D.L. Martin and G. Gershuny (eds.)
The Rodale Book of Composting. Rodale Press, 1992. (ISBN 0-87857-991-5)

Chapter 1: Composting Throughout History
-the biological reduction of organic wastes to humus via soil organisms and fauna is composting
-this process creates a beneficial growing environment for plants that supports all life
The Human Element
-human participation in this process can be done to benefit gardening/food production
-it is believed humans likely began composting shortly after they began cultivating food, likely using animal manure
-clay tablets from the Akkadian Empire contain the first written records
-it was also known to the Greeks, Romans, and Arabs
-records refer to the use of blood as fertiliser
-knowledge survived the Dark Ages via Arab writings and of the mediaeval churches
-Renaissance literature also makes reference to composting
Early American Compost
-North American native tribes and early European settlers used compost to enhance food production
-fish remains were used in coastal settlements as well as animal manure and swamp muck
-innovative farming techniques (e.g., stationing cattle in fields) were implemented
-renewing cropland soil fertility was known to be important
-both animal manure and rotting vegetation was effective, or allowing a field to be left uncultivated/unpastered for a time
Organic Origins
-the Organic Method has included the importance of compost since Sir Albert Howard introduced it (1940)
-he found a ratio of 3 to 1 (plant matter to manure) made the best compost, devising the Indore Method of layering the components and turning it periodically as it decomposed
-Rudolf Steiner's Biodynamic Agriculture had composting as a central tenet (1924)
-J.I. Rodale, pioneer of the Organic Method in North America emphasised composting and introduced several innovations into the practice (e.g., adding ground rock powder, shredding materials prior to addition)
-chemical fertilisers were not introduced until the 19th century with the 'scientific' method
-agricultural chemistry began with Jean Baptiste Boussigault (1834)
-Justus von Liebig (1840) demonstrated plants obtained nourishment from certain chemicals in solution paving the way for increasing the role of chemistry in farming
-organic food production has made a resurgence in recent decades and become a staple alternative to 'industrial agriculture'
-composting has become a means to better recycle animal waste and improve soil fertility; it is even being used to help solve the 'solid waste' problems of municipalities

Chapter 2: The Benefits of Compost
-the complexity of nature's interrelationships has been increasingly recognised as has the recognition that disturbing one plant/animal can have oversized impacts on others in the system
-composting works to take advantage of these interrelationships and nature has been using it since the first appearance of primitive life
-it is an, if not the most important way to build healthy soil and has become integral to organic farming
-soil texture and structure can be improved via composting helping to retain nutrients, moisture, and air, and recycles biological waste
-more moisture-holding capacity helps fight erosion

-compost also gives protection against drought, controlling pH, and supporting important bacteria, stopping nutrient loss, protecting against toxins, controlling weeds
-it is perhaps "the single most important part of gardening"
The Great Recycler
-recycling food/garden waste is a natural process and doing it via composting conserves nutrients for the ecosystem in an efficient way
-chemical fertilisers are manufactured from finite resources, especially natural gas for ammonia-type ones, and have encountered diminishing returns
-composting can reduce use of chemical fertilisers
-the biggest impact can be made via municipal composting programmes
Building Soil Structures
-good garden soil depends upon particles of san, clay, and silt grouping together into aggregates that promote aeration and water drainage
-soil structure is determined by aggregate shape and its formation is enhanced by organic material but reduced by chemical treatments (and then require ever-increasing artificial enhancements)
-compost can help loosen soil that has too much clay allowing roots to access nutrients and moisture
-sandy soils that drain water too easily can be held together by organic matter and retain moisture
-the more humus, the more moisture that can be retained
Aggregate Formation
-aggregates form as fungi grow on organic material, soil bacteria then causes the fungal products to act as cement to hold soil particles together
-experiments clearly showed that the addition of fungi to soil increased aeration and water permeability (threadlike mycelium of fungi hold soil particles together)
-earthworms have been found to help aggregation stability via their castings (especially on grasslands where more roots increased intestinal microbial populations)
-humic acid was discovered to improve aggregation and its permanence and is formed as organic material breaks down
-the salt calcium humate was seen to be more potent than humic acid in providing stability to aggregates (but humus-bound crumbs can be broken down by certain bacteria present in organic matter composting)
-crop rotation that feeds organic matter back into soil to replace what is broken down by bacteria is also important
Drought Protection
-adding compost to soil helps it retain water and thus helps prevent drought damage
-195 pounds of water can be held by 100 pounds of humus
-the granular structure that helps to hold moisture is also helped by the bacteria and fungus humus attracts
Stopping Erosion
-the good soil structure provided by adding compost also helps prevent erosion
-erosion is one of if not the top reasons for sil loss
-in 1986, it was estimated the US loses 6 billion tons of soil a year due to erosion
-the incorporation of organic matter improves structure and significantly slows erosion
Improving Aeration
-soil health also depends upon proper aeration for without air soil can become alkaline, lose organic content, humus 'deactivate', and lose nitrogen
-air is necessary to help convert minerals into a form usable by plants
-as soil processes tend to be oxidative (require oxygen), aeration must be maintained for them to occur
-the formation of mycorrhiza also depends upon good aeration
-compost is vital to building soil with good aeration as it encourages air pockets
Nutrients When Plants Need Them

-compost is great for getting nutrients into your soil and to plants
-no other forms of fertiliser should be required with good, healthy compost
-compost tends to release nutrients slowly which optimises use by plants; so it is a storehouse as well as a source of nutrients
-when temperatures are cool in the spring and plants are just beginning to grow, compost releases its nutrients slowly; as temperatures warm and plants are speeding up in growth, compost breaks down more quickly
-a greater variety of compost material provides a greater variety of nutrients for plants
-plants require both maor (i.e., nitrogen, phosphorus, potassium) and minor elements (e.g., iron cobalt, manganese, boron, zinc, copper , molybdenum, iodine)
-manure and compost are a good way to supply many of the micronutrients a garden needs

Colloids and Minerals

-humus holds and make s available the nutrients plants need and transfers them through a process called base exchange
-very small negatively charged colloidal humus particles attract positively charged elements (e.g., copper, magnesium, sodium, potassium, iron)
-when a rootlet contacts humus, it exchanges hydrogen ions for an equivalent amount of mineral ions thereby 'feeding' the plant
-the mineral-holding capacity of these colloidal particles is important to soil fertility; if the soil lacks these, rain can wash nutrients away
-a soil with high organic content, maintains its nutrients throughout rains for the most part
-soluble mineral fertilisers are also lost to rain and may even cause naturally-occurring minerals to be lost
-while low-humus soils may facilitate growth during rain, dry weather is something quite the opposite; whereas soil with high organic content may display slower growth during rain, it will continue to feed plants through dry weather due to the minerals held by colloid particles

Neutralizing Toxins

-compost is also excellent at neutralising toxic elements in soil
-organic matter can form stable complexes with problematic elements such as aluminum, salt, heavy metals; this allows such elements to be much more slowly released and less problematic and more beneficial if needed in smaller quantities

A Better Buffer

-compost can also act as a pH buffer that helps protect plants from soil that is too acidic or alkaline
-organic matter reduces a plant's reliance upon specific soil pH

Welcome Worms

-earthworms also help to balance soil pH bringing it closer to neutral
-compost helps support earthworms and their population with the two working well together

Growth Stimulators

-compounds that help to stimulate plant growth (i.e., humic acids) are produced by compost, especially root growth
-humic acids occur in an ionically dispersed state that is readily assimilated by plants; these acids help improve oxygen assimilation as well as the uptake of bitumens, vitamins, and vitamin analogs
-all of these substances are provided by decaying organic matter

Chemicals vs. Compost

-chemical fertilisers supply only the major nutrients, and usually in a quick-release form
-while plants may exhibit quick growth from them, the long-term benefits are minimal
-they are no substitute for compost and their dependence upon finite energy resources means they will become increasingly expensive and scarce as time passes

-it is estimated that large percentages of the elements are lost (35% nitrogen, 15-20% potassium and phosphorus) due to overapplications (amounts higher than can be assimilated immediately and are then washed away)
-pollution from these fertilisers finds its way into our water systems causing algae blooms that destroy aquatic life and contamination of water wells; such runoff has also been linked to nitrate poisoning, cancer, soil fertility deterioration, earthworm and microorganism destruction, loss of crop proteins and vitamins, and increased susceptibility to disease and ability to reduce true-to-type
-the complex biological processes and mechanisms that living organisms depend upon are still not and may never be completely understood, so the assumption of industrial agriculture that chemicals can replace what plants remove from the soil
-the evidence shows that synthetic supplements and enhancements provide short-term growth in exchange for a loss of soil fertility and robustness

Chapter 3: Life Inside a Compost Heap
-its chemical makeup and population of organisms are the most important aspects of compost that makes the breakdown of organic matter to humus possible
-complex, biodegradable matter is broken down by a succession of organisms, each creating material for its successor
-as the material becomes simpler in molecular structure, the less likely it is to come under bacterial attack and ore biologically stable it becomes
Humus
-humus is the nutrient-rich, organic matter that results from composting and is beneficial to the soil and plants that grow in it
-by helping to loosen soils's structure, air and moisture can penetrate more deeply and efficiently to help the organisms present and plants growing in it
-humus tends to be particularly rich in nitrogen, phosphorus, potassium, sulphur, iron, and calcium (and many microelements), actual amounts dependent upon compost inputs
-while finished compost displays relatively low levels of N-P-K, its benefit comes from the slow release of these as plants grow and it not leaching out
How Compost is Produced
-complex chemical and microbial processes are responsible for turning raw organic matter into humus
-soil microorganisms breakdown the material via enzymatic digestion
-these microorganisms in turn depend the chemical processes of oxidation, reduction, and hydrolysis taking place
-bacteria relies on these chemical processes to gain their energy and nutrients
-oxidation provides their energy and heats up a compost pile as bacterial activity increases; this activity slows and heat drops as the material it depends upon is used up (heat may persist if pile is large enough to insulate the inner areas
-only material it depends upon is used up (heat may persist if pile is large enough to insulate inner area
-only material of biological origin will breakdown via decomposition iot simpler protein s and carbohydrates that a wider array of bacteria can use
-carbohydrates (starches/sugars) broken down into simpler sugars, organic acids, and carbon dioxide; proteins into peptides and amino acids, and then into ammonium compounds, and eventually into nitrates and atmospheric nitrogen
-once all those processes have completed, the compost is largely ready for the garden as humus (some say it is largely composed of the remains of microbial organisms)
-microorganisms depend upon carbon from the carbohydrates and various forms of nitrogen from the proteins
-the main nutrients to help bacteria, actinomycetes, and fungi thrive in compost are nitrogen, phosphorus, and potassium
-these chemicals, however, do not occur in a form the microorganisms can assimilate readily or in proper ratios for use
-the ideal carbon-nitrogen ratio is around 25:1

-if there is too little carbon, nitrogen is unavailable for microorganisms as it is lost as ammonia (giving compost an unpleasant odour)
-if there is too much carbon, decay slows significantly and nitrogen is diverted away from plants to aid decomposition
-various environmental factors also impact compost breakdown processes
-aerobic decomposition requires oxygen with temperature, moisture, bacteria population size, and nutrient availability all impacting its levels
-moisture content must be adequate and in fact high (but not too high to keep oxygen out) green manures are particularly good at holding moisture (e.g., garden waste, leaves, wood shavings/chips, straw); ideally, compost should be 40-50% moisture levels
-low temperatures slow decomposition; when it's warmer microbial activity intensifies and can result in very high internal temperatures
-mesophilic decomposition occurs around 10-45℃/50-113℉, while thermophilic around 45-70℃/113-158℉
-the higher temperatures are ideal for killing weed seeds and disease organisms; periodic temperature checks on compost can inform its progress
-the bacterial microorganisms in compost prefer a 6-7.5 pH level while funi 5.5-8.0
-pH depends upon hydrogen ion concentrations
-mature compost will ideally be neutral (7.0) or just slightly acidic (6.5-7.0)
-lime can be added to raise pH but this may lead to the formation of ammonia and the loss of nitrogen
Compost Organisms
-most organisms that aid decomposition are microscopic although a few are larger

Microscopic Decomposers

-bacteria are a compost's primary decomposers
-others include protozoa, actinomycetes, and fungi, with larger organisms of earthworms, mites, centipedes, snails, flies, ants, beetles, etc. breaking down larger structures for the microorganisms
Bacteria: aerobic bacteria that specialise in breaking down organic matter thrive in a thermophilic compost; they are single-celled in a variety of shapes and consume almost anything due to the large array of enzymes they can produce; as relatively simple organisms, they cannot adapt to unfavourable conditions and will die or become inactive if temperature or acidity changes too much; fresh compost tend to be dominated by mesophilic bacteria and fungi; as compost matures and temperature increases due to decomposition processes, thermophilic bacteria dominates; as the pile stabalises, fungi and actinomycetes begin to dominate
Actinomycetes: these are higher-from bacteria that give freshly plowed soil its 'earthy' smell; very important to the development of humus, these tend to occur deep in soil converting dead plant matter to a peat-like substance; in compost, they convert organic matter into carbon, nitrogen, and ammonia soil so it is available for plants; most are mesophilic and aerobic; their ability to produce antibiotics causes other bacteria to die off as they reproduce
Protozoa: these are simple, single-celled animals that are more complex than bacteria but less important to composting
Fungi: these are primitive plants , even more complex than protozoa; they lack chlorophyll so cannot create carbohydrates; live on dead/dying material , breaking it down to obtain their energy; they takeover during the final stages of decomposition when temperatures are cooler and material has been broken down to a point they can digest

Physical Decomposers

-the microscopic decomposers above use chemical processes
-larger organisms that chew up or grind material are physical decomposers
-both chemical and physical decomposers are part of a complex food chain composed of first-, second-, and third-level consumers with each level keeping a lower one in check to help maintain a balance; mostly exist in mesophilic conditions
-the larger physical decomposers include:

a) Mites-display eight leglike, jointed appendages; reproduce rapidly, attacking plant matter and some second-level consumers.
b) Millipedes-wormlike with many segments, the front few with pairs of legs; feed directly upon plant material.
c) Centipedes-flattened and segmented with a pair of legs per segment; feed on living animals as 3rd-level consumers.
d) Sow bugs-flat and fat-bodied in segments; eat decaying vegetation as 1st-level consumers.
e) Snails and slugs-mollusks that feed on living plant material but may inhabit compost plies; NOTE: keep them away from crops.
f) Spiders-3rd-level consumers related to mites, feed on insects and other invertebrates helping to control garden pests.
g) Beetles-these visible insects with two sets of wings are 3rd-level consumers feeding on decaying vegetables , snails, and smaller insects.
h) Ants-feeding on a variety of decaying matter and other decomposers, especially 1st-level consumers; benefit composting by bringing fungi and other organisms into the nest they often build within compost piles.
i) Flies-many flies spend their larval stage in compost piles; adults that lay their eggs in compost are useful in bringing bacteria onto the pile; their presence can be reduced by covering kitchen waste with green manure soon after it has been added; fly larva cannot survive thermophilic temperatures, and other consumers feed upon them; while most die with frost, the few that survive can repopulate an area quickly
j) Springtails-small insects that jump when disturbed; feed on decomposing plants, fungi, grains, and pollen.
k) Nematodes, Flatworms, and Rotifers-these are all found in compost; there are three types of microscopic nematodes (a) live on decaying organic matter; b) prey on other microorganisms; c) garden pests that live off plant roots); flatworms live in pockets of compost water and are carnivorous; rotifers, also found in water, feed on microorganisms
l) Earthworms-known for tilling and enriching soils; worms continually ingest, decompose, and deposit casts; calciferous glands near the gizzard secrete calcium carbonate that helps to breakup and neutralise organic matter; digestive juices rich in enzymes, hormones, and other fermenting substances continue to breakdown matter which then gets expelled as casts that compose the richest of humus materials ; the best composting takes advantage of earthworms.

