CHAPTER-5

DEFICIENCIES IN EXISTING PACKAGING SYSTEM IN INDIA

There are few deficiencies which exist in existing packaging system and these are as follows:

1. Environmental issues
2. Packaging legislation
3. Financial constraints

5.1 ENVIRONMENTAL ISSUES:

Packaging of food and drink is used to make sure the contents get from the farm or the sea to people’s plates in good condition. It is just one part of the food supply system and cannot be considered in isolation. Over two thirds of packaging is used for food but the same principles apply to packaging for all items. Many different foods make up the total diet. Packaging and other technological developments have provided huge improvements in food quality and have extended the choice of foods over the seasons. People now have a choice of over 15,000 different product lines in a typical supermarket. The total consumption of food depends on people’s nutritional requirements and has hardly changed over the years:

- The range of types of food we eat is still fairly traditional,
- Limited by our digestive capabilities, we continue to eat roughly 10 times our body weight each year.

What has changed is people’s lifestyles and demographics, particularly the number of people who live in smaller households. It is obvious that the amount of food

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2 http://www.iip-in.com/
consumed per household depends mainly on the number of inhabitants. It is also obvious that larger households can buy bigger portion sizes than single people who tend to rely on smaller portion packs. However, it is not always appreciated that packaging has a significant effect on the environmental aspects of the food supply system. The environmental aspects are also affected by the food inside the pack and people's needs. Once opened, the quality of food deteriorates, so pack sizes have to be appropriate to the number of people who are going to eat the food at any one time. Even if the food does not deteriorate, most consumers like a variety of foods, so again smaller portions are desirable.

To get a better understanding of the relationship between packaging and the whole supply system, including the effects of demographic trends, we consider the government's survey. The main source of information was the government's National Food Survey which has provided continuous information on weekly shopping and food consumption, split by size of household (number of inhabitants) since 1940.

An extensive study of Indian food & supply chain i.e. kitchen sink' was carried out by a number of volunteers which was supplemented by information from companies and retailers, information from professor. The study was overseen by a Steering committee, which included representatives of consumer and environmental organizations. The initial results were reviewed by a group of 50 experts at a meeting in September 1995. Additional information from the National Food Survey and other government publications was included.

Ask any group of people what is in their dustbin and they will tell you "packaging". In terms of volume, it may be a corn flake box or a large bottle etc. But in terms of weight, packaging is less than a third of household waste.

Packaging is the largest, fastest growing, and most complex component of municipal solid waste (that is, municipal waste generated by homes and business, as opposed to industrial and as agricultural waste). Between 1970 and 1990, per

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1 http://www.statistics.gov/ssd/surveys/national_food_survey.asp
2 http://www.isb.edu/faculty/Working_Papers_pdfs/Can_India_be_the_Food_Basket_for_the_World.pdf
3 http://www.statistics.gov/ssd/surveys/national_food_survey.asp
capita consumption of bottles, cans, boxes, wrappers, and other packaging increased by 63 percent. In 2000, packaging accounted for more than 30 percent of the municipal solid waste stream\(^1\).

5.1.1) Components of municipal solid waste & types of packaging waste\(^2\):
Municipal solid waste consists of packaging, total durable, yard waste, food waste, total nondurable and miscellaneous inorganic. Out of these components waste, packaging is the main component as per the figure-5.a. Basic types of packaging waste consist of aluminium, wood, steel, glass, plastic and paper. Out of these paper is the main component which is used in packaging, as it is depicted in the table-5.b given as below.

![Figure-5.a](http://www.iip-in.com/)

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\(^1\) http://www.iip-in.com/
\(^2\) http://www.iip-in.com/
Packaging thus creates a unique opportunity for industry to assume a leadership role in solving the municipal solid waste crisis. The sheer volume of packaging in the municipal solid waste stream and also incremental improvements in packaging can make a real difference in solving the garbage crisis.

Business is a responsible practitioner of environmentally sound packaging. The reasons for assuming such a role is not merely altruistic. Many major corporations are building market share and achieving a competitive edge by demonstrating environmental consciousness in their packaging policies.

A number of steps companies have taken regarding the change in packaging policies in recent years and few of them are as follows:

- Coca-Cola company and PepsiCo, Inc. announced simultaneously that they would introduce bottles made with reused plastic. So, it became the first beverage companies to reuse plastic for containers.

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1 http://www.thehindubusinessline.com/catalyst/2008/01/24/stories/20080124500101.htm
Procter & Gamble has pioneered a number of environmental improvements in packaging by including the first major consumer product in a 100% recycled plastic bottles. P&G has reduced the amount of packaging in produces, by offering refills and concentrates. It is also committed to use at least 25% recycled content in the plastic bottles. Most important, it has helped to develop an infrastructure for recycling.

H. J. Heinz company replaced its multilayer plastic ketchup bottle with polyethylene terephthalate (PET) bottle that is more easily recyclable. The company expects to improve its 51% share of the $600 million American Ketchup market by prominently labeling the bottles as recyclable.

International paper has invented a paper package that not only is 10% cheaper than plastic containers but also extends the shelf life of juices, soups, cereals, and other plastic products. The composite paper package is designed to be recycled.

