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Review

Overview of manure treatment in France

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ABSTRACT

Manure treatment becomes a focal issue in relation to current EU and national policies on environmental, climate and renewable energy matters. The objective of this desk study was to collect all available data on the treatment of manure from cattle, pig and poultry farms for an overview of manure treatment in France. Specific surveys in 2008 showed that 12% of pig farms, 11% of poultry farms and 7.5% of cattle farms was concerned by manure treatment. Taken together, the treatment of pig, poultry and cattle manure accounted for 13.6 million tons corresponding to 11.3% of the total annual tonnage (120 million tons). The main processes, mostly applied on the farm, were composting (8.5 million tons), aerobic treatment (2.9 million tons of pig slurry) and anaerobic digestion (1 million tons). Other manure treatments, including physical-chemical treatment, were less frequent (0.4 million of m^3). Treated manure was mainly used to fertilize the soil and crops on the farm concerned. Manure treatment can thus be considered to be underused in France. However, anaerobic digestion is expected to expand to reach the European target of 20% of energy from renewable sources. Nevertheless, this expansion will depend on overcoming the constraint requiring registration or normalization of the use of the digestate as fertilizer. Thus, to avoid penalizing farmers, the further development or creation of collective processing platforms is recommended, combined with an N recovery process that will enable the production of organic amendments and fertilizers in an easy marketable form.

Contents

1. Introduction

The livestock sector must respond to the world food demand that can under certain conditions be in conflict with environmental issues and climate change. Indeed, livestock production generates about 1400 million tons of manure annually in the European Union (EU) with the largest production in France (Foged et al., 2011). Manure is generally stored and then spread on agricultural fields (Loyon et al., 2010). Even if manure is a resource for preserving the soil fertility, its management has become one of the main problems for the environment. These environmental effects have been

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widely reviewed and reported (Martinez et al., 2009; Montes et al., 2013; Steinfeld et al., 2006).

The management of the large volumes of manure was identified to cause water pollution and eutrophication by leaching and/or runoff of nitrate/phosphorus, ammonia emissions in addition to air pollution (greenhouse gas (GHG) and ammonia (NH_3) emissions). This is particularly the case of intensive farming concentrated in specific regions (Martinez et al., 2009). The main problem is the excess of nutrients often associated with intensive farms with not enough land to spread the manure. In regions were nitrogen and phosphorus are in excess relative to available land, the export of excess nutrients out of the region can reduce the environmental impact of livestock (Martinez et al., 2009). Farmers must then consider new strategies for manure management to minimize its environmental impact in accordance to its fertilizer value (Petersen et al., 2007). Manure treatment is an alternative to the traditional nutrient management based only on spreading because it produces manure co-products (e.g. anaerobic digestate, separated liquid and solid fractions, compost) differing by their nutrient content from untreated manure.

In this context, treatment may be essential to reduce the risk of losses of nutrients to water resources in regions with intensive livestock rearing where too much manure is produced (Bernet and Béline, 2009). In addition to better management of nutrients, treatment can also reduce gas emissions (Chadwick et al., 2011; Loyon et al., 2007; Montes et al., 2013). Other possible objectives of manure treatment are the removal of pathogens (Martinez et al., 2009), xenobiotic compounds (emerging pollutants), etc.

Many manure processing systems already exist for livestock farming and can be classified as mechanical/physical separation (Burton, 2007), aeration or anaerobic digestion, and chemical methods (Burton and Turner, 2003).

For the European Commission manure treatment techniques become an important tool for the enforcement of regulations regarding nitrate and phosphorus loading of water resources addressed by the EU Nitrates Directive (EEC, 1991) and the EU Water Framework Directive (EC, 2000). Manure treatment is also recommended as part of the reduction of gas emissions (NH_3, GHG) under the Gothenburg Protocol (UNECE, 1999) and the NEC Directive (EC, 2001). Manure treatment is considered as a Best Available Technique (BAT) under the Industrial Emissions Directive (IED (EC, 2010)). Recently, manure treatment by anaerobic process (also called biogas process) is considered as a source of energy within the EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources (EC, 2009).