Chapter 4: Compost and Plant Health

-soil that includes rich compost adis plants in resisting pests and diseases

-soil low in toxic substances and disease organisms are best along with sufficient light, water, and heat

Temperature and Plants

-temperature is a key element in plant germination and growth

-with dark colours absorbing heat, rich, dark humus helps in retaining heat for plants

-soil temperature in the top region of soil varies over 24 hours with difference affecting water/nutrient uptake

-as temperatures rise, roots tend to grow better (to a certain point)

-microorganisms best for soil multiply best between 10-40℃/50-104℉ with organic matter decomposition increasing as temperatures approach 27℃/80.6℉ (temperatures reduce in importance past this)

-disease organisms are also impacted by temperatures with several doing greater damage at higher temperatures when plants are stressed

-by helping to stabilise soil temperature, humus helps reduce the effect of disease organisms

-below 4℃/40℉ plants grow very slowly; above 43℃/110℉ they begin to sustain damage (especially stems that have little ability to adapt)

Light and Plants

-plants require light for their chlorophyll to convert solar energy into chemical energy (simple sugars)

-light also plays a role in germination and plant growth/development
-different plants require different light intensities
-atmospheric carbon dioxide combines with soil moisture and sunlight to help plants produce glucose; light controls the opening/closing of leaf stomata to allow the uptake of carbon dioxide (increased light equals increased uptake); with rich humus providing moisture and nutrients, the sunlight energy is converted efficiently into sugars to aid plant growth

Respiration and Use of the Air

-plants require both oxygen, carbon dioxide, and water from the air and soil (via leaf stomata and roots)
-air tends to contain higher concentrations of oxygen (20.96%) than carbon dioxide (0.03%)
-soil has very different concentrations
-compost promotes aeration and moisture content, promoting the uptake by plants of carbon dioxide, oxygen, water, and nutrients

Water and Plant Growth

-the need and uptake of water by plants exceeds all other elements
-water is also lost via transpiration
-water is broken down in plants to supply hydrogen and some oxygen needs (via carbohydrates)
-drought is the primary cause of crop failure; too little water shuts down photosynthesis as stomata close
-roots are essential in obtaining water and nutrients; their growth to facilitate uptake relies upon soil health (friability and moisture-holding capacity in particular)
-the moisture content impacts nutrient uptake and bacteria presence (e.g., nitrogen can be absorbed when levels are low but less so phosphorus and potassium; nitrogen-fixing bacteria survive in low-moisture soil, but other beneficial ones not so much; too much water may stop all bacteria functions that support plants)
-too much moisture can cause toxic substances to form, deprive roots of oxygen, stop nitrate formation, and increase susceptibility to disease
-adding humus improves soil and prevents those conditions

Humus and Plant Nutrition

-the role of humus in plant nutrition is still being explored although much has been uncovered as scientific understanding has increased

Complex Relationships

-research has shown that "soil organic matter contains physiologically active fractions of humic substances of low molecular weight that have an effect on the metabolism of plants after their uptake." (p. 53)
-it's also been observed that amino acids (simple proteins) are taken up and used in protein metabolism
-this nutrient uptake is similar to chemical reaction ion transport and not absorbed via capillaries as long believed
-humic substances have been found to aid nutrient uptake when moisture and air levels in soil are low
-humic acids from manure are even better than those from peat (or lignin–woody substance in plant cell walls); they foster nitrogen uptake, and improve respiration, synthesis, and photosynthesis
-the liberation of oxygen (that helps increase respiration rate) and nitrogen compounds in this humic acid (primarily amino acids and proteins that improve photosynthesis) are improved with manure; when these two aspects are balanced, plants will put on weight

Known Benefits

-humus appears to aid plant nutrition in a variety of ways:

a) Direct assimilation of organic compounds (replacing nitrates in solution).
b) Obtain nitrogen in the form of organic compounds.
c) Assimilation of sugars, use lecithin as a source of phosphate and cystine as one of sulphur.
d) Make available inorganic phosphorus.
e) Source of iron and microorganisms that optimise growth.
f) Provide energy for plants lacking chlorophyll (in association with mycorrhizal fungi).

g) Maturation of some plants can be prolonged.
h) Increase membrane permeability to allow greater nutrient uptake.
i) Increase vitamin amounts in plants.
j) Help to control plant pathogens, harmful fungi and bacteria, and nematodes.
k) Provide carbon dioxide.

-in addition, humus makes available macro- and micronutrients for both plant and beneficial organisms
-microbes help the release of nutrients throughout the growing season
-chemical fertilisers are good for providing needs all at once, but are lost rapidly via leaching and can actually harm plants and microorganisms in large doses
-compost should be able to provide plants all their needs but periodic testing can determine if adjustments are required

Macronutrients

-significantly required nutrients are termed macronutrients and include nitrogen, potassium, phosphorus, calcium, sulphur, and magnesium
Carbohydrates-using air, water, and sunlight, plants produce most of their needed 'food' themselves
-90-95% of plant tissue is made up of carbon (via air CO_2), hydrogen (via water), and oxygen (via water) in the form of carbohydrates
-carbon is recycled by microbial action and is essential to their growth
-organic matter provides the carbon needs of microbes, that give off CO_2 via respiration
-this CO_2 is beneficial to plants
Nitrogen-being a vital part of proteins, nitrogen is important to plant protoplasm formation; plants discolour and lack vigour when deprived of nitrogen; they especially require it during early growth for stem and leaf development; too much nitrogen can slow growth and cause them to be more susceptible to diseases/pests; humus tends to release nitrogen as it is needed by plants; manure tea is a way to feed nitrogen-deficient plants
Phosphorus- phosphorus is required for photosynthesis, within plant energy transfer, and important for flower/fruit development; it is more vital to plant maturation than growth; soil phosphorus is present as organic matter and as insoluble iron, calcium, and aluminium compounds; plants need it as phosphoric acid that is released by soil microbes as they decompose organic matter
-phosphorus deficiencies cause stunted early growth, poor root development, discolouration on underside of leaves (red, purple), and seed abnormalities
-excess soluble phosphates (e.g., nitrates) are subject to leaching
-sources that release phosphate slowly (e.g., rock phosphate, bone meal) are best for plants
-microorganisms can breakdown rock powder into a form available for plants
-phosphate added to compost also prevents nitrogen loss
Potassium- many plant life processes require potassium (e.g., manufacture and movement of sugars, cell division, root development, water retention)
-it is commonly bound with silicates in soil
-it is not part of organic compounds within plants
-older leaves yellowing at their edges suggest deficiency; discolouration towards brown follows and spreads
-root crops may grow longer but smaller in diameter
-potassium becomes adequate in compost with six inches of green matter to two inches of manure
-adding greensand or granite dust to compost improves soil potassium levels
-heavy mulching helps contain potassium in soil
-sparing use of wood ash or any other source of highly soluble potassium helps build levels (large amounts can be negative due to high salt content that increases alkalinity and stimulates potassium uptake)
Calcium-a lack of calcium retards plant growth, the development of thick, woody stems, and often leaf discoloration

-deficiency is difficult to diagnose as its uptake depends upon magnesium, manganese, and potassium levels
-deficiency tends to occur in acidic/sandy soils
-ground limestone can supply calcium, and in neutral/alkaline soils gypsum can correct deficiency (and adds sulphur)
Magnesium-only required in small amounts, magnesium is vital for photosynthesis and acts as a carrier for phosphorus
-discolouration of tissue between veins is common during deficiency
-excess of other elements, especially potassium, may reduce magnesium uptake by plants
-acidic soils tend be deficient, adding dolomitic limestone can counter
Sulphur-essential to proteins
-deficiency symptoms similar to those of nitrogen
-vital to development of onions, peppers, and fruit trees
-organic matter usually ensures sulphur is present
-deficiency has been noted in areas that use chemical fertilisers since they tend to lack the element
-sulphur levels can be increased via organic matter, gypsum (calcium sulphate), langbeinite (sulphate of potash magnesia)
MIcronutrients
-it's been long recognised that soil lacking a variety of minerals (e.g., copper, zinc, boron, iron, etc.) can stunt crop growth
-using a variety of organic matter in one's compost guarantees a good balance of these micronutrients
-many of these elements can be present in poor quality soils but are locked into compounds that plants cannot use
-the humic acids produced when organic matter decomposes help to release the micronutrients locked in compounds and make them available to plants
-some of these micronutrients help microorganisms to fix nitrogen
-humus also regulates micronutrient balances via chelates
-a chelate is a complex organic molecule that holds micronutrient ions, keeping them from being leached away by rain but making them available for plants; these also serve to hold toxic heavy metals out of the food chain
Iron-iron is present in all soils but may not be available to plants in neutral or alkaline soils
-iron deficiency is difficult to identify
-humus keeps iron in solution and available to plants, but in neutral/alkaline soils it is immobilised into insoluble compounds
-iron is also necessary for beneficial microorganisms (e.g., azotobacter)
-manure, crop residue, or dried blood can all add iron to soil; foxglove in particular in compost is beneficial, as well as seaweed or field weeds
Manganese-manganese is important to plants for oxidising enzymes, iron uptake, vitamin formation, and photosynthesis
-leaf tissue between veins will show mottling with deficiency
-acid soils contain plenty of manganese but may reach toxic levels if too acidic
Copper-copper is an important catalyst for plant enzymes and is found in abundance in areas of plant growth
-leaf tip issues indicate deficiency
-it tends to get bound in stable organic complexes in mucky soil
Zinc-starch and protein synthesis, and seed maturation require zinc
-it can become immobilised by phosphorus so excess phosphate fertiliser can cause its deficiency
Boron-fruit and seed formation, carbohydrate, and nitrogen metabolism, water relations, and flowering are all impacted by boron
-growth is stunted when deficient, and when serious terminal bud, twig, and leaves may die
-light, acidic soils subject to leaching tend to be deficient
-compost can provide sufficient amounts

Plant Diseases
-fungi and bacteria are the prime causes of plant diseases
-while humus feeds beneficial microorganisms, it also supports those that can result in disease
-it also promotes the growth of bacteriophages that destroy harmful bacteria and help to control them
-subsequently, plant diseases tend to be less severe in soils rich in organic matter as plants are more vigourous and microorganisms more active
-custom composts have been found to help suppress specific diseases; e.g., bark composts that fight Pythium, ones to protect against Rhizoctonia, Fusarium, Phytophthora
-liquid extracts from compost can help fend off certain fungi (as a preventative, not treatment once established)
-organic matter helps to kill nematodes due to certain fungi that exist in decoying vegetable matter
-research shows compost controls plant disease organisms as opposed to encouraging them
Pathogen and Toxicity Problems
-some pathogenic organisms can, however, survive in compost particularly viruses
-bacterial pathogens must be exposed to prolonged high temperatures to be killed so composting plant debris can be problematic for similar plant families
-diseased plant debris might best be burned rather than composted
-incomplete compost contains high levels of organic acids especially acetic acids and can prevent seed germination
Preventative Medicine: blight and mildew can be prevented with a compost tea spray; mix one part mature compost (preferably with manure) with six parts water; stir and let sit seven days; filter through cheesecloth; spray onto plants; spray every 5-7 days during extended wet, overcast and humid periods
Compost and Insect Control
-observation and experimental research both confirm that compost helps to reduce insect damage to plants
-organic gardening that relies on compost aims to ensure all garden life forms live in balance
-if the predators of harmful insects can thrive, insect damage can be reduced; compost encourages this
-compost helps control insects through the microorganisms it hosts and by the heat decomposition produces
-insects can thrive in the cooler edge of compost thus the need for periodic turning; or they can be discouraged by covering organic matter with soil shortly after addition

Chapter 5: The Frontiers of Composting
-with the energy crisis of the 1970s, a push for more energy-efficient agriculture grew with compost a major focus
-municipal composting has been encouraged to help deal with refuse but has failed to be adopted fully due to landfill use still being cheaper and industrial agriculture's preference for chemical fertilisers
-some progress has been made as landfill sites dwindle and greater regulation of pollution sources
From Trash to Treasure
-in the last 30 years interest in composting (and recycling) has grown considerably
-about 75% of household waste is organic and can be composted, and could contribute to fertilising farmland
-composting also helps conserve energy, reducing agricultural fossil fuel use, can be done on site or close to garden/farm
Leaf and Yard Waste Composting
-yard/leaf waste composting is easiest to perform locally and serve to divert it from municipal responsibility
-the resulting compost is perfect for home gardeners/local farms
-one concern with such ventures is pesticide/herbicide use and contamination
A Compost Bin in Every Yard
-ideally, each household would be responsible for their own organic waste and composting of it
Composting Hazardous Wastes
-research has begun and continues on processes to breakdown hazardous organic compounds

-the safest approach is to not produce and use them in the first place

Biothermal Energy

-a great deal of heat gets produced during the decomposition process

-efforts have been made to harness this heat to heop warm greenhouses/homes

-circulating coils of water pipes have been tried

-experiments have attempted to tap the methane/biogas produced

-CO_2 is also produced making it and the heat useful for greenhouse gardening (although not entirely reliable)

-one stumbling block can be the amount of ammonia gas produced (peat moss filters in air ducts were found to help)

Individual initiatives

-while still a long way to go, composting programs are becoming more common in municipalities

-most progress can be made at the individual home and local community levels

Chapter 6: Materials for Composting

-virtually any organic material can feed your compost

0if you can locate manure closeby, add it to your pile

-supplementary matter, if required, should be easy to find

Where to Begin

-everything organic (except perhaps excrement) can be added without worry

-offer to compost organic matter for neighbours, family, friends, etc. if more is needed; provide them with a large plastic pail and tight-fitting lid, picking it up weekly (peat moss or sawdust on the bottom of pail absorbs moisture and odour)

-local sources of matter may include:

a) Farms and orchards-spoiled hay, eggshells, manure, feathers, barnyard litter, spoiled fruit/veggies, orchard litter.
b) Factories and mills-apple pomace (waste residue), cannery wastes, sawdust, wood shavings, fly ash, leather dust, lignin, spoiled meal, tankage from slaughterhouses.
c) City agencies-dried sewage sludge, leaf mould, aquatic weeds, pulverised wood.
d) Stables and feedlots-manure, stable litter.
e) Retail stores-vegetable trimmings, hair, food waste, plant waste.
f) Roadsides, fields, and waterways-old leaves, weeds, water plants (but be aware of protected/endangered plants).

