

Techno-Economic Aspects of Solid Food Wastes into Bio-Manure

Dr. Rajeev Singh¹, Er. Vipin Kumar Verma² and Er. Dileep Kumar Verma³

¹Associate Professor, Department of Business Management, Faculty of Technology, Etawah, C.S. Azad University of Agriculture & Technology, Kanpur, U.P., INDIA

²Faculty, Department of Agricultural Engineering, Faculty of Technology, Etawah, C.S. Azad University of Agriculture & Technology, Kanpur, U.P., INDIA

³Assistant Professor, Department of Computer Science & Engineering, Faculty of Technology, Etawah, C.S. Azad University of Agriculture & Technology, Kanpur, U.P., INDIA

¹Corresponding Author: rajeev.abmcsa@gmail.com

ABSTRACT

Solid waste is health hazard and cause damage to the environment due to improper handling. Solid waste comprises of Industrial Waste (IW), Hazardous Waste (HW), Municipal Solid Waste (MSW), Electronic waste (E-waste), Bio-Medical Waste (BMW) which depend on their supply & characteristics. Food waste or Bio-waste composting and its role in sustainable development is explained in food waste is a growing area of concern with many costs to our community in terms of waste collection, disposal and greenhouse gases. When rotting food ends up in landfill it turns into methane, a greenhouse gas that is particularly damaging to the environment. Composting is biochemical process in which organic materials are biologically degraded, resulting in the production of organic by products and energy in the form of heat. Heat is trapped within the composting mass, leading to the phenomenon of self-heating. This overall process provide us Bio-Manure.

Keywords— Environment, Sustainable Development, Food Waste, Bio-Manure

into broad categories as- ecological wastes like green waste, paper food and kitchen waste; recyclable resources like glass, paper, bottles, cans, metals, certain plastics, etc., and inert wastes like rocks, debris and dirt. The main risk to human health arises from the breeding of disease vectors like flies, mosquitoes and rodents. Solid wastes are ideal breeding places for pathogens. Improper disposal of solid waste has resulted contamination. The environmental damage cause by wastes is mostly aesthetic in nature. Uncontrolled dumping destroys the beauty of country. There is a danger of water pollution when the leachate from a refuse dump enters surface or ground water resources. The rest of the study is organized as follows. Food waste or Bio-waste composting and its role in sustainable development is explained in Food waste is a growing area of concern with many costs to our community in terms of waste collection, disposal and greenhouse gases. When rotting food ends up in landfill it turns into methane, a greenhouse gas that is particularly damaging to the environment. Composting is biochemical process in which organic materials are biologically degraded, resulting in the production of organic by products and energy in the form of heat. Heat is trapped within the composting mass, leading to the phenomenon of self-heating that provide us Bio-manure.

Solid waste is health hazard and cause damage to the environment due to improper handling. Solid waste comprises of Industrial Waste (IW), Hazardous Waste (HW), Municipal Solid Waste (MSW), Electronic waste (E-waste), Bio-Medical Waste (BMW) which depend on their supply & characteristics. On one hand, the eco-friendly components of solid waste could be useful as secondary source for production processes. Some of the toxic and harmful ingredients cause a danger if not processed appropriately. Composting, Recycling, energy conversion from wastes, and land filling are some of the basic moves toward waste management. Urban Solid Waste popularly known as MSW(Municipal solid waste), is a type of waste that includes primarily household waste (domestic waste) in addition to construction ,destruction debris, commercial wastes, sanitation remains, waste collected by a municipality inside a given area. It can be found either in hard or semisolid form which generally excludes industrial hazardous wastes. MSW is broadly classified

