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Economic Implications on the Composition of Municipal Solid Waste and its Management in Kota City

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ABSTRACT

An appropriate technology for waste management in developing countries not only reflects the concern over the operation and cost of machines imported from developed countries but also entails the social and environmental goals of sustainable development based on techniques appropriate to specific settings. In connection with much of the published data, the information is of only partial benefit to a designer or planner, since the national averages presented are applicable only very broadly to the entire nation; that is, to adequately design a solid waste management system for a particular locality comprehensive information about the solid waste in that locality must be obtained. Since solid waste reflect the life-style of the generating populace, the character and amounts of various components in the solid waste stream will vary from locale to locale in Kota city. This paper presents the findings of a study carried out in economically different localities in Kota city to determine the solid waste composition based on field surveys and its management.

Keywords-- Solid Waste Management, Socio-Economic Factors, Compost, Moisture Content, Waste Generation, Municipal Solid Waste, Recycle, Reuse

I. INTRODUCTION

Kota is a city located in the southeast of northern Indian state of Rajasthan. It is located Around 250 kilometers (155 mi) south of the state capital, Jaipur, situated on the banks of Chambal River. With a population of over 1 million, it is the third most populous city of Rajasthan after Jaipur and Jodhpur, 46th most populous city of India and 53rd most populous urban agglomeration of India. It serves as the administrative headquarters for Kota district and Kota Division.

The population density of the city is 374 persons per square kilometer. It has been encountering high growth rate of populace as of late and of the explanations behind that is the vast number of understudies to the city from various parts of the nation for either coaching or taking admission in a portion of the outstanding institutes of the city. Aside from this, the number of inhabitants is growing at a consistent rate and it is expected that the rate of population growth will keep on growing in a similar pace in the future.

To solve the problem of solid waste management in perspective, it is necessary to gather and present some basic data in regard to the amounts of solid waste which are generated in Kota today. These data should be considered necessary for the reason that any future system for collection and disposal of this refuse will have to be geared to the total amount and quantity of the materials produced. For example, selection of collection and transfer equipment, selection of routes for such equipment, choice of auxiliary equipment such as compactors and the overall economics of the procedure used for the collection and disposal can be economically determined only on the basis of adequate basic data.

While it appears that data on the categories and amounts of solid waste are quite necessary and desirable from the point of view of optimal planning and design, a survey of the engineering literature reveals that very little comprehensive data are available at the present time. The majority of the published data have come from governmental sources such as the Office of Solid Waste Management Programs. The lack of comprehensive data can be attributed to several factors:

1. The measurement and categorization of solid waste is inherently difficult since the material is heterogeneous and appears in seasonally variable quantities

2. There has been no development of a standardized method of gathering and presenting this data.
3. In many cases, the need for such data has not been recognized by persons or agencies which have the ability or opportunity to collect it and the information, therefore, has remained lacking.

Without a comprehensive compilation of data on solid waste generation characteristics, collection and disposal in a given area, it is impossible to fully appreciate the total problem of solid waste management in that area or to formulate an effective solution to it. Moreover it would be impossible to forecast future needs for management in the area of service. Finally, without adequate data on waste production, it is not feasible to attempt the formulation of any sort of scheme or plan for systematic waste collection and disposal or recycling.

Materials as Waste

1. Paper
2. Polythene
3. Vegetable/ Fruits
4. Dust
5. Plant
6. Cloth
7. Metal
8. Plastic
9. Glass

Magnitude of the Problem

Waste handling is a big problem all over the world. Be it liquid or solid it is a matter of great concern, as it contributes a lot in disturbing the eco-balance. The organic matter of different types of waste such as Municipal Solid Waste (MSW), food processing waste, and other industrial & agricultural waste can be converted into Bio-gas and fertilizers using anaerobic digestion technology.

Disposal problems become difficult with increase of population density. Simultaneously there is a greater production of waste per unit area and a decreased proportion of land available for its disposal. Therefore the history of solid waste management is largely connected with the histories of larger cities.