Regional Materials

-specific regions may have an abundance of specific organic matter, depending on industry and/or environment

-for example, coastal areas tend to be rich in seaweed, fish scraps, and greensand

-collecting such local materials both improves your soil's fertility and ensures waste recycling

Materials to Avoid

-there are a few organic materials that should be avoided in compost

-always try to balance material inputs (manure, soil, green matter, animal waste)

-to avoid odours and pest infestations, include soil on top of organic matter every time it is added

-avoid human faeces due to pathogens that may be present (it can be included but only if properly treated/aged); urine can safely be added

-pet waste should be avoided due to pathogens to humans (particularly cat faeces)

-material that does not decompose easily should also kept out of compost: large wood pieces, clam/oyster shells, heavy cardboard

-pine needles and oak leaves that are acidic should be kept out, or a special compost created with them to feed acid soil-loving crops

-adding diseased plants can be problematic; better to burn them then add the ash to the compost

-if weeds are to be added, thermophilic composting must occur (although some species may even survive this; e.g., Canada thistle)
-minimise addition of kitchen grease/oil as they may inhibit decomposition
-never add toxic materials such as pesticide/herbicide-treated material

Materials for Enrichment

-some find materials to enhance certain nutrients useful to add
-most are available through garden centres: manure, dried blood, bone meal, limestone, greensand, peat moss, seaweed, etc.
-lime is a common-used additive to increase pH but not necessary if manure is added; if needed, best to add it to soil or mix with compost when transferring to garden; compost microbes benefit from the calcium present in the lime (alternately, crush eggshells and oyster/clam shells, and/or crushed bone and wood ash to supplement; avoid all these if making 'acidic' compost, i.e., for blueberries)
-mineral content can be enhanced via rock or colloidal phosphates; best added to compost as microorganisms make minerals into a form available to plants; micronutrients and calcium als o enhanced
-rock powders and greensand do their best enhancement work when added to compost rather than soil
-adding plant material rich in specific nutrients is a great strategy
-seaweeds are rich in potassium and include iodine, copper, boron, magnesium, phosphorus, and calcium
-leaves are a great source of micronutrients

Activators

-biological decomposition can be stimulated by 'activators'
-organic activators contain high amounts of nitrogen in various forms (e.g., urea, proteins, amino acids) and include manure, dried blood, compost, urine
-artificial chemical activators are available but not recommended
-activators work by introducing microorganisms and increasing nitrogen and micronutrients into the compost
-the biodynamic agricultural method considers specific activators with precise creation methods to be vital to composting
-some believe specific bacteria are essential
-there is, however, probably no significant benefit to using an activator apart form a layer of previously composted material or healthy topsoil

Nitrogen Activators

-insufficient nitrogen is the most common cause of compost 'failure'
-the bacteria and fungi that serve to decompose organic matter require sufficient nitrogen to survive and thrive
-addition of blood meal has been found in to increase significantly a pile's bacterial activity (as seen via temperature increases); best result found when adding 3 pounds of blood meal to 31 pounds of compost
-additional nitrogen activators include: manure, bone meal, alfalfa meal, human urine

Common Materials

<u>Alfalfa</u>-good nitrogen source and absorbency; can serve as a stimulant/activator; 12:1 carbon:nitrogen ratio helping to meet 25/30:1 desired level
<u>Apple pomace</u>-this pulp from cider production should be added with absorbent material (e.g., drived leaves); low in nitrogen but high in phosphoric acid and potash (be aware of source pesticide use)
<u>Bagasse</u>-waste from sugarcane mills
<u>Banana residue</u>-contains abundant amounts of potash, phosphoric acid, and nitrogen; boosts bacterial activity
<u>Basic slag</u>-byproduct of iron ore smelting that contains lime, silicone, magnesium, sulphur, manganese, aluminium, and iron plus trace amounts of tin, zinc, chromium, copper, boron, molybdenum, potassium, strontium, zirconium, and sodium; pulverised into a powder of insoluble particles, it can be added generously but avoid mixtures high in sulphur
<u>Beet wastes</u>-sugar beet processing waste is good for adding nitrogen, potassium, and phosphoric acid

Bone meal-a major source of phosphorus, pulverised bone also contains significant nitrogen; even higher concentrations if produced via steaming; most effective if added with organic materials in well-aerated soil; monitor pH if adding as it is alkaline
Buckwheat hulls-grows well on marginal soils; the hulls can be used as mulch or added to compost as an absorbent that holds moisture
Castor pomace-residue after oil extracted from beans is high in nitrogen (4-6.6%) and phosphoric acid and potash (1-2%); it will quicken bacterial activity when added to organic matter and watered
Citrus wastes-residue from citrus processing can add significant nitrogen, phosphoric acid, and potash; orange skins are 3.6% phosphoric acid and about 27% potassium; avoid waste from industrial growers due to pesticide use
Cocoa bean shells-rich in nutrient and often used as mulch, cocoa bean shells are great in compost; if the shells have been treated to extract caffeine and theobromine (2.7% nitrogen, 0.7% phosphoric acid, 2.6% potassium); if untreated, these amounts are higher
Coffee wastes-worms love coffee grounds; as acidic in nature, they can be added directly around acid-loving plants (e.g., blueberries, evergreens); mix with ground limestone to reduce acidity; grounds hold moisture well and should be mixed with other organic matter
Corncobs-need to be shredded prior to composting; great moisture retention and can be sued as mulch once shredded; will provide good aeration in compost
Cottonseed meal-rich source of nitrogen but cotton is often subject to large applications of pesticides, so only get from organic sources; used to increase acidity; 7% nitrogen, 2-3% phosphoric acid, 1.5% potash
Dried blood-a slaughterhouse byproduct high in nitrogen (12%), varied phosphorus (1-5%); can be expensive; can be applied directly to soil but back from stems as may burn; stimulates organisms in compost
Felt wastes-discarded hair, felt, and wool can all be added and may contain up to 14% nitrogen; need to be wet and mixed with manure or green matter
Fish scrap-7+% nitrogen and phosphorus as well as many micronutrients; needs to be well buried in compost and aerated; mix with dry, high-carbon matter (e.g., leaves) to balance high nitrogen and moisture
Garbage-organic kitchen scraps are a valuable input providing nitrogen, calcium, phosphorus, potassium, and other micronutrients; may be dug right into garden or added to compost; cover with absorbent material after adding; suggests not adding mea, bone, or fat
Gin trash-cotton industry byproduct useful in compost depending upon chemical use (e.g., some areas spray with arsenic acid for defoilage
Granite dust/meal-natural source of potash; 3-5% potassium plus micronutrients; slow acting and can be added to soil and/or compost
Grape wastes-winery residues; not a great source of nutrients but can promote aeration and microbial activity; mix with absorbent matter
Grass clippings-fresh clippings are rich in nitrogen; add in thin layers as very moist, alternating with other matter; will heat and decompose quickly; dried clippings hold less nitrogen but can act as an absorbent; can serve as a great mulch; can be turned into soil as a green manure after harvest, providing nitrogen and stimulating microbial activity; avoid clippings that have been exposed to herbicides
Greensand-an iron-potassium-silicate deposit found undersea and a great source of potash (6-7%); slowly released in soil when added directly; improves availability of potassium and micronutrients in compost
Hair-6-7 pounds of hair contains the equivalent amount of nitrogen as 100-200 pounds of manure; moisten and mix thoroughly into compost with aerating matter
Hay-great source of carbon and potassium (especially if alfalfa, clover, or hairy vetch in) great as a mulch around fruit trees; can introduce weed seeds into compost if cut late, so may need thermophilic composting (and shredding to assist this); best to alternate with manure and ensure moist

Hoof and horn meal-granular form needs to be kept covered and moist; may encourage maggots; horn dust has a high nitrogen content (10-16%), and 2% phosphoric acid

Hops-brewing wastes contain 1.5-3.5% nitrogen and 1% phosphoric acid; wet hops can be added directly to garden (spring/fall) and turned in to the top few inches from plants; mix in compost with absorbent matter; a good mulch when dry

Incinerator ash-good source of potash (2-3%) and phosphorus (5-6%); consider source as some burn inappropriate material

Leather dust-byproduct of processing containing 5.5-12% nitrogen and plenty of phosphorus; can be amended directly into sil or layered in compost; may be contaminated with chromium so avoid if unsure

Leaves-very valuable with plenty of nutrients; contain twice the mineral content of manure; its fibre content helps with aeration and giving sil structure; they may take a long time to breakdown due to their low nitrogen content; this can be overcome by adding extra nitrogen in the form of manure (5:1 ratio, leaves:manure)n or dried blood, alfalfa meal, bone meal; add leaves before drying out as this further reduces nitrogen content; shred prior to adding (via a mower); making leaf mould is also a great option; construct an enclosure (wire, snow fencing), placing leaves in and wetting them then tamping down; limestone should be added to reduce acidity; by spring/summer you will have a mulch; if left for 1+ years a black and crumbly humus will form; this will release nutrients slowly, hold moisture; leaves can also be used as litter or bedding for livestock (along with straw); leaf mould mixed with nitrogen-rich matter/supplement can be added directly to soil or in compost

Limestone-important source of calcium and magnesium (via dolomitic limestone); used to raise pH of acidic sils and can counter acidity of pine needles; not necessary if compost is made with a variety of matter; should not be mixed with fresh manure as it creates ammonia gas, depleting compost of nitrogen; add directly to soil if it is acidic; application every 3-4 years in fall for humid regions advised; most vegetable-garden plants prefer a slightly acidic soil (but no legumes like peas, beans, alfalfa)

Manure-very valuable addition to compost

Molasses residue-sugar refining wastes are rich in carbohydrates and hold some mineral nutrients

Olive wastes-olive pits offer a compost lignin; phosphorus, and nitrogen but require grinding prior to addition; pulp varies in nutrient content and should be added with other material

Paper-useful for compost or mulch; ensure shredding prior to addition; absorbent; should be layered in compost; require presence of nitrogen-rich matter to stimulate decomposition

Peat moss-fibrous material; decayed plant residue; very absorbent helps loosen heavy soils, binds light ones, holds nutrients, and increases aeration; low in nutrients, and increases aeration; low in nutrients itself and increases acidity; great as a rooting medium, mulch, or soil amendment for acid-loving crops (e.g., blueberry, sweet potato, eggplant, potato, tomato)

Pea wastes-rich in nitrogen, especially when green; vines should be shredded; diseased plants should be burned and ash added to compost (3% phosphoric acid, 27% potassium)

Pet wastes-potential carrier of disease and should be avoided; aquarium wastewater is okay to add

Phosphate rock-very valuable amendment; usually about 65% calcium phosphate or bone phosphate of lime; also lots of other micronutrients; do not confuse with superphosphate that has been treated with sulphuric acid; is slow acting; 1 pound per 10 square feet of garden is good for 3-5 years; light sprinkling over layers of compost recommended to hold in nitrogen

Pine needles-breakdown slowly; acidic in nature; shred prior to adding to compost; can help control understable fungi when used as mulch or directly in soil

Potato wastes-peels are source of nitrogen (0.6%); tubers can add potash (2.5%) but should be chopped up; dried vines add potash (1.6%), calcium (4%), a magnesium (.1.1%), plus sulphur and other minerals

