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Analysis of Food Waste Management Using Composting

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Introduction

Food waste is defined by the USDA as any piece of food that is discarded by retailers due to color or appearance and waste by consumers. The largest sources of this is from households – about 2/3 of all food waste at home results from produce and dairy products spoiling before they are used. This waste makes up 31.75 million tons, or 12.7%, of the 250 million tons of solid waste in U.S. landfills (Buzby, et al.). Only 3% is recycled and the rest goes into landfills, incinerators, and the wastewater. Disposing of organic waste in this fashion is damaging to the environment and results in the production of harmful greenhouse gases. Life cycle analysis studies have found composting to be more environmentally advantageous than other disposal methods. Most composting today is on a small scale and is done by individual consumers. If composting was at a larger scale, then there would be greater environmental advantages.

Process Description

The life cycle of food and food waste represents a process with a beginning (fields/farms) and an end (landfill/sewage). When composting is involved, this process becomes more of a continuous cycle where each step benefits from its predecessor. These steps include:

1. Production: The production of food mostly originates from two different categories that benefit from one another:

- Crops
- Livestock

2. Distribution: The food that is not wasted is packaged and transported for retail
3. Retail : The food that is not wasted is sold to consumers
4. Consumer Use
5. End of Life: Uneaten food usually ends up in landfills and wastewater which introduces these environmental problems:

- Harmful emissions released from food in landfill
- Wasted energy from processing uneaten food
- High water consumption from the production of food that is eventually wasted

6. Waste Recovery: Waste produced from steps 1-5 can be composted resulting in:

- Lower values of harmful emissions from less food waste in landfills
- Less food waste in wastewater
- Fertilizer

7. Recycling: Fertilizer from the compost can be brought back to fields and farms where it can restart the cycle

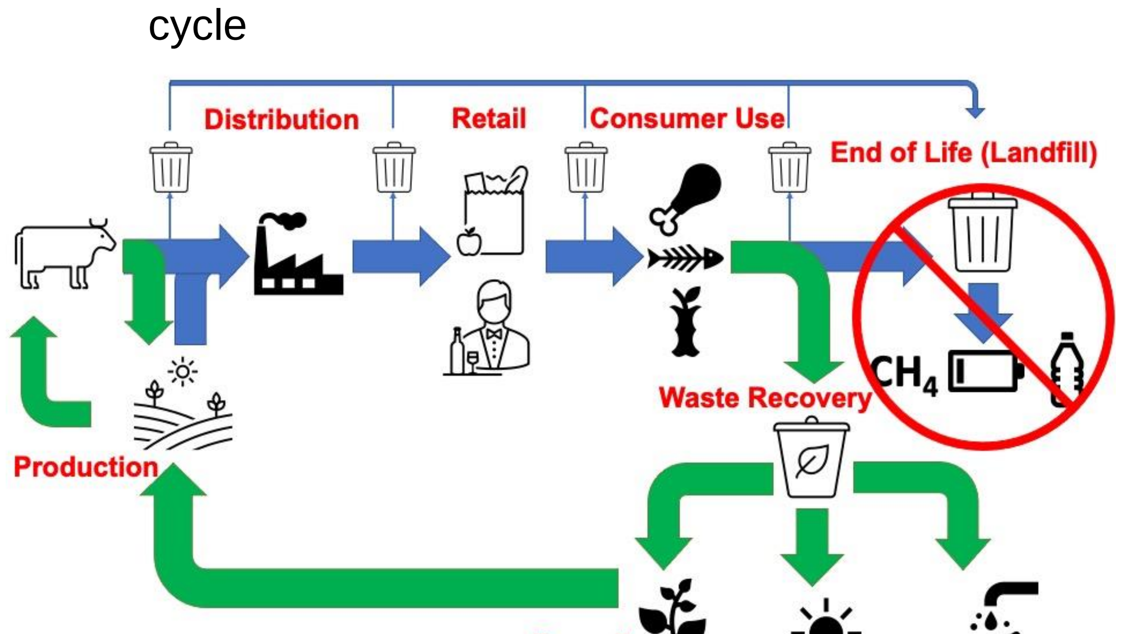

Figure 1. Life cycle analysis of food waste and composting ("Food Waste is a Massive Problem-Here's Why").

Potential Impact Ecosystem Services

Food Waste: Food lost at the retail and consumer levels represents more than just uneaten food, it includes the resources that are put into the production of the food that are consequently wasted. Those resources are:

- Land
  - Around 1.4 billion hectares of land (about ⅓ of the world's total agricultural land area) is used to grow food that is wasted ("The environmental impact")
- Energy
- Agriculture chemicals (e.g., fertilizers, pesticides, peat)
- Water
  - Recent studies indicate the production of wasted food requires the expenditure of ~ 300 million barrels of fresh water (Buzby, et al.)
  - Throwing out one kilogram of beef equals to wasting 50,000 liters of water ("The environmental impact")

The US Environmental Protection Agency accounts food waste for 31.75 million tons of solid waste in U.S. landfills (Buzby, et al.). When that food anaerobically decomposes it produces harmful emissions for the environment, including:

- Methane
  - 21x more powerful in accelerating global warming than CO_2
  - Landfills account for 34% of all man-made methane emissions in the U.S.

