ENVIRONMENTAL IMPACT OF SWINE WASTE

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Abstract
An error in managing the manure from swine industry growing could produce a negative environmental impact, damaging both soil and water quality. The major risk is that it can cause irreversible damages in animals' and humans' health and welfare. Between soil and soil fertilizers there is a thin separation line showing the fact that too much fertilizer could have devastating effects on the living organisms in soil and water.

Keywords: manure, slurry, pollution, microorganisms

The aim of this review paper is to reveal the importance of exposure to potential toxicants. Agricultural effectiveness and reducing environmental pollution risk consist in efficient manure management.

The consequences of using pig slurry as part of soil fertilizing concern the quantity of organic matter, of nutrients, micronutrients, and other additional factors like additives, zoo sanitary and pharmacological products (Torre, 2000).

Swine slurries could carry compounds like phenols (derived from the bacterial decomposition of proteins in the pig intestine), ammonia, nitrite, and surfactants (Torre 2000). The enhanced understanding of complex soil agro ecosystems supports efforts to sustain agricultural production while preserving environmental quality (Deng 2006).

Swine manure applied to croplands as fertilizer or soil conditioner has been shown to improve effectively soil tilt and increase soil water holding capacity, resistance to crusting, and resistance to compaction (Letson and Gollehon 1996). Soils' chemical composition often suffers changes because of the application of liquid hog manure and because of the influence of several factors like soil texture, time and method of manure application, amount of precipitation, crop and time of sampling (Bayley and Buckley 1997).

Deng (2006) highlighted that, after using anhydrous ammonia in soils, nitrate contents increase while reducing microbiological and biochemical activities (Deng 2006). Animal manure increase nitrogen content (Garcia-Gil 2000, Ndayegamiye 1989), enzyme (Parham 2002), and microbial activity (Parham 2003, Plaza 2004). Salt addition or additives in swine feeding can change manure composition and they can accumulate in the soil.

Increased levels of salt in food could increase Na levels in manure and Na loading in soil (Sutton 1984). Manure from pigs fed on high doses of Cu increases levels of Cu, Zn, P, Ca, and Mg in the soil (Kornegay 1976). Bernal and Kirchmann (1992) showed that pig manure can cause salinisation in arid and semiarid areas.

Because bacteria have a great movement in liquid manure phase, liquid manure tends to be more uniformly contaminated than solid manure. Even if animals do not show any symptoms, pathogens might be present in the manure.

An important fact is that, although manure samples from certain animals are not contaminated, stored manure could contain pathogens shed by a restricted number of animals (Busato 1999, Strauch 1988, Goss 2002). Bacteria survive a longer period in high water-holding capacity soils (Gerba and Bitton 1984). Animal manure is an important factor in spreading diseases therefore the algorithm of assessing animal waste from the point of view of their polluting potential aims at protecting water and soil from both epizootic and hygienic points of view (Jones 1986, Venglovsky 1994, van Bruggen and Semenov 2000, Papajova 2002, Unc and Goss 2004).

Microorganisms affect soil quality while being indicators of soil health.

Quality is an indicator of sustainable agriculture (Herrick 2000). Microbiological studies reveal the organic or microbial origin of pollution (Danon-Moshe 1985). Manure microorganism type and number depend on animal species, age, type of bedding, storage method (solid or liquid), and storage period (Lachica 1990, Nodar 1992).

Soil and water pollution might involve agents that could lead to zoonoses (tuberculosis, brucellosis, anthrax, tetanus) (Petkov and Baykov 1978, Bratanov 1979). Petkov and Baykov (1978) revealed that soil 1 m far from slurry lagoons is contaminated (number of cultivable microorganisms between log 5- log 6 CFU/g soil), in all seasons, and that soil 30 m far from lagoons it lightly contaminated (number of cultivable microorganisms between log 4- log 5 CFU/g soil) (Petkov and Baykov 1978).

E. coli number for stored slurry was higher in summer (at an average temperature of 21.7^{0}C) and it was shown that *E. coli* survived better at 5^{0}C than at 25^{0}C (Cools 2001, Petkov 2006). Soil microbes transform manure mass into humus, therefore changing the living conditions of pathogens and potential pathogens (Petkov 2006).

Depending on soil physical configuration, on soil chemistry, and on microbial cells properties, bacteria infiltrate the soil, a process depending on macropore flow and on interaction particles (Unc and Goss 2004).

Gessel (2004) inoculated *Salmonella anatum* in swine manure overtaking Johnston (1996) studies that this pathogen survives at least 27 days in the soil, based on different soil depths.

Swine manure represents a source of 5% nitrogen and 3% phosphorus and this quantity often overcomes plants necessity, therefore being able to become a potential pollutant for surface and ground waters. An excess of nitrogen products results in a release of potential pollutants in the air, and nitrate will leach into the waters, becoming a major risk factor for public and animal health. Phosphorus migrates together with the eroded soil into surface waters, thus damaging water quality (Cromwell 2008). Cromwell (Idem) also underlines the fact that nitrogen is present in swine manure because of unutilized dietary protein or of a breakdown of body protein.