Rice hulls-very rich in potash; can be used as mulch; valuable in compost

Sawdust-better as a mulch; low in nitrogen and may require supplement to compensate (e.g., manure tea); good carbon source and for aeration
Seaweed-rich in micronutrients; mix into compost and add absorbent matter; great activator as bacteria love the alginic acid in its leaves; decomposes quickly; small amounts hould be soaked overnight in hot water and then liquid added to successive layers of compost or as fertiliser
Sewage sludge-the sold residue remaining after processing may, depending on type of processing, contain up to 6% nitrogen and 3-6% phosphorus; needs to be thermophylically composted and should not be used for edible crops due to industrial waste heavy metal toxins
Soil-not a necessity, but its high levels of organisms can give a boost to compost and act as an activator (similar to mature compost); adding thien layers to compost can help absorb unstable elements, help keep heat and moisture in
Straw-low in nutrients but adds organic matter and carbon (that feeds bacteria); may require nitrogen supplement (e.g., manure); may need chopping up and absorbent mateer added; if aon own, will require longer to decompose; will help in development of fungi that form mycorrhizal relations
Sugar wastes-processing residue contains bone charcoal that is used as a filtration medium; 2% nitrogen, 20% phosphorus, variable potassium
Tanbark-leather tanning waste is sold as mulch; 1.7% nitrogen, 0.9% phosphorus, 0.2% potassium, plus many other elements in small amounts
Tankage-refuse from slaughterhouses/butchers; phosphorus levels vary depending on bone content; 5-12.5% nitrogen, 2% phosphoric acid (but may be higher); very good for compost
Tea grounds-as mulch or in compost; 4.2% nitrogen but less than 1% phosphorus and potash
Tobacco wastes-high in potash; 2.5-3.7% nitrogen, 1% phosphoric acid, 4.5-7% potassium; do not apply to soil directly for areas growing tomatoes, potatoes, and peppers as same family and may carry disease viruses; best to compost than use as a mulch as nicotine may kill beneficial insects in garden
Water hyacinth-available in southern streams; shred and mix with partially decomposed matter or soil or manure
Weeds-good for providing humus to soil; seeds should be killed by high temperatures in compost; can help conserve nitrogen and add various minerals; some are better to be burned first and then the ash added, particularly those that reproduce via underground rhizomes
Wood ash-good source of potash (hardwood, 1-10% plus 35% calcium, 1.5% phosphorus); apply judiciously as too much can unbalance nutrients; increases alkalinity and salinity; can be mixed with other fertilising material; if adding directly to garden, keep away from new or germinating plants
Wood chips-better than sawdust as a higher nutrient content; breaks down slowly with a higher nitrogen content; increases aeration and moisture-holding capability; great as a mulch; best applied ahead of green manure crop laying it down a year prior to seeding
Wool wastes-textile mill 'shoddy' adds nitrogen (3.5-6%), phosphoric acid (2-4%), and potash (1-3.5%)

C/N Ratios and Nutrient Analysis

-inclusion or exclusion in the following tables does not speak to its viability as compost material

-burned matter (i.e., ash) concentrates nutrients but fresh matter adds moisture and various organisms
-don't attempt to boost specific nutrients in compost unless soil analysis indicates significant deficiency
-pages 114-120 provides tables of materials that provide nitrogen, phosphate, and potash, as well as a break down as to the mineral composition of various materials

Chapter 7: Using Manure

-animal dung and urine is a valuable addition to compost
-it has been used to enhance soil for millennia
-it is especially good for adding nitrogen, bacteria, and increasing pile heat

-unfortunately, most of this manure does not find its way into soil; about only 20% does
-dung is extremely packed with nitrogen, potash, phosphoric acid, and bacteria (about 30% of the mass)
-urine is very high in nitrogen and potash, and since it is in solution is readily available for plants; it is also a great activator turning organic matter to humus
-manure value rests with type of food consumed, animal age, and its health

Manures Contribution to the Soil

-what an animal produces in the way of food can also impact its manure's quality (e.g., cown's excrete a lot of nutrients in their milk and not so much in their wastes)
-manure can be problematic for alkaline soils, raising toxic salt levels
-manure also loses its nutrients rapidly
-rotted manure loses moisture and concentrates nutrients
-the nitrogen in fresh manure tends to be soluble, in composted manure it is fixed by microorganisms
-phosphorus and potash tend to be soluble in composted manure
-preventing nitrogen loss during composting of manure is recommended
-manure in compost decomposes in stages:

1) Urinary nitrogen decomposes–nitrogen loss can be reduced by keeping manure moist and compact or adding a source of phosphorus (e.g., phosphate rock)
2) Insoluble nitrogen decomposes–solid excrement breaks down and produced ammonia
3) Soluble nitrogen converts to insoluble form–this occurs inside microorganisms and is released when they die
4) Free nitrogen formation–ammonia and nitrate decompose and are released into the atmosphere
5) Nitrogen-free compounds decompose–fibrous elements (e.g., lignin, cellulose) break down releasing carbon dioxide and water reducing the pile by 25-50% by bulk

Out of Balance

-farms (in the traditional sense of a family one) can be a balance of crops and livestock
-when used wisely, manure can return a significant percentage of the nutrients used in the livestock's feed crops (70% nitrogen, 75% phosphorus, 80% potash)
-large-scale livestock operations, however, tend to ignore such a 'balance' by not utilising manure's fertilising potential

Using Manure to Advantage

-manure by itself does not bestow 'balance', especially if simpoy added 'fresh' to soil
-the imbalances of fresh manure can be mitigated through decomposition
-urine-soaked bedding especially is a great addition to a compost pile; it is extremely high in nitrogen, so be sure to add high-carbon material with it (e.g., coarse, dry vegetable matter) and rock phosphate
-covering your pile can prevent rain from casing nutrients to leach out
-manure often contains weed seeds and disease pathogens but these will be destroyed if the compost heat is high enough (i.e., thermophilic)

Chicken Manure

-manure from chickens is considered 'hottest' due to its high nitrogen, phosphorus, and potassium content
-droppings must be composted with a high-carbon mulch or cover crop due to its 'richness'
-precautions must be taken in catching dropping and cleaning them up due to possible respiratory issues for both chickens and humans

Horse Manure

-also high in nitrogen, horse manure is considered 'hot'
-mix in compost with high-carbon matter and add water

Swine Manure

-concentrated in nutrients as well, hog manure is best when mixed with large quantities of vegetation

Sheep Manure

-another ‘hot’ manure that is rich and dry

Cattle Manure

-moist and not as ‘rich’ as others (i.e., low nitrogen, high water)

-ferments slowly and filled with beneficial microorganisms

Rabbit Manure

-very high in nitrogen and phosphate

-decomposes quickly

-should be used in small quantities due to high nitrogen content

-earthworm pits under wire rabbit cages is recommended as worms convert manure to fully composted castings

Finding Manure

-where animals exist but lack fields to fertilise, is a good place to find manure to add to compost

-riding stables, dairies, poultry farms, and zoos are examples

-dog/cat wastes should be avoided due to their possibility of carrying pathogens dangerous to humans

-hauling wastes away from most places that don’t take advantage of the manure helps the home garden and the location it is taken from where it is often dumped in concentrated amounts where it upsets environmental balances

-be aware, however, if the manure has been treated at all (some spray it with larvicide to control fly populations) as such chemical suppress microbial populations important to compost

Manure Tea

-organic liquid fertiliser can be created with manure

-place a couple of shovelfuls of dried manure in a permeable bag (e.g., burlap), tie closed, and place in large pail with water ensuring bag is submerged; let steep for at least a week

-this tea can be used directly as a periodic feed or diluted and used for more regular watering

-adding to green/dry material in compost pile adds important bacteria and nitrogen

-it can be saved for extended periods and is easy to store

Substitutes

-high-nitrogen alternatives to manure are unavailable: blood meal, cottonseed meal, tankage, fish, shellfish scraps, hair, activated sludge, hoof/horn meal, shoddy, wool wastes, leather dust, alfalfa, soybean, fresh weeds/grass/leaves

Chapter 8: Methods

-there exist a variety of composting methods, most based upon Albert Howard’s Indore method

-they all aim to nourish and sustain the microorganisms that turn organic matter into humus

–they need: air, moisture, energy (carbon) and protein (nitrogen), and warmth

-a critical mass is required to reach the best temperature

Air

-while anaerobic composting is possible, most home composting tends to be aerobic and requires air throughout the pile

-turning the compost is the most common means of ensuring air; increased turning means increased decomposition

-less labour-intensive means are possible

-one strategy is to place perforated drainage at intervals in the pile allowing natural air currents to reach inside pile

-building a bin off the ground with a strong wire bottom is another option (plastic drainage sheet underneath to capture runoff to pour back into compost recommended)

-layering poles in the pile and withdrawing a few each day during heat buildup

-open air channels with pitchfork tines

-occasional layer of sunflower stalks (whose centres rot)

-if in no hurry, a static pile upon a base of course brush will suffice; ensure such piles have periodic layers of ‘fluffy’ material such as leaves, hay, paper

Moisture
-good compost should be a sdamp as a moist sponge but not water should come out of it if it is squeezed
-microorganisms require a hot, moist environment
-too much moisture will produce a strong odour, bring down internal temperatures, decrease aeration, and wash away nutrients
-drainage should be considered for wet environments; in dry climates, consider sinking a pit into the soil to help trap moisture
-too much hay can also be an issue due to its water-resistant tendencies; shredded hay is less problematic; water thoroughly if adding and mix with wet material (e.g., kitchen wastes); it can be a useful cover for open piles
-when turning, note moistness and add absorbent material
Carbon/Nitrogen Ratio
-decomposers need both carbon and nitrogen, ideally in a 25-30:1 ratio
-brown or yellow, dry and coarse material tend to provide carbon (e.g., plant matter)
-green, succulent, gooey, and dense materials tend to be nitrogen rich (e.g., animal by-products but also grass clippings and alfalfa meal)
-some materials are naturally in the idea range: kitchen waste, fresh clover, manure/bedding mix
-carbon materials make up mass majority
-nitrogen stimulates microbes to reproduce
-if the C/N ratio is too high, N is lost as ammonia but should stabilise in a few days (in worst case, pile may turn anaerobic as carbon contributes to aeration)
-it should be unnecessary to add synthetic activators (e.g., urea, sodium nitrate) and they can disrupt microbe populations
Warmth and Critical Mass
-for continuous composting, a wandering compost pile is suggested where fresh waste are added to a front sloping side while finished compost is sliced from the back side
Inoculation
-bacteria are always present in material being added but they are not always the best ones for decomposition
-adding diverse types of material increases likelihood of beneficial bacteria being added
-the best guarantee is to add good topsoil or finished compost over each new layer
Choosing a Method
-deciding what composting method depends upon space, materials, amount needed and rate of use, time, labour required, and crop needs
-one can consider quick, hot composting to slow, cool techniques
-there are pros and cons to every method but all require knowledge about the ideal conditions for a pile's microorganisms
-quick composts can finish their work in 2-8 weeks requiring high aeration to ensure high temperatures; using a thermometer to monitor is useful if using such a method
Some Like It Hot
-hot composting produces mature compost more quickly and is useful if needs are high or space is limited
-it also produces temperatures that help to kill weed seeds and pathogens (avoid materials that may host these if temperatures cannot be reached)
-thermophilic composting does require more labour, is more sensitive to C:N ratio and moisture levels, and is not amenable to periodic additions (it requires a complete pile from outset)
-N is not as well maintained in hot piles as it is used up quickly for fast bacterial growth
-some research suggests cool piles are better for killing soil-borne pathogens as the necessary bacteria and fungi tend to be killed in thermophilic piles

A Cool Alternative
-if you have the space, coll composting may be a better option as it is less labour intensive
-cool composting still heats up to 49C/120F
-mesophilic microorganisms will create humus in 6-24 months depending on conditions (i.e., climate, aeration, material)
-while it may not kill weed seeds or pathogens, it also spares disease-suppressing microbes
-organic matter can be added periodically
-more care is needed in balancing the C/N ratio and wet/dry matter or anaerobic conditions will arise
-remember to add some good topsoil or mature compost each time fresh material is added
The Indore Method
-Howard's original method relied solely upon manure, brush, leaves, straw, hay, and sprinkling of earth and chalk in layers
-a layer of brush was topped with green/dry vegetable matter (6"), then manrue (2"), sprinkling of soil; this layering was repeated up to about 5' in height
-vegetable matter to manure ratio of 3-4:1 was sought
-Howard recommended spreading chalk or limestone with the earth
-later iterations of this method included night soil (human waste), garbage, and sewage sludge; layered with high-carbon matter (e.g., straw, animal litter, leaves)
-piles were turned at 6 and then 12 weeks (sometimes more often to limit fly reproduction), but this was also accomplished by covering the pile with a two-inch layer of soil
-liquids draining from the pile were in some early trials captured and poured back on the compost
-this method can be practised on a large scale and with minimal labour
-for home piles largely of kitchen scraps, it is best set up in a bin or pit
Modifications
-in India, a derivation called the Bangalore method is widely used
-other modifications use night soil, sewage sludge, garbage, or green matter in place of manure
-some seek higher temperatures via more frequent turning
-another approach uses only green plant matter and animal bedding covered by black plastic sheet; compost is ready in 3 weeks
The University of California Method
-the early 1950s method developed at the University of California is a well-known quick approach
-it is similar to early modifications of the Indore method
-it has been used widely for municipal waste composting where material shredding, frequent turning, careful C/N ratio is moisture control is attempted
-material bulk and the presence of paper and ash necessitate more careful monitoring
-for a home-based compost, the method requires: a bin to contain material; all material present at one time (in proper condition and composition); a set procedure for bin contents
-the C/N ratio should be 25-30:1 via green garden debris or garbage for N and dry garden debris for C
-manure can be added to lower C
-it is recommended that dry and green material be alternately layered (2-4")
-paper is not a great absorbent and woody matter offers C but in a 'resistant' form, requiring additional N-heavy mater early on
-high-C matter can add structure and be absorbent
-a cubic metre should be the minimal size and larger if weather is cold to ensure insulation for interior to reach high heats
-matter to be composted should not be too large (e.g., vines, stalks no more than 6-8:); coarse material takes longer to decompose

