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Review

Best available technology for European livestock farms: Availability, effectiveness and uptake

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ABSTRACT

Concerns over the negative environmental impact from livestock farming across Europe continue to make their mark resulting in new legislation and large research programs. However, despite a huge amount of published material and many available techniques, doubts over the success of national and European initiatives remain. Uptake of the more cost-effective and environmentally-friendly farming methods (such as dietary control, building design and good manure management) is already widespread but unlikely to be enough in itself to ensure that current environmental targets are fully met. Some of the abatement options available for intensive pig and poultry farming are brought together under the European IPPC/IED directive where they are listed as Best Available Techniques (BAT). This list is far from complete and other methods including many treatment options are currently excluded. However, the efficacies of many of the current BAT-listed options are modest, difficult to regulate and in some cases they may even be counterproductive with respect to other objectives ie pollution swapping. Evaluation of the existing and new BAT technologies is a key to a successful abatement of pollution from the sector and this in turn relies heavily on good measurement strategies. Consideration of the global effect of proposed techniques in the context of the whole farm will be essential for the development of a valid strategy.

Contents

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1. Introduction

1.1. The environmental impacts of livestock farming

Concern over the negative impacts from livestock farming across Europe is certainly not new. Many studies have been carried out on the assessment of the detrimental effects of modern farming systems and the possible abatement methods that might be implemented. These issues relate to air and water quality, and the consequential impacts on ecosystems and biodiversity (Hoffmann, 2011; Gerber et al., 2013) and also to the potential impact on human health (Seedorf and Hartung, 1999; Gilchrist et al., 2007). In particular, nitrogen (N) losses from the livestock farming process is present in many forms of pollution including nitrate (NO_3^-) leaching contributing to eutrophication (Jarvie et al., 2005; Moreau et al., 2013), and ammonia (NH_3) emissions from livestock manures (Fangmeier et al., 1994) with recognized detrimental effects on soil condition, forests and biodiversity (Steinfeld et al., 2006). Furthermore, the presence of surplus nitrate in certain soils can lead to the production and emission of nitrous oxide (N_2O) (Fangmeier et al., 1994; Sommer et al., 2009). Livestock production activities also contribute to greenhouse gas emission (GHG), especially methane (CH_4) from enteric fermentation, and both CH_4 and N_2O from manure management (Steinfeld et al., 2006; Chadwick et al., 2011). The accumulation of copper and zinc in soils may impose a toxicity risk to plants and micro-organisms (Dourmad and Jondreville, 2007). Livestock production accounts for an estimated 14% and 64% of world GHG and NH_3 emissions, respectively (Gerber et al., 2013; Steinfeld et al., 2006) and 78% of NH_3 emissions in Europe (EEA, 2010).

1.2. Abatement of pollution by the development of regulatory measures

The environmental impacts from modern farming, has led to a series of international protocols, European directives and national regulations. Control of NH_3 emissions comes under the EU National Emissions Ceilings Directive (EC, 2001) resulting from the Gothenburg Protocol (United Nations Convention on Long-range Transboundary Air Pollution – CLRTP, UNECE, 1999). Emissions of CH_4 and N_2O from livestock farming are regulated by the Kyoto Protocol under the United Nations Framework Convention on Climate Change – UNFCCC (UN, 1997). Nitrate and phosphorus loading of water resources are addressed by the EU Nitrates Directive (EEC, 1991) and the EU Water Framework Directive (EC, 2000). The Nitrate Directive sets limits for the period of time of permitted manure application and a standard of 50 mg L^{-1} for NO_3^- concentrations in surface and ground waters, whilst the Water Framework Directive sets phosphorus concentration standards of 50–120 μg L^{-1} for good ecological status. Under this legislative framework, European member states have implemented national programs to achieve their obligations to reduce NO_3^- losses (to water) and NH_3 and GHG emissions (to air). These measures are based on official documents that specify the current scientific knowledge and best techniques to reduce pollution: for NO_3^- "Good Agricultural Practice for nitrates" (EEC, 1991), and, for NH_3 the "Guidance document for preventing and abating NH_3 emissions from agricultural sources" (UNECE, 2014).

An even more prescriptive approach to implement abatement measures has emerged from the Integrated Pollution Prevention and Control Directive IPPC 96/61/EC (EC, 1996), which has been incorporated in to the Industrial Emissions Directive 2010/75/EU (EC, 2010). This directive sets common rules for licencing industrial activities with the broad objective of environmental protection. One of the defined sectors is intensive livestock farms (currently those with more than 40,000 places for poultry or 2000 places for fattening pigs) which must have an operating permit that describes the whole environmental performance of the farm. This takes in to account pollution of air, water and land, waste production and resource utilization (including water consumption and energy efficiency). The operating permit is only given if the farmer demonstrates the appropriate use of "best available technologies not entailing excessive costs" (BAT's) which are listed and described in the official "Reference Document on Best Available Techniques for The Intensive Rearing of Poultry and Pigs" or BREF (EC, 2003).

1.3. Challenges to the implementation of effective abatement strategies

Despite the extensive concerted effort by governments and researchers over many years, success in protecting the environment is still questioned on the basis of (a) the efficacy of the individual