ENVIRONMENTAL BENEFITS OF COMPOSTING

Waste & Emission Reduction through Composting

Composting can reduce our overall waste production and is a highly effective means of recycling valuable nutrients in organic matter. By keeping organics out of the waste stream we lengthen the life of municipal landfills, and improve air quality through decreased processing emissions and reduced anthropogenic green house gas production.

10 MILLION TONS OF ORGANIC WASTE IS THROWN AWAY EACH YEAR IN CALIFORNIA, ACCOUNTING FOR 25% OF LANDFILL CONTENT

Composting Diverts Organic Waste

Composting is a critical component of zero-waste programs. One of the most visible benefits of composting is the diversion of organic materials from the waste stream. On top of that, we are then able to reuse the nutrients from these organics to the benefit of your local environment. According to CalRecycle, approximately 10 million tons of organics are sent to landfills each year in California. This amounts to about 25% of total landfill content. Once in a landfill setting, the nutrients from these materials cannot be cycled back into the environment.

Landfills

Landfills, due to the nature of the wastes they hold, generate emissions. Landfill gases are largely comprised of methane – a more noxious greenhouse gas than CO_2. Because landfill gases are known to be a source of serious safety concerns for both site employees and proximate community members, landfills must submit to emissions monitoring and control programs. Additionally, landfills produce hazardous leachate that can degrade habitats and water quality as well as poison flora and fauna if it enters water sources. The US Composting Council notes that although barriers are often put in place in an attempt to prevent emissions and leachate escaping, if these liners break down, contaminants can be leaked into surface runoff and groundwater.

Composting Reduces Our Impact on the Waste Stream!

Participating in backyard composting, however, is an effective means of reducing one's impact on the waste stream, and a means of gaining use from nutrients that would otherwise be trapped in an environment where they cannot be effectively recycled. By diverting organic wastes from landfills, the lifespan of municipal landfills can be lengthened, reducing the need to continually create new landfills.

SOURCES: EPA, CalRecycle, Clean Air Council, Global Alliance for Incinerator Alternatives, US Composting Council

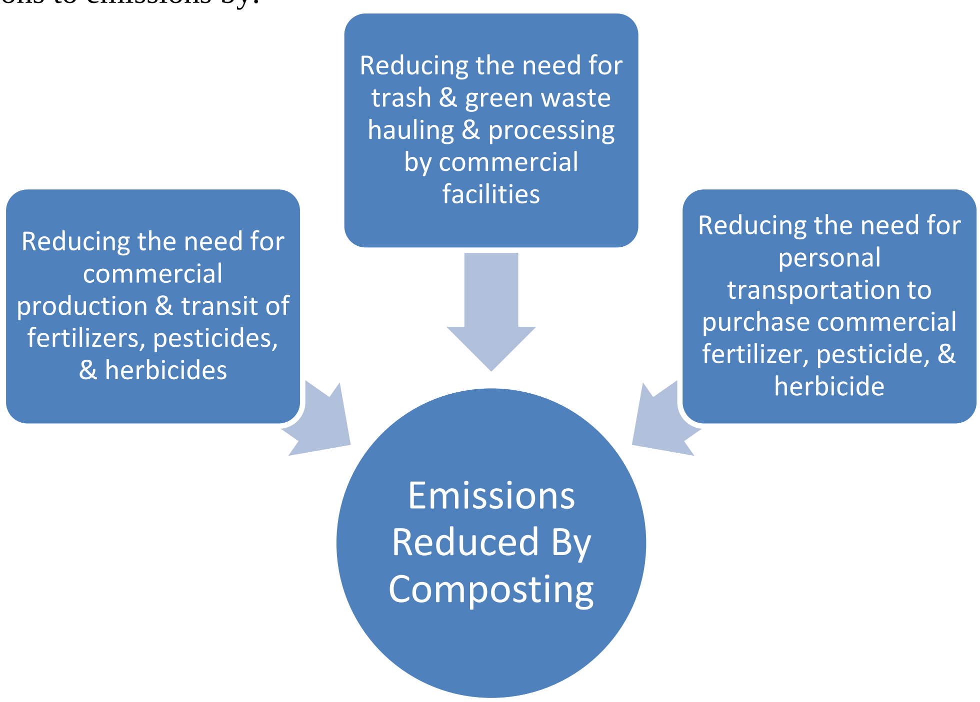
Greenhouse Gas Reduction

Composting has massive implications for improving air quality when treated as an alternative to waste incineration. According to The Global Alliance for Incinerator Alternatives, waste incinerators produce more CO_2 emissions than oil, coal, or natural gas-fueled power plants. Research by the EPA and the USCC conclude that aerobic composting does not significantly contribute to a rise in CO_2 emissions. In fact, any emissions from aerobic composting are considered part of the natural carbon cycling. Aerobic compost can also be used as a landfill cover to reduce methane emissions. Acting as a bio-filter, aerobic compost can remove 80 –90 % of volatile organic compounds from gas streams. Aerobic compost also serves as a carbon sink by sequestering carbon in the ground where it promotes soil fertility and structural stability.