Soil earthworms tend to have quite an impact by reducing *Salmonella enteritidis* in the soil (Murry and Hinckley 1992) and normal soil bacterial flora. The survival of faecal bacteria can be very long after manure application and, after reaching groundwater, the survival period can be prolonged to several months (Goss 1996).

Studies made by Sjogren and Gibson (1981) revealed that, in lake waters, although diluted environments, they ensure a viable medium for faecal bacteria.

Due to intensive use of animal manure as part of soil fertilizing process, it can lead to high quantity of residual nitrogen (Figure 1) in different forms like nitrate leaching into waters or ammonia emissions (Vitousek 1997, Yadav 1997, Deng 2006).

Scientific studies reveal that inorganic fertilizers have a more reduced microbial activity than organic fertilizers (Parham 2002, Parham 2003, Linderman and Davis 2004, Plaza 2004, Deng 2006). Water quality is a major concern while handling agricultural practices (Table 1).

The biochemical process of organic nitrogen mineralization includes several enzymes like L-asparaginase, L-glutaminase, amidase, and urease (Tabatadai 2004, Deng 2006).

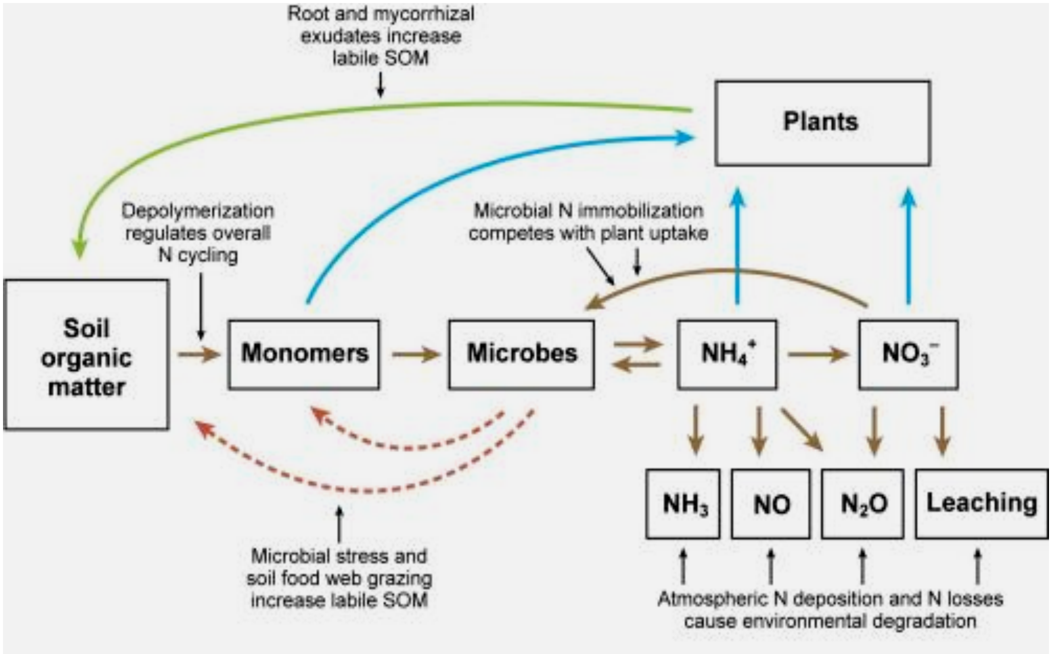

Figure 1. The soil nitrogen cycle (After: Jackson 2008, Schimel 2004)

Table 1. Potential impact of manure properties in soil and groundwaters
(After: Unc and Goss 2004)

Manure properties	Potential impact	Estimated contaminant risk to water resources
Microbial population	Contamination source	Variable
Dry matter content	Filtration and straining of bacteria within manure and at manure soil interfaces	Diminishes
	UV protection	Increases
	Reduced hydraulic gradient at surface (vs. liquid manures) limits soil dispersion caused by the kinetic energy of rain; more pore available for transport	Increases infiltration risk
	Decreased infiltration due to surface sealing	Increases runoff risk
	Residual absorbent capacity of bedding material	Diminishes
	At low dry matter content (liquid manure) flowing manure solution; flow rate and path dependent on hydraulic gradient at soil surface	Variable
Ionic concentration and ionic species	Favours interaction of like charged surfaces (soil and bacterial cells); increases cell retention	Diminishes
	Competition for retention sites; decreases cell retention	Increases
	Increased soil structural stability; improved macropore stability and continuity	Increases
	If high Na+ content; clay dispersion; decrease aggregate stability and thus macropore integrity	Diminishes, Variable
	Available mineral nutrients from manure can modify the physiological response of soil organisms	Variable
pH	Initial manure pH is slightly alkaline; ammonia volatilization can acidify slightly the soil environment	Variable (likely not significant)
Soluble and colloidal, charged and hydrophobic carbon	Competition for retention sites	Increases

compounds		
	Interaction with bacterial cell charged and hydrophobic surface loci	Variable
	Surfactant-like behaviour may favour flocculation and retention	Diminishes
Available carbon	Increases the physiological response of soils. Accelerates soil metabolic activities, increasing predation and competitive pressures	Diminishes, Variable
High ammonia and fatty acids concentration	Toxic effects within manure	Diminishes
	Toxic effect in soil after application can modify the interaction between manure and soil microbes	Variable

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