Factors influencing airborne pollutant concentrations within and emissions from Australian piggery buildings

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ABSTRACT

Different airborne pollutants, such as ammonia, airborne bacteria, respirable endotoxins, inhalable and respirable particles can be found in high concentrations in the airspace of piggery buildings. It has been suspected that these airborne pollutants can interfere with animal health, production efficiency and welfare, can increase occupational health and safety risk for farm workers, hasten the damage of building components and jeopardise the environmental sustainability of livestock operations. As a first step in the investigation of these potential problems, a literature review was undertaken with two major aims in mind. First to systematically review problems associated with high airborne pollutant concentrations, which then facilitated the prediction of the likely benefits associated with reducing the concentrations of different airborne pollutants. The second aim of the literature review was to catalogue previous work, which correlated the concentrations of airborne pollutants with management and housing factors. This facilitated the development of solid understanding of the likely risk factors predisposing certain piggery buildings to higher airborne pollutant concentrations. During this review however, it was realised that almost all previous work used simple correlation matrixes to establish relationship between the concentration of airborne pollutants and different housing and management related risk factors, without an attempt to properly model the effects of all the possible risk factors. Therefore, a study was designed with the main objective to use a multifactorial statistical modelling approach to actually take into consideration all likely main effects, covariates and interactions simultaneously to identify the statistically important risk factors and explain the variation observed in the concentrations and emissions of key airborne pollutants. The development of the models resulted in two major benefits. First, after the identification of statistically significant factors, their better management could lead to improvement in air quality inside and outside of piggery buildings. Second, by combining the sub-models developed for individual airborne pollutants, an easy-to-use prediction tool was developed, which could reduce the need for expensive air quality measurements on site.

As a first step in the study, an 'environmental measurement kit" was developed which was used in 160 individual piggery buildings over two years to collect air and environmental quality related information as part of the data collection phase of the study. The information collected in four states of Australia was sent to a central location and

analysed using a general linear modelling approach. Altogether seventeen models were developed to explain the variation observed in the concentrations and emissions of all key airborne pollutants (such as ammonia, carbon dioxide, airborne bacteria, respirable endotoxins, inhalable and respirable particles) as well as environmental parameters, such as air temperature, relative humidity and ventilation rates. After the identification of statistically important factors for individual pollutants, these risk factors were combined into a "universal" internal concentration, ventilation and emission prediction model. The combined model predicts the likely internal concentrations, ventilation and emission rates based on engineering and management features of the piggery buildings without the need to conduct expensive measurements.

However, it was recognised that the computations to calculate these internal concentrations, ventilation and emission rates had to be automated, in a form of dedicated software, as the complexity of these models would not allow manual calculations. It was also recognised that in some instances measurements would be still appropriate, indeed necessary under individual farm circumstances when predictions have to be backed by real measurements. Therefore, as a delivery mechanism for project results, a packaged hardware and software kit was developed. This assessment kit (called BASE-Q system) is essentially the simplified, user-friendly version of the scientific measurement kit and data management system used during the data collection phase of the study. The BASE-Q kit enables the users to pre-screen the buildings using the Pocket PC software (containing the "combined" model developed during the study) that will predict the internal concentrations and emission rates of all important airborne pollutants. Furthermore, if the predictions were not satisfactory for the users, the robust hardware components of the BASE-Q kit would enable them to conduct air quality measurement accurately and cost effectively, without the need for high levels of technical knowledge. The PC based BASE-Q software stores and processes the acquired information, making the whole system very labour efficient and user friendly. By developing these hardware tools and associated softwares, the scientific results of the main study will be efficiently extended to the farming community.