I. INTRODUCTION

Solid waste is health hazard and cause damage to the environment due to improper handling. Solid waste comprises of Industrial Waste (IW), Hazardous Waste (HW), Municipal Solid Waste (MSW), Electronic waste (E-waste), Bio-Medical Waste (BMW) which depend on their supply & characteristics. On one hand, the eco-friendly components of solid waste could be useful as secondary source for production processes. Some of the toxic and harmful ingredients cause a danger if not processed appropriately. Composting, Recycling, energy conversion from wastes, and land filling are some of the basic moves toward waste management. Urban Solid Waste popularly known as MSW(Municipal solid waste), is a type of waste that includes primarily household waste (domestic waste) in addition to construction ,destruction debris, commercial wastes, sanitation remains, waste collected by a municipality inside a given area. It can be found either in hard or semisolid form which generally excludes industrial hazardous wastes. MSW is broadly classified

industrial hazardous wastes. MSW is broadly classified into broad categories as- ecological wastes like green waste, paper food and kitchen waste; recyclable resources like glass, paper, bottles, cans, metals, certain plastics, etc., and inert wastes like rocks, debris and dirt. The main risk to human health arises from the breeding of disease vectors like flies, mosquitoes and rodents. Solid wastes are ideal breeding places for pathogens. Improper disposal of solid waste has resulted contamination. The environmental damage cause by wastes is mostly aesthetic in nature. Uncontrolled dumping destroys the beauty of country. There is a danger of water pollution when the leach ate from a refuse dump enters surface or ground water resources. The rest of the study is organized as follows. Food waste or Bio-waste composting and its role in sustainable development is explained in Food waste is a growing area of concern with many costs to our community in terms of waste collection, disposal and greenhouse gases. When rotting food ends up in landfill it turns into methane, a greenhouse gas that is particularly damaging to the environment. Composting is biochemical process in which organic materials are biologically degraded, resulting in the production of organic by products and energy in the form of heat. Heat is trapped within the

composting mass, leading to the phenomenon of self-heating.

II. BIO-MANURE

Bio Manure is organic fertilizer derived from Food Wastes, Vegetable Matter, Dry Leaves, Animal excreta, etc. It provides bio-energy and bio-stimulants which crops require for healthy growth without compromising on the integrity of the soil.

Advantages of Bio-Manure

- These are a good source of macronutrients.
- Improves soil fertility.
- Cost-effective
- Reduces soil erosion and leaching.
- Improves the physical properties of the soil and aerates the soil.
- Improves the water and nutrient holding capacity of the soil.
- It helps in killing weeds and pests.
- It can be transported easily.
- Methane gas is evolved as the by-product of manure that can be used for cooking and heating purposes.
- The crops grown on the land treated with manure produces healthy crops.



III. SOURCES OF FOOD WASTES

Food-processing wastes are those end products of various food-processing industries that have not been recycled or used for other purposes. Food industry produces large volumes of wastes, both solids and liquid, resulting from the production, preparation, and consumption of food. These wastes pose increasing disposal and potentially severe pollution problems and represent a loss of valuable biomass and nutrients. In general, wastes from the food-processing industry have the following characteristics (Litchfield, 1987):

1. Large amounts of organic materials such as proteins, carbohydrates, and lipids
2. Varying amounts of suspended solids depending on the source
3. High biochemical oxygen demand or chemical oxygen demand

Fruits, vegetables, dairy products, grains, bread, unbleached paper napkins, coffee filters, eggshells, meats, and newspaper can be composted. Food waste has unique properties as a raw compost agent. Because it has a high moisture content and low physical structure, it is important to mix fresh food waste with a bulking agent that will absorb some of the excess moisture as well as

add structure to the mix. Bulking agents with a high C:N ratio, such as sawdust and yard waste, are good choices. Composting provides a way in which solid wastes, water quality, and agricultural concerns can be joined.

Benefits of Compost to the Food Industry

1. Reduces solid waste disposal fees.
2. Ends wasting large quantities of recyclable raw ingredients.
3. Educates consumers on the benefits of food waste composting.
4. Markets your establishment as environmentally conscious.
5. Markets your establishment as one that assists local farmers and the community.

In India, the bigger the wedding, the larger the party and the more colossal the waste. No doubt weddings and banquets are a huge source of wastes, but restaurants and hotels also contribute though the awareness around this has grown in the last five years. While some restaurants in India employ food controllers to check food spoilage, others donate it to their staff and other personnel, and smaller standalone restaurants, donate it to orphanages. Few also reuse non-perishable food.

