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Information

Sewage Sludge

Potential Pollutants
Raw sludge contains large amounts of readily available nutrients, which can cause substantial leaching of nitrates resulting in environmental pollution. Many sewage systems do not separate domestic from industrial effluents that contain large amounts of pollutants. These include chemicals such as bio-oestrogens implicated in the 'feminisation' of male fish in some UK rivers, and pesticides. Other industrial pollutants include heavy metals, which can also be present at high levels.

Health Risk
From the public point of view the major concern about using sewage sludge on agricultural land is the potential human health risks from food-poisoning type bacteria including Clostridium and Salmonella.

Treatment of Sewage Sludge
Typical sewage treatment involves a screening process to remove non-biodegradable objects, followed by filtration through gravel beds containing bacteria and micro-organisms. After these have done their work breaking down the raw sewage, the mixture enters settlement tanks. Water is drawn off, leaving behind the sludge, which has a dry-matter content of about 5%. This untreated liquid sludge can be compared to slurry – both liquids contain similar nitrogen levels. Whereas sludge contains about twice the phosphate levels of slurry and potash levels are usually lower. Further 'de-watering', using a belt press, increases the dry-matter content to around 25%, producing a 'sludge cake'. This is more comparable to farmyard manure, although potash levels remain low. Further treatment is still needed, however, to remove pollutants and pathogens.

This entire information sheet refers to the use of sewage cake rather than some of the earlier, unprocessed sewage sludge. It is expected that all sewage sludge disposal will be ended by the year 2002. Heat kills bacteria and in some European systems the heating of sludge to temperatures of 165°C or above produces a thermally dried cake containing 93% solids. This type of sludge is more suitable for most crops, although not soft fruit and vegetables, which can only receive this material before planting, and crops must be harvested at least 10 months after application.

Quicklime can be added as an alternative way of pasteurising. The heat of the reaction raises the temperature to over 70°C and is held like this for 30 minutes, which kills the bacteria. pH also increases to greater than 12, which kills off flies and other larvae and one ends up with an odour free, vector free product with significant nutrient and liming values. The final product is 40-50% dry solids and is free of E-coli and other pathogens.

Read the label before you buy – use pesticides safely

However, these heating processes tend not to remove pollutants such as pesticides or heavy metals and sludge producers rely on input levels of these contaminants being low.

Composting as a way of removing organic pollutants has been made possible. The heat generated during composting would also effectively pasteurise the final product and removes most of the pathogens.

Regulations

MAFF figures indicate that around 2% of agricultural land will be treated with sludge in one form or another. However, before this is done an assessment must be made of the field topography, proximity to watercourses and other factors such as nitrate vulnerable zones. No sludge can be applied within 50 meters of a spring or borehole, or within 10 meters of a stream or river. Some areas, though, remain sensitive where the sub-soil is free draining. In these cases it is recommended that you contact the Environment Agency for advice.

Care should be taken when treating land used for nursery stock, particularly nursery stock for export or seed potatoes, as the sludge treatment does nothing to control potato cyst nematodes in the land. Although potato cyst nematodes are not present in the sludge this point should be borne in mind when treating with sludge.

Beneficial Effects of Sewage Sludge

The nitrogen, phosphorus and organic matter content of sewage sludge are regarded as its main attributes. Other nutrients and trace elements present may also be beneficial to crops, thereby making it an economically attractive organic fertiliser.

In the case of derelict land the soil is commonly deficient in both nutrients and organic matter and, if the soil is heavily compacted, excessively dry or cannot retain nutrients due to lack of soil structure, the addition of chemical fertilisers will result in only limited improvement and growth. However, the addition of dewatered sewage sludge, rich in readily available and slow release nitrogen and phosphorus and a high organic matter content can be substantially more beneficial to the restoration of poor quality soil. The properties of the different sludge types are summarised in Table 1

Table 1- Typical Sludge Nutrient Analysis

Sludge Type	Dry Solids Content (%)	Nitrogen N	Phosphate P_2O_5	Potash K_2O
		(expressed as % of dry solids)		
Liquid undigested	5	3.5	3	0.4
Liquid digested	4	5 (3 + 2)*	4	0.4
Undigested cake	25	3	2.5	0.3
Digested cake	25	3	3.5	0.3

* (ammonia + organic N) – the proportion of ammonia may very from 30 – 70% of total N.

