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# Including spatial data in nutrient balance modelling on dairy farms

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The Annual Nutrient Cycle Assessment (ANCA) calculates the nitrogen (N) and phosphorus (P) balance at a dairy farm, while taking into account the subsequent nutrient cycles of the herd, manure, soil and crop components. Since January 2016, Dutch dairy farmers are required to use ANCA in order to increase understanding of nutrient flows and to minimize nutrient losses to the environment. A nutrient balance calculates the difference between nutrient inputs and outputs. Nutrients enter the farm via purchased feed, fertilizers, deposition and fixation by legumes (nitrogen), and leave the farm via milk, livestock, manure, and roughages. A positive balance indicates to which extent N and/or P are lost to the environment via gaseous emissions (N), leaching, run-off and accumulation in soil. A negative balance indicates that N and/or P are depleted from soil. ANCA was designed to calculate average nutrient flows on farm level (for the herd, manure, soil and crop components). ANCA was not designed to perform calculations of nutrient flows at the field level, as it uses averaged nutrient inputs and outputs across all fields, and it does not include field specific soil characteristics. Land management decisions, however, such as the level of N and P application, are typically taken at the field level given the specific crop and soil characteristics. Therefore the information that ANCA provides is likely not sufficient to support farmers' decisions on land management to minimize nutrient losses to the environment. This is particularly a problem when land management and soils vary between fields. For an accurate estimate of nutrient flows in a given farming system that can be used to optimize land management, the spatial scale of nutrient inputs and outputs (and thus the effect of land management and soil variation) could be essential. Our aim was to determine the effect of the spatial scale of nutrient inputs and outputs on modelled nutrient flows and nutrient use efficiencies at Dutch dairy farms. We selected two dairy farms located on cover sands in the Netherlands. One farm was located on relatively homogeneous soil type, and one on many different soil types within the sandy soils. A full year of data of N and P inputs and outputs on farm and field level were provided by the farmers, including field level yields, yield composition, manure composition, degree of grazing and degree of mowing. Soil heterogeneity was defined as the number of soil units within the farm corrected for surface area, and quantified from the Dutch 1:50.000 soil map. N and P balances at farm and field level were determined, as well as differences in nutrient use efficiency, leaching, and N emission. We will present the effect of the spatial scale on nutrient balance analysis and discuss to which degree any differences are caused by within-farm land management and soil variation. This study highlights to which extent within-farm land management and soil variation should be taken into account when modelling nutrient flows and nutrient use efficiencies at farm level, to contribute to field-based decision making for improved land management.