- ❖ 25% of fresh water used to produce food is ultimately wasted, even as millions of people still don't have access to drinking water. When you calculate the figures in cubic kilometers, this is a bit more than an average river.
- ❖ Even though the world produces enough food to feed twice the world's present population, food wastage is ironically behind the billions of people who are malnourished. The number of hungry people in India has increased by 65 million more than the population of France. According to a survey by Bhook (an organization working towards reducing hunger) in 2013, 20 crore Indians sleep hungry on any given night. About 7 million children died in 2012 because of hunger/malnutrition.
- ❖ Acres of land are deforested to grow food. Approximately 45% of India's land is degraded primarily due to deforestation, unsustainable agricultural practices, and excessive groundwater extraction to meet the food demand.
- ❖ 300 million barrels of oil are used to produce food that is ultimately wasted.
- ❖ Food wastage is a global problem. According to Food and Agriculture organization (FAO) of the United Nations, approximately one third of the food produced for the human consumption, which amounts to 1.3 billion tones, gets lost or wasted.
- ❖ India is second largest population in the world. In 2012, government announced that about 22% of Indian population lives below poverty line. According to FAO estimates in 'The State of Food Security and Nutrition in the world, 2017'

report, 190.7 million people are undernourished in India. This represents 14.5% of the Indian population, which makes India, the home to largest undernourished population in the world.

- ❖ In spite of this, it is estimated by the United Nations that nearly 40% of the food produced in India is wasted or lost. And this cost India one lakh crore rupees every year.
- ❖ Food wastage in India is happening at every level; from harvesting, transporting, processing, packaging and consuming.
- ❖ Weddings, events, restaurants, hostels and houses are a major source for food wastage of cooked food. There are many organizations in the country who are working towards helping to reduce this food wastage by collecting the food and distributing it to the needy. But they are all scattered and most of the times, the poor people in India still rely on their luck to be able to find a proper meal.
- ❖ Majority of food wastage in India is caused before it is packaged. This is caused due to the loopholes in the transport and infrastructure system in India. The government has looked into this and started finding investments to develop better technology to reduce this wastage.
- ❖ For reducing the wastage of cooked food, the government can set up a service where they collect food from every source, and set up a shelter where the hungry people can come and feed themselves for free or at a subsidized rate. This way they do not have to hunt for the hungry people, who might be staying at a remote place and wouldn't get an advantage of the service if not present at a particular time, or might not come out and stay undernourished for their pride.
- ❖ All the efforts by the government and organizations would not succeed if there is no individual involvement. In order to participate in the movement to save food, there are certain things every individual has to do. One is to not waste food. Serve yourself with the amount of food that is less than what you can finish. There is always a second serving available. But do not over serve and contaminate more food. Be careful and alert about the food wastage. Always remember, every grain counts.
- ❖ Compost the food that is cooked and spoilt because of improper storage. This way you would give something back to the environment. Re-use the food that is available and experiment with different ingredients to enhance a dish and reduce the wastage. Organize your grocery shopping well after planning a meal schedule, while avoiding impulse purchases.

IV. OBJECTIVES OF STUDY

1. To study per month inflow of Bio-waste in small unit at city level.
2. To measure the cost of conversion of Bio-waste into bio manure per Kg of waste.

1. To study per month inflow of Bio-waste

Per month inflow of Bio-waste nearly 240 kg which is produced by the peel of the vegetables, fruits and other food product.

2. To measure the cost of conversion of Bio-waste into Bio-manure

Solid waste digestion of Bio-waste is done in the pits depending on availability of Bio-waste and space for decomposition. In general a pit of approximately 2×1×1 m will be used for filling the kitchen waste. The beneficiaries may dig out pits on their own or they may deploy labours which will cost approximately Rs. 125/- per pit. A beneficiary may easily utilize 100 pits for production of organic manure. The total manure produced out of this method would be approximately 10 quintal per cycle. In one year about 800quintal of organic manure will be produced hence a beneficiary may earn about Rs. 10,0000/- per year.

