

Management of Vegetable Wastes: Methods and Application

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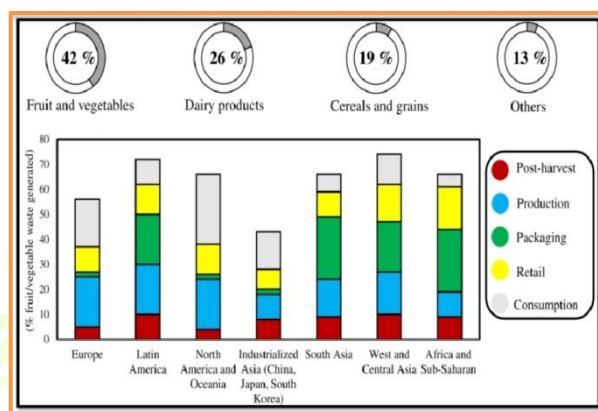
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Out of all the horticultural crops, fruits and vegetables are the most commonly used products. They can be eaten either raw, cooked or processed into value-added products. But as the world's population is increasing day by day, supply chains occasionally become imbalanced and there arises growing concern about the amount of food waste being produced worldwide.

These vegetable wastes are produced after harvesting produce in fields and also as leftovers in homes, restaurants and business firms. Fruit and vegetable waste make up a sizable portion (42%) of the various percentages of food waste. The waste derived from vegetable has a wide range of characteristics depending on the plant species and tissues. For example, leftover peels and seeds contain a lot of phyto-chemical compounds, which make them suitable for use as food flavourings and preservation agents. In a similar vein, vegetable tissues high in carotenoids, vitamins and fiber have anti-diabetic and antioxidant qualities that help shield people from illnesses. Therefore, the efficient use of waste materials in various applications offers a useful way to lessen environmental problems and find sustainable solutions to problems. Vegetable waste is a biodegradable substance that is produced in large quantities. A lot of it is left on land to rot in the open, which not only smells bad but also attracts pigs, rats and birds and disease-carrying insects. The rotten peels, seeds, shells, pomace (dry, pulpy residue left over after juice extraction) and scraped bits of vegetables or slurries are all considered vegetable wastes. In addition to post-harvest losses brought on by inadequate storage space, improper vegetable processing and inadequate packaging, consumer preferences also contribute significantly to the production of vegetable wastes. In this context, vegetable waste management is most important in preventing environmental pollution, is a good supplement for the nutrition of the human population, aids in solving the problem of food scarcity and preparation of various types of value-added products, increases soil fertility and economic returns.