-pile turning is vital to providing aeration and avoiding anaerobic conditions; it's important that all matter be exposed to the internal heat for some period of time
-compost can be mature in as little as 12 days depending on the amount and if it is turned every 3 days; longer composting guarantees maturity
-a hotbed thermometer can assist in accurate assessment and should reach at least 12: into pile
-try not t be too casual or neurotic about the process
-practice will ensure your basic senses can assess progress and maturity
Modifications
-the California System can be modified in a number of ways
-the turning schedule is shiftable; sifting out large matter after 7-10 days for re-shredding or use as mulch
-creating a 'bottom' aeration system eliminates labour-intensive turning (i.e., building off ground)
The Biodynamic Method
-this method is derived from the anthroposophy philosophy that holds a worldview of interconnected life processes
-basics include digging a pit (5-10: deep), the bottom covered with a thin layer of manure or mature compost that should be moist but not wet; the pile should form a trapezoid 13-15' wide at the bottom and 6' at the top, and 5-6' high
-layers should alternate soil and organic matter; the final layer should be soil all over
-if using manure, layer in bedding, leaves, and/or sawdust with it; ensure the pile is kep moist; drainage can be accomplished by having the very bottom layer of brushwood or drainage tiles; only add fresh leaves, not dry ones
-the aspect that makes this method different from the other methods is that when it is about a metre high 'preparations' are added
-these 'preparations' are created by biodynamic farmers who combine various plants (e.g., yarrow, nettle, valerian, horsetail, dandelion, chamomile) in a special fermentation process (buried with specific animal organs)
-this preparation serves as an activator
-after 3-5 months the pile is turned/mixed, more preparations are added (if needed)
-through careful observation and experimentation, compost matter can be adjusted in a way that benefits specific crops
-for example, tomatoes have been found to benefit most from compost that includes its own waste matter
-rapid decomposition has been aided by the addition of stinging nettles, an important part of this method
-some research shows this method's compost aids in healthier plants that grow faster
-some believe it may be due to rich micronutrients added via the 'preparations'
The City People's Method
-this method was developed with urban living in mind
-it is considered a 'fast' aerobic process that helps minimise odours and attracting wildlife (via frequent turnings)
-it is recommended that 3 bins (sturdy, covered) be placed in a shady place to help keep moist
-to avoid odours, the C:N ratio needs to be well maintained (if N too high, ammonia is produced)
-rather than manure, human urine ca provide much of the N and needed moisture (and acts as an activator); it tends to be disease free can be applied shortly after excretion, can be stored easily (do avoid urine from people who are sick)
-layering should be: sawdust on bottom, followed by alternate layers of green matter then dry matter (sprinkling urine or other N sources–e.g., dried blood or alfalfa meal–over each layer)
-try to avoid or at least chop up large dry matter
-some watering may be necessary
-after 1-2 days turn it by forking it into an adjacent bin; repeat this every 3 days,, forking it back into the original bin
-the 3rd bin is to start accumulating fresh matter
Compost in a Bag
-if very limited space available (e.g., apartment), composting can still be done

-using a watertight, sealable bag place a cup of shredded organic matter in (the finer the better); add ½ cup garden soil; add 1 tablespoon of alfalfa meal/pellets and 1 ounce of water then seal bag; shake well and set aside; shake/mix/squeeze each day; leave open every other day for aeration; in 4-6 weeks you should have mature compost

Compost Tumblers

-turnable composters are another option for those with limited outdoor space and/or only a limited compost need

-they have limited capacity and cannot be used for the 2 weeks that matter requires to mature after full

-moisture needs to be monitored and C:N ratio watched

The Raised-Bin Method

-turning piles is labour intensive

-one method to avoid the need for constant running is to build a bin off the ground

-another is to insert pipes to allow air in from the outside to reach the centre

-raised beds are believed to pull cool air from below them up through the matter and is actually more effective than periodic turning

-criticism of the raised-bin method is that aeration is uneven and matter tends to dry out (perhaps these are more problematic for larger piles than smaller home-based ones); this method may also allow weed seeds and pathogens to survive

Ogden's Step-by-Step Method

-Sam Ogden has developed a method that relies upon cool temperatures and partly anaerobic decomposition

-using three piles, he lays out organic matter as it becomes available topping it with soil before it starts to decompose; this pile is used for 6 months then left for 12, putting matter in the 2nd pile for 6 months, and finally putting matter in the 3rd pile; once the 3rd pile is full, the 1st can be emptied of mature compost

-Ogden advises against adding leaves and/or grass clippings but instead create a separate pile for them (they tend to lead to anaerobic decomposition); if leaves are well shredded, spreading them in a thin layer can occur

-this method is useful if: speed of turnover or large amounts of compost are not required; grinding/shredding is not possible; supplemental matter is readily available (e.g., manure, blood meal); winters are server and compost required in spring

Pit Composting

-garbage pits have been found on prehistoric human occupation sites as far back as humans have been around

-composting 'pits' are those that go partially into the ground

-they are partially anaerobic

The Movable Compost Pile for Raised Beds

-raised beds for intensive gardening have grown in popularity

-having plants tightly grouped in small beds requires soil with plenty of nutrients

-24" beds contain lots of compost and/or manure

-root systems grow vertically rather than horizontally, reducing water requirements, heavy fertilisation, and mulch

-beneficial interplantings are common and helps promote growth and fight pests

Windrows and Piles

-piles and windrows are open composting that have no confining structure and occur on open ground

-windrows are elongated piles that require periodic turning; used usually where large quantities of matter is involved; are hot or cold dependent upon frequency of turning

Mulch and Sheet Composting

-spreading organic matter directly in the garden in a thin layer is not a formal composting system but is also effective and requires far less labour

-is is referred to as sheet composting

-green manuring is one approach and requires only incorporating certain crops/weeds into soil

-all that is required is filling organic matter (waster, weeds, specific crops) directly into soil; usually done on a large scale with machinery, but can be done on a small scale–just requires letting an aea going 'fallow' for a year
-a drawback of sheet composting is that the residue for decomposition draws upon the soil's N and high-N material may release N too quickly and in wrong form
-what may require only a few week's in an actual compost system, could take a year via sheet composting
-growing 'green' manure then turning it into soil may be most practical for a large garden; a cover crop (e.g., winter peas, clover, vetch) is planted after food crop harvested and then turned into soil about 2 weeks prior to next food crop seeding
-green manuring and sheet composting can be combined; adding rock powder is suggested when doing this; best to do this with relatively fertile soil
-rotating crops as well as using cover crops are ideal methods for keeping pests and diseases at bay

No-Work Mulching

-in the early 1950s, Roth Stout popularised the use of a deep mulch layer
-this approach requires a fertile soil over which a deep layer of mulch is placed
-this layer reduces weeds, retains moisture, can be simply pulled back to seed, and helps to moderate temperatures
-it is, however, a slow way of adding nutrients compared to adding compost
-it creates partly anaerobic decomposition as the mulch reduces aeration below it
-any compostable waste can be used as mulch but layering and mixing using ideal proportions is next to impossible
-it also does not compost rapidly
-many recommend combining mulch with a compost method program

Some-Work Mulching

-a modification of No-Work Mulching was developed by Mark Lyle and is better for enhancing soil
-he covered hard-baked clay with 4" of a mulch/organic matter mix, watered, added a layer of cottonseed meal, 3" of leaf mould, watered, then a final application of cottonseed meal
-after 2 days a rototiller mixed it all up then was watered again
-after 4 days, green matter (leaves, grass clippings) was layered on top then more cottonseed meal
-the rototiller was used after another 4 days, then again after 4 days, then again after 4 days after which earthworms were found and soil was darkening
-Lyle topped this off with 3: of cottonseed hulls and then left for the winter
-the result was similar to conventional methods
-mostly aerobic and most similar to the California method but with a pile depth less than 10" so no thermophilic temperatures are reached
-Lyle's approach differs from Stout's in that no crop growing goes on during mulch/composting period
-the process is basically aimed at enhancement of poor soil, not crop growing

Trench and Posthole Composting

-filling trenches with compost has been advocated by some as a great way to improve poor soil
-drawbacks include: pockets of anaerobic activity; slow decomposition; and possible N deficiency
-spot composting is another method where 'post holes' are dug about the garden; holes 12-18: deep are suggested; in the spring, garden debris can be put in and topped off with a couple of handfuls of manure and then a layer of the best topsoil from the hole; at planting time, holes can be dug and filled between plants; then holes will retain moisture and a fertile 'tea' will leach from them

Anaerobic Composting

-composting without air is possible, although there are critics
-J.I. Rodale wrote about it in 1968, highlighting that the Indore method includes aerobic decomposition for only a portion of its time and once the organic matter has broken down sufficiently the creation of humus takes place in anaerobic conditions

-so, the first half is aerobic and the second half anaerobic
-a drawback of typical composting methods that encourage aeration is that oxidation destroys organic N and CO2, releasing them
-another problem is the leaching out of nutrients as water drains out the bottom
-oxidation is reduced via anaerobic composting
-the fermentation that results reduces significantly N loss
-it has been difficult to find an efficient anaerobic method; one method found useful is to cover a pile in a black plastic sheet

A Compost Checklist

1) Structure: martial should be medium loose and not packed or lumpy; the more crumbly the better
2) Colour: black-brown is best; if black, soggy, and smelly, it indicates anaerobic fermentation; greyish-yellow means water-logged
3) Odour: should be earth-like; foul odour means material is still breaking down; musty smell suggest moulds present
4) Acidity: slightly acidic or neutral best; too acidic indicates lack of air and/or too much water; earthworms and N-fixing bacteria prefer neutral/slightly acidic; pH of 6.0-7.4
5) Mixture of raw materials: aim for the right mix of matter, 25-505 in final product
6) Moisture: matter should be moist like a wrung-out sponge but never dry

Solving a Heap of Problems

-most issues can be solved by turning the pile or adjusting conditions to suit microbes

Problem	Remedy
Wet, foul-smelling heap	Turn pile and add high-carbon, absorbent materials. Protect pile from rain.
Dry center and little or no decomposition of materials	Turn pile, thoroughly soaking each layer as it is replaced. Cover with plastic to retain moisture.
Dampness and warmth only in middle	Increase amount of material in pile and moisten.
Damp, sweet-smelling heap but no heat	Add more nitrogenous materials such as blood meal, fresh manure, or urine, and turn or aerate.
Matted, undecomposed layers of leaves or grass clippings	Break up layers with garden fork or shred them, then relayer pile. Avoid adding heavy layers of leaves, grass clippings, hay, or paper unless first shredded.
Large undecomposed items	Screen out undecomposed items and use as starter for next pile.

-a gardener with limited space and close neighbours may find composting in a garbage can or plastic bag may work best; once filled with matter the container can be closed and left in a sunny location; a bag can easily by rolled around to mix matter

Chapter 9: Composting With Earthworms

-earthworms are a huge benefit to composting consuming their own weight in soil and organic matter each day creating rich, productive compost called castings
-earthworm intestinal secretions help to free plant nutrients
-their addition to a compost pile is of great benefit, turning organic matter into rich humus

-earthworms do require certain conditions to survive, and different species require different things

Earthworms in the Indore Method

-entering from the bottom, earthworm mix the soil and organic matter

-they reproduce quickly, helping to mix nutrients around that rains have leached deep into sil

-worms will dig deeper into a pile as it decomposes, once high temperatures have subsided

-typical field worms do not survive long in a compost pile due to high heat produced and can only be introduced after most decomposition has completed (normally at least 3 weeks after last organic matter added)

-manure-type worms are best for an Indore pile

The Right Worm

-earthworm breeders tend to focus on red and brandling worms that do not survive for long in garden/farm soils but can in compost piles; they will avoid high heats produced by bacterial activity

-field worms and nightcrawlers tend to enter piles from the bottom but then retreat back into soil as they cannot survive the compost heating process

No-Heat Indore Composting

-earthworms can be used in a system that produces little heat but decomposes matter quickly

-a longer and wider pile but only 12-18" high with finely shredded matter can host manure-type worms that will quickly breakdown the pile

-as the surface area is large, the pile will never heat up too much for the worms

-weed seeds and pathogens will not be destroyed in this process, however

Maintaining the Earthworm Population

-save worms from mature compost to introduce to new piles

-this can be done by only removing half a pile and using leftover half to begin a new pile

-as worms avoid light, another way is to remove thin layers allowing 30+ minutes between removals to give worms time to burrow down into pile

Earthworms in Bins and Pits

-some worms can't survive winters without 'protection', and they are a food source for some animals (e.g., moles)

-both of these dangers can be avoided by digging a pit below the frost line and placing a screen along the pit bottom/sides; these allow earthworms to migrate into the deep soil in winter and prevents moles from finding them in piles

-combining a pit and bin is another approach, where a pit is dug 16-24" deep and a bine built within rising up about 16: above ground; place a screen on bottom as above; one side can be left open for easier access to the matter bin material (wood, concrete block) can vary but sides should leave some space between components for aeration

-having two pits is recommended, one for new matter and one with older matter decomposing ; as mature compost is removed for the garden, worms can be removed and placed with the fresh matter

-some pits/bins are outfitted with lids that help to shade the pile so as to retain moisture and allow worms to work nearer the surface; using a lid may require more moisture checks

Winter Protection in the North

-red/brandling worms will survive with minimal protection in the winter where temperatures do not go below 20 F/-7 C; some burlap or straw on the pile is all that is needed

-where temperatures fall lower, worms need to be protected if they cannot get to soil

-there are several ways to do this and to keep the worms working over the winter

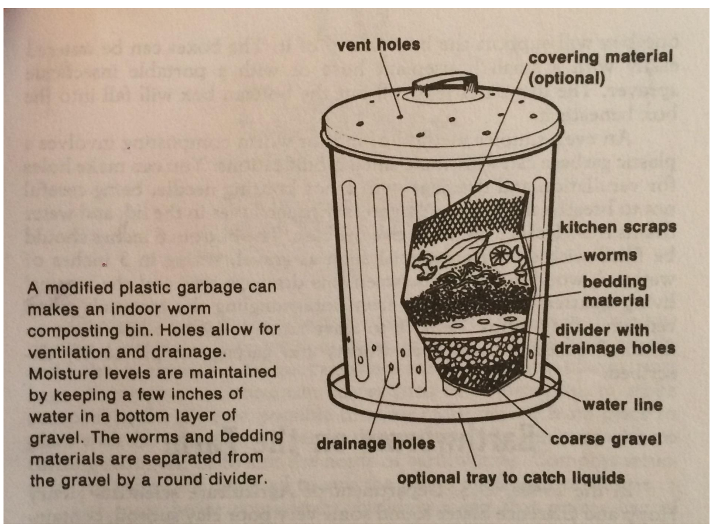
Indoor Composting in the Winter

-earthworm composting can be done indoors over the winter

-a do-it-yourself bin 2'x2'x1' of wood with drilled holes for drainage and aeration

-a pound of worms would be sufficient and could turn a pound of matter into compost per day

-bedding of dampened peat moss (⅓ bucket), garden loam (⅓), and manure (⅓) with some dried grass clippings, hay, or leaves; leave this to soak overnight then squeeze out excess water
-line bin bottom with pebbles/rocks then place prepared bedding on top; check temperature following day, if above 100 F/38 C let sit another 2 days
-once temperature okay, the centre of the bedding can be pulled back and worms added then covered back up with bedding
-a burlap bag, cheesecloth, or several years of newsprint, lightly watered, can go over bedding and worms,
-place a dishpan under bin to catch drippings, using liquid to water house plants
-only provide worms matter they can digest over 24 hours otherwise it will begin to rot, smell, heat up, and possibly kill worms
-begin with ‘soft’ foods and avoid onions, garlic, and strongly-flavoured foods
-tamp matter down slightly into bedding and within 2 weeks decomposition by the worms should be occurring continuously
-adding a bit of decayed manure periodically helps build better compost
-turn and aerate the matter every 2 weeks, reducing the matter added after such turnings for 2 days
-after a month, add more bedding material to accommodate population growth
-after 3 months begin a new bin (they can be piled on top of one another)
-this can also be done using a plastic garbage pail
-fill bottom 6” with gravel, with 3” water (aeration holes in side, above 3”); palace a wooden barrier with some holes for drainage on top of gravel and then bedding on top



A modified plastic garbage can makes an indoor worm composting bin. Holes allow for ventilation and drainage. Moisture levels are maintained by keeping a few inches of water in a bottom layer of gravel. The worms and bedding materials are separated from the gravel by a round divider.

