A STUDY ON

WASTE MANAGEMENT SYSTEM AS PER COMMUNITY MEDICINE AND ITS IMPORTANCE

BY

MS. JYOTI RAJPUT

BACHELOR OF NATUROPATHY

AND YOGIC SCIENCES

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WASTE :-

Waste includes all items that people no longer have any use for, which they either intend to get rid of or have already discarded.

Any material which is not needed by the owner, producer or processor.

TYPES OF WASTE ON THE BASIS OF THEIR PHYSICAL STATE

- Solid waste
- Liquid waste
- Gaseous waste

ON THE BASIS OF BIO-DEGRADABILITY

- Biodegradable waste
- Non-Biodegradable waste

ON BASIS ON EFFECTS ON HUMAN HEALTH

- Hazardous waste
- Non-Hazardous waste

SOURCES OF WASTE :-

- Residential
- Commerical
- Institutional

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Industrial
Municipal Solid waste (Construction and Demolition)
Treatment facilities
Agricultural

MAGNITUDE OF PROBLEM IN INDIA :-

Per Capita waste generation increasing by 1.3% per annum.
With urban population increasing between 3 - 3.5% per annum.
Yearly increase in waste generation is around 5% annually.
Per capita generation of waste varies from 200 gm to 600 gm per capita / day.
Collection efficiency ranges between 50% to 90% of the solid waste generated.
Crude dumping of waste is the most common disposal in many cities.
Public or community nuisance due to foul odour and unsightliness.
Obstruction of drainage systems.
Fire hazards.
This all lead to environment pollution, breeding of disease - vector - insects, animals, scaungers and rodents.

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* WASTE MANAGEMENT :-

Waste management is all those activities and action required to manage waste from its inception to its final disposal. This includes amongst other things, collection, transport, treatment and disposal of waste together with monitoring and regulation. It also encompasses the legal and regulatory framework the relates to waste management encompassing guidance on recycling etc.

Waste management shall mean "The collection, transport, recovery and disposal of waste, including the supervision of such operations and aftercare of disposal sites."

However the newer concepts of Waste management talk about Reduse, Reuse and Recycle of waste over and about waste disposal.

Waste can be solid, liquid or gas and each type has different methods of disposal and management. Waste management deals with all types of waste including industrial, biological and household. In some cases, waste can pose a threat to human health. Waste is produced by human activity, for example extraction, processing of raw materials. Waste management is intended to reduse adverse effects of waste on human health, the environment or aesthetics.

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PRINCIPLES OF WASTE MANAGEMENT :-

WASTE HIERARCHY

The waste hierarchy refers to the '3R's' Reduce, Reuse and Recycle. Which classifies waste management strategies according to their desirability in terms of waste minimisation. Their waste hierarchy is the cornerstone of most waste minimisation strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of end waste, resource recovery.

The waste hierarchy is represented as a pyramid because the basic premise is that policies should promote measures to prevent the generation of waste. The next step is to seek alternative uses for the waste that has been generated by re-use. The next step is material recovery and waste to energy.

The final action is disposal, in landfills or through incineration without energy recovery. This last step is the final resort for waste which has not been prevented, diverted or recovered. The waste hierarchy represents the progression of a product or material through the sequential stages of the pyramid of waste management.

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LIFE CYCLE OF A PRODUCT :-

The life cycle begins with design, then proceeds through manufacture, distribution and primary use and then follows through the waste hierarchy's stages of reduce, reuse and recycle. Each stage in the life cycle offers opportunities for policy intervention, to rethink the need for the product to redesign to minimise waste potential, to extend its use. Product life-cycle analysis is a way to optimize the use of the worlds limited resources by avoiding the unnecessary generation of waste.

RESOURCE EFFICIENCY :-

Resource efficiency reflects the understanding that global economic growth and development can not be sustained at current production and consumption patterns.

Globally, humanity extracts more resources to produce goods than the planet can replenish. Resource efficiency is the reduction of the environmental impact from the production and consumption of these goods, from final raw material extraction to last use and disposal.

POLLUTER - PAYS PRINCIPLE :-

The Polluter Pays principle mandates that the polluting party pays for the impact on the environment.

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RECYCLE :-

Saves limited natural resources.

Prevents greenhouse gas emissions and water pollutants.

Saves energy.

Provides raw material for industry and creates the job opportunity.

Saves landfill space.

Recycling is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. The materials from which the items are made can be reprocessed into new materials. Materials for recycling may be collected separately from general waste using dedicated bins and collection vehicles, a procedure called kerbside collection.