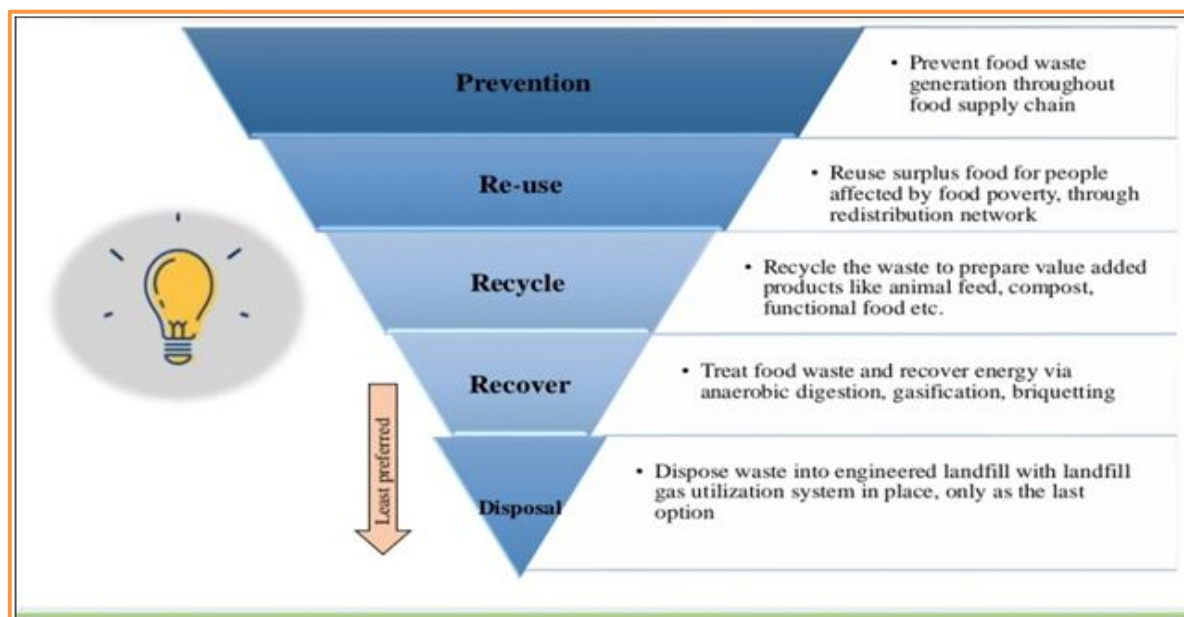


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Major factors contributing towards post-harvest losses

A lack of connection between farmers and processing facilities makes it difficult to exchange accurate cost information, stabilise the market for vegetables, maximise benefits and reduce the risk of price fluctuations. To stop losses, the government can close the gap between institutions and industries. Post-harvest losses are also facilitated by the underutilization of cutting-edge technologies in food processing. The issue of post-harvest waste generation is

exacerbated by village storage capacity and warehouse conditions, processing and packaging facilities, transportation, inadequate infrastructure, and knowledge of post-harvest technologies, quality seeds and market demand.



Food waste management hierarchy

Vegetable Waste Management

Conventional applications of vegetable waste management include waste to bio energy conversion by animal feeding, land fills, anaerobic digestion, composting, thermal processes by gasification, pyrolysis, incineration and briquetting.

(1) Waste to bio-energy conversion: The foundation of waste-to-energy (WTE) technology in India works on the build, operate and transfer model. By lowering the amount of waste that goes to landfills, this model lowers greenhouse gas emissions clean and dependable energy from a renewable fuel source is produced.

- a. **Animal feed:** Because of their high moisture content (80–90 per cent), fruit and vegetable wastes such as tomato pomace, bottle gourd pomace, citrus pulp, carrot pulp, cabbage and cauliflower leaves, sarson saag waste, pea pods, pineapple waste, etc., are highly fermentable and perishable. Appropriate techniques should be used to preserve these waste materials so that they can be fed to animals all year long or especially during the lean time of green fodder production. The two most popular processes for producing animal feed are silage (anaerobic fermentation of waste material) and drying.
- b. **Land fill:** One of the most conventional and straight forward methods for disposing of solid waste is a landfill. These vegetable wastes are dumped in landfills because they are more biodegradable than other wastes. The sole drawback is that landfill gases are thought to be one of the main man-made sources of methane, which contributes to greenhouse gas emissions worldwide. These landfills stabilise over time and produce leachates that have a significant effect on the environment and soil quality.
- c. **Anaerobic digestion:** Anaerobic digestion turns biomass waste into compost and biogas, which is produced by bacteria without oxygen. The primary operating parameters of anaerobic digestion can be controlled in specially made bioreactors or digesters. The method can be used at three different temperatures: thermophilic (55–65 °C), mesophilic (25–35 °C), and psychrophilic (10–20 °C).
- d. **Composting:** The biodegradation of organic matter or composting, is characterised by reactions in which aerobic microorganisms break down waste substrate to release heat and carbon dioxide before turning into stable compost. Vermicomposting, windrow composting and static composting are among the various composting methods used.