V. REVIEW OF LITERATURE

- **(Litchfield, 1987)** : Food-processing wastes are those end products of various food-processing industries that have not been recycled or used for other purposes. Food industry produces large volumes of wastes, both solids and liquid, resulting from the production, preparation, and consumption of food. These wastes pose increasing disposal and potentially severe pollution problems and represent a loss of valuable biomass and nutrients.
- **Suhane (2007)** : professes that as compared to cattle dung compost, Bio-waste manure (KWM) is at least 4 times more nutritive. Farmers, in Argentina, prefer KWM over conventional composts as they believe that it is up to seven times richer in nutrients and growth enhancing values (Pajon, 2007). Studies suggest that KWM has higher soil moisture retention hence it reduces the need of water for irrigation by around 30- 40%.
- **Ulrich and Nadkarni (2009)** : carried out several sustainability projects with inmates in a corrections centre work. These included a vermiculture and thermophilic composting system to reduce kitchen waste, which resulted in reduced landfill-bound waste. Academic staff, prisoners and non-prisoner administrators worked together to adapt these systems to the prison environment, and along with the other sustainability projects there were results in terms of positive psychological and social aspects.
- **Sharp et al. (2010)** : this synthesis review includes many examples of household waste prevention intervention campaigns, and compares how much waste they reduced. One project example is Love Food Champions (WRAP, Love Food Hate Waste campaigns), which provided participants with workbooks, information, and kitchen containers to measure waste, and asked them to rate their ability to reduce food waste. A training day was held to distribute resources that would help enthusiastic champions to engage other residents. Self-weighting was found to be effective in connecting participants to their own consumption practices, and providing personalized feedback helped reinforce participants' commitment.
- **Thiemeet al. (2012)** : a project to encourage behaviour change by automatically logging Bio-waste through placing a smartphone on the inside of a bin lid. Captured images were automatically uploaded to a BinCam application on Facebook which all BinCam users could see. This increased users' awareness and reflection on their waste habits, and their motivation to improve.
- **Cook and Quigley (2013)** : asked students to take photographs around their campus which showcased an element of their chosen environmental issue (Bio-waste is one of several examples listed). Students were also asked to write narratives about the issue, answering prompts which explored the intricacies of the issue (who is affected, why is it important, what could happen next). The authors argue that photovoice connected students to science and "empowered students to dialogue with informed community members".
- **Ganglbauer (2013)** : carried out fieldwork in 17 households to understand how the passage of food into waste occurs in everyday life, and how/if technology can intervene. Methods included interviews and contextual inquiries at participants' homes. In Ganglbauer et al. (2013), researchers used a FridgeCam technology probe to capture time-lapse films of participants' fridges, and later researchers (Ganglbauer et al., 2015) developed a food waste diary app, to enable people to reflect on issues around food waste. They then analysed the entries to understand what people throw away and why.
- **Mills et al. (2014)** : describes a school in the US with "collaborative inquiry" at the heart of its system. Some third graders noticed issues in the school cafeteria, and the class decided to

collect and record data in the cafeteria over several days. The task was to simply document what they saw, and among other issues, food waste was identified. The students decided to collect further data, saw that vegetables were the most wasted food, and surveyed the school to find out which vegetables kids prefer, and discussed the results with the cafeteria manager.

- **Joutsela and Korhonen (2015)** : a study which demonstrated that using an online research community could be useful for collecting information, user experiences and ideas from a community of packaging users. The authors argue that this method can be used for quantitative and qualitative research.
- **Ng et al. (2015)** : researchers provided participants in the UK (8) and in Malaysia (10) with wearable cameras which passively took still images every 10-30 seconds. The researchers argue that this is more reliable than traditional methods, such as diaries. The images were then used as prompts in interviews, and the results used to investigate food consumption lifecycles (from planning through to waste).
- **Arrington et al. (2017)** : used user-generated data from the citizen science application Falling Fruit (fallingfruit.org) to investigate the social-ecological and demographic dynamics of urban foraging. They found high ethnic diversity in the gathering communities and a bimodal income distribution. Falling fruit asks users to map the urban harvest.
- **Veckman et al. (2018)** : Saving Food is a project which develops a collective awareness platform for connecting food donors, charities and citizens in a more efficient way, and creating an online community in which actors are motivated to take direct action against food waste. The project included behaviour change techniques, grounded in data from surveys and interviews to investigate barriers and enablers of participating in food distribution.

VI. MATERIAL & METHODS

Bio-waste has been collected from different kitchen halls of Engineering College hostels (A small unit) kept in digesters to produce biogas through anaerobic decomposition (AD). CM was collected from nearby village. In kitchen waste, total amount of vegetables and rices were near about 70%. Potatoes, eggs, fruits etc. were relatively low in mass. After removing the bones, plastic bags, metals and inorganic residues, wastes were cut into small size in order to reduce size to get efficient biogas production. Then these wastes were mashed into pest by using hopper.

