LIVESTOCK DENSITY AND NUTRIENT BALANCES ACROSS EUROPE

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The rising demand for animal products over the past five decades has been met by a rapid growth of specialised intensive production. The main environmental problems likely to be associated with these systems are: 1) accumulation of animal waste, leading to build up of excess nutrients and heavy metals in the soil, 2) emission of ammonia, airborne particulates and odours to the atmosphere, 3) emission of greenhouse gases: methane, nitrous oxide, 4) release of chemical inputs, feed additives and animal health inputs, tannery and slaughter house wastes, 5) degradation and depletion of fresh water resources 6) high consumption of fossil energy leading to CO_2 emission and global warming and 7) loss of biodiversity in farm animals (De Haan, Steinfeld et al. 1998; Steinfeld, De Haan et al. 1998; Hartung 2000; Hartung and Wathes 2000; Seedorf and Hartung 2000; Montel 2001).

Nutrient loading in crop-livestock systems may occur in areas where the nutrients present in manure are not properly recycled or treated. The major effects of animal waste mismanagement include eutrophication of surface water (deteriorating water quality, algae growth, damage to fish etc.) due to input of organic substances and nutrients; leaching of nitrate and possibly pathogens into ground water; and accumulation of nutrients, drug residues and heavy metals in the soil (Hamscher, Sczesny et al. 2000; Hooda, Edwards et al. 2000; Schröder 2002).

The impact of livestock on nutrient fluxes in the European area has been estimated as part of a global study by the Food and Agriculture Organization of the United Nations. In this respect, Phosphate (P_20_5) balance is used as a robust indicator of livestock production impact on nutrient fluxes (Basnet, Apan et al. 2002; Gerber, Chilonda et al. 2002; Menzi, Ruettimann et al. 2002).

Statistics (1995 – 2000) on agricultural land, crops, mineral fertilizers and animal numbers (weighted according to species and production intensity to give total livestock biomass and total manure excretion) were used to estimate the phosphate balance at soil level per given agricultural land area. The balance is estimated as the difference between recognized inputs (manure spread and mineral fertilizers) and outputs (crop uptake) (Scoones and Toulmin 1998; Bindraban, Stoorvogel et al. 2000). The results of this study are conform to prior work, implemented at local level (Brouwer, Godeschalk et al. 1995; Hooda, Edwards et al. 2000; Provolo 2002).Although spatial patterns and levels may vary, nitrogen balance analyses demonstrate similar trends (Hoffmann, Johnsson et al. 2000; Hooda, Edwards et al. 2000; OECD 2001).

Phosphate overloads can result in water system pollution (eutrophication) by surface runoff, threatening surface waters and dissolved Phosphorus leaching, which mainly concerns ground waters. The most important factors influencing both the two diffusion modes are fertiliser application, land use, soil type and the degree of soil saturation with phosphorus (DSSP) (Hooda, Edwards et al. 2000). In the Netherlands, a DSSP value of 25% is considered critical, above which significant Phosphorus losses are expected to occur(Uunk 1991). By analysing nutrient balances, this study indicates how fast the DSSP is progressing in the various regions of Europe.

The broad pattern of nutrient loading of the environment follows closely the distribution of total livestock density (figure 1). Livestock densities can be divided into three categories:

High: High density areas (>500 kg biomass/ha) are characterized by high intensity dairying (>2 livestock units/forage ha plus >1.5 tonnes concentrate/cow) and high proportions of monogastric species (De Haan, Steinfeld et al. 1998). High phosphate overloads are generally evident in these areas (figure 2). The nutrient overload attributable to the contribution of manure to total P_20_5 supply on agricultural land is shown in figure 3. When this is considered, areas with high livestock densities and substantial mineral fertilizer application (e.g. Netherlands, Brittany, Catalonia) have very high overloads (>70 kg/ha), whereas areas with high animal densities and low mineral fertilizer application (e.g. west UK, Denmark, northern Germany) have low (10-20 kg/ha) to moderate (20-40 kg/ha) overloads. In fact, surveys have shown that a total area of 270,00 ha in the sandy areas in the middle, eastern and southern parts of the Netherlands are P-saturated due to intensive application of livestock wastes (Hooda, Edwards et al. 2000).

Medium: Medium density areas (200-500 kg biomass/ha) are broadly suitable for forage production with lower intensity dairying, more beef and sheep production and monogastric species constituting less than 50 percent of the livestock mass. In these areas, the combination of manure and mineral fertilizer application is also critical to the nutrient balance situation. In Northern Italy and Ireland for example, the combination of medium animal densities and high mineral fertilizer applications results in high overloads (>40 kg/ha). Conversely, in central France, central Germany and Spain, balances are lower (<20 kg/ha).

Low: Low intensity areas (0-200 kg biomass/ha) are broadly in the Mediterranean zones of Greece, Southern Italy, France, Spain and Portugal; Scandinavian countries, and the specialized cereal zones of central France and Eastern England. Little or no phosphate overload related to livestock production is evident.

Conclusion :

Nutrient loading throughout Europe is influenced by livestock density and the combination of manure and mineral fertilizer application. It appears that Phosphate losses in runoff will generally not exceed 2kg ha^{-1} $year^{-1}$ of total phosphorus, but could be much greater in specific cases (Hooda, Edwards et al. 2000). Critical overload hotspots have been detected, generally resulting from a combination of high livestock densities and elevated mineral fertilizer application (Hooda, Edwards et al. 2000; Schröder 2002).

These observations need to be set in the context of limited Phosphorus resources management as a whole. Under current trends, the duration of Phosphorus resources is estimated to be between 120 and 154 years (Folke 1997). Folke argues that in a balanced agriculture 25% of the Phosphorus circulated is exported. Theoretically, only those exports would needed to be balanced by non agricultural Phosphorus material, such as City sewage sludge or chemical fertilisers.

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Maps cited in the text :