(2) Thermal processes:

- ❖ **Gasification:** It is a thermal process that turns solid biomass into combustible synthetic gas, or syngas (primarily CO and H₂), by using high temperatures of over 8000°C and an oxygen-deficient environment. Electricity can be produced using the syngas. A solid by-product biochar has numerous uses in agriculture, including improving soil quality by increasing nutrient content, remediating pollution by adsorbing heavy metals and aromatic contaminants and rehabilitating acidic, nutrient-poor soil.
- ❖ **Pyrolysis:** Pyrolysis is a thermochemical conversion process that involves heating biomass to temperatures above 400°C while capturing the by-product gases and either partially or completely removing oxygen.
- ❖ **Incineration:** The process of incineration involves burning biomass directly in the presence of air and oxygen, converting the chemical energy it contains into thermal energy or heat. The temperature range in which this process occurs is roughly 800–1000 °C.

(3) Briquetting: Converting solid vegetable waste into high-density briquettes is a practical alternative treatment that allows for flexibility in storage, transportation, and use as needed. Dry vegetable waste biomass can be briquetted by either compacting it directly, drying it and combining it with a binder or bringing its moisture content down to a certain level. Following open sun drying, the raw green vegetable market waste yielded roughly 15–20% dry matter. The waste contains lignin, which has a high calorific value and helps particles bind together to form briquettes or pellets.

Emerging opportunities

- **Bioactive Substances:**

Good sources of potentially useful bioactive substances, including carotenoids, polyphenols, dietary fibers, vitamins, enzymes, organic acids and oils, can be found in fruit and vegetable waste. These phyto-chemicals have applications in the food industry, for the creation of enriched or functional foods and in the health sector for nutraceuticals. Antioxidant, anti-bacterial, anti-tumor, anti-viral, anti-mutagenic and heart-protective properties are among its advantageous health qualities.

- **Natural Pigments:**

Numerous food products have made extensive use of synthetic pigments derived from petrochemicals. These pigments, however, are harmful to human health. As a result, sustainable pigment production using renewable bio-resources is required. Natural pigments like anthocyanins, betalains, carotenoids and chlorophylls are abundant in vegetable wastes and by-products. The needs of natural pigment production at the industrial level for applications in pharmaceuticals, cosmeceuticals, natural food dyes and functional foods can be satisfied by using vegetable wastes and their by-products.

- **Bio-plastics:**

Trifluoro acetic acid (TFA) solutions can be used to age industrially processed wastes from cellulose-rich vegetables and edible cereals to create bio-plastics.

Challenges faced during the process

Certain challenges faced during the vegetable waste management which need to be addressed properly include absence of segregation of waste at source, lack of technical expertise and appropriate institutional arrangement, unwillingness of LSGI (Local Self Government Institutions) to introduce proper collection, segregation, transportation and treatment/disposal systems, lack of waste management information systems, lack of planning for waste management while planning townships, lack of funds and indifferent attitude of citizens towards waste management.

Policy framework regarding waste management

Addressing environmental issues in India is the responsibility of the Ministry of Environment, Forests and Climate Change. On April 8, 2016, this organisation announced the new solid waste management regulations. Building and implementing a waste management framework that promotes sustainable development is the main goal of governance in India. In order to manage waste, people are encouraged to adhere to the waste administration standards, which incorporate the 3Rs principle—"reduce, reuse and recycle" and individuals are encouraged to adhere to these guidelines when handling waste.



Conclusion

India, as one of the biggest agricultural countries in the world, produces a wide variety of vegetables. The demand for food and other necessities has led to an increase in the amount of waste generated daily by each household. Means should be adopted to extract maximum advantages from the waste materials without causing any financial loss or endangering the environment. Therefore, waste products produced by these industries can be converted into animal feed, biogas, compost and value-added products, as well as land filled through anaerobic or aerobic treatment. Consequently, disposing of waste is a major problem, as a result, vegetable waste should be managed properly using the appropriate methods and their best forms of application.

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