizers are applied: swine liquid manure, unseparated biogas plant digestate, and the liquid phase of a mechanically separated digestate. Steady state soil organic carbon stocks of both crop rotations are simulated. The unseparated digestate and the liquid phase were provided by a one-stage mesophilic 500 kW_{el} biogas plant with mechanical separation of the digestate into a solid and liquid phase. In a previous case study with this biogas plant, the composition of the unseparated digestate and the separated liquid phase were determined. For the chosen scenarios,

modelling with CANDY showed that the combination of a narrow energy crop rotation with application of unseparated digestate and separated liquid phase can result in significant changes of steady state soil organic carbon stocks. Even if these changes are of minor importance for the function of soil as a carbon sink they may have severe effects on soil quality.