Human habitation generates large quantities of waste, which has a significant component of putrescible waste. In urban areas these waste are disposed of unscientifically by dumping them in low lying areas and injuring health and environment through land, water and air contamination.

Collection and disposal of urban solid waste is one of the major problems for the local governments all over India. Owing to lack of financial and human resources, Municipal Corporations fail to organize timely lifting, transportation and disposal of solid waste. Delay in lifting, results in spreading of pollution by stinking garbage heaps throughout the city. This situation causes a major threat to the public health.

The increased incidence of epidemics is a pointer for this situation. Moreover, irreparable damage is being caused to the ecosystem and therefore, a safe dependable waste management and disposal system is the need of the hour.

Existing Situation/ Problems

1. Waste is thrown in open dumps, back lanes, vacant plots, parks, road, pits, river/ canal, drains.
2. Waste is wrapped in polythene and disposed off when people go for walk/ work.
3. Very few households, shops, etc., have engaged private sweeper.

Knowing it fully well that the earth has finite capacity to support human life and that capacity is determined in large measure by the purity of air and water, present study will signify as part of national interest and will evaluate the aesthetic and economic factors affecting the solid waste generation. The management of solid waste is also discussed in the interest of nation.

II. REVIEW OF LITERATURE

The very first record to describe the characteristics of the different classes of refuse and to draw attention to the fact that, if a uniform method of nomenclature and record of quantities handled could be kept by various cities, then the data obtained and the information so gained would be a material advance towards the sanitary disposal of refuse. Such uniformity would not put any expense upon cities, and direct comparisons and correct conclusions could be made for the benefit of others. This statement of objective in itself does not seem too unusual, until it is realized that it was written in 1906 by H.de. B. Parsons in his book entitled, "The Disposal of Municipal Refuse".

During World War II, the U.S. Army Corps of Engineers, under the direction of Jean Vincenz, who then headed its Repairs and Utilities Division in Washington, modernized its solid waste disposal programs to serve as model landfills for communities of all sizes. But municipalities did not follow these programs with consistency.

A.J. Muhich, A.J. Klee and P.W. Britton in 1968 published "Preliminary Data Analysis" in their National Survey of Community Solid Waste Practices. Working for the same D.F. Bender, M.L. Peterson and H. Stierli (1973) published a book entitled, "Physical, Chemical and Microbiological Methods of Solid Waste Testing" which described various methods for the analysis of solid waste.

Solid waste is very heterogeneous in nature and its composition varies with place and time. Even samples obtained from the same place on the same day, but at different time may show totally different characteristics. Due to this reason the method by which the sample is collected and the number of sample collected is critical. Dennis E. Carruth and Albert J. Klee (1969) in their book

entitled, "Analysis of Solid Waste Composition", suggested a method of determining the number of samples by statistical technique.

R.F. Testin, G.F. Bourcier and K.H. Dale (1971) published their findings in their book entitled, "Recovery and Utilization of Aluminium from Solid Waste". They found that amount of aluminium currently being wasted amounts to about 20% of the total production capacity of the country per day while the ferrous metal wasted amounts to only 10% of the daily nationwide production. Furthermore, aluminium is more easily reprocessed than is other metallic scrap and represents a higher value of percentage of the production cost of recycled materials than do other types of metals.

John Pickford in 1983 published "Solid Waste Problems of Poor People in Third World Cities in Practical Waste Management", which described peculiar problems presented by collection of refuse as household waste are thrown out indiscriminately.

A.D. Bhide and B.B. Sundaresan in 1987 in "Solid Waste Management in Developing Countries" presented the changes in the characteristics of waste over the past two decades. The data showed the changes in the relative share of different constituents of waste in the past several decades. They stated that the percentage of recyclable waste is increasing in the municipal waste streams. This can be largely attributed to changing lifestyles and increasing consumerism. The strategy to deal with MSW in the country should therefore target maximizing recycling/ reuse efforts so that dependence on landfills for final waste disposal can be minimized.

