Applied Environmental Science and Engineering for a Sustainable Future

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Prospects of Organic Waste Management and the Significance of Earthworms

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Applied Environmental Science and Engineering for a Sustainable Future

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Preface

Waste management practices are well known for its recycling and reuse formulae. With the help of media, the propaganda of organic waste treatments has been adopted by those who sought interest in safeguarding our own environment. The search for an alternative method has paid the price through these types of waste treatment protocols. Numerous researchers have worked and designed various technologies including natural treatments, biological methods, and chemical methods. Among these methods, biological methods are very popular due to its effective nature and thus an interesting subject in the history of waste management. To be precise, earthworms have been considered as one of the pioneers in waste management practices. As experimental studies and behavior assessment of different species of earthworms are vital in understanding its pivotal role, specific chapters have been allocated for recent studies on earthworms.

Chapter 1 deals with the introductory part on various organic wastes, its generation, and its effect. One of our goal is to bridge the gap between different organic waste management principles, and aerobic and anaerobic treatments are discussed in Chaps. 2 and 3. This book is more concentrated on studies of earthworms through Chaps. 4, 5, 6, and 7. More researches and capabilities of different species of earthworms distributed throughout the world have been discussed. Particularly, Chap. 4 discusses the earthworm's ecology, biology, digestion and also the species suitable for waste treatment practices. Chapter 5 has its own specialty as it discusses important enzymes associated with the earthworms and the synergism between microbes and earthworm. A unique attention has been paid to the microbes associated with earthworms in Chap. 6. This particular chapter signifies the earthworm gut-associated microorganisms and their role through symbiotic relationships. For the first time ever, we have tried proposing the optimal conditions in breeding earthworms for vermicomposting process in Chap. 7. A separate chapter (Chap. 8) has been allotted for vermicomposting, its history, steps, and methods. Vermicompost is the result of vermicomposting. Its properties, applications, and derivatives are discussed in Chap. 9. Chapter 10 discusses the importance of earthworms, its scope, and future aspects of earthworm research. Impact of waste management practices

on human health is discussed in Chap. 11. Various investigations carried out by several researchers and safety considerations are discussed under this chapter.

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Pulau Pinang, Malaysia Katheem Kiyasudeen S

Contents

Chapter 1
Introduction to Organic Wastes and Its Management

Abstract Each year, approximately 38 billion metric tons of organic wastes are produced all over the world. Human behaviour, consumption rate, and population explosion are the generally proposed factors responsible for this dramatic increase. As wastes materials are always considered to be either unusable or disposable, burning and deposition has always been the result. Burning and deposition in turn results in numerous environmental problems. Burning pollutes atmosphere whereas land disposal of organic waste materials may directly or indirectly alter the heavy metal status of the soil by affecting metal solubility or dissociation kinetics (Del Castilho et al. J Environ Qual 22:689–697, 1993). In order to deal with this challenging area, various treatment methods and practices have been formulated and applied by countries all over the world. Hence, much attention has been paid to convert such nutrient-rich organic waste materials into useful outcome for sustainable agricultural practices (Suthar Biorem. J 13(1):21–28, 2009). The utilization of the organic materials of animal and plant origin is a viable means of improving soil fertility and a reliable way of disposing wastes (Adegunloye et al. Pak J Nutr 6(5):506–510, 2007). Solid organic waste is understood as organic-biodegradable waste with a moisture content below 85–90 % and these organic materials are recycled by a variety of decomposer microorganisms such as bacteria, fungi and detritus-feeding invertebrates.

Keywords Organic amendments • Municipal solid wastes • Animal wastes • Food wastes • Palm oil mill effluents • Biological treatment

1.1 General

Each year, approximately 38 billion metric tons of organic wastes are produced all over the world. Human behaviour, consumption rate, and population explosion are the generally proposed factors responsible for this dramatic increase. As wastes materials are always considered to be either unusable or disposable, burning and deposition has always been the result. Burning and deposition in turn results in numerous environmental problems. Burning pollutes atmosphere whereas land