The organic substances play direct role in the enhancement in the soil fertility as they are the sources of plant nutrients liberated in available form during the course of decomposition. Humus is the ultimate product, which can be considered as a store house of various plant nutrients essentials plant growths. During the microbial decomposition of organic substance there is a release of nutrient with subsequent mineralization of carbon, nitrogen, sulphur, phosphorus and other elements. Decomposition is the conversion of complex organic substances into simple once that animals and plants are broken down into large particles and eventually into small molecules. The dead organic matter is thus gradually disintegrated until structure can no longer be recognized and the complex organic molecules are broken down into carbon-dioxide, water and mineral nutrients.

Decomposition of organic matter is a necessary and preliminary step to utilization, since the protein molecules must be broken before crop plants can use the mineral and nitrogen logged up in the plant cell. The process of bacterial and fungi of many kinds take place in several stages; various intermediately products being formed before the final substance useful to crop plants appears. The soil fauna cropped down thus solid waste material into small pieces and provide more surface area for soil organism to decompose them at faster rate. Soil organic level and microbial activities vital for nutrients, turn over long term productivity of soil are enhanced by use of organic amendments.

Biological Methods of Waste Utilization

All biological waste utilization methods involve the decomposition of biodegradable wastes by living microbes (bacteria and fungi), which use biodegradable organic matter as a food source for growth and reproduction. Microbes excrete specialised enzymes that digest biodegradable waste components (e.g. cellulose, lignin starch and other complex polysaccharides, proteins and fats) into simple nutrients - sugars, amino acids and fatty acids, which they absorb. As the microbes grow and reproduce a significant proportion of these nutrients is converted into heat, carbon gases and water. This results in a large loss in weight during the process. Sometimes slightly larger organisms are also used such as invertebrates. There are two main types of environments in which such micro is live. Therefore, there are two main types of biological processes used to treat biodegradable waste: aerobic e in the presence of oxygen and anaerobic e in the absence of oxygen.

Aerobic Absorption Process

Aerobic absorption process is an organic process which utilizes long-term aeration to counterpoise and decrease the total mass of organic waste by organically obliterating unstable solids. This process outspreads decomposition of solids and also re-growth of organisms up to a certain level where the energy obtained in living cells and waste material storage is considerably small. During aerobic digestion, aerobic

and facultative microorganisms employ oxygen and acquire energy from the existing biodegradable organic matter in the waste sludge. However, when the available food supply in the waste sludge is inadequate, the microorganisms start to feed on their own protoplasm to

gain energy for own cell maintenance. This phenomenon is called endogenous respiration. The aerobic digestion process which occurs within in-vessel aerobic composters is identical to the process that takes place without human interference in environment.