Earthworms on the Farm
-research has found that soil inhabited by earthworms produces much better crops, holds moisture better, and contains significantly more soil aggregates
-every organic farmer should attempt to maintain their earthworm populations, particularly during cold winter by using large-scale mulching or sheet composting, to ensure healthy soil structure and crop-growing capacity

Chapter 10: Compost Structures
-the variety of compost structures is wide and experimentation is suggested
-an important aspect for type is one’s available space
-an Indore heap with no formal enclosure is possible if space is not a concern
-a sub/urban lot likely needs an enclosed pile
-if no permanent spot available, investigate portable structures
-if winters are severe, consider a pit structure that goes below frost line if you want decomposition year round

-if you want to have worms in your pile you will need to build a structure that can protect them in cold weather or compost inside
-also consider your own physical abilities and how much labour you wish to put in

Pens and Bins

-a bin is any container that's fairly substantial/permanent of wood, concrete, brick, masonry
-a pen is a less substantial structure of wire/hardwire cloth
-pens allow greater aeration but tend to attract more pests; bins are more stable but less-well ventilated
-both are easier to keep tidy compared to unenclosed/open structures and tend not to become anaerobic

Lehigh-Type Bins

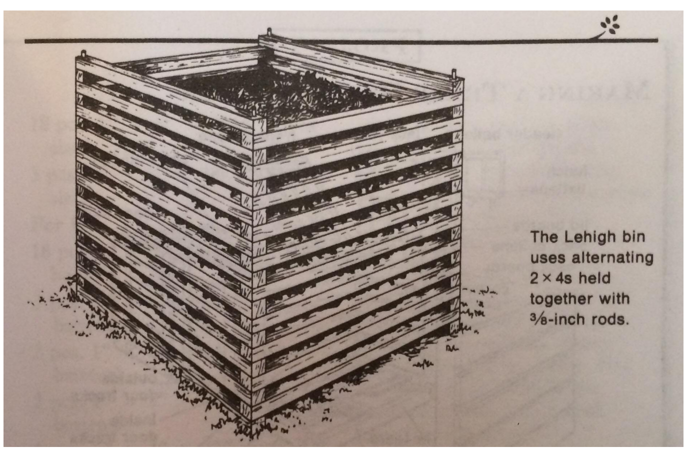
-a simple bin of alternating 2"x2" with metal rods running down the four corners for stability can be raised as needed by adding more boards

Cage-Type Bins

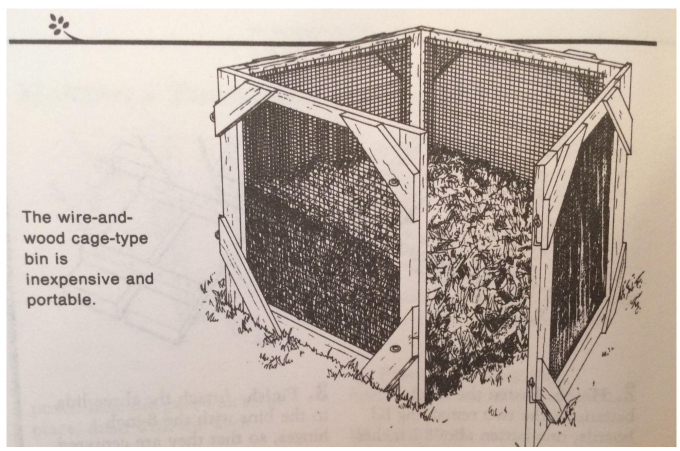
-a simple and inexpensive build that allows easy turning by having a removable side
-some variations allow the entire structure to be deconstructed when turning is required; unhook the 2 L-shaped components, reconstruct right beside pile, and fork matter into the bin oat the new location (just ensure periodic watering as needed)

The New Zealand Bin

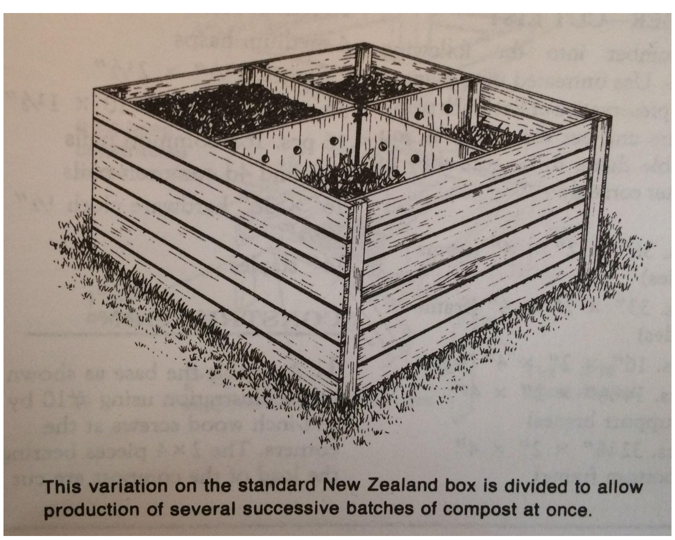
-a simple wooden structure of 1" X 6" boards spaced (½") for aeration by 2" X 4" corners
-the boards on the front side should slide down between 2" X 4" supports so they can slide in and out for easier access to turn the pile, and can be built up gradually as the pile grows
-hardware cloth, screening, or burlap can cover the top
-one variation has been to place a divider in the bin so there are 4 separate areas with compost at different stages



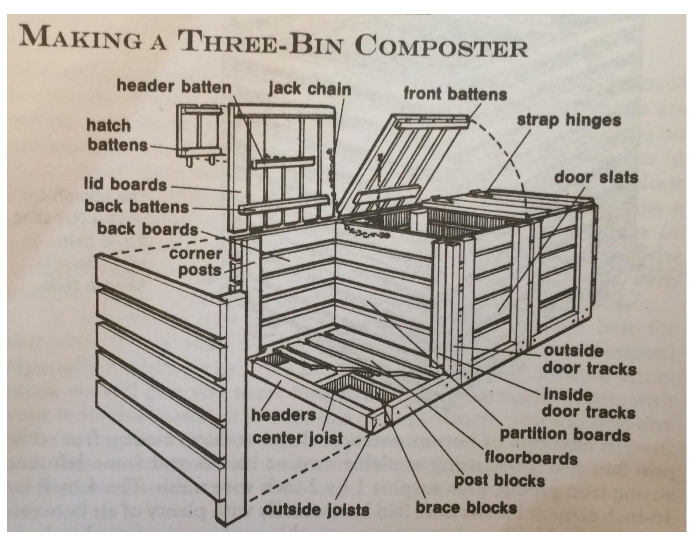
The Lehigh bin uses alternating 2 × 4s held together with ⅜-inch rods.



The wire-and-wood cage-type bin is inexpensive and portable.



This variation on the standard New Zealand box is divided to allow production of several successive batches of compost at once.



Using a Three-Bin Composter

-the following schedule is recommended for a 3-bin system:

Week 1–in the centre bin create a traditional, layered pile with high-N matter (e.g., manure, bone meal); begin with a layer of dry leaves/straw adding kitchen wastes and/or garden trimmings every couple of days

Weeks 2 & 3–stir the compost and then continue adding matter

Week 4–transfer matter from the centre bin to one of the end ones to finish decomposition; spread a new layer of dry matter in the bottom of the centre bin

Week 5–matter in the end bin should be ready for use in the garden

-during the above schedule ensure the moisture of the matter is checked, adding water if too dry or dry matter if too wet

-to boost microbial activity, add soil/mature compost to middle bin periodically

Block and Brick Bins

-brick/block bins can be permanent structures (if cemented) or movable

-space can be left between blocks for aeration

-wooden-hinged lids can be added

-if the bottom is concrete, it should be sloped to allow run-off to be collected

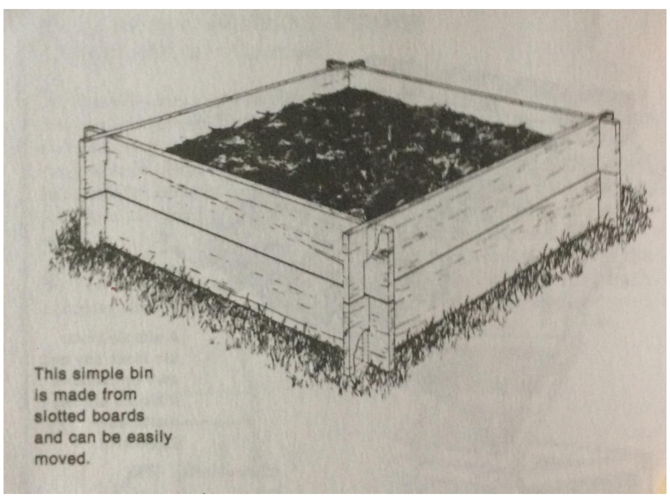
-one approach is to have wooden boards on the front that can be removed for easy access

The Movable Slat Bin

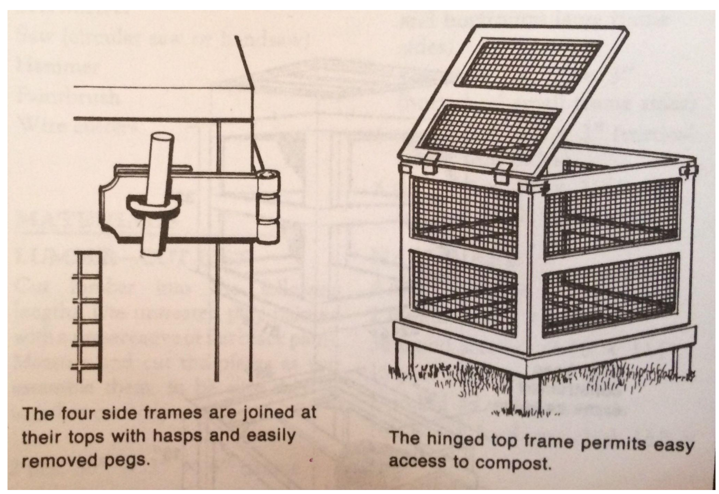
-wooden slats can be used to construct a portable bin

-using 1" x 10" boards cut 5' long

-create a slot about 4: from each end of the boards so that the (⅞" W x 4 ⅝" L) boards slide together



This simple bin is made from slotted boards and can be easily moved.



The four side frames are joined at their tops with hasps and easily removed pegs.

The hinged top frame permits easy access to compost.

Winter Bins

-insulating an existing bin with hay/straw allow decomposition to continue through winter

-cold-frame type structures can also be built (south-facing glass lid)

-adding manure also helps by increasing microbial activity

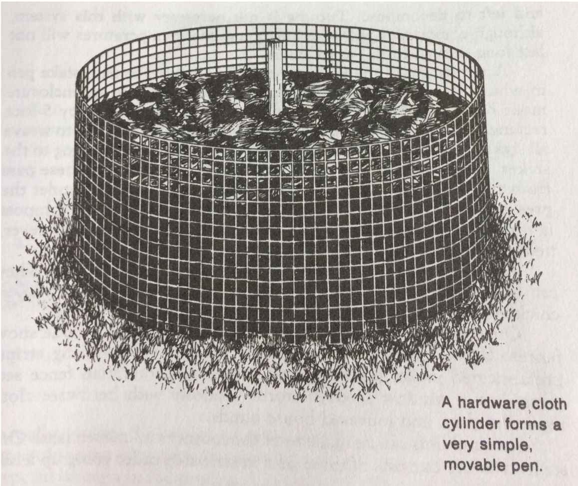
Pens

-simple pens are quick and easy to construct

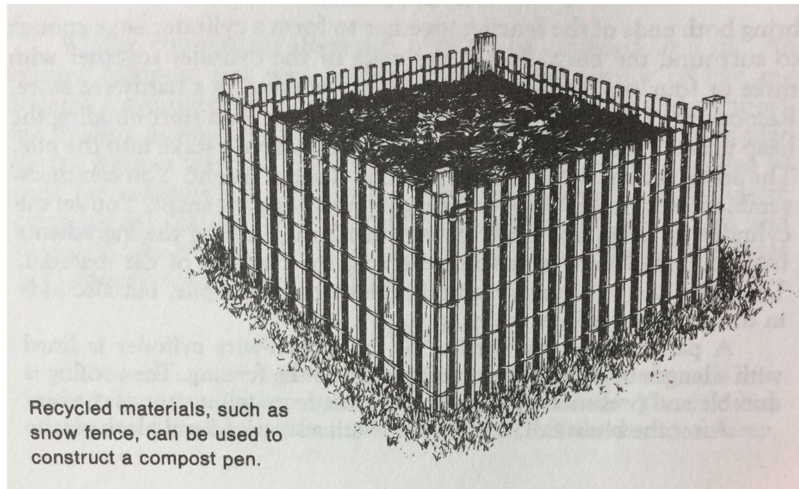
-one example requires woven-wire fencing in a circle with ends fastened; when half full, drive a stake in middle with a length of desired pile height; turning can be easily accomplished by unfastening and then refastening when finished

-the above pen can be made partly anaerobic by fastening roll roofing to wire fancy; when full, cover pen with black plastic sheet; turning not necessary but decomposition will take longer and temperatures will not get high enough to kill weed seeds

-another variation is a wire-and-tomato-stake pen where ½" poultry netting is placed inside a pen enclosure of 4' high tomato stakes looped together by baling wire; the wire can be removed for turning then reconstructed



A hardware cloth cylinder forms a very simple, movable pen.