Nutrient Availabilities in First Year (%)

Sludge Type	N	P_2O_5	K_2O
Liquid undigested	35	50	100
Liquid digested	60 (100 + 15)*	50	100
Undigested cake	20	50	100
Digested cake	15	50	100

* (100% ammonia + 15% organic N)

Soil pH

The addition of sewage sludge to soil has been shown to increase and stabilize the pH value of many soils. Some sludge treatments also involve the addition of lime and this further enhances the pH stabilization effect.

Oxidation of pyrite, a common constituent of colliery spoil, can result in the creation of extremely acid conditions with pH values falling to 3 or less.

Colliery spoil is a typical example of an acidic soil that can benefit from sewage sludge addition. Due to the oxidation of pyrite in some spoils, local pH values of around 3 may occur. The addition of sewage sludge can reduce the problem by complexing iron – limiting the oxidation of Fe(ii) to Fe(iii) and hence reducing the potential acidity of the spoil.

Trace Elements

Some essential trace elements are present in sewage sludge at higher concentrations than are found in most soils. In certain cases deficiencies of magnesium, copper, boron and zinc in soils have been alleviated by the addition of suitable sludge.

Constraints on Use

The reservations that have been expressed with regard to the application of sewage sludge to land are the physical nuisances that may arise, the potential for the spread of disease, possible pollution of watercourses and the effects that toxic elements may have on vegetation or livestock. These will not be experienced if appropriately treated sludge is used in accordance with standard procedures and advice.

Potentially Toxic Elements

Heavy metals are present in all sludges. The amounts present are governed by the catchment area of the original sewage in particular whether it is derived from domestic or industrial origin. The supplier usually monitors the quality of the sludge and its end use is governed by the levels present as set out in the EC Directive (EC 1986): the Sludge (Use in Agricultural) Regulations 1989 and the UK Code of Practice (DoE 1989) on The Use of Sewage Sludge in Agriculture. If sewage sludge is to be applied to land intended for agricultural purposes the above regulations set out limits including maximum soil metal limits and the maximum rates of sludge application.

However, these limits do not apply when considering the application of sewage sludge to derelict land for which the aims are usually different from conventional agriculture.

The addition of this organic matter will act as a food source for the soil organisms thus enhancing rapid re-establishment of the natural soil processes.

There are two main criteria for determining sludge application rates (apart from sludge availability): nitrogen content and metal content.

To achieve the following levels of fertility, Nitrogen additions to non-top soils would typically be:

Very fertile	400kg/ha
Moderately fertile	100-400kg/ha
Low fertility	100kg/ha

By applying the known nitrogen content of the sludge to be used, it is possible to determine the required application rate.

Application rates to topsoils should take account of existing nitrogen content. Additions of phosphate and potash that will result from the applied rate can also be determined from the known sludge content. Any shortfall in the amounts required for the intended level of soil fertility can be made up with normal inorganic or other organic fertilisers.

Additions of metals to soils are governed by a number of regulations and Codes of Practice. There the land is to be restored for any agriculture purpose the two most important codes are The Code of Practice for Agricultural Use of Sewage Sludge (1989) and The Use of Sewage Sludge in Land Restoration (WRc 1989). Suggested limits for a range of heavy metals are given in Table 2.

Table 2 - Suggested heavy metal limits for the addition of sludge to different types of disturbed land.

Element	Maximum Application rate (kg/ha) 1	Maximum soil limit (mg/kg) Arable and lowland grass 2	Low intensity grazing, forestry amenity 3
Zinc	300	300	1000
Copper	150	135	300
Nickel	60	75	150
Cadmium	3	3	12
Lead	300	300	1000
Mercury	2	1	4
Chromium	300	600	1000
Molybdenum	4	4	8
Selenium	3	3	9
Arsenic	140	50	150
Flouride	400	500	1000