

## Assessment and planning methods for Solid Waste Management (mostly organic)

Farmers do not need to be told of the value of adding organic matter to the soil. From centuries of experience they know that soil rich in organic matter is usually the easiest to work and is most likely to give good harvests. Wherever there is settled agriculture, organic materials are reused to some degree. In Europe, manuring techniques were well developed by the first century BC. Roman farmers were well aware of the value of dung as a fertilizer, and distinguished between various types of dung. Ploughing back green plant materials (generally referred to as 'green manure') was also mentioned by Roman historians.

Together with extensive terracing and irrigation works, the recovery of organic material was one of the foundations of the highly productive agricultural system practised by the Incas in the Andes of South America. The Incas were among the first to discover the value of dead fish as manure, and they made extensive use of *guano*, the accumulated droppings of the large colonies of seabirds that inhabit the islands off the Peruvian and Chilean coasts. The *guano* is high in nitrates and phosphates and therefore serves as an excellent fertilizer.

Traditions of reusing organic material are extremely strong in many parts of the world, especially where population density is high. Throughout India, Bangladesh, and many other parts of Asia, compost pits can be found in villages. Even where chemical fertilizers have taken over as the main source of plant nutrients, farmers still place a high value on organic manure. Outside Asia, organic recycling traditions are generally less well developed, yet there is ample evidence that most farmers appreciate the beneficial effects of organic matter. In parts of the African Sahel, for instance, settled farmers encourage nomadic herdsmen to pen their animals on their fields at night, to obtain the dung they produce.

### What is compost

Compost is the stable end product derived from the biological degradation of organic material, which can vary from dead leaves and roots to kitchen waste and vegetable remains. If well decomposed, the odourless and pathogen-free blackbrown mixture can be used as a soil conditioner.

Organic fertilizers such as compost serve a quite different function from that of chemical

fertilizers. The main reason for using chemical fertilizers is to enrich the soil with the elements nitrogen (N), phosphorus (P) and potassium (K), nutrients that are vital for crop growth. Compost also contains these elements, but in much smaller amounts. In contrast with chemical fertilizers, compost plays a complex role in maintaining the humus balance in the soil. Humus is the result of natural processes of breaking down and composting of leaves and roots in the ground by micro-organisms, which need air and water to survive. Humus improves the structure of the soil, ensuring the proper circulation of air and water, and is thus indispensable for the growth of healthy crops.

Compost has many interrelated positive effects, depending on the kind of soil (i.e. clay or sand) to which it is applied:

- enlarges the air spaces in the soil, improving its permeability for air and water circulation;
- enhances the clumping of soil particles and thus improves the texture;
- lowers the degree of acidity (pH);
- helps to retain moisture; facilitates the mechanical treatment of heavy clay soils;
- adds nutrients and trace minerals to the soil,
- stimulating biological activity and encouraging vigorous plant rooting systems;
- helps to bind nutrients, preventing them from being leached out of the soil;
- if applied around plants, it will smother small weeds and prevent the surface soil from drying out; and
- helping to reduce soil erosion.

Compost is especially useful because of its humification characteristics and its long-lasting effects. The addition of compost to soil helps to compensate for the losses of organic material that result from intensive agriculture, and helps to maintain or restore soil fertility.

## ***Some misunderstandings***

The biological degradation of organic material can take place in two ways. Aerobic decomposition, which occurs in the presence of oxygen, is called 'composting', while anaerobic decomposition, which occurs in the absence of oxygen, is called 'digestion' or 'fermentation'. Often the term composting is also used to refer to anaerobic processes, but this is incorrect. However, the end product of both aerobic and anaerobic conversion processes is called compost. If efficiently carried out, composting can rapidly produce a pathogen-free end product, whereas digestion requires much longer decomposition times and is seldom free of pathogens and odour problems.

Another mistake that is frequently made, is to underestimate the length of time required for biological degradation. The process is a microbial reaction, and the length of time it takes to complete depends on the state of the raw material. It is very difficult to reduce the length of this process; complete degradation cannot take place in a couple of days, as is sometimes claimed. The time required for degradation also depends on the biological cycles of the micro-organisms involved. Their replication times are conditioned by their genetic constitution and environmental factors; although the environmental factors may be improved upon, the genetic limits nevertheless remain.