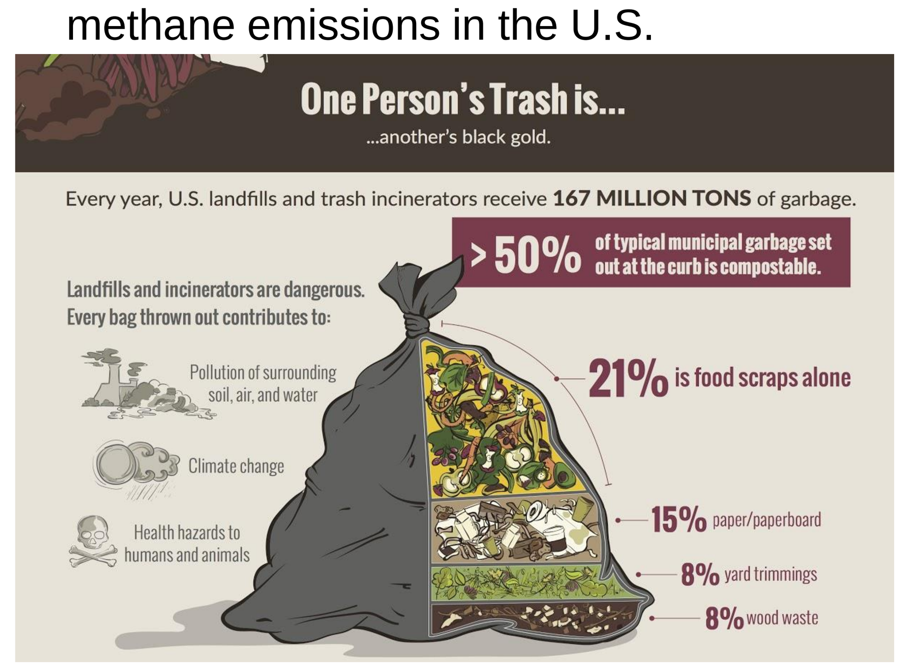

Figure 2. Impact of food waste and U.S. garbage breakdown (Platt)

Composting: In 2010, less than 3% of food waste generated in the U.S. was recovered and recycled, with the remainder going into landfills, wastewater or incinerators. The process of composing results in a nutrient rich product that can replace peat, fertilizers and manure.

Composting positively benefits the environment and soil quality by:

- Incorporating organic matter and nutrients into the soil
- Reducing the need for fertilizer, pesticides and peat
- Improving soil structure and water retention capacity
- Enhancing carbon storage

Negative impacts of composting can include:

- CO_2 emissions from the fossil fuels used to transport and process food waste
- Methane, nitrous oxide and ammonia emissions during the decomposition stage in the composting process
- Odors

Despite these negative impacts, LCA studies have found that composting is more advantageous and has fewer negative impacts than other organic waste disposal methods.

Sensitive Unit

Safety: Introduction of large-scale composting would create the demand for new composting companies and would subsequently require more waste management workers to work for those companies. The process of composting involves biological components such as bacteria that can pose a risk to the health and safety of composting site workers. Two important factors to look at are inhalable dust and inhalable endotoxins. An endotoxin is a toxin that is present inside a bacterial cell and is released when the cell degenerates. Endotoxins can cause fever, inflammation, dysfunction of organ systems and even death at high enough levels in humans (Zivot). There is a strong positive correlation between the levels of Inhalable dust and inhalable endotoxins, as seen in the data shown below.

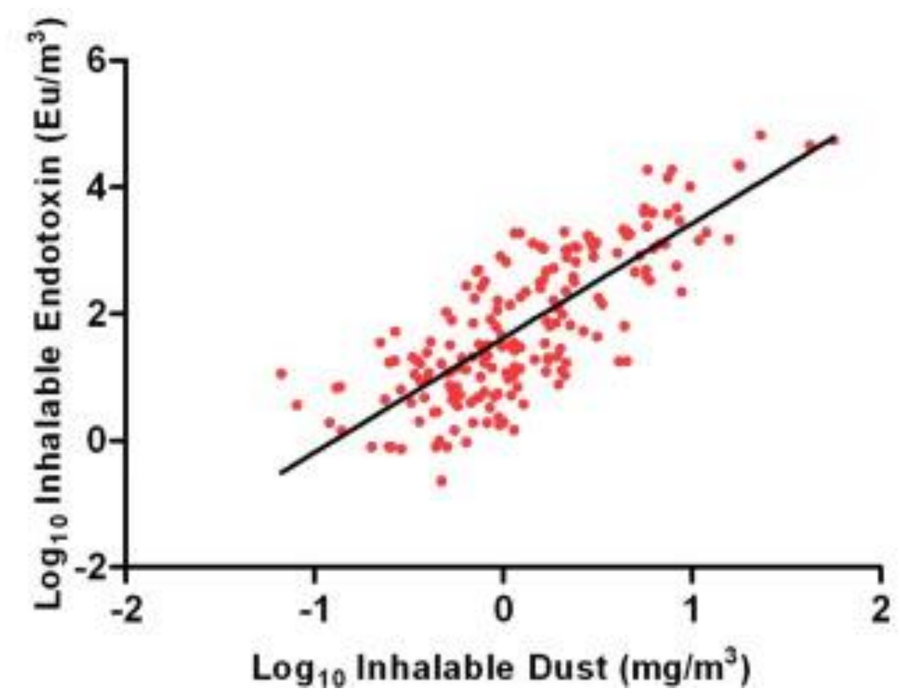

Figure 3. Inhalable Endotoxin vs. Inhalable Dust (Sykes)

Findings indicated that compost site workers were exposed to an elevated levels of endotoxins. Inhalable dust and inhalable endotoxin levels were found to be increased during any process that involved the movement of waste.