G.P. Nagori and C.S. Rao in 1988 have suggested their views in "Biogas Manure Plants Based on Agricultural Residues". They suggested that few bio-gas systems are currently available to treat waste of fruit and vegetable origin. Though currently unfeasible as a large scale option, Bio-gas systems can effectively handle localized and specific waste and contribute to environment friendly disposal of waste.

III. METHODOLOGY

To carry out work in this study on "Economic Implications on the Composition of Municipal Solid Waste and its Management in Kota City" three different colonies of Kota were selected. The selected colonies were Sanjay Nagar (belonging to low income group); Talwandi (belonging to middle income group) and Vallabh Nagar (belonging to high income group).

Different income group regions as described above helped in gathering information about the difference in composition of the solid waste generated in these localities. Because of the heterogeneous nature of solid waste, determination of the composition is not an easy task. For this reason, a more generalized field procedure, based on common sense and random-sampling techniques, has been developed for determining composition.

To study for the same all the three selected localities were visited every alternate day in the morning before the arrival of sweeper. Household waste of the fifty houses in each selected colony were collected, segregated and weighed. Data were collected for two years and were analyzed for the comparison of waste generation in different localities.

The component categories reported in the literature are Paper, Polythene, Vegetables/ Fruits, Dust, Plant waste, Cloth, Plastic and Metal. Presence of these waste materials at various locations is indicated in **Table 1**.

Table 1: Location wise Material Waste

Location / Waste Material	Sanjay Nagar	Talwandi	Vallabh Nagar
Paper	√	√	√
Polythene	√	√	√
Vegetables/ Fruits	√	√	√
Dust	√	√	√
Plant	√	√	√
Cloth	√	√	√
Metal	X	√	√
Plastic	√	√	√
Glass	X	√	√

IV. OBSERVATION AND RESULT

The pooled analysis of individual waste collected per day per house from various locations of Kota during two years show that Vegetables/ Fruit waste is significantly higher at all locations. The amount of Glass and Metal is found negligible in lower income group colonies. The amounts of Cloth, Plastic, Glass and Metal wastes were immeasurable as compared to other wastes at all locations. Polythene waste was higher at Vallabh Nagar

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while it was at par at the other two locations. The paper waste was minimum at Sanjay Nagar while it was at par at the other two locations. The mean daily individual waste (in gms) per house is indicated in **Table 2**.

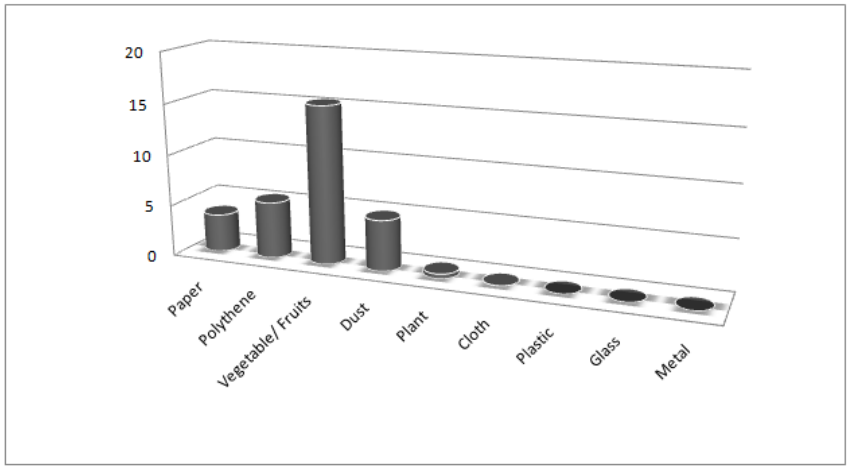
Table 2: Mean Daily Individual Waste (in gms) per House