In some communities, the owner of the waste is required to separate the materials into different bins (paper, plastics, metals) prior to its collection. In other communities, all recyclable materials are placed in a single bin for collection, and the sorting

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is handled later at a central facility. The latter method is known as single-stream recycling.

The most common consumer products recycled include aluminium such as beverage cans, copper such as wire, steel from food and aerosol cans, old steel furnishings or equipment, rubber tyres, polyethylene and PET bottles, glass bottels and jars, paperboard, cartons, newspapers, magazines and light paper and corrugated, fibreboard boxes.

PVC, LDPE, PP and PS are also recyclable. These items are usually composed of a single type of material, making them relatively easy to recycle into new products. The recycling of complex products are more difficult, due to additional seperation.

The type of material accepted for recycling varies by city and country. Each city and country has different recycling programs in place that can handle the various types of recyclable materials. However, certain variation in acceptance is reflected in the resale value of the material once it is reprocessed. In July 2017, the Chinese government imposed ban of 24 categories of recyclables & solid wastes including plastic, textiles, mixed papers.

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RE - USE :-

Recoverable materials that are organic in nature, such as plant materials, food scraps, and paper products, can be recovered through composting and digestion processes to decompose the organic matter. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes.

In addition, waste gas from the process (such as methane) can be captured and used for generating electricity & heat maximising efficiencies. The intention of biological processing in waste management is to control and accelerate the natural process of decomposition of organic matter.

Reuse envelopes
Reuse single-sided paper for scratch paper
Reuse foam peanuts and other packing material
Use remanufactured or surplus office equipments
Use rechargeable batteries
Compost grass clippings and food waste
Donate old clothes, toys and other items to charity.
Use rechargable fax and printer cartilages.

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REDUCTION [Waste reduction or minimization] :-

Waste minimisation is a set of processes and practices intended to reduce the amount of waste produced. By reducing or eliminating the generation of harmful and persistent wastes, waste minimisation supports efforts to promote a more sustainable society. Waste minimisation involves redesigning products and processes and changing social patterns of consumption and production.

Traditional waste management focuses on processing waste after it is created, concentrating on re-use, recycling and waste to energy conversion. Waste minimisation involves efforts to avoid creating the waste during manufacturing. To effectively implement waste minimisation the manager requires knowledge of the production process, Cradle to Grave analysis, (the tracking of materials from their extraction to their return and details of the composition of waste.

PROCESSES

Reuse of scrap material. Scraps can be immediately re-incorporated at the beginnings of the manufacturing line so that they do not become a waste product. Many industries routinely do this.

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- Improved quality control and process monitoring steps can be taken to ensure that the number of reject batches is kept to a minimum. This is achieved by increasing the frequency of inspection and the number of points of inspection.

Waste exchanges, This is where the waste product of one process becomes the raw material for a second process. Waste exchanges represent another way of reducing waste disposal volumes for waste that cannot be eliminated.

Ship to point of use, this involves making deliveries of incoming raw materials or components direct to the point where they are assembled or used in the manufacturing process to minimise handling and the use of protective wrappings or enclosures.

Zero waste, this is a whole system approach that aims to eliminate waste at a source and at all points down the supply chain, with the intention of producing no waste. Since, globally speaking, waste as such, however minimal, can be prevented (there will always be an end of life even for recycled products), a related goal is **population prevention.**

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* WASTE HANDLING AND TRANSPORT :-

Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local government authorities, or by private companies for industrial and commerical waste. Some areas, especially those in less developed countries, do not have formal waste - collection systems.

- WASTE HANDLING PRACTICES :-

Curbside collection is the most common method of disposal in most European countries, Canada, New Zealand, United States, and many other parts of the developed would in which waste is collected at regular intervals by specialised trucks. This is often associated with curb - side waste segregation. In rural areas waste may need to be taken to a transfer station. Waste collected is then transported to an appropriate disposal facility. In some areas, vacuum collectetion is used in which waste is transported from the home or commerical premises by vacuum along small bore tubes. Systems are in use in Europe and North America.

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FINANCIAL MODEL :-

In most developed countries, domestic waste disposal is funded from a national or local tax which may be related to income, or property values. Commerical and industrial waste disposal is typically charged for a commerical service, often as an integrated charge which includes disposal costs. This practice may encourage disposal contractors to opt for the cheapest disposal option such as landfill rather than the environmentally best solution such as re-use and recycling.

In some areas such as Taipei, the city government charges its households and industries for the volume of rubbish they produce.

