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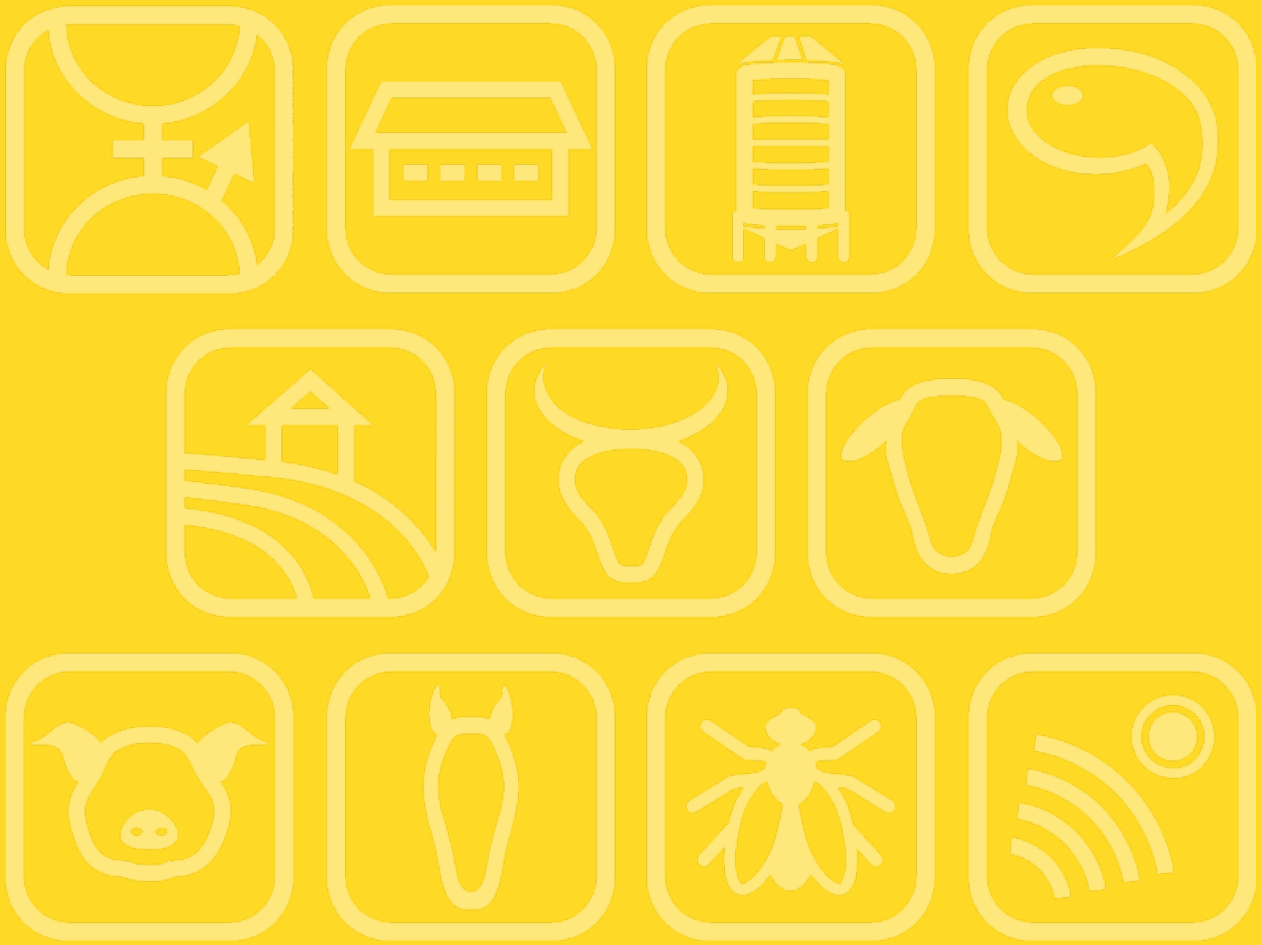

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Developing an in-flight network for gas and particulate emissions assessment in cattle dairy farms

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Quantifying and reducing greenhouse gases (GHGs) emissions in livestock systems and, specifically, in the context of dairy farming, is a debated topic. International policies are supporting mitigation strategies to reduce the environmental impact of agricultural practices. Besides, the assessment of air quality in livestock buildings for ensuring human and animal safety and welfare is poorly addressed and no real-time monitoring systems are currently available. In this framework, automated and low-cost tools enabling a continuous monitoring of air concentrations of gases and particulate in cattle buildings, manure and feed stores would represent a significant advancement in the sector. As part of the *CCCFarming* project, we aimed to assess the feasibility of a UAV-based system (drone) for real-time measurements of air pollutants at farm level. Given that drones are increasingly used for air quality monitoring in several fields (e.g. atmospheric chemistry research, industrial emission monitoring), we present a first attempt to develop an integrated prototype system for gas and particulate monitoring using portable self-engineered measurement units at ground and on a small UAV. The goal is to detect emission hotspots and to provide real-time graphic alerts by means of a web-app. The system embeds low-cost commercial sensors for GHGs (CH_4, CO_2), NH_3 and particulate ($PM_{2.5}$, PM_{10}) into customized portable units located at ground and on a rotor-based drone. The sensors were calibrated in a specialised laboratory and the system was tested in a commercial dairy farm. Ground measurement units were located inside and close to the external boundaries of the cattle building, while simultaneous flights were carried out in the top atmospheric boundary layer up to 30 m a.g.l. Gas and particulate concentration measurements were timestamped and georeferenced with centimetre accuracy. The results confirmed the feasibility of the project at farm level, although further research is required to validate field measurements with reference instruments and techniques.

Air filtering as alternative approach to combat emissions from cattle facilities

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Various strategies can be followed to reduce ammonia and methane emissions. One strategy is to adapt the animal to the environment and the other is to adapt the environment to the animal. Practices of the first category are feeding practices, e.g. adding methane blockers to the feed or lowering protein in feed, and genetics, e.g. selecting for low methane animals. We study the filtering of the air belonging to the second strategy. In pig husbandry air washers are common to filter ammonia from the air in barns. The air is sucked into a water basin where ammonia reacts with acid to a solid component. This technique has not been adopted in cattle housings, mostly because those facilities have an open structure and other source oriented approaches prevailed. For methane, the very low concentration in barns (measured on 60 farms spread over Europe from 5 to 80 ppm at 2 m height) and low solubility in water complicates the filtering of methane. In a dairy housing about 20% of methane comes from the manure and 80% from the mouth of cows by the natural physiological process of rumination. We studied the challenging possibility of simultaneously filtering methane and ammonia from the air in the housing including manure storage facilities. We examined three processes: (1) Air circulation: try to combine air containing methane and ammonia in one flow; air is sucked from manure storage plus above floor (close to mouth of cows). The effectivity of filtering air with varying degrees of openness of barn, and by increasing of methane concentration by recirculating the air. (2) Filter techniques: Study of the effectivity of absorbing material, bio-bed and land/soil filters for oxidation or conversion of methane and ammonia. (3) Re-use of filtered N and C material. Background information from literature and a variety of mostly experimental applications in practice will be demonstrated, which indicate that the filtering of methane from barns and storages forms the biggest challenge to solve.