Waste / Location	Paper	Polythene	Vegetable/ Fruits	Dust	Plant	Cloth	Plastic	Glass	Metal
Sanjay Nagar	3.705	5.505	15.401	4.965	0.441	0.043	0.001	*	*
Talwandi	7.053	5.901	212.975	5.650	2.081	0.103	0.025	0.038	0.020
Vallabh Nagar	8.223	8.164	419.174	6.224	0.290	0.011	0.004	0.032	0.001

***Negligible amount**

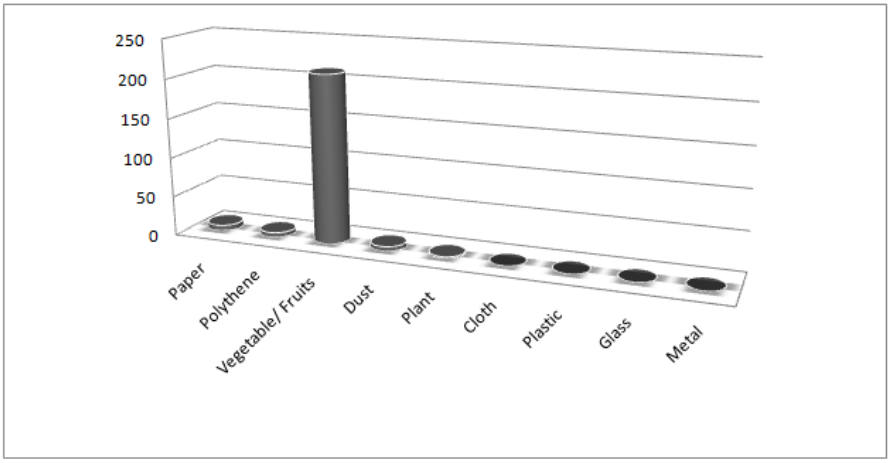
The composition of various wastes at Sanjay Nagar (belonging to lower income group) is shown in **Figure 1**. The amount of Vegetable/ Fruits waste is highest followed by Polythene, Dust, Paper and Plant. The amount of other wastes was negligible.

Figure 1: Composition of Waste at Sanjay Nagar



The composition of various wastes at Talwandi (belonging to middle income group) is shown in **Figure 2**. The amount of Vegetable/ Fruits waste is highest and the amount of all other wastes was negligible as compared to it.

Figure 2: Composition of Waste at Talwandi



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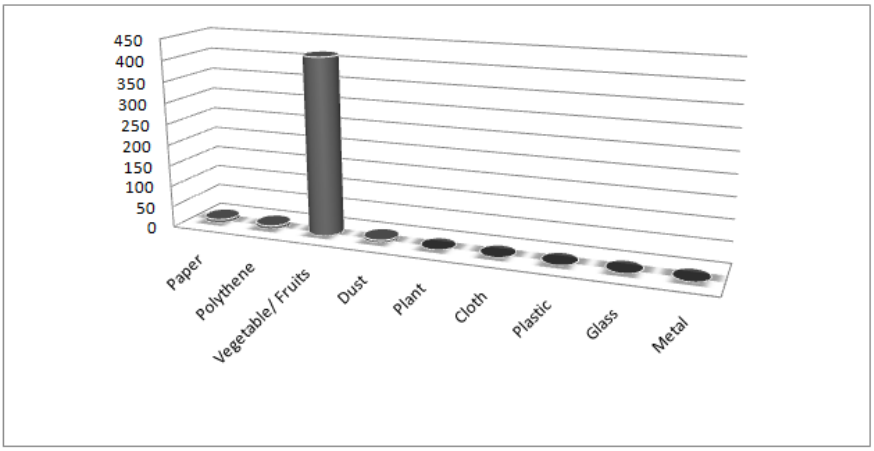
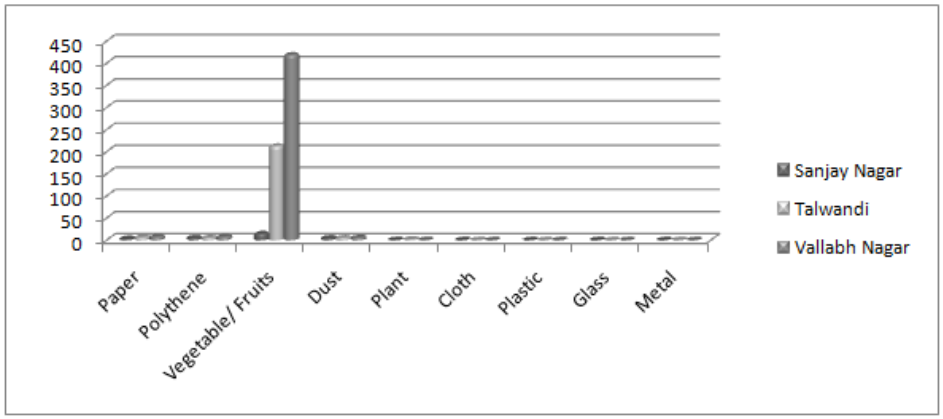
The composition of various wastes at Vallabh Nagar (belonging to higher income group) is shown in **Figure 3**. The amount of Vegetable/ Fruits waste is highest and the amount of all other wastes was negligible as compared to it.