By focusing too much on packaging and household waste, people tend to ignore other wastes such as food waste. A typical family might throw away just over 4 kg of packaging in a week but it also throws away approximately the same amount of food\textsuperscript{1}. Consumer surveys show that people think a packaging as a necessary evil and ignore it. Consumer take packaging for granted. Consumers are also unaware of its positive contribution, which help them to have foods out of season, saving food preparation time in the kitchen and actually helping to reduce waste. Packaging has been under challenge on environmental grounds for a number of years. The industry has responded, not only by putting significant resources into recycling schemes, but also by continuing to reduce the use of resources in packaging. Much of the criticism of packaging is based on emotion and a lack of information.

Packaging has stimulated research and development by industry and has helped to identify areas for continuous improvement. Legislators have also responded to challenges the packaging but their input has not always been beneficial because

\textsuperscript{1} http://www.packagingdigest.com/article/CA659226.html?nid=3466
they have not taken account of the total production, supply chain and consumers’ needs\(^1\). There is a real danger that, far from helping the environment, current legislation on packaging could drive us into wasteful practices.

**The role of packaging**

Truly “bad” packaging from an environmental standpoint is a matter of extremes. Under-packaging is disastrous because it does not preserve and protect and over-packaging is equally problematic for its wastefulness and cost.

Packaging is the tool that protects and contains goods so that the environmental impact of our consumption is minimized. It is vital to the health and welfare of the consumer. However, packaging is a consumer’s resources but raw material and energy are costly to manufacturers. It is therefore in the self-interest of the manufacturer to reduce Waste at the source. “Light weighting” is a long-standing trend in packaging. Originally it was adopted in order to reduce energy and materials costs but it has additional environmental benefits as well.

Most household use dozen of packaged items every day, and two-thirds of all packaging is used to protect food\(^2\). In developing countries, between 30 and 50% of food shipments are spoiled because of inadequate storage and distribution systems. In more developed countries with sophisticated packaging and distribution, only 2-3 percent of food shipments are wasted\(^3\). The growth of the packaging led to a significant change in the way products are sold and marketed. Due to rise in labour costs, the retail industry has moved in the direction of discount and shelf service department stores. As a result, product packaging came to assume a new role of informative packaging. In many cases, the new marketing function meant a different form of packaging. Consumer goods were no longer manually wrapped in tissues and boxed by a sales clerk but packaged at the factory.

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1. [http://www.isb.edu/faculty/Working_Papers_pdfs/Can_India_be_the_Food_Basket_for_the_World.pdf](http://www.isb.edu/faculty/Working_Papers_pdfs/Can_India_be_the_Food_Basket_for_the_World.pdf)
2. [http://www.foodproductiondaily.com/Processing/New-active-sensor-has-many-food-sector-uses-claims-ITW/?c=iryxuw%2Flhwec69xfryrvm0g%3D%3D](http://www.foodproductiondaily.com/Processing/New-active-sensor-has-many-food-sector-uses-claims-ITW/?c=iryxuw%2Flhwec69xfryrvm0g%3D%3D)
in display boxes that went from retail shelf to home. This was a major revolution in product packaging.

There have been revolutionary developments in packaging. Product tampering is a new way of packaging innovation. To develop tampering: both through material and design, packaging will have the gentlest impact on the natural environment. While the sheer volume of municipal solid waste is the most obvious and visible problem for environment, the public is rightly concerned about many related environmental problems such as the toxicity of landfills, the depletion of scarce or nonrenewable resources, litter, pollution, ozone depletion, and wildlife endangerment. The brief history of these concerns, as well as the industry and legislative responses are as follows:

Table 5.1

Growing concern: the revolution of trends in the packaging industry

<table>
<thead>
<tr>
<th>Decade</th>
<th>Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>The'60s</td>
<td>• Convenience as a basis of competition-“Throw away society”</td>
</tr>
<tr>
<td></td>
<td>• POP marketing-“The silent salesman”</td>
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<tr>
<td>The'70s</td>
<td>• Fragile assessment-analytical design for movement</td>
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<td></td>
<td>• Energy shortage-light weighting</td>
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<td>The'80s</td>
<td>• Malicious tampering-“safe” packaging</td>
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<tr>
<td></td>
<td>• Extended shelf life-barrier technology; controlled atmosphere technology</td>
</tr>
<tr>
<td></td>
<td>• Quality-sensory issues</td>
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<tr>
<td></td>
<td>• Industry restructuring-“evaporation” of resources</td>
</tr>
<tr>
<td>The'90s</td>
<td>• Environmental issues</td>
</tr>
</tbody>
</table>

1 http://www.packagingtoday.com/introenvironment.htm
Responding to the municipal solid waste crisis

The industry response to the municipal solid waste crisis has been multifold and includes the following initiatives:

- Research & development
- Joint venture with recyclers
- Public education/promotion
- Voluntary labeling
- New products & packaging concepts

Legislation initiatives have paralleled the industry’s work in public education, R&D, and product labeling. Additionally legislative also provided a system of financial incentives and disincentives to both industry and consumers. Public sector supported the curbside of recycling and in many cases it has imposed mandatory source separation laws and even fines for noncompliance.

