

Chapter 1

Introduction

1.1 Background

Sewage sludge is an inevitable end product of wastewater treatment, presented as a concentrate of waste material. As sewage sludge is rich in organic matter and nutrients, it can successfully be used in agricultural practices especially in arid countries such as South Africa. The use of human excreta for soil fertilization has been widely practised in parts of Asia for centuries and more recently sewage sludge from modern wastewater treatment plants has been used as a soil conditioner or has been spread on land as an inexpensive means of disposal (WHO, 1979). Today, even first world countries such as the United States and Canada use sewage sludge as soil amendment (NRC, 1996).

One of the problems faced by the agricultural industry in South Africa is the widespread degradation of the soils by erosion and nutrient depletion through incorrect agricultural practices. Sewage sludge serves as a suitable inexpensive alternative to fertilizers. Recycling of organic waste materials to be used for agriculture is in line with sustainable agriculture. Apart from nutrient recycling, organic matter acts as a soil conditioner by improving the soil structure and permeability, making heavy clay soils more friable and manageable (Easton, 1983). Demand for sludge for agricultural purposes appears to be on the increase as South African farmers begin to recognize the importance of using organic substances to improve soil properties (Korentajer, 1991).

Having recognized the benefits of sewage sludge and the widespread use of this product, it is important to discuss the restrictions on using sewage sludge in agricultural practice. Sewage sludge may contain toxic organic chemicals such as pesticides, heavy metals including lead, cadmium and mercury (Purves, 1990) and disease-causing pathogens (Straub *et al.*, 1995).

The subject of this study will be limited to pathogens. These pathogens originate from humans who use the sewerage systems and who suffer from acute or latent infections. Pathogens are excreted from infected individuals via faeces, urine, secretions or excretions of the nose, pharynx and skin depending on the type of infection, and reach the sewage treatment plants via sewers and sanitary installations in homes (Strauch, 1991). The spectrum and quantity of pathogens are extended by other sources connected to the system, including hospitals, abattoirs, livestock markets and related activities (Strauch, 1991).

Most of the human enteric diseases are caused by bacteria of the family *Enterobacteriaceae*, particularly *E. coli* and *Salmonella* spp. These organisms are present in high numbers in sewage.

Biological wastewater treatment processes such as lagoons, trickling filters and activated sludge treatment may substantially reduce the number of pathogens in the wastewater. However, these processes do not completely remove or inactivate pathogenic organisms as some of them are adsorbed to faecal particles (Strauch, 1991). The resulting sewage sludge still contains sufficient levels of pathogens to pose a public health and environmental concern (EPA, 1999).

1. 2 Motivation for Present Study

The South African sludge guidelines are presently being revised. The scientific premises of the current guidelines have been evaluated. This evaluation revealed that the pathogen limits used in the sludge guidelines were based on international trends and experiences. It is therefore necessary to investigate the appropriateness of the current guidelines for South African use.

However, very little information is available on the pathogen load in sludge and the human health risk associated with sludge used in agricultural practices in South Africa.

1.3 Aim and Objectives

The aim of this research is to understand the behaviour and risks associated with the agricultural use of sewage sludge in terms of pathogenic infections, so as to adequately protect humans against sludge borne pathogens associated with the agricultural application of sewage sludge.

This will be achieved by

- Evaluating the risk to human health associated with the agricultural application of inadequately disinfected sewage sludge, and
- Recommending management practices to ensure that all spheres of the population associated with the agricultural application/use of sewage sludge are adequately protected against pathogenic infections.

The aim of the study will be addressed by:

- Investigating the current microbiological quality of South African sewage sludge from various wastewater treatment plants in South Africa.
- Determining the microbial quality of sewage sludge prior to application to soil.
- Determining the persistence of microorganisms in soil following sludge application.
- Establishing the survival of pathogenic organisms using a high risk crop.
- Using the research results of the above-mentioned experiments to quantify the risk to human health associated with the agricultural application of sewage sludge that has not been adequately disinfected prior to application.
- Developing a management framework based on the literature and results from this research to adequately protect humans against sludge borne pathogens associated with the agricultural application of sewage sludge.

1.4 Approach

A countrywide survey will be performed to establish South African sludge quality using sludge collected from Wastewater Treatment Plants.

Microbiological assessment in sludge dedicated for soil amendment will be determined prior to using the sludge for planting. The crop chosen for the purpose of this study is potato (*Solanum tuberosum*) (Recke *et al.*, 1997). Potato was chosen as it is a high risk crop for growing in sewage sludge treated soil (WRC, 1997; EPA, 1999). Also the season was appropriate for growing potato. Green house experiments coupled with advanced laboratory techniques will be employed to establish if any pathogens persist in soil and potato. Knowledge accrued from these experiments and from the risk assessment will then be used to recommend management approaches for adequate protection of human health.