Figure 3: Composition of Waste at Vallabh Nagar



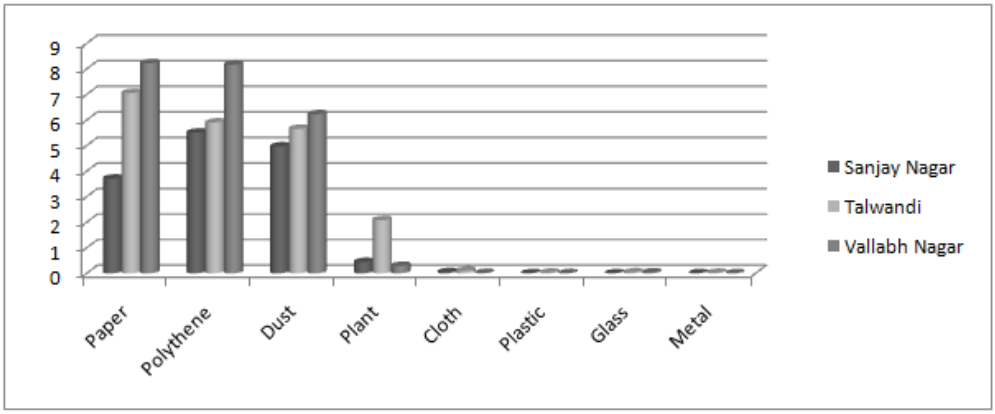
A comparison of the composition of various components of solid waste at various locations show that Vegetable/ Fruit waste is highest at all the locations with maximum at Vallabh Nagar and minimum at Sanjay Nagar. The same has been depicted in **Figure 4**.

Figure 4: Composition of Solid Waste at various Locations



On comparing the amounts of various wastes excluding Vegetable/ Fruit waste as the amount of all other wastes is negligible as compared to Vegetable/ Fruit waste, it was found that Paper and Polythene wastes comprises the highest percentage in all the three locations followed by Dust and Plant wastes. Rest all are in negligible amounts which are not thrown by the people on regular basis or might be reused or recovered for other purposes. Except Plant waste all other components of solid waste were maximum at Vallabh nagar and minimum at Sanjay Nagar. The same has been depicted in **Figure 5**.

Figure 5: Comparison of Solid Waste excluding Vegetable/ Plant waste at various Locations



V. DISCUSSION

The composition of solid waste means the different types of waste material that it consists of and their characteristics. It is important to understand the factors that affect the composition of solid waste in an area. These factors include the season of the year, the habits or culture of the community, people's educational or economic status and the geographical location.

The composition of solid waste affects the length of time that it can be safely stored before disposal. If kept uncovered for too long, some waste will become a health hazard or cause some other nuisance. Improper management of MSW by a community can have a significant impact on human health and the environment. For this reason, all the information on solid wastes, especially the sources, quantity and composition, are vital to the design and operation of the functional elements associated with the management of solid wastes.