## ***The quality of compost***

The main requirement for compost is that it should be suitable for use as an organic soil conditioner. Physical, chemical and biological stability, non-toxicity and a balanced mineral element content are therefore the essential elements for compost to be useful. The amount of organic material or, more specifically, the quantity of humus, can be used as indicators to determine the quality of the compost. The quality of the compost obtained from aerobic and anaerobic degradation are more or less the same, and both depend on the quality of the original organic waste material. The best quality compost will be produced from stable organic material with low levels of visible contamination, micro contaminations and heavy metals.

## **Stability**

Compost should be stable, which means that the organic fractions of the degrading matter should have been sufficiently decomposed. Also, mature compost is free of odour and is easy to handle, store and transport. It is well known that the direct use of 'green manure' and ploughing-in crop residues inhibits plant growth until these materials have undergone a process of decomposition in the soil. Between two and four weeks are necessary for organic matter to be degraded in the soil and only at this stage can the organic residue have a positive effect on crops.

The degradation of organic matter in the soil results in the production of intermediate products of metabolic processes, which are toxic to crops. Other disadvantages are competition between micro-organisms and roots, a high carbon/nitrogen ratio (C/N), shortages of oxygen in the soil and the production of ammonia (see also Chapter 7). In economically less developed countries there are few official standards for compost quality. In Jakarta, Indonesia, the only condition is that compost needs to have a C/N ratio of less than 20, such that it will not damage the plants.<sup>4</sup>

In addition to sensory perceptions such as smell and visible appearance, temperature can also be used as an indicator of whether the process of degradation is complete. During the process, temperature is high (on the average 50 - 60 °C), but when the compost is mature, it falls sharply to 30 - 40 °C. However, a fall in temperature may occur due to other factors, such as turning the contents of the compost heap.

At present, there are no reliable methods for measuring the maturity or stability of compost. This problem requires further and better study, to find an unambiguous, generally accepted indicator. Good methods of measuring the maturity of compost are urgently needed because of the frequent appearance of insufficiently stabilized compost on the market.

## **Nutrients**

Although the nutrient value of chemical fertilizer may be much higher than that of compost, these nutrients usually dissolve and easily leach away from plant root zones. Organic fertilizers hold their nutrients in colloidal forms which are slowly released as the organic materials decompose in the soil. The low nitrogen and phosphorus contents of compost can be an advantage, because this makes dosages of these nutrients controllable. Compost may contain lime, which is useful for neutralizing acid soils. Compared with animal manure, compost derived from municipal waste has a low salt content; a high salt content can inhibit the growth of rooting systems.

## ***Modern applications of compost***

The most important use of compost is its application to the soil. This can take several forms: it can be applied as a fertilizer, as a soil conditioner, as mulch and can also be used as a means of land reclamation. Compost may be added to soil for many purposes: urban agriculture, horticulture, home gardening, vegetable gardening, viticulture, landscaping, landfills, forestry or commercial farming. Thus the uses of compost can range from domestic applications by gardeners to large-scale applications by commercial farmers on cropland, or by municipal gardeners on parks and gardens. Other consumers are vegetable and fruit farmers, shops selling ornamental plants, golf course operators, city parks departments and housewives.

Apart from the traditional soil applications, compost can be used for a number of other purposes. Compost derived from night soil and vegetable matter can be used in fish farms as a nutrient for both the growth of algae and as fish feed. It has also been used to increase the porosity of bricks by incorporating it into the bricking material before firing. The organic matter burns during firing, leaving the bricks porous. Compost from horse manure has been used as a substrate for growing mushrooms for more than 200 years, but compost from urban organic waste could also be used for this purpose.

Sawdust from industrial sources may be used in its natural condition as soil conditioner or as a mulch. Wood contains several components (cellulose, lignin and pentosan) that are of agricultural interest, but lignin is regarded as the most valuable. Lignin, its degradable products and the residues of micro-organisms, tend to remain in the soil for a considerable time as constituents of humus, thus improving the physical condition of the soil. Lignin also reduces leaching and acts as a storehouse of several nutrients. Sawdust lacks nitrogen and thus, farmers add proportional amounts of ammonium nitrate in order to maintain the nitrogen

## **Composting**

Composting is probably the most well-known system for treatment of organic material. This topic describes various different systems that function on small or on large scale. Because of the importance of composting, the process is described in detail.