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Over the years, an array of innovative ideas for the utilization of these wastes have been put forward. The management of solid waste continues to be a major challenge in urban areas throughout the world, but particularly in the rapidly growing cities and towns of the developing countries. The production of these organic wastes can be thought of as an integral part of a developed society (Callaghan et al. 1999). As urbanization continues to take places, the management of solid waste is becoming a major environmental and public health problem in urban areas. These problems are caused by technical, financial, institutional, economic, and social factors which constrain the development of effective solid waste management systems. A typical solid waste management system in developing countries displays an array of problems, including low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control, the breeding of flies and vermin, and the handling and control of informal waste picking or scavenging activities. To increase the productivity and to meet the heavy demand for food of the growing population, it is necessary to recycle available resources and wastes. Wastes of animal and plant origin are one of the major under-utilized resources in many countries. These wastes could not be fully exploited due to the non-availability of a viable technology for their economic recycling (Jeyabal and Kuppuswamy 2001). The large amounts of agricultural wastes are produced especially in intensive agriculture. Agriculture products like animal dung, farmyard manure, and crop residues are potential sources of nutrients and are subjected to various studies and treatments. Application of these wastes as a source of organic matter is a common practice to improve soil properties (Baran et al. 2001). The transformation of organic waste to compost or vermicompost is increasingly popular across the world among the various waste management techniques (Suthar 2009). Both fresh and composted amendments stimulate soil biological activity; fresh wastes produce an initial burst of biochemical activity (due to high release of easily degradable organic compounds) which tends to fall away as time progresses, while compost induces lower biochemical activities but more resistance in soils (Masciandaro et al. 2000).

Biological treatments are the clearest alternative for treating such wastes and these technologies can maximize recycling and recovery of waste components. The recycling and utilization of organic wastes (Fig. 1.1) and by-products through

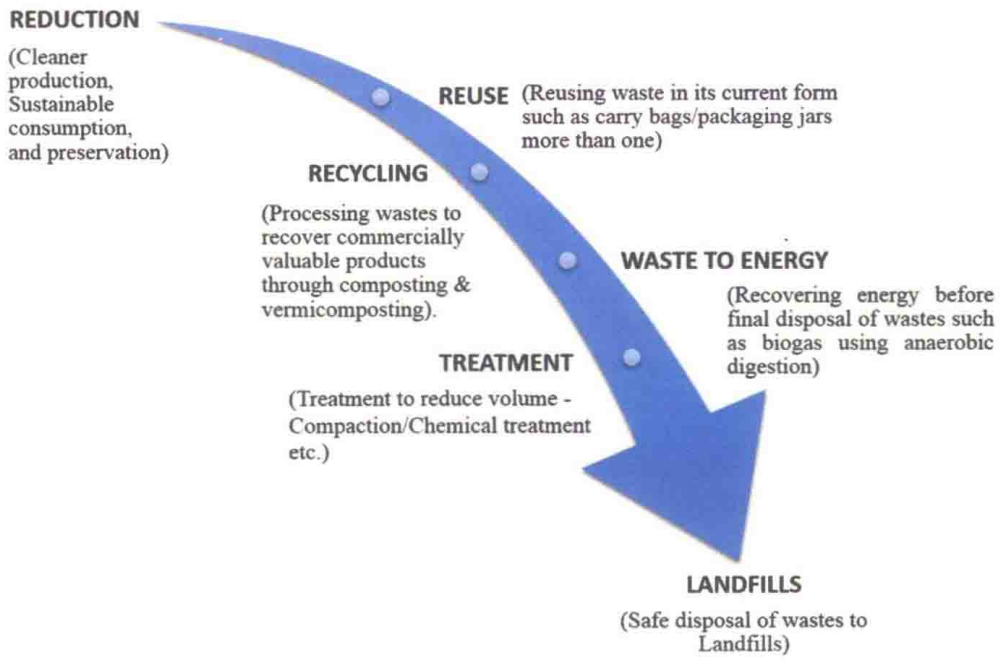

Fig. 1.1 Waste management hierarchy

development of an economically viable, socially accepted and eco-friendly technology is urgently needed for the reason that the large scale accumulation of these wastes will increase pollution and also pose disposal problems (Raj and Antil 2010). Among biological treatments, aerobic and anaerobic digestion are frequently the most cost-effective, due to the high energy recovery linked to the process and its limited environmental impact (Fig. 1.2). Biogas production throughout Europe, could reach over 15 million m^3/day of methane reported during 1998 (Tilche and Malaspina 1998). An appropriate technology in waste management for producing compost is the use of earthworms as an aerobic treatment known as vermicomposting. This technology, which refers to both social and environmental goals of sustainable development and is largely used in India, Australia, New Zealand, Cuba, Italy, and many countries all over the world.