Waste is collected by the city council only if it is put in government issued rubbish bags. This policy has succesfully reduced the amount of waste the city produces and increased the recycling rate.

Morocco also have seen benefits from implementing a $300 million sanitary landfill system. While it might appear to be a costly investment, the country's government has saved $440 million in damages or consequences of failing to dispose the waste properly.

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DISPOSAL METHODS :-

LANDFILL -

A landfill is a site of the disopoasal of waste materials by burial. Landfill is the oldest form of waste treatment, although the burial of the waste is modern, historically refuse was simply left in the piles or thrown into pits. Historically, landfills have been the commonst method of organized waste disposal and remain so in many places around the world.

Some landfill sites are also used for waste management purposes, such as temporary storage, consolidation and transfer or for various stages of processing waste materials, such as sorting, treatment or recycling. Unless they are stabilized landfills may experience severe shaking or soil liquefaction of the ground during a large earthquake.

OPERATIONS

Operations of well-run landfills for non-hazardous waste meet predefined specifications by applying techniques to :-

Confine waste to as small an area as possible
Compact waste to reduce volume.

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They can also cover waste (usually daily) with layers of soil or other types of material such as woodchips and fine particles.

During landfill operation, a scale or weighbridge may weigh waste collection vehicles on arrival and personnel may inspect loads for wastes that do not accord with the landfill's wastes that do not accord with the landfills waste acceptance criteria. Afterwards, the waste collection vehicles use the existing road network on their way to the tripping face or working front, where they unload their contents.

After loads are deposited, compactors or bulldozers can spread and compact the waste on the working face. Before leaving the landfill boundaries, the waste collection vehicles may pass through a wheel-cleaning facility. If necessary, they return to weighbridge for re-weighing without their load. The weighing process can assemble statistics on daily incoming waste tonnage, which databases can retain for record keeping. In addition to trucks, some landfills may have equipment to handle railroad containers. The use of "rail-haul" permits landfills to be located at more remote sites, without the problems associated with many truck trips.

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SANITARY LADFILL LIFE CYCLE :-

The term landfill is usually shorthand for a municipal landfill or sanitary landfill. These facilities were first introduced early in the 20th century, but gained wide use in the 1960 and 1970's in an effort to eliminate open dumps and other "unsanitary" waste disposal practices. The landfill is an engineered facility that seperates and confines waste. Sanitary landfills are intended as biological reactors (bioreactors) in which microbes will break down complex organic waste into simpler, less toxic compounds over time.

Usually aerobic decomposition is the first stage by which wastes are broken down in a landfill. These are followed by four stages of anaerobic degradation. Usually, solid organic materials in solid waste decays rapidly as larger organic molecules degrade into smaller molecules. These smaller organic molecules begin to dissolve & move to the liquid phase, followed by hydrolysis of these organic molecules, and the hydrolyzed compounds then undergo transformation and volatilization as carbon dioxide (CO_2) and methane (CH_4) with rest of the waste remaining in solid and liquid phases.

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INCINERATION :-

Incineration is a disposal method in which solid organic wastes are subjected to combustin so as to convert them into residue and gaseous products. This method is useful for disposal of both municipal solid waste and solid residue from waste water treatment. This process reduces the volumes of solid waste by 80 to 95 percent. Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incinerators convert waste materials into heat, gas, steam and ash.

Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. It is recognized as a practical method of disposing of certain hazardous waste materials (such as biological medical waste). Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants.

In several countries, there are still concerns from experts and local communities about the environmental effect of incinerators pollutants.

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Incineration with energy recovery is one of several waste to energy technologies such as gasification, pyrolysis and anaerobic digestion. While incineration and gasification technologies are similar in principle, the energy produced from incineration is high temperature heat whereas combustion gas is often the main energy product from gasification. Incineration and gasification may also be implemented without energy and materials recovery.

In some countries, incinerators build just a few decades ago often did not include a materials seperation to remove hazardous, bulky or recyclabe materials before combustion. These facilities tended to risk the health of the plant workers and the local environment due to inadequate levels of gas cleaning & combustion process control. Most of these facilities do not generate electricity.

Incinerators reduce the solid mass of the original waste by 80-85% and the volume by 95-96% depending on composition and degree of recovery of materials such as metals from the ash for recycling.

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WASTE TO ENERGY :-

Energy recovery from waste is the conversion of non recyclable waste materials into usable heat, electricity or fuel though a variety of processes, including combustion, gasification, pyrolyzation, anaerobic digestion and landfill gas recovery. This process is often called waste to energy. Energy recovery from waste is part of the non-hazardous waste managagement hierarchy.