### ***The principle of composting***

Composting is similar to the natural process of biological degradation, such as the breakdown of leaf litter in forests or the ageing of cow manure. A scientific definition of composting would describe it as the biological decomposition of organic wastes under controlled conditions, the most important being that they are aerobic (i.e. they occur in the presence of oxygen) and at an elevated temperature. In its simplest form, composting is done by piling up organic materials, covering and turning the pile regularly and then leaving it to decompose until it is suitable for distribution over fields or gardens.

Almost any plant or animal waste will decompose if preservative measures are not taken. Consequently, several kinds of organic wastes are suitable for composting: vegetable and fruit waste, farm waste such as coconut trash and sugar cane waste, crop residues such as banana skins, corn stalks and husks, garden trash such as leaves, grass and trimmings, sawdust, bark, kitchen waste, spoiled food, human and animal excreta, etc. Animal waste such as meat and fish scraps can be used, but may attract dogs, flies and other insects to the composting pile.

Not all materials of biological origin decompose fully. Less readily decomposing materials include wood, bone and industrially 'altered' organic materials such as paper and leather. Also, woody materials such as green coconut shells decompose slowly; the hardness and high moisture content of the shells make them unsuitable for compost.

## ***Pretreatment***

Before composting household waste, it should first be pretreated in some way to remove contaminants that may cause process failures, and to ensure the quality of the compost. Inert materials can be removed by several mechanical processes; for example, electromagnets can be used to separate out iron components, and ballistic or aerated separation may be used to remove larger components. Sieving is the simplest method of sorting certain materials.

The process of composting organic waste can be accelerated if the sizes of the components are reduced. Smaller particles have a greater surface area to mass ratio, so that the rate of biological decomposition is increased. In practice, the degree of size reduction is limited by the structural strength of the raw material, or by practical or financial constraints. Also, sufficient interstices for the circulation of air should be conserved. The sizes of the components of waste are generally smaller in economically less developed countries than in industrialized countries, so that mechanical size reduction may not always be necessary. Typical particle sizes of material used for composting should be between 10 mm for forced aeration and 50 mm for static piles or windrows

In solid waste treatment plants, the organic fraction for composting can also be prepared by biologicalmechanical processes. The solid waste is placed in biological reactors for short periods ( 1 - 3 days), during which time it undergoes initial biological transformation together with size reduction. At this stage, the biodegradable organic fraction is already drastically disintegrated and is therefore more easily separated by mechanical means from non-organic materials.

## ***The composting process***

Composting utilizes the ability of micro-organisms to break down organic material by oxidation. Knowledge of the various micro-organisms and their roles in the process of bio-oxidation is therefore essential. Composting comprises two phases, during which the activities of different groups of micro-organisms predominate. The transformation of waste through composting results in the mineralization and humification of the organic substances present.

In the first phase, the more easily biodegradable materials are broken down. Simple carbon compounds (such as soluble sugars and organic acids) are metabolized and mineralized by

various micro-organisms, forming CO<sub>2</sub> and water. High rates of metabolic activity may increase the temperature within the composting mass up to more than 70 °C.<sup>35</sup> This first phase can last between 5 days and 3 months. It is important that there is a plentiful supply of oxygen during this phase; the transition to the second phase is gradual.

During the second phase, which lasts several weeks, the more resistant components such as wood and other lignin-containing materials are degraded. These natural large molecules are attacked by a different group of micro-organisms (fungi and acid-producing bacteria). This phase of the process is slower than the first, and the temperature gradually drops to about 30 - 40 °C. The metabolic activity of the acid-producing bacteria is fundamental to the humification of the organic matter.

## ***Influencing factors***

There are several methods of composting, although the principle is the same in each case. The success of each method depends on a number of influencing factors, although the optimal conditions might differ. The main factors that contribute to an optimum environment for the microbial composting processes, and which can be controlled to a certain extent, are the characteristics of the organic waste material, such as moisture content and C/N ratio, the aeration of the compost pile, and the temperature and degree of acidity (pH) within the pile. These factors are strongly interdependent.

## **Carbon/nitrogen ratio**

The carbon/nitrogen (C/N) ratio is very important in the nutrient balance of all organisms. Carbon is a source of energy for the micro-organisms and nitrogen is necessary for the synthesis of protoplasm. More carbon than nitrogen is required, but when there is a too great excess of either, biological activity diminishes and the completion of the process is delayed. Two-thirds of the carbon consumed by micro-organisms is given off as CO<sub>2</sub>, and the rest is combined with nitrogen in the cell. When there is insufficient carbon to convert the nitrogen into protoplasm, micro-organisms make full use of the small amount of carbon available and eliminate the excess nitrogen as ammonia. Large amounts of ammonia can be formed, and if the compost is applied during this phase of active composting, it may prove toxic to plants.

