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Indicators for a sustainable agriculture – a farmstead approach to model N-trace gas emissions from agricultural crop production in Germany

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Sustainability has become a major issue in environmental and agricultural policy. It is known that agricultural crop production causes huge environmental nitrogen losses. For example, high nitrogen fertilisation rates result in an average nitrogen surplus of 80-110 kg N ha^{-1} a^{-1} in German agricultural systems. Among other consequences such as inorganic and organic nitrogen exposure of surface waters and groundwater, nitrogen surplus increase N_2O- and NO trace gas emissions from agricultural fields. From a viewpoint of climate change a reduction of these N trace gas emissions improves environmental sustainability.

Based on environmental indicators different instruments have been developed to assess farming systems in view of their sustainability. One of these instruments is the REPRO (Reproduction of the soil organic matter) model. REPRO carries out an ecological and economical analysis. Based on the ecological analysis it further evaluates the environmental effects caused by the farm management. Even though REPRO calculates a broad range of farm matter and energy fluxes, there are still some deficits. Prediction of trace gas emissions as an indicator for climate sustainability is not yet explicitly included in the model. For example, gaseous nitrification and denitrification losses are not divided into N_2O, NO and N_2. This is achieved by linking REPRO with the Denitrification-Decomposition (DNDC) model. DNDC is a process-oriented simulation model of soil carbon and nitrogen biogeochemistry. It consist of two components: (1) Sub-models for soil climate, crop growth and decomposition predict soil environmental variables such as temperature, soil moisture, pH, Eh, and substrate concentration profiles. (2) Nitrification, denitrification, and fermentation sub-models es-

timate N- and C- trace gas fluxes based on the aforementioned soil environmental variables.

Given that the emissions of NO, N_2O, and N_2 are highly variable in space and time it is necessary to estimate N trace gas emissions for every specific field site of a farm. By linking the DNDC model to the REPRO model, it will be possible to predict N_2O and NO emissions depending on site conditions and management practices for all relevant agricultural cropping systems in Germany. The overall method and first results of linked models will be presented.