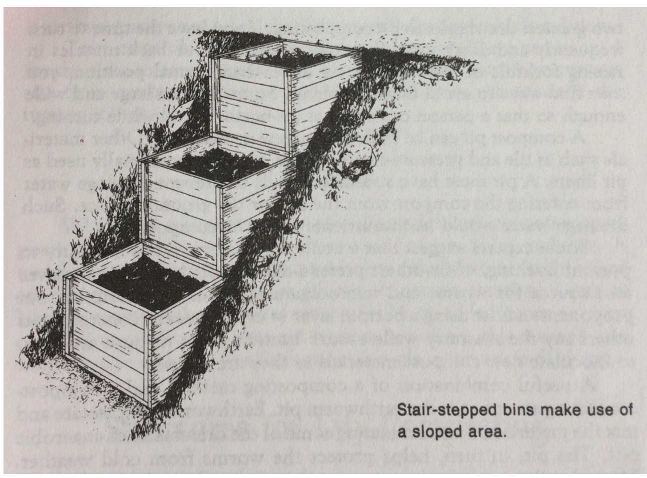


Recycled materials, such as snow fence, can be used to construct a compost pen.

-hardwood pallets can also be used with wire/hardware cloth lining to deter rodents

-snow fencing steel posts and chicken wire, picket fence sections, window screening, etc. are all possible material to build pens

-for hilly terrain, consider a stair-stepped bin that starts matter in the top bin and turns matter by moving down the hill



Stair-stepped bins make use of a sloped area.

Pits

-wholly or partially underground piles have an advantage of a stable and insulated structure

-it can be more easily secure from certain pests and can allow decomposition in cold climates

-matter can, however, become soggy and experience anaerobic conditions drainage can help mitigate these drawbacks; frequent turning is also advised

-various material can be used to line a pit (e.g., pressure-treated wood, concrete blocks, tile); such walls are needed to reduce/eliminate subsurface moisture from entering and causing nutrients to leach away

-some advise having a concrete bottom to prevent such loss, whereas others advise against this to allow entry of earthworms and microorganisms

-an Earthworm Pit combines elements helping to avoid anaerobic conditions and protect from the cold climates

Drums

-where space/odour conditions are a concern, a plastic or metal barrel can be used

-it can be raised up via bricks/blocks and drainage and aeration holes drilled in

-simply layer organic waste with absorbent matter (e.g., shredded paper)

Structures for City Composting

-one suggestion for urban composting is the 2- or 3-bin brick structure

-sawdust at the bottom captures run-off and is then turned with other matter

-garbage is accumulated in 5-gallon cans mixed with sawdust (added with each waste addition) layed on top; this will require high-N matter to compensate the high-C matter
-others advocate garbage pails/metal drums; but these more easily go anaerobic so drainage/aeration holes are a must; elevate can and collect run-off to water plants or add back in; layering matter is important
-cutting the bottom off a garbage can and setting in the ground is another option
-a good indoor system is an earthworm box

Commercial Composters

-many commercial units use a rotating-drum system which are wonderful for making quality compost with minimal effort
-they are, however, relatively expensive

Chapter 11: Shredders and Other Equipment

-mechanical equipment is not necessary to compost matter but it can facilitate more and faster composting so has become popular
-shredders make composting faster (as smaller matter can be affected by microorganisms more easily), creating greater quantities, of greater quality (as more uniform throughout, more balanced mixture if sorted appropriately at shredder, and providing a greater variety of composts/mulches)
-shredders, being portable, make certain tasks less labour intensive (e.g., creating a mulch pile where needed)
-they are also useful in breaking finished compost into a finter product
-a shredder allows one to incorporate more garden waste (e.g., tree branches) into the garden/compost

Features to Consider

-there exists a wide range of shredders and available options from small electric units ideal for leaves/kitchen waste to heavy duty ones that can chip thick tree branches

Materials

-there is never a shortage of organic and compostable materials house and garden that can be broken down by a shredder

The Cutting Mechanisms

-there exists only a few basic systems for reducing/chipping/shredding matter
-steel flails on a rotating shaft are good for absorbing shock from stones and minimising blockage from wet matter
-fixed steel teeth/knives on a rotating shaft work with baffles and a screen to ensure matter remains in contact with blades
-smaller units tend to use a couple of rotary blades similar to a lawnmower that pass between stationary blades

Shredder Design

-efficiency in shredding wer or dry matter is the product of unit design
-indirect-feed units work well with dry/damp matter but not so well with wet, sticky matter, or soil and manure
-direct-feed ones handle wet and dry matter
-the difference being how the feed-hopper throat is related to the rotor assembly
-in an indirect-feed system, material enters from the side of the shredding chamber being shredded as it enters the quickly spinning blades bu twitch a direct-feed shredder material enters the chamber directly and proceeds to be shredded until small enough to pass through the metal grate for discharge

Jamming and Clogging

-jamming can result from overload, especially if matter is wet
-using a larger discharge screen (e.g., 1 ¾”) can help avoid this
-avoid shredding wet leaves and allow vegetative debris to wilt for a couple of days in sun prior to shredding
-mixing wet and dry matter helps, or putting in a few handfuls of dry wood chips should clear wet matter
-work more slowly if shredding damp matter, alternating dry and wet materials

Machine Mobility
-having wheels on your shredder is advised as being able to move it easily is suggested to lessen mulch/compost moving
Safety First
-safety glasses/shoes, gloves, and long-sleeved shirt and pants are recommended when operation shredder
-hearing protection is also warranted
-ensure electric units are grounded and not used in wet conditions
-use a flexible stick or similar device to push material into the hopper (e.g., large sunflower stalk)
-avoid standing close to the discharge chute
Rent or Buy?
-renting in spring/fall may be most economical for limited use; one can 'stockpile' fibrous material to be shredded when one rents a unit for a few days
-group ownership is another option between family, or community members
Substitutes for the Shredder
The Rotary Mower
-a rotary grass mower may be used to shred some material such as hay, straw, weeds, dry leaves
-place material in low piles and lower tilted mower slowly on top; ensure to have a solid backstop to halt discharge (e.g., fence, compost bin)
-repeat if material needs to be finer
The Meat Cleaver
-much organic material can be manually reduced in size using a meat cleaver with no need of mechanical aid
A Disposal Diverter
-a sink-based garbage disposal unit can be diverted to feed dompost
Tillers and Tractors
-sheet composting and green manuring are aided by rotary tillers and tractors
-these devices help to more easily turn fertility-building crops into the soil to aid humus production
-sheet composting and green manuring tend to be more efficient than heap composting as the decomposition occurs right in the sil and the process is less labour intensive
-rotary tilling helps to make these approaches occur much quicker
-using a tiller with a shredder is advised for large gardening operations

Chapter 12: Using Compost
-"The real purpose of the organic method is to build permanent fertility into the soil by adding to its natural rock mineral reserves and to its humus content. Practically all the natural fertilizers are carriers of insoluble plant food. They start working quickly, but they don't drop their load of food all at once, as does a soluble fertilizer. An insoluble fertilizer will work for you for months and years." (p. 216)
-by using organic compost, the gardener is adding a supply of both immediate plant food needs and ublidng up reserves for the future
When to Apply Compost
-the maturity of compost best determines when to apply it; half-finished matter can be added in the late fall (Oct/Nov) so it begins to feed plants in the sporing; mature compost can be added to soil about a month prior to seeding (ensure it is more completely worked into soil if less time between application and seeding)
-if compost is mature, but not to be used over the summer, make sure it remains moist
-applying compost before planting or after harvesting is best to avoid possible damage to crops
-one suggested approach is to apply the compost over the soil to be worked in the spring a few weeks prior to tiling/turning; some microorganisms will begin to activate ust above 0 C/32 F, and all by the time 10 C/50 F is reached

-while plants demand more nutrients in the summer, this is also when the soil has more to supply due to increased microbial activity that helps to release nutrients from organic and non-organic matter
-adding compost in the summer along with natural rock fertilisers (e.g., colloidal phosphate, granite dust, greensand, helps support plants during their primary growth but most of the benefits won't occur until the following season for the slowly released nutrients

General Rules for Applying Compost

-each year, about ½ to 3" of fresh compost should be applied to one's beds each year
-there is far less chance of burning due to overuse as with chemical fertilisers
-compost should be well-finished (i.e., decomposition has stabilised) for best results, although some crops prefer partially-finished compost (e.g., corn, squash)
-fall applications may be the best for ensuring appropriate microbial activity when crops need it
-try to get the compost down 12-18" in poor soil; half-composted matter is fine to add this deep leaving the top half cloddy so that winter's freeze-thaw will mellow it or plant green manure
-deep compost addition also helps plants during drought periods as humus is a great moisture retainer

The Vegetable Garden

-liberal applications of compost greatly benefit vegetable crops
-mature compost can be buried in the fall, placed in holes with seedlings or in furrows when seeding
-as plants begin their rapid growth in warmer weather, mix it with soil to create a topdressing or mulch plants with partially-rotted compost mixed with hay/straw/dry leaves/sawdust (thinner layers should be used if finely shredded)

The Flower Garden

-flowers do well with addition of finely screened, mature compost
-it can be applied alone as a mulch (1") to control weeds and retain moisture, or as topdressing when mixed with soil
-it can be workers into the top couple of inches of soil or added when sowing seeds
-a compost tea provides seeds with an excellent nutrient-rich water that can be used throughout the growing season
-compost has also been found to help keep ants from nesting in the soil due to high moisture content

Your Lawn

-using liberal applications of compost over one's lawn can help keep it green and reduce weeds, crabgrass, and the need for watering
-it thickens the roots and quantity of grass
-if building a new lawn, work compost down 6"
-do this in the fall if cold winters in region; the spring is fine for warmer climates
-repairing a lawn requires digging up bare spots about 2" deep, working in mature compost, sowing seeds, and watering
-annual spring maintenance is advised for lawns via aeration, spreading of finely shredded mature compost and bone meal, raked into aeration holes and across the lawn (do not bury grass, however)

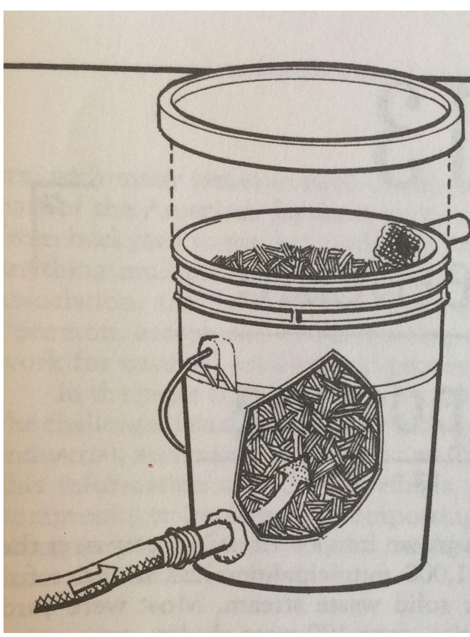
Trees and Shrubs

-despite advice to add compost to tree planting holes, this should not be done as it limits root growth and can cause waterlogged holes
-using compost as topdressing above the root system and watering it in is suggested, or adding to small 'plugs' along to drip line
-manure tea watering is also recommended
-a 'ring' method is also beneficial: beginning 2' from trunk, work compost into soil out to 1' beyond drip line; and/or apply liquid compost from trunk out to ust beyond drip line

Fruit Trees

-the ring method of compost application works well for fruit trees and bushes also
-work in 3-4" of compost then cover with mulch
-another approach fills augured holes with compost around the tree

Houseplants
-adding humus to houseplants helps them to retain moisture and be well aerated
-mix equal amounts of sand, loam, and compost for a healthy potting soil
-leaf mould compost can be useful as well
-water with compost tea every 2 weeks during growing season
-established plants can be rejuvenated by 'scratching' in compost twice a year
Soil-Compost Mixture for Starting Seedlings
-seed germination can be facilitated by adding compost to starting soil (50% garden loam, 25% sand, 25% compost) but let sit for several months prior to seeding especially if compost is not fully mature
Starter Solution for Plants
-using compost to create a starter solution for young plants has been found to be very beneficial
-leaf and root growth are stimulated by the immediately available nutrients fed to recent transplants
A Good Start
-one method for creating a starter solution suggests filling a container 25% full of compost and 75% water; stir periodically over the next 48 hours
-decant the liquid, diluting with water to a light amber colour
-water transplants with a pint (every 10-14 days during growth if poor soil)
-seeds soaked in this liquid have been found to sprout butter as long as compost is mature
How to Use Compost Tea
-compost nutrients dissolve in water easily, making compost tea an invaluable resource for feeding plants–especially during dry spells
-plants can be made healthier, bare spots in lawns, rejuvenated, transplants take to new soil/location better, and houseplants perked up
-creating it on a small scale is quite easy: place a burlap bag full of mature compost in a container with water, agitate for a few minutes, let it sit for a bit, and then use; as not all nutrients will be washed out on first use, the bag can be used several times and then the matter returned to the garden soil or used as mulch where microbes will continue to make remaining nutrients available
-creating a system to make continuous compost tea is a little more work; one suggestion is to attach an input and output hose to a container that hosts compost, allowing water to flow through the system
-ensure input and output hoses are 'screened' and well-sealed



A 5-gallon plastic bucket with a lid may be turned into a simple compost tea system with the addition of hose connections at the top and bottom of the can. Water enters through the bottom connection, circulates through the compost, and exits at the top as compost tea.