A material that contains 30 times more carbon than nitrogen has a C/N ratio of 30. Extensive experiments have determined that the optimum C/N ratio for most types of organic material is between 25 and 30. According to Bertoldi, the C/N ratio of the organic fraction of urban solid waste varies between 26 and 45. Low C/N ratios will slow down the rate of decomposition and increase the loss of nitrogen in the form of ammonia. Table 7-1 gives approximate nitrogen contents and C/N ratios of various compostable organic wastes.

## **Temperature**

The metabolic and growth rates of the micro-organisms involved in the chemical and biochemical reactions tend to increase with temperature, up to certain maxima. Each species has different optimal metabolism and growth rates within a well defined temperature range. Micro-organisms can be classified as psychrophilic, mesophilic and thermophilic, according to their optimal temperature ranges, as shown in Table 7-2.

Table 7-2: Optimal temperature ranges for various micro-organisms (in °C).

	<i>range</i>	<i>Optimum</i>
Psychrophilic	0-30	15
Mesophilic	20-40	32
Thermophilic	40 - 70	55

High temperatures are the consequence of biological activity. Within the pile, the heat liberated through the respiration of micro-organisms that decompose the organic matter builds up, since there is little dispersal of heat because of the natural insulation provided by the waste. Depending on the microbial activity and (therefore) on the temperature, different microbial groups prevail.

Temperatures of 50 to 60 °C provide an optimal environment for the activities of certain micro-organisms, and are also necessary to kill unwanted pathogens that thrive at human body temperature. However, excessively high temperatures (above 65 °C) will inhibit the growth of the majority of micro-organisms present, and will slow down the decomposition of the organic

matter. For rapid composting, high temperatures over long periods must be avoided.

Within a compost pile there can be temperature variations. For example, a lack of oxygen can raise the temperature, and a high moisture content can lower it; both of these situations should be avoided. Aeration can solve the problem of temperature control; by turning the organic waste, cool air is introduced into the pile. Observations of temperature changes during the decomposition of organic matter can be used to indicate whether the process is functioning properly. .

## **Oxygen**

The most important factor during the composting process is the availability of oxygen; without oxygen, composting is not possible. A constant level of oxygen should be maintained by aerating the composting material to ensure a stable end product. Aeration takes place naturally by air diffusion in the piles or windrows, but if the supply of oxygen is limited it will slow down the process of biological degradation. To guarantee sufficient aeration, the compost pile or windrow should be turned regularly, either manually or mechanically by wheel loaders. A third option is forced aeration by means of pipes laid under or through the windrows in such a way that air is constantly and uniformly circulated throughout the composting mass. Here, optimal conditions of oxygen supply, temperature and moisture can be maintained by mechanically blowing or drawing air through the windrow. Forced aeration is the best method of providing a controlled supply of oxygen.

The rate at which the material is aerated also affects the process of composting. If the aeration rate is too high, the excess flow of air will cause the compost mixture to cool down. If the aeration rate is too low, aerobic activity will decline and the process may become anaerobic.

## **Moisture**

Moisture content and aeration are closely interrelated. If the air in the intervening spaces in the pile is displaced by water, this will promote clumping, which will make the structure of the material inferior. The optimal moisture content in the composting process varies, depending essentially on the physical characteristics and sizes of the waste particles, but is usually in the range of 50 - 60%. Below 40% moisture content, the pile will begin to dehydrate, causing the biological process of degradation to slow down considerably. This will give a physically stable but biologically unstable compost. Above 60% moisture content, the high moisture levels will interfere with aeration by clogging the pores, and anaerobic conditions are created; these should be avoided at all costs.

The moisture content of a composting mass will tend to decrease as decomposition proceeds, mainly because of evaporation losses during the first thermophilic phase. In some cases water may have to be added in order to maintain optimal conditions. During the rainy season, composting in open systems is less practised.