A recent European survey (Foged et al., 2011) estimated that manure treatment in Europe accounts for around 8% of the total volume of livestock manure produced, with major differences between countries. Data on manure treatment in France are still irregular, widely dispersed and not always synthesized. However, some French government or professional organizations do publish data on manure management. These data come from national livestock surveys or from dedicated surveys of manure management in some regions with intensive livestock farming.

Thus, the objective of this paper was to collect all data on the treatment of cattle, pig or poultry manure to obtain as precise an overview of manure treatment in France as possible. Our main objective was to estimate the proportion of manure that is treated relative to the total amount of manure produced in France every year. The technical characteristics of the treatment (energy consumption, nitrogen or carbon abatement, etc.) is beyond the scope of this work.

Table 1
Estimated annual quantity of manure, nitrogen and phosphorus produced on farms by cattle, pig and poultry in France (tons of fresh manure, pasture not included).

Type of livestock	Total excrement (in tons of fresh manure)	Nitrogen[d] (tons of N)	Phosphorus (tons of P)
Cattle[a]	Solid manure: 68.7 million tons Slurry: 18.2 million tons	1,326,000	100,000[e]
Pigs[b]	Slurry: 25.4 million m[c] Manure: 828,000 tons	143,000	57,800[b]
Poultry[c]	Solid manure: 2.5 million tons Droppings: 0.6 million tons Slurry: 2.5 million tons	127,000	35,000[c]

[a] Capdeville et al. (2015).
[b] Ifip (2010).
[c] Itavi (2013).
[d] Eau France (2014).
[e] Personal estimate.

2. Manure production by the French livestock (cattle, poultry and pig)

According to the French Agricultural census 2010 (Maaf, 2010), 19.5 million cattle, 13.9 million pigs and 221.6 million poultry were counted in France. On the farm itself (not including pasture-land) this livestock produces around 120 million tons of manure per year (Table 1) comprising 60.6% solid manure, 38.8% slurry, the remainder being poultry droppings (Capdeville et al., 2015; Ifip, 2010; Itavi, 2013). The corresponding amounts of organic N and P are estimated to be around 1.6 and 0.2 million tons per year, respectively (Table 1). Manure is mainly spread on the soil and on crops. Manure production is not homogenously distributed over the whole French territory. The majority of slurry and solid manure is produced in the north-west (Brittany, Pays de la Loire and Lower Normandy). The concentrated production of manure in a small area results in a N surplus estimated at 902,000 tons with a national average of 32 kg ha^{-1} of Utilized Agricultural Area (MEDDE, 2013a,b).

3. French legislation of manure treatment

In France, depending on the farm's livestock thresholds, cattle, pigs and poultry farms are subject to (i) Departmental Health Regulations (RSD) or (ii) Classified Installations for Environmental Protection (ICPE). Depending on their geographical location, farms are also covered by European directives (Nitrates Directive, Water Framework Directive) which introduced additional requirements for land application of manure in certain areas. In France, the majority of farmers recycle manure on their farm by spreading, but livestock manure is also treated for various reasons: (i) to transform manure into organic amendment (NFU 44-051, AFNOR, 2016a) or organic fertilizer (NFU 42-001, AFNOR, 2016b) for commercial purposes (or not because in France manure must have the status of an organic product to be saleable off the farm), (ii) as a way of reducing N surpluses in some areas to meet the regulatory requirements of the Nitrates Directive concerning N fertilization, (iii) as mandatory under the Nitrates Directive for farms located in Nitrate Vulnerable Zones (NVZs) that produce specific N surplus which are defined regionally, and (iv) mandatorily under the Water Framework Directive in the river district "Loire-Bretagne" to respect the balance of P fertilization. Manure treatment, especially anaerobic digestion, is also recommended and receives financial support in some regions, mainly in Brittany, where manure production is very high, and under occasional plans that aim to restore the quality of water (MEDDE and MAAP, 2010, 2013). In France, when reporting NH_3 emissions under the IED directive, farmers can declare a 70% reduction in emissions if they use nitrification-denitrification manure treatment, and anaerobic digestion treatment with or without phase separation (MEDDE, 2015).