Using energy recovery to convert non-recyclable waste materials into electricity and heat, generates a renewable energy source and can reduce carbon emissions by offsetting the need for energy from fossil sources as well as reduce methane generation from landfills. Globally, waste to energy accounts for 16% of waste management.

Energy from waste is the process of generating energy in the form of electricity and heat from the primary treatment of waste, or the processing of waste into a fuel source. Wte is a form of energy recovery. Most waste to energy processes generate electricity and heat directly through combustion and produce combustible fuel such as methane, methanol, ethanol or

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synthetic fuels.

METHODS USED IN WASTE TO ENERGY :-

INCINERATORS - The combustion of organic material such as waste, is the most common implementation.

THERMAL TECHNOLOGIES -

Grasification - Produces combustible gas, hyrdogen and synthetic fuels.

Thermal depolymerization - Produces synthetic crude oil, which can be further refined.

Pyrolysis - Produces combustible tar | bio oil and chars.

Plasma arc gasification - PGP [Plasma gasification process] produces a rich syngas including hyrogen and carbon monoxide usable for fuel cells or generating electricity to drive the plasma arch, usable vitrified silicate and metal ignots salts and sulphur.

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NON THERMAL TECHNOLOGIES:-

Anaerobic digestion - Biogas rich in methane.

fermentation - fermentation produces gases like ethanol, lactic acid, hydrogen.

Mechanical Biological treatment (MBT) -
MBT + Anaerobic digestion
MBT to refuse derived fuel.

CARBON DIOXIDE EMISSIONS:-

In thermal WtE technologies, nearly all of the carbon content in the waste is emitted as Carbon Dioxide (CO_2) to the atmosphere (when including final combustion of the products from pyrolysis and gasification, except when producing bio-char for fertilization). Municipal solid waste contain approximately the same mass fraction of carbon as CO_2 itself (27%), so treatment of 1 metric ton (1.1 short tons) of MSW produces approximately 1 metric tons (1.1 short tons) of CO_2.

In the event that the waste was landfilled, 1 metric ton of MSW would produce approximately 62 cubic metres methane via anaerobic decomposition.

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PYROLYSIS :-

Pyrolysis is the thermal decomposition of materials at elevated temperatures in an inert atmosphere. It involves a change of chemical composition. The word is coined from the Greek derived elements 'pyro' means fire & 'lysis' means seperating.

Pyrolysis is the most commonly used in the treatment of organic materials. It is one of the processes involved in charring wood. In general, pyrolysis of organic substances produces volatile products and leaves a solid residue enriched in carbon, char. Extreme pyrolysis, which leaves mostly carbon as a residue is called as carbonization. Pyrolysis is considered as the first step in the processes of gasification or combustion.

The process is used heavily in the chemical industry, for example to produce ethylene, many forms of carbon and other chemicals from petroleum, coal, and even wood to produce coke from coal. Aspirational applications of pyrolysis would convert biomass into syngas and biochar, waste plastics back into usable oil, or waste into safely disposable substances.

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GENERAL PROCESS & MECHANISM :-

Pyrolysis is generally consists in heating the material above its decomposition temperature, breaking chemical bonds in its molecules. The fragments usually become smaller molecules, but may combine to produce residues with larger molecular mass, even amorphous convalent solids.

In many settings, some amount of oxygen, water or other substances may be present, so that combustion, hydrolysis or other chemical processes may occur besides pyrolysis proper. Sometimes those chemicals are added intentionally, as in the burning of firewood, in the traditionally manufacture of charcoal, and in the steam cracking of crude oil.

Conversely, the starting material may be heated in a vacuum or in an inert atmosphere to avoid adverse chemical reactions. Pyrolysis in a vacuum also lowers the boiling point of the byproducts, improving their recovery.

When organic matter is heated at increasing temperatures in open containers, the following processes generally occur,

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Below about 100°C, volatiles, including some water, evaporate. Heat sensitive substances such as Vitamin C & proteins may partially change or decompose.

At about 100°C, any remaining water that is merely absorbed in the materials is driven off. Water trapped in crystal structure of hydrates may come off at somewhat higher temperatures.

Some solid substances like fats, waxes and sugars may melt and seperate.

Between 100° & 500°C, organic molecules break down. Most sugars start decomposing at 160-180°C. Cellulose and lignin, The decomposition products usually include water, carbon monoxide and carbon dioxide.