5.1.2) Material: limitations and opportunities

The opportunities for environmental advances in packaging are as limitless and varied as the materials themselves. Beyond the most basic materials such as paper, glass, aluminum, steel, and plastics of all kinds, there is a dizzying array of new composite materials. These composite materials are such as the combinations of paper and aluminum, plastic and paper and so on which can be tailored/used for any packaging specification.

Packaging materials and designs have traditionally been selected on criteria such as consumer appeal, convenience, utility and cost. A new set of design and selection criteria is the environmental consequences of the manufacturer, use or post use fate of the packages. It is the material and the way it is constructed that determines the environmental impacts of the package. There should be a check on

1 http://envfor.nic.in/legis/hsm/mswmhr.html
2 http://www.indiaenvironmentportal.org.in/content/implementing-integrated-solid-waste-management-systems-india-moving-towards-regional-approac
material in turn to provide a better understanding of the environmental issues surrounding their production, their transformation into packaging and their disposal. The types of packaging material are as follows:

- Paper
- Glass
- Plastic
- Metal

1) Environmental issues in paper packaging

Paper is the most familiar and widely used packaging material. Paper accounts for 47 percent of all packaging\(^1\). Packaging accounts for more than half of the paper manufactured today, whether in the form of milk carton, take-out food containers, gift boxes or heavy corrugated cartons\(^2\). In year 2000, shipments of paper packaging are estimated at $39 billion. In spite of losing market share to plastics, the use of paper as a packaging material overall continues to grow\(^3\).

Paper accounts for 54 percent by weight and 47 percent by volume as a portion of all solid waste in landfills- including newspapers, office waste, and other paper products as well as packaging\(^4\). Clearly, paper represents the largest opportunity for waste reduction and recycling in the packaging industry.

The general perception of consumer is that paper packaging is environment friendly because paper is biodegradable. If paper is exposed to air and water, paper certainly will biodegrade, although wax and plastic coatings slow the process considerably. However, the paper that goes into landfills is largely sealed off from the elements and has little chance of degrading, even over many decades. Archaeological digs into landfills have turned up thirty-year-old newspapers that

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\(^1\) [http://findarticles.com/p/articles/mi_m3765/is_n2_v14/ai_11190346/pg_1/](http://findarticles.com/p/articles/mi_m3765/is_n2_v14/ai_11190346/pg_1/)

\(^2\) [http://findarticles.com/p/articles/mi_m3765/is_n2_v14/ai_11190346/pg_2/](http://findarticles.com/p/articles/mi_m3765/is_n2_v14/ai_11190346/pg_2/)

\(^3\) [http://www.indiamarkets.com/imo/industry/packaging/market.asp?display_content_link=0&search_link=0](http://www.indiamarkets.com/imo/industry/packaging/market.asp?display_content_link=0&search_link=0)

were still intact, and quite legible\(^1\). Biodegradability becomes a more useful concept where roadside and marine litter are concerned.

Consumers also favor paper packaging because it is recyclable. However, paper packaging is often made from recycled waste-papers, of which the most important sources are corrugated boxes and old newspapers. Used corrugated boxes, which are easily separated from other kinds of papers are the largest single source of wastepaper and are part of a well-established recycling infrastructure\(^2\). In 1990 alone, almost 11 million tons of corrugated boxes were recycled by paperboard mills\(^3\). However, household paper packaging waste has not been widely recycled for two reasons and these are as follows\(^4\):

1.) The collection infrastructure does not yet exist, and

2.) The materials are not clearly defined. Household paper packaging may be made from virgin fibers, recycled newsprint, corrugated or some combination of these. Inks and coating make the sorting process even more problematic.

During World War II, waste paper recycling increased to provide material in response to a very high demand for paperboard packaging\(^5\). By this way packaging is once again receiving special attention because of environmental concerns. Recyling offers a major opportunity to conserve energy and water while preserving natural resources. For every ton of recycled paper used, an estimated ten to seventeen trees are spared\(^6\).

2) **Environmental issues in glass packaging**

As a packaging material, glass holds many advantages such as it is rigid, transparent, inert, impermeable, odorless and microwavable. Consumers view glass as a premium packaging material. Glass is the material of choice for wines,
sauce and many other types of food. Now glass is especially in foods and soft drinks markets losing its market by aluminum and plastic. There may be two reasons of losing the glass market which are as follows:

- One reason is the faster fill rate of aluminum cans; that is, it is quicker to fill a can than a bottle.
- Secondly, because of its greater volume and weight, glass is costlier to ship. The aluminum can represent a compact way.

In addition, glass has benefited from a number of new applications, particularly for microwave cooking. The glass containers and its contents can be warmed in the microwave. The product sold in glass jars, illustrate the successful new marriage of glass and the microwave oven. Consumers are attracted to the glass containers because, unlike cans, they are resealable and leftovers can be stored in the refrigerator without creating an odor problem. Glass is also recyclable. Unlike paper, which is weakened by the process, it loses none of its strength in recycling and can be used over and over again to make new containers.