## **pH level**

In general, organic matter with a wide range of pH values (from 3 to 11) can be composted,

although the optimum range is between 5.5 and 8. Whereas bacteria prefer a nearly neutral pH, fungi develop better in fairly acid environments. In practice, it is not easy to change the pH level in a pile. Generally, the pH begins to drop at the beginning of the composting process due to the activity of acid-producing bacteria that break down complex organic material to organic acid intermediates. In some cases, the pH may indicate that the process is malfunctioning. For example, if the conditions within the composting mass begins to turn anaerobic, the pH may fall to about 4.5 due to the accumulation of organic acids. Conversely, as the process approaches stability, the pH shifts towards neutrality (pH = 7).<sup>42</sup>

## ***Composting systems***

Composting systems can be categorized as open or non-reactor, and closed or reactor systems. In closed systems (container, tunnel or enclosed hall systems) at least the initial composting occurs in a mechanical reactor with forced aeration. A closed system may be easier to control than the open-air alternative, but because of the complexity of the hardware and the need for highly skilled operators, the costs of construction, operation and maintenance are high, whereas open systems are less complex and require less technically skilled staff.

Closed systems are popular in industrialized countries, where the need to compost solid municipal waste is increasing. In addition, complex equipment is required to sort the large amounts of non-compostable waste material in areas where space is limited and labour costs are high. In less industrialized countries, there is less need to opt for the reactor system on the grounds of limitations of space, and sorting can be less sophisticated, offering ample employment opportunities. Often more than 60% of organic waste is compostable material, since scavengers have removed most of the non-compostable material. For these reasons, closed systems are rarely used in economically less developed countries and so are not described here.

In open composting systems the organic waste material can be arranged in piles or in windrows. Each system consists of the following steps: the piles are aerated to ensure adequate levels of oxygen, and the material is sieved either before or after decomposition to remove non-organic materials.

## ***Backyard composting***

Composting at the household level is a simple technique, requiring only organic waste, limited space and some time and effort to make the necessary construction. The waste can be placed in a composting pit of 2 x 2 m and 1 - 1.5 m deep, and left to decompose for 2 - 3 months (if desired, turned once in a while). The resulting compost can be used to enrich the soil of agricultural fields or gardens. If one household does not produce sufficient organic garbage to fill a compost pit within the required time, then one pit could be shared by several households. A simple shelter constructed over the pit can provide shade and keep out animals. Food leftovers can be used, but they should be covered with soil so that they do not attract rats and mice.

If groundwater levels are high, either permanently or periodically, such as during the rainy season, composting piles can be built up above ground level. A simple system involves piling refuse within four poles placed in the ground, making a square of, say, 1.2 x 1.2 m. Leafy branches placed behind the poles will help to keep the composting material together. During the rains, nutrients will leach from the compost into the soil, increasing its fertility. Each new heap could therefore be made at a new place in the garden.

Not all households may be able to set up their own backyard composting systems, however. They may not have enough space for a compost heap, they may not own gardens where they can apply the compost, and extra labour is needed to maintain the piles.

## ***Neighbourhood composting***

At the neighbourhood level several composting systems can be used, varying from capital-intensive to labour-intensive systems.

As with any community-based project, small-scale composting faces all the problems of obtaining sufficient resources initially, of sustaining the motivation of the 20 community, and achieving stable markets. However, there have been several attempts to link composting with urban food production, or with plant nurseries and park improvements, as part of a waste management strategy. Such opportunities may be worthwhile and deserve serious investigation.

## ***Centralized composting***

The large-scale composting plant has become a striking example of a technology that is wholly inappropriate for use in economically less developed countries. Over the last 20 years several city councils have opted to build complex, centralized plants without first studying the potential markets for the output, or the likely overall costs<sup>20</sup>. Such plants are usually beset by mechanical problems; some have been closed down, others have been scaled down, and many operate well below their planned capacities. The construction and operating costs of these large plants are often higher than the revenue received from the sale of compost. The frequent lack of technical knowledge of operating over-sophisticated equipment and processes often results in mechanical failures, and ultimately in low-quality compost.

## ***Co-composting***

The term co-composting refers to the composting of two or more raw materials together, in most cases a combination of human or animal waste with household garbage or other organic materials. Like composting, co-composting has been practised for centuries, particularly in the rural areas of Asia. In Java, for example, virtually all the available animal dung is collected, composted together with straw, bedding material, vegetable wastes, household garbage, and ash from cooking fires, and is returned to the fields. Composting pits are common features in rural Chinese villages. Dung from animal pens is added, together with excess straw and bedding material, vegetable wastes, ashes and household garbage. This is left to decompose for a few weeks up to six months, before being spread on the fields or vegetable plots. In parts of Egypt, fresh soil is deliberately spread on the floors of animal sheds to soak up urine and some of the dung. The soil builds up, and is periodically transferred to the compost heap, and from there it is eventually recycled back to the fields.