Fruits and vegetables waste comprises the highest composition in all income group colonies as they are the most utilized commodities among all horticultural crops. They are consumed raw, minimally processed, as well as processed, due to their nutrients and health- promoting compounds. With the growing population and changing diet habits, the production and processing of horticultural crops, especially fruits and vegetables, have increased very significantly to fulfill the increasing demands. The waste is composed mainly of seed, skin, rind, and pomace, containing good sources of potentially valuable bioactive compounds, such as carotenoids, polyphenols, dietary fibers, vitamins, enzymes, and oils, among others. These phytochemicals can be utilized in different industries including the food industry, for the development of functional or enriched foods, the health industry for medicines and pharmaceuticals, and the textile industry, among others. The use of waste for the production of various crucial bioactive components is an important step toward sustainable development.

The leftovers which are tossed into the trash are a major source of landfill waste. Finding ways to recycle fruits and vegetables can make a significant dent in the amount of waste your household generates. Fruits and vegetables can easily be repurposed as compost. This use benefits the environment in several ways. First, it reduces landfill waste. Secondly, we can provide our garden and lawn with a high-quality source of organic material for reducing our use of chemical fertilizers. Since these foods are biodegradable, we can quickly realize the benefits of our decision to compost. In addition, our plants will be healthier and more resistant to parasites and pests, reducing our need to use pesticides. Fewer chemicals enter the public water supply system because of the less use of pesticides and fertilizers. All of these factors contribute to cleaner drinking water. Thirdly, by recycling fruits and vegetables, the amount of greenhouse gas emissions caused by rotting foods can be reduced. Because these foods are organic, they decompose quickly, releasing methane into the atmosphere. The Environmental Protection Agency (EPA) explains that methane is more dangerous to the environment than carbon dioxide because of its global warming potential. Thus the recycling of fruits and vegetables can reduce the amount of methane generated by landfills and thus, decreases the contribution to climate change.

Over the last couple of years, shortage of raw material, high capital investments, large energy requirements and environmental problems have shifted the focus from paper made of wood pulp to that made from agricultural residues and waste paper. About two-third of waste paper based Indian mills use imported waste paper because of its better quality in terms of fiber strength and also due to inadequate domestic supply. Also, waste paper based production is far less polluting. The biochemical oxygen demand values of the water effluent discharged from a waste paper mill is approximately 25 mg/liter, which is far below the value of 150 for agro based paper and 100 for wood based paper. Using waste paper requires

far less energy than that required by a process based on other raw material.

Given the current stress on liberalization and industrial growth, and the changing lifestyles, consumption levels are going to rise in the near future. The share of packaging paper has been continually rising over the past many years while that of writing and printing paper has been falling. This trend towards higher consumption of packaging paper is also evident from the increasing percentage of paper in MSW. About 6%-10% of the household waste consists of paper, which ends up being used for landfill along with most other types of waste because it is not sorted or separated. However, a small percentage of this which can be recycled and has not been spoiled by other waste is recovered by the vast network of rag pickers working specially in large towns and cities and recycled. Most old newspapers, magazines, books, etc., however, enter the recycling chain through kabariwallahs.

Unfortunately, even the major metropolitan cities in India have not been able to augment the recovery, sorting and bailing of waste paper. The recovery and recycling of waste paper has received little support, either institutional or governmental. In the absence of financial incentives and the latest technology, paper recycling industry remains an undeveloped industry.

Plastics in the form of bags and bottles make up a relatively small proportion of residential waste, but these present a major problem. Plastics do not degrade (or degrade at a very slow rate), and so they tend to accumulate in the streets and in watercourses. Plastic bags can also choke farm animals and wildlife if they are ingested.