Composting Methods: There are many different forms of composting. All have different levels of sustainability. Reactor technologies appear to be the most sustainable form of composting. "Overall, the rotating drum is ranked as the most sustainable composting technology achieving the optimal balance among the environmental, financial/economic, social, and technical criteria" (Makan).

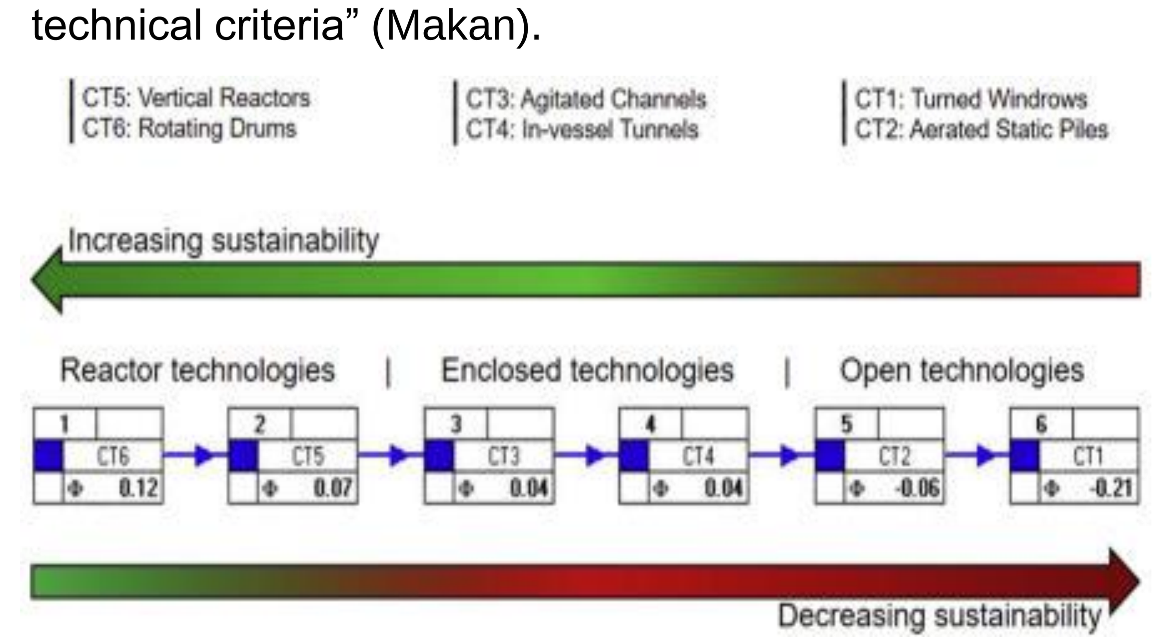

Figure 4. Sustainability Rankings of Composting Methods (Makan)

The goal of incorporating large-scale composting into the existing waste management systems is to provide a more sustainable form of managing large amounts of food waste. Only reactor technologies should be used, when possible, in order to maximize the positive impact on the environment. Intense use of enclosed and open technologies could diminish the efforts of implementing large-scale composting and minimize the positive impact that composting has on the environment.

Research

The Anaerobic Digestion and Education Center in East Lansing is a facility that shows the potential implementation of a composting system. The ADREC takes food waste from grocery stores and manure waste from the MSU dairy farm and turns it into energy (MSU). Anerobic digestion is very similar to composting, in the sense that they both decompose organic matter while benefiting the environment.

Composting comes in many shapes and sizes. Two types include small-scale and large-scale. An example of a small-scale system is a pile/pit. These can be in someone's backyard. An example of a large-scale system is static piles. This is where open-ended pipes allow air to flow in and decompose the piles faster. Both are great ways to dispose organic waste.

Food waste is a growing issue in supermarkets and in recent years has reached an all-time high. Composting is something that should be considered for daily waste. Per year, retail stores are responsible for wasting nearly 43 billion pounds of food (SmartSense). Instead of contributing to landfills, supermarkets could donate it to a composting program so that it can be converted into a beneficial product, such as energy or fertilizers.

Although these options seem great, there needs to be more research on the feasibility before implementing a system in grocery stores. For instance, something that needs to be analyzed is cost of transportation needed to move the food waste to a composting system. This would be expensive and give off harmful emissions. Knowing this, there needs to be more research on how to make this step more cost efficient and to determine the positive and negative impacts it would have on the environment.

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