At 200-300°C, if oxygen has not been excluded the carbonaceous residue may start to burn, in a highly exothermic reaction, often with no or little visible flames.

Once combustion, of the carbonaceous residue is complete, a powdery or solid mineral residue is often left behind, consisting of inorganic oxidized materials of high melting point.

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RESOURCE RECOVERY :-

Resource Recovery is the systematic diversion of waste, which was intended for disposal, for a specific next use. It is the processing of recyclables to extract or recovery materials and resources or convert to energy. These activities are performed at a resource recovery facility. Resource recovery is not only environmentally important, but it is also cost-effective. It decreases the amount of waste for disposal, saves space in landfills, and conserves natural resources.

Resource recovery uses LCA [life cycle analysis] attempts to offer also the alternatives to waste management. for mixed MSW [Municipal solid waste] a number of broad studies have indicated that administration, source seperation and collection followed by reuse and recycling of the non-organic fraction and energy and compost/fertilizer production of the organic material via anaerobic digestion to be the favoured path.

Application of rational and consistent waste management practices can yield a range of benefits include;

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Economic - Improving economic efficiency through the means of resource use, treatment and disposal and creating markets for recycles can lead to efficient practices in the production and consumption of products and materials resulting in valuable materials being recovered for reuse and the potential for new jobs and new business opportunities.

Social - By reducing adverse impacts on health by proper waste management practices, the resulting consequences are more appealing civic communities. Better social advantages can lead to new sources of employment and potentially lifting communities out of poverty especially in some of the developing poorer countries and cities.

Environmental - Reducing or eliminating adverse impacts on the environment through reducing, reusing and recycling and minimizing resource extraction can result in improved air and water quality and help in the reduction of greenhouse gas emissions.

Inter-generational Equity - following effective waste management practises can provide subsequent generations a more robust economy.

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* LIQUID WASTE MANAGEMENT :-

SEWAGE SLUDGE TREATMENT

Sewage Sludge Treatment describes the processes used to manage and dispose of sewage sludge produced during sewage treatment. Sludge is mostly water with lesser amounts of solid material removed from liquid sewage. Primary sludge includes settleable solids removed during primary treatment in primary clarifiers. Secondary sludge separated in secondary clarifiers includes treated sewage sludge from secondary treatment bioreactors.

Energy may be recovered from sludge through methane gas production during anaerobic digestion or through incineration of dried sludge, but energy yield is often insufficient to evaporate sludge water content or to power blowers, pumps or centrifuges required for dewatering. Coarse primary solids and secondary sewage sludge may include toxic chemicals removed from liquid sewage by absorption into solid particles in clarifier sludge. Reducing sludge volume may increase the concentration of some of these toxic chemicals in the sludge.

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WASTE HIERARCHY CHART

- Prevention
- Minimisation
- Reuse
- Recycling
- Energy recovery
- Disposal

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BIOGAS :-

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen (anaerobic respiration). Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste.

It is a renewable energy source and in many cases exerts a very small carbon footprint. Biogas is primarily methane (CH_4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulfide (H_2S) moisture and siloxanes. The gases methane, hydrogen and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel, it can be used for any heating purpose, such as cooking.

It can also be used in a gas engine to convert the energy in the gas into electricity and heat.

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SOLID WASTE IN INDIA :-

7.2 million tonnes of hazardous waste.

One sq km of additional landfill area every year.

Rs 1600 crore for treatment and disposal of these wastes.

In addition to this industries discharge about 150 million tonnes of high volume low hazard waste every year, which is mostly dumped on open low lying land areas.

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SUSTAINABLE SOLID WASTE IN INDIA :-

- Maharashtra 17.1%
- West Bengal 12.0%
- Uttar Pradesh 10.0%
- Tamil Nadu 9.0%
- Delhi 8.9%
- Andhra Pradesh 8.8%
- Karnataka 6.0%
- Gujarat 5.4%
- Rajasthan 3.8%
- Madhya Pradesh 3.5%
- Others 15.6%

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PLASTIC WASTE GENERATION :-

TOP 10 Cities

Delhi	(689 TPD)
Chennai	(429 TPD)
Kolkata	(425 TPD)
Mumbai	(408 TPD)
Bengaluru	(313 TPD)
Ahmedabad	(241 TPD)
Hyderabad	(199 TPD)
Surat	(149 TPD)
Kanpur	(106 TPD)
Pune	(101 TPD)

TPD :- Tonnes Per Day