There are a number of reasons why glass is not practiced in the industry:

- One reason is because of higher cost.
- Another problem in glass recycling is that glass containers must be separated by color and this has been invariably a manual process. Coloring agents are used to protect the bottled product from the effect of sunlight-green bottles, for example, green bottles contain ferrous sulfate or chromic oxide, while brown or amber bottles contain ferric oxide.

The easiest place to separate glass is at the household level or at the food service establishment, although collection agencies also do this work, by hand.

Theoretically, it is possible to separate the different coloured glasses using light.

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1 http://www.wasteonline.org.uk/resources/InformationSheets/Glass.htm
3 http://www.wasteonline.org.uk/resources/InformationSheets/Glass.htm
4 http://www.theglassrecyclingcompany.co.za/
waves, since each colour is associated with a different wavelength. Research has already been conducted in automated separation systems but none have found their way into commercial use, however, hand sorting continues at the collection agencies.

Reusable bottles need to be thicker and stronger than one way bottles. A thicker bottle takes more energy and raw material to make and is heavier and costlier to ship. However, the overall potential energy in saving of refilling versus recycling the bottle may help to bring the refillable back into favour. It should be noted that the glass melting process releases large amount of carbon dioxide and therefore poses the danger of contributing to global warming. The refillable bottle may hold out a solution to this problem. Light weighting is another important trend in the glass container industry. The average 16-ounce non-refillable bottle weighted just over 9 ounce in 1995, by 2000, the weight had been shaved to just over 7 ounce, and the downward trend is continuing. Glass maker have to maintain the strength of glass containers while making them ever thinner.

The greatest competitive advantage that glass enjoys over other material is its inertness to a variety of food and non food products. Acidic foods will readily react with metals and will alter the taste of the food. Components of plastics will leach into some foods, again altering the taste of the product. The clarity and visibility afforded by glass make it premium packaging material for many foods and beverages. In addition, its impermeability to oxygen and other gases is important, especially for beer and carbonated beverages. It is a low-cost container, and its raw materials are in abundant supply throughout the world.

On the negative side are the weight and breakability of glass. The expense of transporting cullet may take it less attractive for glassmaker to use recycled materials, although it can be argued that the cost of not recycling are far greater to society.

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1 http://www.wasteonline.org.uk/resources/InformationSheets/Glass.htm
2 http://www.wasteonline.org.uk/resources/InformationSheets/Glass.htm
3 http://www.wasteonline.org.uk/resources/InformationSheets/Glass.htm
3) Environmental issues in plastic packaging

Plastics in their many forms are the third most fastest-growing and common family of packaging materials, following paper and glass. Plastics account for 14.5 percent of all packaging materials\(^1\).

Plastics used in packaging may be one of several possible polymers. The following are the most common types in order of highest to lowest market share, along with examples of typical applications\(^2\):

- **Low-density polyethylene (LDPE)**-a flexible packaging used in films, wraps, trash bags and coated papers, as well as in some lid stock.
- **High-density polyethylene (HDPE)**-a translucent material used in milk and detergent bottles.
- **Polypropylene (PS)**-a stiff, heat and chemical-resistant substance. It is used in tubs and syrup bottles, as well as in films for food packaging.
- **Polystyrene (PS)**-a foam packaging material with excellent thermal properties. It is used in foam coffee cups, lids, food trays as well as in nonfoamed clear food trays.
- **Polyethylene terephthalate (PET)**-a tough and shatterproof material. It is used in soft drink bottles, as well as in food and medical containers.
- **Polyvinyl chloride (PVC)**-a clear and stiff packaging material used in water and cooking oil bottles as well as in meat wrap.

The growth of the plastic containers has to do with a number of appealing characteristics that have won it market acceptance. Plastic is relatively unbreakable and for due to this reason it has displaced glass as the containers of choice. Plastic is lightweight and durable. It can be either clear or opaque, smooth or textured, white or brightly colored. The widespread acceptance of plastic garbage bags and the displacement of paper grocery bags by plastic is because plastic is moisture-resistant.

\(^1\) [http://www.fao.org/WAIRDOCS/X5403E/x5403e06.htm](http://www.fao.org/WAIRDOCS/X5403E/x5403e06.htm)
\(^2\) [http://www.wasteonline.org.uk/resources/InformationSheets/Packaging.htm](http://www.wasteonline.org.uk/resources/InformationSheets/Packaging.htm)
The worldwide effort is made by supermarkets and industry to replace conventional oil-based plastic with eco-friendly "bioplastics" made from plants but it results in causing environmental problems and consumer confusion\(^1\). The substitutes increased emissions of greenhouse gases on landfill sites. Some need high temperatures to decompose and others cannot be recycled in India. Many of the bioplastics are also contributing to the global food crisis by taking over large areas of land which was used to grow crops for human consumption.

The market for bioplastics, which are made from maize, sugarcane, wheat and other crops, is growing by 20-30% a year\(^2\). The industry, which uses words such as "sustainable", "biodegradable", "compostable" and "recyclable" to describe its products means bioplastics saves 30-80% of carbon as compared with conventional oil-based plastics and also extend the shelf-life of food\(^3\).