SOURCES: EPA, US Composting Council, The Global Alliance for Incinerator Alternatives

Compost Reduces Production, Transportation, & Processing Emissions

Although industrial-scale composting facilities provide an important service of waste diversion in many areas, processing and transportation machinery emit greenhouse gases by the very nature of their work. By participating in local/back yard composting work, one is reducing their contributions to emissions by:

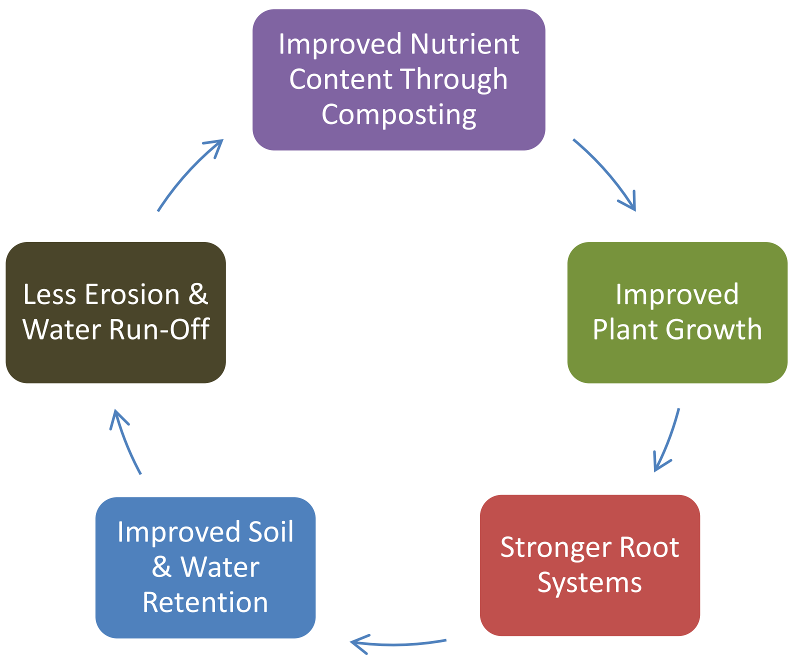


It is important to note that large-scale commercial composting facilities often utilize heavy-duty machinery for processing and transportation needs, thus contributing to greenhouse gas and volatile organic compound emissions. Concerns have been raised about the possibility that large-scale composting itself releases VOCs or GHGs, though emissions levels would vary due to materials being composted, management practices, and climate. For example, excessively dense windrow structures restrict oxygen and require more frequent aeration, which results in higher CO_2 readings. Because these relationships are still poorly understood, CalRecycle research is currently underway to examine the quantities and impacts of large-scale composting emissions. These results are expected in 2014.

SOURCES: USCC, CalRecycle, EPA, Wisconsin Dept of Natural Resources

<u>Compost Improves Soil Health and Water Quality</u>:

The benefits of composting for our soil are numerous and cyclical. The production of humus increases the nutrient content of soil, which leads to improved plant health and growth; these plants grow stronger and more diverse root systems, which lead to improved soil and water retention and less eroded sediment and water run-off. The nutrients are then not leached or washed away and are able to further improve plant health and root development. Topsoil, or a healthy, compost-amended soil, binds nutrients and toxins, preventing them from running off into lakes, streams, and surface waters. Nutrients held within the soil remain available to plants, and the potency of harmful toxins may be greatly diminished by microbial activity. These benefits build upon each other as is illustrated in the diagram below.



The Benefits of Healthy, Compost-Amended Soil:

Composting can lead to healthier soil in many ways. It especially affects topsoil fertility, which is vital to agricultural success. The increasing demands that an ever-growing population exert on our soils are obvious. Development pressures and short-sighted farming practices are two key culprits. Fertile soil is a critical component of our biosphere; it ensures healthy plant growth, increases fruit and vegetable yields, improves root systems, and increases biodiversity.