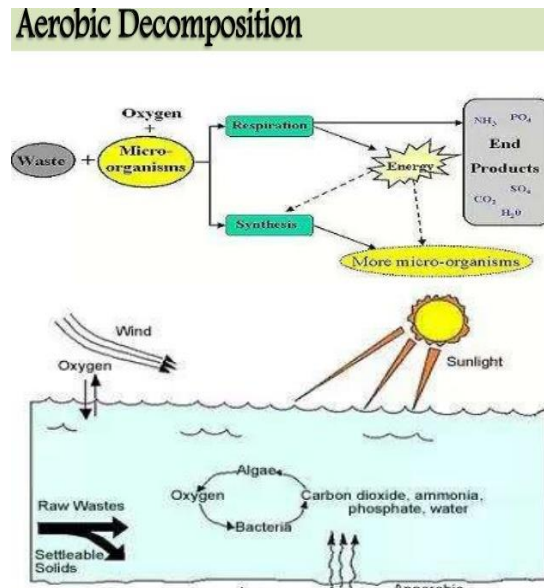


Figure2: (H)Aerobic Decomposition

Anaerobic Absorption Process

Anaerobic absorption process is a micro-organic decomposition process of biological matter into carbon dioxide, methane, inorganic nutrients and compost in oxygen depleted region in the presence of the hydrogen gas. Several anaerobes like Streptococcus, Clostridium, Bacillus Lactobacillus, Carnobacterium, Enterococcus and Homoacetogens, etc. effect in the anaerobic fermentation process for organic waste. This procedure is also well-known as bio-methanogenesis. Biogas being an end product is applied for combustion process in order to generate heat and electricity. It can also be developed into transportation fuels and renewable natural gas. The variety of anaerobic absorption technologies are transformed into municipal wastewater solids, livestock manure, high strength industrialized wastewater solids, fat, oils and grease (FOG), food waste, along with various other organic waste streams into organic-gas, 24x7 hours a week. Composting of separated digested solids help in dairy bedding, along with complete utilization of cropland or transformed into different products. Nutrients found in the liquid stream are utilized as fertilizers for agricultural purpose.

VII. CONCLUSION

Once rotting food is buried, it produces methane, a greenhouse gas that is very harmful to the environment. Composting is a biochemical process in which organic materials are organically decomposed,

yielding organic byproducts as well as energy in the form of heat. The phenomena of self-heating occurs when heat is contained within the composting pile. This entire procedure results in Bio-Manure.

REFERENCES

- [1] Arrington, A.B., Diemont, S.A.W., Phillips, C.T. & Welty, E.Z. (2017). Demographic and landscapelevel urban foraging trends in the USA derived from web and mobile app usage. *Journal of Urban Ecology*, 3(1). Available at: <https://academic.oup.com/jue/article/3>.
- [2] Comber, R. & Thieme, A. (2013). Designing beyond habit: opening space for improved recycling and food waste behaviors through processes of persuasion, social influence and aversive affect. *Personal and Ubiquitous Computing*, 17, 1197-1210. Available at: http://designandwellbeing.com/papers/Designing_beyond_Habit_Ubi_and_Pers_Computing.pdf.
- [3] Comber, R., Thieme, A., Rafiev, A., Taylor, N., Kramer, N. & Olivier, P. (2013). BinCam: Designing for engagement with facebook for behavior change. In: *IFIP Conference on Human-Computer Interaction. INTERACT 2013: Human-Computer Interaction*, pp. 99-115.
- [4] Cook, K. & Quigley, C.F. (2013). Connecting to our community: Utilizing photovoice as a pedagogical tool to connect college students to science. *International Journal of Environmental and Science Education*, 8(2).
- [5] Ganglbauer, E. (2013) Towards food waste interventions: an exploratory approach. *UbiComp '13*

Adjunct Proceedings of the 2013 ACM conference on Pervasive and ubiquitous computing adjunct publication, pp. 337-342. Ganglbauer, E., Fitzpatrick, G. and Comber, R. (2013) Negotiating food waste: Using a practice lens to inform design. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 20(2).

[6] Ganglbauer, E., Fitzpatrick, G. & Guldenpfennig, F. (2015). Why and what did we throw out?: Probing on Reflection through the Food Waste Diary. *CHI '15 Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, pp. 1105-1114.

[7] Joutsela, M. & Korhonen, V. (2015). Human-packaging interaction. Capturing the user mindset – Using the online research community method in packaging research. *Packaging Technology and Science*, 28, 325-340.

[8] Mills, H., O'Keefe, T., Hass, C. & Johnson, S. (2014). Changing hearts, minds, and actions through collaborative inquiry. *Language Arts*, 92(1).

[9] Morrell, E. (2017). Localizing detroit's food system: Boundary-work and the politics of experiential expertise. *Science as Culture*.

[10] Okot-Okumu, J. & Myenje, R. (2011). Municipal solid waste management under decentralisation in Uganda. *Habitat International*, 35. Available at: <https://www.sciencedirect.com/>

[11] Sharp, V., Giorgi, S. & Wilson, D.C. (2010). Delivery and impact of household waste prevention intervention campaigns (at the local level). *Waste Management & Research*, 28, 256-268.

[12] Thieme, A., Comber, R., Miebach, J., Weeden, J., Kraemer, N., Lawson, S. & Olivier, P. (2012). "We've bin watching you": designing for reflection and social persuasion to promote sustainable lifestyles. *CHI '12 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 2337-2346. Ulrich, C. and Nadkarni, N.M. (2009).