Glass is among the preferred materials not only for its aesthetics but also for its own characteristics. Glass preserves taste and vitamins. As an inert material, it guarantees that food and beverages placed in glass containers are not stained by the packaging. It is also commonly used in the pharmaceutical industry to preserve the properties of medicines. In another side of the medical sector, optical glass helps improve the vision of millions of Europeans.

In construction as well, architects not only use large glazed areas for their energy-saving properties but also because they provide natural light into buildings which enhance living and working conditions of occupants. Studies show that glass in buildings, through all these benefits, contribute to people's well-being and improved health conditions.

VI. CONCLUSION, RECOMMENDATIONS AND FUTURISTIC APPROACH

In terms of solid waste management planning, knowledge of future trends in the composition of solid waste is of great importance. For example, if a paper recycling program were instituted on the basis of current distribution data and if paper production were to be eliminated in the future, such a program would more than likely become a costly "white elephant". Although this case is extreme, it nevertheless illustrates the point that the future trends must be assessed carefully in long-term planning. Another important question is whether the quantities are actually changing or only the reporting system has improved.

Whether or not you have an interest in the environment, you will not be able to escape news on it these days. More and more individuals are beginning to change the way they live their lives in a bid to do their bit. Whether they are recycling at home, buying from retailers with strong environmental policies or simply cutting back on chemicals in a bid for a healthier existence it appears the environment topic is not one that is going away, even for those who doubt global warming is a real issue.

In the 21st Century we are all working hard to improve our quality of life and hoping to leave something for our grandchildren's children to enjoy. We are all learning to put our recyclable goods in certain bins for suitable collection and opting for organic goods over ones full of pesticides. Businesses too are more environmentally conscious than ever before, not only because of legislation but also because consumers care. One of the ways businesses are being encouraged to help improve their corporation's responsibilities is by examining their waste products and finding ways to ensure they are not ending up in the landfill or contaminating the environment.

Vegetable/ Fruit Waste:

The quantity of residential food waste collected has changed significantly over the years as a result of technical advances and changes in public attitude. Recently, because the public has become more environmentally aware and concerned, a trend has developed toward the use of more raw, rather than processed, vegetables. Alternative uses for food waste, such as composting, have served to offset any increases in quantities produced.

Kitchen and vegetable waste have high moisture and organic content and are largely suited for anaerobic digestion. These wastes can be collected and treated at source, if space permits. The resulting bio-gas can be used for captive energy use such as lighting and cooking.

Paper Waste:

The percentage of paper found in solid waste has increased greatly in recent years. Using less paper can save your organization money and can also help with several environmental problems. Of all trees harvested for industrial use, 42% go to making paper. Unfortunately, the degradation of forests is only part of the story. The pulp and paper industry is also the largest industrial user of water, the biggest water polluter, and the third largest

emitter of global warming pollution in most industrialized nations .

Plastics Waste:

The percentage of plastics in solid waste has also increased significantly during the past 20 years. Future conditions surrounding the oil-producing industry will affect the production of plastics. The extent of any impact is at present unknown.

Metal Waste:

Scrap metal is a common by-product found in production. Rather than simply allowing this metal to fill up landfill sites the metal should be recycled. It has following advantages:

Scrap metal can be melted down and reused in various industries and for multiple uses. This reduces the need to create new metal which is environmentally intensive.

- The waste products produced when making metal are all bad for the environment. Reusing metal reduces the production of these waste products.
- Toxic fumes are created when manufacturing metal. By reusing instead of making more we cut down on the amount of pollution that is produced.
- Scrap metal is just as good as using newly produced metals, so why let it go to waste when it is perfectly usable?
- Recycling scrap metal is not only better for the environment; it can also be more affordable and cost effective for the buyer. In this case, everyone wins.

Glass Waste:

Glass is a wonderful substance. It can be recycled over and over again. The good thing about glass recycling is that the glass retains its quality. Cullet, better known as domestic glass, is the most common glass. A number of bottles of soda, juice and glass jars are used and wasted on daily basis. If we were to simply throw them away, the environment would suffer greatly. It is therefore important that the culture of recycling be kept alive.

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