$27 billion US dollars are spent every year to offset the loss of nutrient rich soil being eroded into our waterways

Once vegetation or the topmost layers of soil are removed, a cycle of progressive depletion occurs until the entire stratum of friable, biologically active soil is lost.

The loss of topsoil is not only a detriment to our environment, but is fiscally counterproductive. In the US, a total cost of $27 billion per year has been associated with the loss of topsoil, nutrients, water quality, and production caused by water erosion (Brady and Weil, 1996). Billions more are estimated to be lost due to resulting sedimentation. Composting can provide immediate protection against erosion and its associated economic inefficiencies.

Once the soil has been lost, or depleted, it is not easy to replace. According to further information provided by the National Resources Conservation Service, it takes naturally-occurring processes over 400 years to create one inch of healthy topsoil. In the US we are eroding soil at a rate that is ten times faster than it is being replenished. An estimated 4 x 109 tons of soil are lost every year due to erosion from both agricultural and non-agricultural lands in the US (Brady and Weil, 1996). In a report by the Nutrition Security Institute they state that at this rate, we will only have enough topsoil to continue our current agricultural development practices through 2054.

Given the loss of nutrients in our topsoil, it is no surprise that the nutritional values in food have declined over the past 70 years (Nutrition Security Institute, 2006). This has been attributed to mineral depletion of the soil and loss of microorganisms along with changes in our consumption of crops and plant varieties. Food grown in nutrient-deficient soil will lack the available nutrients needed to provide a healthy diet. By composting, we can replenish lost nutrients and create healthier, more nutrient-rich produce.

The loss of topsoil can be curtailed if we can properly apply compost and mulch. Mulching is another use for organic material and benefits plant growth and assists in moisture retention. If we can enrich our soils through composting, we can produce healthy plants that recontribute to healthier, nutrient rich and nutrient diverse soils. Healthier plants require less (if any) fertilizer and pest control products, therefore decreasing our perceived dependence upon and habitual overuse of these substances.

Compost and Habitat Restoration

An increasingly common practice is the use of compost to aid in habitat restoration. Revitalizing soil is an often overlooked but vital foundation upon which ecological restoration work can flourish. By utilizing the power of compost to balance soil pH, boost macronutrient and micronutrient levels, encourage population growth of microorganisms in soil, improve the ability of soil to hold and supply nutrients and reduce the frequency and intensity of water usage, soil can be boosted to a optimal state and/or a state specific to helping desired species flourish. Because the organic matter and microbial make up of compost is often similar to wetland soils, composting may be especially useful for wetland restoration. By rethinking ecological restoration from the soil up, habitat restoration projects may find success in reintroducing conditions suitable to grow and attract desired species and in creating a more nutrient-rich, diverse, and self-sustaining habitat that requires less labor and resource use to manage and maintain.

SOURCES: Clean Air Council, Global Alliance for Incinerator Alternatives, EPA "Compost Use in Forest Restoration" (Pacific North West) & "Innovative Uses of Compost Reforestation, Wetlands Restoration, and Habitat Revitalization", Global Restoration Network "Idaho: West Page Swamp Wetland Restoration Project"

Compost and Large-Scale Soil Remediation

Compost has impressive potential to remediate mass amounts of contaminated soil when applied in an industrial setting. Composting has been used in a number of instances to remove or severely limit the impact of hazardous materials in soil. Compost has been shown to bind heavy metals, as well as to degrade and even eliminate semi-volatile or volatile organic compounds and other toxic byproducts in soil. These products include, but are not limited to, heating fuels, explosives, pesticides, wood preservatives, and polyaromatic, chlorinated & non-chlorinated hydrocarbons. This prevents these potentially harmful compounds from moving to water sources and being absorbed by flora. Bioremediation of hazardous soils is a result of micro-organisms' ability to convert contaminants into harmless substances such as carbon dioxide, salt, and water. Impressively, treated soils are often rendered benign enough to be reused for horticultural purposes, and flora grown in remediated soil shows no sign of impact by the previously toxic make-up of the growing medium.

Composting can remove or break down hazardous materials in soil and turn them into harmless substances.

Industrial-scale composting is not without complications. Sometimes, remediated soils cannot be fully treated for safe re-use, and are sent to landfills as a safety measure. Although they cannot be recovered, these soils are substantially less toxic after undergoing soil remediation.