Pla is another form of plastic which is used by some of the biggest supermarkets and food companies, including Wal-Mart, McDonald's and Del Monte. It is also used by Marks & Spencer to package organic foods, salads, snacks, desserts, and fruit and vegetables. Pla Made from GM crops, it looks identical to conventional polyethylene terephthalate (Pet) plastic\(^4\).

Recycling companies said to invest in expensive new equipment to extract bioplastic from waste for recycling. "If we could identify them, than the only option would be to landfill them," said one recycler who asked to remain anonymous\(^5\). The plastics industry argues that the majority of plastic packaging can be recycled and does not create a significant burden on the environment. According to Environment and Plastics Industry Council\(^6\), "packaging is necessary to prevent contamination or spread of bacteria in foods and that industry has taken major steps to reduce its impact on the environment in recent years.

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\(^2\) http://www.guardian.co.uk/environment/2008/apr/26/waste.pollution
\(^3\) http://www.guardian.co.uk/environment/2008/apr/26/waste.pollution
\(^4\) http://www.fao.org/WAIRDOCS/X5403E/x5403e06.htm
\(^5\) http://www.wasteonline.org.uk/resources/lnformationSheets/Plastics.htm
d) Environmental issues in metal packaging

Aluminium: Aluminium is commonly used to make cans, foil, and laminated paper and plastic packaging. Aluminum is a lightweight, silvery white metal derived from bauxite ore, which exists in combination with oxygen as alumina. Magnesium and manganese are often added to aluminum to improve its strength properties. Unlike other metals, aluminum is highly resistant to most forms of corrosion. Its natural coating of aluminum oxide provides a highly effective barrier to the effects of air, temperature, moisture, and chemical attack. Besides providing an excellent barrier to moisture, air, odors, light, and microorganisms, aluminum has good flexibility, surface resilience, excellent malleability, formability and outstanding embossing potential. It is also an ideal material for recycling because it is easy to reclaim and process into new products. Pure aluminum is used for light packaging of primarily soft-drink cans, pet food, seafood, and prethreaded closures. The main disadvantages of aluminum are its high cost compared to other metals (for example, steel) and its inability to be welded, which renders it usefulness only for making seamless containers.

Tinplate: Tinplate is produced from low-carbon steel (which is black plate), tinplate is the result of coating both sides of black plate with thin layers of tin. The coating is done by dipping sheets of steel in molten tin (hot-dipped tinplate) or by the electro-deposition of tin on the steel sheet (electrolytic tinplate). Tin provides steel with some corrosion resistance. Tinplate containers are often lacquered to provide an inert barrier between the metal and the food product. Commonly used lacquers are materials in the epoxy phenolic and oleoresinous groups and vinyl resins. In addition to its excellent barrier properties to gases, water vapor, light, and odors, tinplate can be heat-treated and sealed hermetically, making it suitable for sterile products. Tinplate can be used for containers of many different shapes.
because it has good ductility and formability. Thus, Tinplate is widely used to form cans for drinks, processed foods, and aerosols. It is also used as containers for powdered foods, sugar or flour-based confections and as package closures. Tinplate is an excellent substrate for modern metal coating and for litho printing technology, by enabling outstanding graphical decoration. It is relatively low weight and high mechanical strength which make it easy to ship and store. Finally, tinplate is easily recycled many times without loss of quality and it is significantly lower in cost than aluminum.

Tin-free steel: It is also known as electrolytic chromium or chrome oxide coated steel. Tin-free steel requires a coating of organic material to provide complete corrosion resistance. Even though the chrome/chrome oxide makes tin-free steel unsuitable for welding but this property makes it excellent for adhesion of coatings such as paints, lacquers, and inks. Like tinplate, tin-free steel has good formability and strength, but it is marginally less expensive than tinplate. Food cans, can ends, trays, bottle caps, and closures can all be made from tin-free steel. In addition, it can also be used to make large containers (such as drums) for bulk sale and bulk storage of ingredients or finished goods.