1.2 Organic Amendments

Applying organic amendments to soil not only increases the total organic carbon (TOC) content and its different fractions but also has a series of effects on microbial proliferation and activity. Such amendments improve microbial development and its activity (Bastida et al. 2008). The characteristics of different organic materials may have a differential effect on the soil microbiota and strongly influence the microbial use of the carbon contained in these materials (Martens 2000), which may in turn affect the preferential development of those groups of microbes better adapted to the amendment

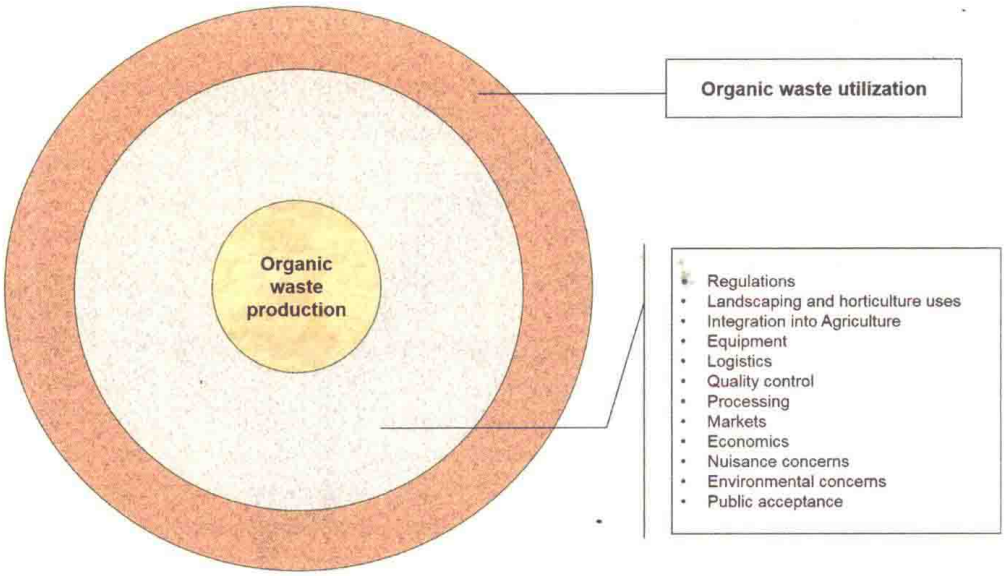

Fig. 1.2 Challenges in going from organic waste production to organic waste utilization

in question. Indeed, changes in the composition of microbial communities as a result of incorporating inorganic or organic amendments have been observed (Marschner et al. 2003; Crecchio et al. 2001). However, the use of organic materials is not exempt from risks and their effectiveness is determined by their stability in the soil. For this reason, although non-composted organic wastes (such as sludges) may activate the soil microbial biomass and hence the biogeochemical cycles. Several authors have suggested that such wastes should be composted to ensure certain biological modifications of the organic material that will prevent the presence of organic compounds of low molecular weight with phytotoxic properties (Gliotti et al. 1997).

Amendment sustainably stimulates soil microbial growth and activity and promotes vegetation cover. These processes are mainly driven by the large amount of nutrients and carbon provided by the amendments. The organic amendments stimulated both bacterial and fungal proliferation, as observed by Marschner et al. (2003). This was mainly due to the nutrient inputs for microbial development derived from the organic amendments. Several authors have indicated that, after a primary succession, an increase in fungal biomass could be related to increase in organic matter content or C/N ratio. After a rapid proliferation, the fungal biomass attains a stabilization period due to the changes in pH, nitrogen content and both the quantity and quality of organic matter. Marschner et al. (2003) showed that the bacterial community structure was altered by low but regularly inputs of organic matter to soil. The use of organic materials has been successful for restoring degraded soil because the high organic carbon and nutrient content of these materials have more benefits than the negative effects that they can have in semiarid areas, where organic content is really low. Alteration of microbial and plant community (decrease in plant diversity) in this short-term experiment with amendments should be kept in mind before a first call on the utilization of these wastes.