While compost can play a number of roles in improving soil structure, nutrient-levels, and biology in both commercial and personal work, industrial-scale bioremediation projects are the result of many years of planning and implementation of programs tailored to address specific contaminants, and of access to land, capital, expertise, infrastructure, and labor resources unavailable to the individual composter. It is important to remember that the results of industrial-scale compost systems are the product of these inputs, and that the results of work at an industrial scale are not directly proportional to results of composting at a personal, backyard scale. *If you'd like further information regarding large-scale soil remediation, please see the case study at the end of this chapter.*

SOURCES: CalRecycle, U.S. Army Corps of Engineers, Compost for Soil

The Benefits of Composting on Water Quality:

As mentioned, composting decreases the chance for erosion and water-run off. Synthetic pesticides and fertilizers that run off into lakes, streams, and oceans and excessive sedimentation from erosion can have profound negative impacts on aquatic ecosystems. Soil erosion is

By composting, we decrease our dependence on fertilizers and pesticides that impact our ecosystems

considered to be the single largest source of nonpoint source pollution in the United States (U.S. EPA, 1997). Gray and Sotir (1996) estimated that about 2 billion tons of eroded sediment is produced every year in the U.S. Of that, around one-third reaches oceans and the rest goes into fresh waterways, like lakes, river channels, and reservoirs.

The USDA's National Resources Conservation Services found that agricultural runoff can impact water quality, carrying potential pollutants into the Nation's streams, lakes, groundwater supplies, and estuaries. States and Tribal Nations have identified sediment and nutrients as the most extensive agricultural contaminants affecting surface water quality, while nutrients and agrichemicals are the major concerns for groundwater.

Excess nitrogen and phosphorus are the primary nutrients that contribute to agricultural nonpoint source pollution. If they reach waterways, they can cause algal blooms which lead to the development of hypoxic conditions, or low dissolved oxygen concentrations, and are unable to sustain aquatic life. Excess sedimentation can also overwhelm aquatic ecosystems by smothering freshwater breeding grounds and degrading coastal and marine habitats- including some of our most biodiverse ecosystems, such as estuaries and coral reefs.

Composting decreases water run-off by 80%

As discussed, composting can decrease our dependence on fertilizer and pesticide use. Many times, these products are used in concentrations beyond what is recommended. This produces an exponentiation of negative effects on our ecosystems and on our health. According to US Geological Surveys done, about 1 billion pounds of pesticides are used each year in the United States for a variety of purposes. 80% of this use is related to agriculture. The use of pesticides has a number of perceived benefits for large-scale agriculture, but there are health and safety concerns related to their use. Additionally, the diversity of modern chemical products and applications means that these materials are acting upon individuals and their environments in synthesis, and the complexity of these interactions can be incredibly difficult to characterize and comprehend. Thus despite their mass application, much is still unknown about the health and safety effects of these chemicals on ecosystems and on human and non-human biota. Further study is needed to address these relationships, but there is no denying their presence in our waterways.

USGS studies have revealed that many of our waterways contain concentrations of pesticides at levels that exceed benchmarks for aquatic life. Even pesticides that have not been used for decades, such as DDT, have been found at unhealthy concentrations. Studies have shown that consumption of foods such as fish and shellfish have led to these compounds presence and bioaccumulation in human tissues, as well as breast milk. By composting, we not only lessen the amount of pesticides reaching our waterways, but we decrease their overall presence in our environment.

Composting can significantly decrease erosion, and therefore decrease water run-off and pollution. The California Department of Resources Recycling and Recovery has found that composting decreases run-off by 80% on average, and also improves water quality by reducing nitrates by 80% as well.

Given the water retention benefits achieved by composting, less water is needed to irrigate plants, so there is less chance for detrimental water run-off to occur. A study in New South Wales, Australia, concluded that compost use increased soil water holding capacities by up to 10%. It was also found that compost treatments increased plant-available water by 5-45% relative to non-amended plants. And when using compost at planting time, a plant's ability to store water was found to increase by 70-150%.

It is worthy to note that mulching may actually be more effective at water conservation than soil amendment use. A study done by Unger et al (1968), reported that when using straw mulch, cumulative evaporation rates decreased by 57%. Combining both methods would result in the most water saved, and the most sediments prevented from entering our waterways.