The borderline between composting and co-composting is not very strict. process of co-composting will be explained as in relation to the various examples given.

## ***The principle of co-composting***

The combined use of organic garbage and animal waste has several advantages because these materials complement each other very well. Human and animal wastes are high in nitrogen content and moisture, whereas garbage has a high organic (carbon) content and is a good bulking material. Co-composting can also provide an answer to the problem of treating human and animal excreta in a safe way. Night soil and wastewater sludge do not compost well on their own: they are too moist and their C/N ratios are too low. Co-composting agents such as refuse, straw, water hyacinth, and rice husks are able to absorb the excess moisture and to correct the C/N ratio.

Other reasons for adding organic material to night soil is to increase air spaces enabling proper aeration, to provide structural support, to reduce the bulk weight of the composting mixture, and to increase the quantity of degradable materials. In Port- Au-Prince, Haiti, research was carried out in the early 1980s to compare the nutrient quality of compost from municipal refuse with co-composted refuse and sewage. As can be seen in Table 8-1, the addition of sewage clearly raises the nutrient level of the compost.

Table 8-1: Nutrient contents of two Haitian composts.

Nutrient	Municipal refuse %	Municipal refuse and sewage %
N	0.20	1.7
P	0.17	1.4
K	0.45	1.0

In principle, the process of co-composting is the same as that of composting. Sewage sludge and night soil can be co-composted with various organic waste materials. A list of possible combinations and their advantages is given below, but the best way to find the optimal combinations and quantities under actual field conditions is to try each of them out.

**Bark.** When bark is used as a bulking agent, it has the added advantage that it absorbs foul odours. The bark can be mixed with dewatered, digested sludge in the ratio of three parts bark to one part sludge. Problems can occur if the wood has been treated with pesticides, however, since they may persist in the compost. The use of bark naturally depends on its availability, for example, on the proximity of a wood-processing plant.

**Wood chips or sawdust.** Both wood chips and sawdust can be used as bulking materials and to absorb excess liquids. For example, digested sewage sludge can be mixed with wood chips in the volume ratio of 1:3. The wood chips can be screened out later for reuse.

**Straw.** In co-composting systems used by many farming communities, straw is added to night soil to absorb the excess liquid and to improve aeration. Appropriate ratios of straw to sludge vary between 1:1 to 1:28, depending on the desired quality of the end product, and on the characteristics of the available starting material (such as the amount of solids and their composition).

**Shredded paper.** Paper improves the C/N ratio of the substrate, prevents the leaching of excess liquids into the ground by absorbing moisture, and it reduces odour problems. A possible organic waste/paper ratio is 5:1.

**Compost.** Compost is sometimes added during the process of co-composting to reduce the need for additional bulking agents. For example, dewatered raw sewage (25% solids) can be mixed with sawdust and compost, for example in the ratio 5:1:4. Many other types of organic waste, such as mushroom wastes, rice husks and grass cuttings can also be used for co-composting.

## ***Influencing factors***

Since the principle of the biological process of co-composting is basically the same as that of composting, the influencing factors are also more or less identical. These factors are described here only insofar as they differ from those described above in the topics covered.

### **Temperature**

Since the sludge added to the organic fraction of solid waste is likely to contain high concentrations of pathogens, special care should be taken to ensure that the end product is pathogen-free and therefore safe for use. A high temperature is the main prerequisite for killing pathogens. During composting a temperature of at least 50 °C should be sufficient, if maintained for a sufficient length of time (say, more than two days). Some heat-resistant pathogens, however, can survive even this temperature

### **Moisture**

Untreated sewage sludge and night soil contain a great deal of moisture (typically about 92%). Even when dewatered, they may still be too wet to be composted on their own, and amendments or bulking materials are then required to reduce the moisture content as well as to increase the carbon content. Typical amendments include sawdust, straw, garbage, grass and wood chips, but also shredded tyres and peanut shells can be used as bulking materials.

PS: The methods of co-composting are the same as those of composting mentioned above (backyard, neighborhood etc.)

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Waste generation aspects lecture 5

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