Material characteristics with its marketing issues, environmental issues and cost of packaging are described in table-5.2.
<table>
<thead>
<tr>
<th>Material</th>
<th>Product characteristics/food compatibility</th>
<th>Consumer/marketing issues</th>
<th>Environmental issues</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>Impermeable to moisture and gases</td>
<td>Free publicity hence</td>
<td>Heavy and bulky in</td>
<td>Low cost material</td>
</tr>
<tr>
<td></td>
<td>Transparent allows cycling of product</td>
<td>Relatively difficult to</td>
<td>Large and bulky in</td>
<td>but more</td>
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<tr>
<td></td>
<td>Non-reactive to chemicals</td>
<td>difficult to dispose</td>
<td>Large and bulky in</td>
<td>expensive.</td>
</tr>
<tr>
<td></td>
<td>Can react with foods, cooking required</td>
<td></td>
<td>Large and bulky in</td>
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<td></td>
<td>* Non-reactive to chemicals</td>
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<td>Large and bulky in</td>
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<td></td>
<td>Non-reactive to chemicals</td>
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<td>Large and bulky in</td>
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<td>Non-reactive to chemicals</td>
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<td>Large and bulky in</td>
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<tr>
<td></td>
<td>Non-reactive to chemicals</td>
<td></td>
<td>Large and bulky in</td>
<td></td>
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<tr>
<td>Tinfoil</td>
<td>Impermeable</td>
<td>Easy to decorate</td>
<td>Recyclable</td>
<td>Heavier than</td>
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<td></td>
<td>Strong, and flexible</td>
<td></td>
<td>Magnetic than</td>
<td>aluminium</td>
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<tr>
<td></td>
<td>Highly resistant to corrosion</td>
<td></td>
<td>Magnetic than</td>
<td>aluminium</td>
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<td>* Non-reactive to chemicals</td>
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<td></td>
<td>Non-reactive to chemicals</td>
<td></td>
<td>Magnetic than</td>
<td>aluminium</td>
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<tr>
<td>Polyethylene</td>
<td>Good modulus barrier</td>
<td>Light weight</td>
<td>Recyclable</td>
<td>Heavier than</td>
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<td></td>
<td>Strong</td>
<td></td>
<td>Magnetic than</td>
<td>aluminium</td>
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<td>* Non-reactive to chemicals</td>
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<td>Non-reactive to chemicals</td>
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<td>Magnetic than</td>
<td>aluminium</td>
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<td></td>
<td>Non-reactive to chemicals</td>
<td></td>
<td>Magnetic than</td>
<td>aluminium</td>
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<tr>
<td>Polypropylene</td>
<td>High barrier to moisture and gases</td>
<td>High clarity</td>
<td>Recyclable</td>
<td>Inexpensive but</td>
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<tr>
<td></td>
<td>Strong</td>
<td></td>
<td>Magnetic than</td>
<td>higher cost among</td>
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<tr>
<td></td>
<td>* Non-reactive to chemicals</td>
<td></td>
<td>Magnetic than</td>
<td>plastics.</td>
</tr>
<tr>
<td></td>
<td>Non-reactive to chemicals</td>
<td></td>
<td>Magnetic than</td>
<td></td>
</tr>
<tr>
<td>Polyethylene</td>
<td>High barrier to moisture and gases</td>
<td>Non-reactive to chemicals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Non-reactive to chemicals</td>
<td></td>
<td>Magnetic than</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-reactive to chemicals</td>
<td></td>
<td>Magnetic than</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-reactive to chemicals</td>
<td></td>
<td>Magnetic than</td>
<td></td>
</tr>
</tbody>
</table>


Table 5.2: Properties, Environmental issues and cost of packaging materials.
<table>
<thead>
<tr>
<th>Material</th>
<th>Product characteristics/food compatibility</th>
<th>Consumer/marketing issues</th>
<th>Environmental issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene</td>
<td>* Available in rigid film and foam form</td>
<td>* Good clarity</td>
<td>* Recyclable</td>
</tr>
<tr>
<td>Polyamide</td>
<td>* Strong</td>
<td></td>
<td>* Requires separating from waste</td>
</tr>
<tr>
<td>Ethylene and alcohols</td>
<td>* High barrier to gases and odours</td>
<td>* Low moisture-barrier sensitivity</td>
<td>* Requires separating from waste</td>
</tr>
<tr>
<td>PLA</td>
<td>* Biodegradable hydrolyzable</td>
<td></td>
<td>* Recyclable</td>
</tr>
<tr>
<td>Paper &amp; paperboard</td>
<td>* Very good strength-to-weight characteristics</td>
<td>* Recycled content makes it unsuitable for food contact material</td>
<td>* Requires separating from waste</td>
</tr>
<tr>
<td>Laminates/coatings</td>
<td>* Properties can be tailored for product needs</td>
<td>* Flexible in design and characteristics</td>
<td>* Relatively expensive for purpose</td>
</tr>
</tbody>
</table>

*All thermoplastic are technically recyclable and are recycled at the production environment, which contributes to lower cost. As inexpensive materials, postconsumer recycling competes with ease of separating and cleaning in mind.*
5.1.3) INFRASTRUCTURE: LIMITATIONS AND OPPORTUNITIES

One of the major challenges society faces is building an infrastructure for sound environmental practices. Without it, all of the environmental consciousness of corporations, legislatures, and consumers amounts to no more than good intentions. For business, it means finding ways of making a return on investment while making thoughtful use and re-use of materials so that the recycled container and its by-products pay their own way back through the system. For government, it means creating the incentive systems to support and encourage such an infrastructure and to distribute responsibility fairly among all participants.

Can the government now apply incentives and innovations to create a kind of reverse distribution and collection? After all it is possible to distribute a product over a wide area to a diverse population of end users, why should it not be possible to get the refuse from that product back to its source?

On closer examination, the problem is much more complex. Recycling is not always a closed loop; that is PET bottles are generally not remade into new PET bottles (although Aluminum cans are typically recycled into more cans). Recycling is less meaningful when plastic milk packs are converted into detergent bags and virgin material is required to make each new milk pack.

This is one of the issues to be faced as our society works to build a sound waste management infrastructure. A partial infrastructure exists for reclaiming certain packaging materials, as well as for incineration and other disposal options.