Compost Soil Remediation Case Studies

(1) US Army Corps of Engineers

Remediating soil contaminated with explosives

Composting has been implemented in various Army contaminated sites. THIS STUDY REFERENCES:

- *Joliet Army Ammunition Plant (JOAAP), Joliet, IL*
- *Plum Brook Ordnance Works (PBOW), Sandusky, OH*
- *Milan Army Ammunition Plant (MLAAP), Milan, TN*
- *Umatilla Chemical Depot (UMCD), Hermiston, OR*

Used large-scale windrow system- all browns & greens locally sourced (except corn waste)
Nitrogens: Manure (cattle, pig, chicken); corn processing waste, hay
Carbons: Wood fines (sawdust, wood bark mulch, wood chip mulch, straw); Stable bedding; Cotton gin waste
*In order for this level of bioremediation to be possible:
- roads + facilities constructed (no data on transportation/air quality)
- Industrial-scale inputs produce industrial-scale effects (i.e. this may not translate directly to personal/backyard attempts to remediate soil via compost)

RESULTS:

-Compost is effective in degrading explosives compounds (i.e. TNT,RDX,HMX,DNT, & Tetryl) & nitrocellulose in soils & sludges
- Considered an effective alternative to incineration (reduces hazardous air pollution & generates enriched material for growing vegetation)
- Found to be most cost effective clean-up solution (In the case of UMCD, the Army saved more than $2.6 million using composting compared to other technologies such as incineration. In

addition, the end-product of the composting process, humus-rich soil, generally sells for at least $10 per ton, resulting in potential revenues of $150,000 – again in case of UMCD)
- Wide-scale applications to reach many Army contaminated sites

Site*	Contamination Type(s)	Approximate Amount Remediated (tons)	Approximate Cleanup Rate (days/windrow)	Cost ($/ton)
JOAAP ('99-'07)	TNT, DNT, Tetryl	274,000	17-21	84
PBOW ('08)	Nitroaromatics	5,200	28	Ongoing data collection
MLAAP ('95-'07)	TNT and RDX	28,100	20	1,025
UMCD ('94-'95)	TNT, RDX, HMX, Tetryl	14,808	10-12	346

[Dates refer to period from construction of composting facility to official completion of remediation activities]

SOURCE:

PUBLIC WORKS TECHNICAL BULLETIN 200-1-95 17 MAY 2011

SOIL COMPOSTING FOR EXPLOSIVES REMEDIATION: CASE STUDIES AND LESSONS LEARNED

U.S. Army Corps of Engineers

http://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_1_95.pdf

(Bulletin published May 17, 2011)

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(2) Compost for Soils (National program) Partnership of Recycled Organics Industry & Australian state and local governments

CASE STUDY I: TPH Soil, Penrice Soda Products, Osborne, South Australia

- Approximately 3000 m3 of total petroleum hydrocarbon (TPH) contaminated soil
- Bioremediation preferred (vs. incineration or chemical stabilization) because produces useable end product vs. waste soil

METHOD: A co-composting method was used with static aerated biopiles [specially engineered Static piles of mixed contaminated soil and remediation amendments usually involving a network of pumps and pipes for forced aeration] (minimized hazardous emissions by lining soil in polyethylene- collected emissions passed through carbon filter to remove VOCs. Fresh green organics were sourced from local processors to accelerate the biological process, Inorganic fertilizer and chicken manure were also added to the soil to provide ideal conditions for the proliferation of the microbes naturally occurring in the soil

- Treated soil reused at Pernice site for horticultural purposes
- Considered more cost-effective than other methods of soil remediation

CASE STUDY II: PCP Soil, Harbourside Quay Development, South Australia

- Approximately 2,000 tons of pentachlorophenol (PCP) contaminated soil
- Off-site bioremediation treatment selected due to time/cost pressures

METHOD:

- The contaminated soil was mixed with approximately 0.8 volumes of freshly shredded green organics supplemented with 0.2 volumes of abattoir lagoon sludge as additional nutrient source

  - The compost mixture was formed into a single windrow (dimensions approx. 80m length x 8m base width x 4m height in a trapezoid shape) on a network of aeration pipes and pumps embedded in a woodchip base
  - The exhaust air from the vacuum pump was channeled through a large compost/woodchip biofilter to remove volatile hydrocarbons being stripped from the pile
- After approximately 12 months the PCP levels decreased sufficiently to allow safe disposal to landfill

SOURCE: Compost for Soils

Bioremediation fact sheets
http://www.compostforsoils.com.au/index.php?page=bioremediation
http://www.compostforsoils.com.au/uploads/file/pdfs/bioremediation/bioremediation_web.pdf