Chapter 13: Large-Scale Composting

-composting on a large-scale by primarily municipalities has grown considerably
-many farmers have also transitioned from manure as a waste problem to it feeding their soil
-food-processing industries have also shifted toward a recycling of their organic wastes
-the demand for 'natural' fertilisers has risen with awareness of chemical pollution and its consequences for planetary health
-while an age-old technology, composting is a new industry
-there are a variety of methods employed and challenges that have been encountered

Composting on a Farm

-many of today's large farms actually produce little manure because of the focus on monocultures and use of technology as opposed to draught animals, removing a primary compost additive
-livestock farms (including dairy), however, produce massive amounts with insufficient plant matter and land to compost it with; its accumulation on such farms actually harms the soil and pollutes nearby water
-traditional family farms that hosted both animals and crops have given way to industrial agriculture that has lost its longer-term concern for the land

On the Right Track

-consumer demand for 'safe' food has sped up conversion to organic farming
-manure management, proper composting, water contamination concerns, and worker health priorities are all growing practices in the search for alternatives to petrochemicals
-governments have slowly put in place supports for organic farming

Arguments for Composting on Farms

-being run by businesses, modern farms consider organic processes such as composting an additional step that needs to exhibit benefit beyond cost
-the additional steps to ensure organic matter is properly decomposed do appear to be more than compensated for
-the advantages include: 1) manure nutrients are stabilised so run-off is safer and application to crops has not negative impacts; 2) reduction of matter lessening labour intensity; 3) weed seed and pathogen destruction as well as providing disease resistance; 4) soil structure improvement

Off-Farm Organic Matter

-farmers with little of not livestock can incorporate off-farm sources (that must be fully composted before use)
-some municipalities and industries will supply matter and perhaps even pay for delivery

Composting Considerations

-farm-scale composting does incur costs in both time, capital, and land
-manure requires special consideration (e.g., storage, soil incorporation) to reduce nitrogen loss via leaching and ammonia creation
-despite methodological improvements, few farmers have implemented it or use their manure efficiently
-a lack of education for farmers and non-economic mechanisation to allow large-scale use are two reasons–although both are changing for the better
-farmers who do use compost report improved soil structure, crop quality, and livestock health

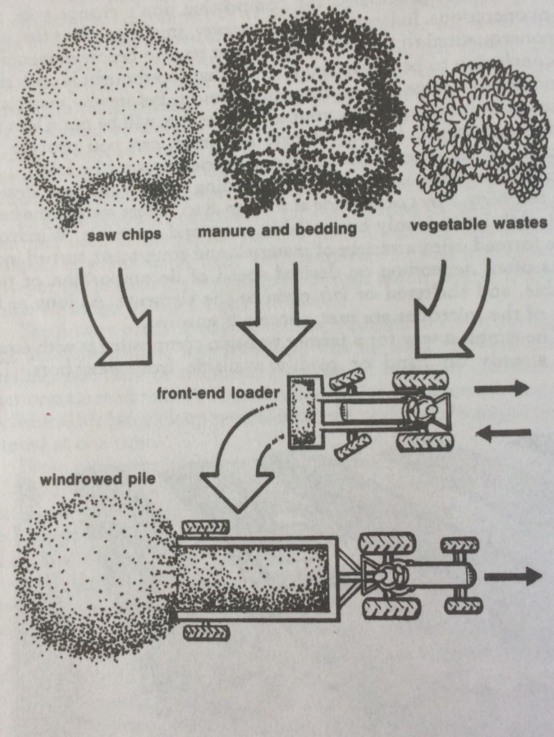
Agricultural Composting Methods

-manure is a farmer's most readily available component and how it is incorporated depends on a variety of factors (e.g. animal, housing, bedding, storage)
-bedding (i.e., straw, hay, sawdust, dead leaves) in the right proportion will balance the N-content and moisture; when not correct, the farmer must add high-C material
-composting requires maure to be dried before being mixed in (but not so dry it forms balls)

-food-processing waste is usually wet and high in N; balancing the moisture content and C:N ratio will be needed to ensure microbial activity when using then in compost; adding dry, high-C matter will likely be required, as well as more turning to aerate
-smaller farms or homesteads do not tend to accumulate enough manure for piles to heat up adequately so must rely on other matter as well
-if compost is being used for the farm/homestead gardens, quality need not be perfect (i.e., completely mature); if better quality compost is needed, screening can help sort; or partially-composted matter can be worked into soil a couple of weeks prior to planting or spread with planting of a cover crop
-much more care must be taken in ensuring decomposition has finished if one is selling the compost
-equipment differs mostly in size from the home garden to the farm
-farms do need equipment to spread the compost given the larger area involved
-large-scale composting normally involves aerated piles, windrows, and/or in-vessel systems
-municipal sludge is usually composted via aerated piles (described below)
-being costly, in-vessel systems such as digesters are not typically found on farms
-farmers tend to use windrows due to their value and mechanical aids that make them ore efficient and reduce time that land is lost to composting
-a manure/green matter windrow can be stabilised in 12 days provided the C:N ratio is not too high

The Windrow Method

-large-scale composting must be well thought out as small issues become magnified
-be aware of site drainage, regional humidity, ad how leachate may be collected
-windrows are usually created to be 4-5’ high, 2’ wide at the top, 8-12’ wide at the base, and length only limited by available space and materials
-turning, shelter, and matter used can vary as long as microbial activity is successful



On-farm windrows can be formed using a tractor pulling a manure spreader and a second tractor with a front-end loader. Raw materials are placed in the spreader, using the front-end loader; the windrow forms as the manure spreader is pulled forward. (Stewart Hoyt, *The Soul of Soil: A Guide to Ecological Soil Management*)

-standard equipment for farm-based windrow composting include: small tractor with power take-off manure spreader and a second tractor with a front-end loader
-the base process is to have the matter arranged in piles parallel to where the windrow will be located
-using the front-end loader, alternate loading piles in to the manure spreader keeping in mind correct proportions, start unloading the matter inching forward when the pile is about 4’ high and 6-8’ wide at the base
-for those that skip the spreader use and try to just create a pile with the front-end loader, the pile tends to require additional turning to endure aeration
Methane Digesters
-use of a mechanised ‘drum’ to create anaerobic digestion is another system sometime used
-it attempts to decompose matter without oxygen, producing methane and carbon dioxide in the process
-the methane can be used as a fuel source
-it involves a 2-step process: 1) organic matter is ‘liquified’ via anaerobic bacteria and chemical processes; 2) the volatile acid produced during ste 1 is consumer by methane-producing bacteria created a biogas that is 55-70% methane
-digesters are expensive and unlikely to pay for itself in a small setting
Industrial and Municipal Composting
-the rise in waste disposal costs has given rise to an interest in composting to deal with municipal and industrial organic waste
Incinerators
-increasing costs and awareness of environmental impacts have thrown light upon the use of incinerators
-while composting has been criticised for not being cost-effective (i.e., not profitable), incinerators ware also non-profitable despite producing some energy through its waste burning
Advantage: Composting
-municipal sewage sludge is increasingly being used in compost as opposed to dumping it in landfills or on land or incinerating
-where money-making is possible, industry has developed uses of the sludge or biodegradable products
Municipal Solid Wastes (MSW)
-leaves and yard waste make up most municipal waste being compsted, as they are easiest to separate and collect and contain the leasts contaminants
-there are many additional organic wastes produced by households that could be diverted from landfills
-about 30% of municipal refuse has been organic waste (mostly food-derived)
-while technologies exist to separate compostables and non-compostable waste, they are not widely used
-one approach has been to pulverise non-compostables to a size where it would be unnoticeable
-mixed solid waste tends to have a high C:N ratio and will breakdown very slowly if no additional matter is added; which is why many municipalities mix it with high-N sources such as sewage sludge and animal manure
Sewage Sludge
–sewage sludge is high in water content and nutrients
-it is often composted with dry, high-C material (e.g., shredded paper, wood chips, sawdust, leaves, yard waste)
-odour control is a major concern and can be mitigated by keeping piles well aerated and combined with high-C matter (and possibly chemical scrubbers)
-disease organisms of virtually all varieties are destroyed in the composting process, although some viruses (e.g., hepatitis) may survive and thus sludge comosts are not recommended for vegetable crops
-sludge fertilisers may also contain PCBs (polychlorinated biphenyls) and PBBs (polybrominated biphenyls) raising concerns about their use for food crops
-sewage sludge from industrial plants tend to contain toxic heavy metals making them unsafe for food crops; the presence of such toxins needs to be addressed at the start of th industrial process as they cannot be removed from the sludge

-zinc, cadmium, cooper, nickel, and lead are the most concerning (although zinc and copper are necessary micronutrients, an overabundance of them is problematic)
-if soil pH is above 6.2, most of these toxins will be in a form that plants cannot absorb–regardless, it is still best to keep such toxins from one's garden
-always check with producers of compost/sludge about the inputs to the sludge before using in garden
Industrial Wastes
-certain industries (e.g., textile, food processing, paper/wood) do produce organic matter that is compostable, and there are also inorganic wastes that can be added
-some organic wastes create disposal headaches for industry as they may contain very high-N (groundwater hazard), diseases, or attract pests; high-C waste may be bulky and expensive to transport but no overly hazardous leading some industries to invest in composting them (but not all, viewing it uneconomical)
-as composting becomes more economically viable, industry is getting involved
Hazardous Wastes
-limited progress is being made in stabilising hazardous materials
-they are not recommended for food gardens
Large-Scale Composting Technologies
-contained systems, windrows, and static piles are the methods employed for large-scale composting
-most use windrow composting
Sorting and Size Reduction
-mixed municipal solid waste needs to be sorted prior to any of it going into compost; the best time to do this is before it is disposed of
-most, however, is not so sorted and must be done after collection
-this allows diversion of: recyclables; removal of material that can damage courting machinery and/or material that is dangerous to those working with compost (e.g., glass, metal) and/or material that can pose health risks if used on crops (e.g., plastics)
-hand-sorting along a conveyor belt is one approach primarily used where labour costs are low
-mechanical sorters depend upon the different physical properties of organic and inorganic matter, but none of the various types are perfect
-the most controversial approach is that which pulverises all the material
-almost all municipal and industrial systems use technology to some degree, even if simply shredders for leaves
In-Vessel Systems
-some more-complex systems are sometimes used, such as container-type unites that aim to control all aspects of the composting process
-aeration is accomplished by turning of the vessel
-moisture and temperature are monitored and adjusted
-compost can be created in as little as 3 days in such a system
-these systems are costly, require significant energy inputs, and need skilled operators
-large corporations tend to be the ones advocating such high-tech systems while small businesses and most citizens seek low-tech ones
Aerated-Pile Method
-sludge composting requires sufficient aeration and high temperatures, that windowing cannot always guarantee
-the aerated-pile method, therefore, tends to be the best approach to meet these requirements
-the process mixes sewage sludge with bulky, carbonaceous matter (e.g., wood chips, shredded paper, leaves) for 3 weeks ensuring air is drawn thru the pile
-the base is a perforated plastic loop covered by 1' of wood chips or unscreened compost; over the top is laid a sludge/bulky matter mix; this is topped off with a 1' layer of screened compost to serve as odour control and insulation

-the perforated pipe is connected to a solid pipe hooked up to a fina that is on intermittently to have air following from the outside towards the pipe at the bottom; the air being drawn out is fed through a pile of screened, mature compost to minimise odours
-this pile is left for 3 weeks
The Economics of Large-Scale Composting
-there is increasing economic value to municipal and industrial waste composting
-it reduces waste volumes, turns much material into stable, non-polluting matter, and is increasingly in demand
-costs vary depending upon the system employed, and composting becomes more attractive as alternative waste disposal increases in cost
-much municipal compost goes to municipal landscaping, saving costs
-when the product is made available to the public, its quality/appearance becomes more important ensuring visual contaminants are removed, moisture is mostly removed, and compost has stabilised (ideally 6+ months)
-nutrient and toxin levels should be monitored; a product that feeds plants and does no harm is the ideal goal
-a number of tests have been developed to assess compost stability, measure harmful organic acids, disease suppression capability, and human/plant pathogens
Legal Issues
-there appear to be no legal issues with home/farm composting
-should there be a danger to public health from improperly-made compost, government likely has some responsibility to act and so have legislated some regulations to cover this
-governments in some regions encourage farm compost use to improve soils especially of manures to reduce ground-water pollutants
Compost for Sale
-most regions have laws regulating commercial 'fertiliser'
-some stipulate plant nutrient levels (N-P-K) and their labelling
-if you plan to sell your compost, you need to check your region's laws–some areas do not consider compost a fertiliser but a soil amendment and some are just beginning to explore regulations pertaining to commercial compost (e.g., waste processed, product maturity, particle size, organic matter content, heavy metal concentrations)
Protecting Public Health
-properly made compost poses no health issues
-regulations do exist to deal with waste disposal and any sanitation issues
-most are concerned with allowing waste to: become an agent for transmitting disease; contaminate water or land; attract vermin or disease-carrying insects; be too close to public thoroughfares
-most home and farm composting can easily avoid these problems
-municipal composting using sewage sludge may lead to one or more of these consequences requiring much closer monitoring (i.e., temperature, dust levels aeration, ventilation)
-uncomposted sewage sludge in particular must be regulated due to its likelihood of introducing disease organisms into the food chain
Environmental Regulations
-many regions treat compost similar to waste disposal at landfills and incinerators whose environmental regulations add costs that can impede composting operations
-some are beginning to treat composting differently than solid waste disposal and attempting to educate the public of the differences
-site location, facility design, and operating standards are standard concerns; as a re boundary setbacks, water contamination, and proximity to public thoroughfares
–site grading and drainage must be considered
-a few regions regulate turning frequency, windrow size

Selecting and Using Commercial Composted Products

-there are a variety of commercially-available compost products for purchase

-besides the convenience of not having to do the labour oneself, there are a broad range of blends that can be used for specific needs

-this convenience, however, is costly

Purchasing Guidelines

-when buying compost you should make sure you know what raw materials went into the product, what was later added to boost plant nutrients, if any toxic contaminants are present (usually held 'safely' as insoluble organic molecules)

-some waste products make the compost unsuitable for food crops (e.g., paper mill sludge), especially if tosix heavy metals are present

-uniformity can be an issue for compost given the variety of materials that go into it; this can be addressed by carefully controlling input matter or amending the compost

-the largest issue seems to be incomplete decomposition that may cause odour problems and cause harm to plants; adding unfurnished compost to your own pile to let it finish is one solution, or letting it sit for a while before applying

-if a plastic bag is inflated, it indicates the product is off-gassing and unfinished

-if the product smells, is too wet, or has unrecognisable matter it should not be used

Buying Locally

-if you are going to purchase compost, look locally

-even better, if you have a need for compost, create your own as you can ensure the content and recycle organic waste