5.1.3.1) Waste management options

Proper waste management is important to protect human health, the environment and to preserve natural resources. EPA strives to motivate behavioral change in solid waste management through non-regulatory approaches, including pay-as-you-throw and Waste Wise. In pay-as-you-throw systems, residents are charged

1 http://www.wastecountr.org.uk/resources/Wasteguide/mn_wmo_overview.html
for MSW services on the basis of the amount of trash they discard. This creates an
incentive to generate less trash and increase material recovery through recycling
and composting. On average, communities with pay-as-you-throw programs
achieve waste reductions of 14% to 27% per year\(^1\).

From a regulatory stand point, EPA guidelines for solid waste management
emphasize the use of a hierarchical, integrated management approach as follows:\(^2\):

1.) **Source reduction**

2.) **Recycling**

3.) **Composting, combustion, and land filling.**

As waste disposal methods, combustion & land filling are governed by regulations
issued under subtitle D of the Resource Conservation and Recovery Act\(^3\).

1.) **Source reduction**

Source reduction (that is, waste prevention) is reducing the amount and/or toxicity
of the waste generated by changing the design, manufacture, purchase, or from the
original materials and products. EPA considers source reduction as a best way to
reduce the impact of solid waste on the environment because it avoids waste
generation altogether. Source reduction encompasses using less packaging,
designing products to last longer, and reusing products and materials (EPA 2002)\(^4\).

Source reduction has many environmental benefits, including conservation of
resources, protection of the environment, and prevention of greenhouse-gas
formation. Specific ways to achieve source reduction includes: light weighting
packaging materials, purchasing durable goods, purchasing larger sizes (which use
less packaging per unit volume) or refillable containers, and selecting toxic-free
products.

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\(^1\) Kumar, S. and Gaikwad, S.A (2004), *Municipal Solid Waste Management in Indian: An
Approach for Betterment*, Atlantic Publishers & Distributors, New Delhi, p.117.


\(^3\) [http://ec.europa.eu/environment/waste/studies/pdf/climate_change.pdf](http://ec.europa.eu/environment/waste/studies/pdf/climate_change.pdf)

\(^4\) [http://www.wasteonline.org.uk/resources/Wasteguide/mn_wmo_overview.html](http://www.wasteonline.org.uk/resources/Wasteguide/mn_wmo_overview.html)
Light weighting: One way to achieve source reduction is through light weighting, which uses thinner gauges of packaging materials either by reducing the amount used or by using alternate materials. According to EPA (2004), Inc. average weight of glass containers decreased by nearly 50% from 1992 to 2002. Similarly, aluminum cans were 26% lighter in 2005 than in 1975, with approximately 34 cans being made from 1 pound of aluminum, up from 27 cans in 1999. Light weighted their 24-ounce aluminum cans in 2003, which resulted in reducing the use of aluminum by 5.1 million pounds\(^1\). The amount of aluminum used in foil lamination has also been reduced. Moreover, steel cans have been light weighted, with cans now at least 40% lighter than those of 1970. The amount of tin has been drastically reduced from 50 pounds of tin per ton of tinplate steel to a current average of 6 pounds per ton after pre-World War II\(^2\). Despite being relatively new packaging materials, plastic containers have reduced in weight as well. The weight of 2-L PETE soft drink bottles has decreased by 25% (from 68 to 51 g) since 1977, resulting in a savings of more than 206 million pounds of plastic packaging each year\(^3\). Similarly, the 1-gallon plastic milk jug has undergone a weight reduction of 30% in the last 20 years\(^4\). Light weighting has been achieved in the paperboard industry by using thinner gauge materials. For example, one inc. saved 7.5 million pounds of paperboard by decreasing the packaging thickness of 12-pack bottle (EPA 2004)\(^5\).

Reusable and refillable containers: Another way to achieve source reduction is through reuse. For example, some glass containers, especially bottles, are frequently reused after washing with powerful detergents. Plastic refillable containers are commonly made from PETE, PEN, high-density polyethylene from the polycarbonate, although its use is on the decline\(^6\). This is partly because

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\(^1\) Kenneth Dr. J. N. (2005), "Food Packaging-Roles, Material and Environmental issues," *Journal of Food Science*, IFI publication, Chicago, Volume 72, p.78.

\(^2\) http://www.tpciindia.org/projects.htm

\(^3\) http://www.packaging-films.com/aluminum-foil.html


\(^5\) http://www.wastemaine.org.uk/resources/InformationSheets/Packaging.htm

\(^6\) http://www.epcb.nic.in/Highlights/2006/MUNICIPALSOLIDWASTEMANAGEMENT%5B1%5D.pdf
collecting, transporting, and cleaning such containers offers logistical difficulties that lead to manufacturing preferences for one-way containers. Furthermore, manufacturers have achieved source reduction by offering refill products, particularly with nonfood items such as household cleaners. Refillable glass containers for beverage use have been mostly replaced with thinner one-way glass or plastic containers because of transportation costs and cleaning requirements. However, refillable glass containers are still prevalent in other countries. PETE containers have been depolymerized and repolymerized to avoid any potential problems with contamination through post consumer waste streams, but the process has not been economically practical.

2.) Recycling

Recycling divert materials from the waste stream to material recovery. Recycling involves reprocessing material into new products, unlike reuse, which involves using a returned product in its original form. A typical recycling program entails collection, sorting and processing, manufacturing, and sale of recycled materials and products. To make recycling economically feasible, recycled products and materials must have a market. EPA's Comprehensive Procurement Guidelines (CPG) promotes the purchase of products which are made with recycled materials. EPA designates and recommends practices for buying the products that can be made with recovered materials. After EPA designates a product, procuring agencies are required to purchase the product with the highest content level of recovered material. EPA has selected more than 60 recycled content products under the CPG program and proposed several additional products. Almost all packaging materials (glass, metal, thermoplastic, paper, and paperboards) are recyclable. Various factors play role in economic assessment of recycling, including costs for collection, separation, cleaning, reprocessing and transportation (energy). Materials reclaimed through metal and glass recycling is considered safe

1 Sahay Subodh Kant (2008), “PPP has come up as a good solution for accentuating growth”, Modern food processing, Mumbai, Vol.3, No.11, Ringier trade publishing, July, p.27.
2 http://epa.gov/osw/wycd/tribal/pdftxt/trib-dmg.pdf
for food contact containers because the heat used to melt and form the material is sufficient to kill microorganisms and pyrolyze organic contaminants. Although the reprocessing of plastics also utilizes sufficient heat to destroy microorganisms, it is not sufficient to pyrolyze all organic contaminants, and post consumer recycled plastics are not generally used in food contact applications.

In general, recycling rates have been on the rise (EPA 2006a)\(^1\). A total of 30 million tons of containers and packaging were recycled in 2005. Glass recycling has grown in recent years because of increased collection and demand for recycled glass. About 90% of recycled crushed glass (cullet) is used as raw material to make new containers. Aluminum can recycling also has risen, hitting 52% in 2005 after reaching 50% in 2003 (Aluminum Assn. and others 2006)\(^2\). Rates of plastic recycling (particularly those of PETE and high-density polyethylene bottles) has increased significantly since the 1990s (Plastics Council 2004)\(^3\).

3.) Composting

EPA considers composting a form of recycling. Composting is the controlled aerobic or biological degradation of organic materials such as food and yard wastes. Composting involves arranging organic materials into piles and providing sufficient moisture for aerobic decomposition by microorganisms\(^4\). Periodic turning of the piles promotes aeration to prevent anaerobic conditions. The resulting humus, a soil-like material, is used as a natural fertilizer, thereby reducing the need for chemical fertilizers. Organic materials continue to be a large component of total MSW. About 25% for food scraps and yard trimmings makes composting a valuable alternative to waste disposal\(^5\).

\(^1\) [http://www.imp.mmc.edu/information/wgpc.html](http://www.imp.mmc.edu/information/wgpc.html)

\(^2\) [http://lib.bioinfo.pl/j17382061](http://lib.bioinfo.pl/j17382061)


\(^4\) [http://edgrecponsorcs/in/explore/solwaste/compost.htm](http://edgrecponsorcs/in/explore/solwaste/compost.htm)

Combustion/incineration

Combustion is the controlled burning of waste. It is an increasingly attractive alternative for waste that cannot be recycled or composted. Reducing MSW volume by 70% to 90%, combustion incinerators can be equipped to produce steam that can either provide heat or generate electricity. In fact, plastics are derived from petroleum feed stocks and possess a high heat content that is advantageous for waste-to-energy incineration. In 2004, country had 94 combustion facilities out of which 89 were WTE facilities, with a processing capacity of about 95000 tons per day or about 13% of MSW.

There are 3 types of incinerators also known as municipal waste combustors (MWCs). These are as follows:

- Massburn incinerators
- Refuse-derived fuel incinerators
- Modular combustors

**Mass-burn incinerators:** Mass-burn incinerators accept all types of as-is MSW except for items that are too large to go through the feed system. Mass-burn incinerators are distinct from other MWCs because they burn the waste in a single stationary chamber and are typically constructed onsite. Most mass-burn facilities are installed with boilers to recover the combustion heat for energy production. In 2004, 65 of the total 89 WTE facilities (77%) employed mass-burn technology to process approximately 22 million tons of MSW.

**Refuse-derived fuel incinerators:** Refuse-Derived Fuel (RDF) incinerators use waste that has been preprocessed to remove non combustibles and recyclables. The combustibles are shredded into a uniform fuel that has a higher heating value. An RDF facility may be equipped for only processing and combustion. In 2004 half of the 20 RDF facilities did both processing and combustion while the remaining 10

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1. [http://edugreen.teri.res.in/explore/solwaste/compost.htm](http://edugreen.teri.res.in/explore/solwaste/compost.htm)
3. [http://www.cpcb.nic.in/Highlights/2006/MUNICIPALSOLIDWASTEMANAGEMENT5Bl5D.pdf](http://www.cpcb.nic.in/Highlights/2006/MUNICIPALSOLIDWASTEMANAGEMENT5Bl5D.pdf)
were equally divided between processing only and combustion only. RDF incinerators had a capacity of 8 million tons of MSW in 2004\(^1\).

**Modular combustors:** As with mass-burn incinerators, modular combustors accept all waste without preprocessing but are typically smaller than mass burn. They are usually prefabricated off site and can be quickly assembled wherever they are needed. Modular combustors accounted for about 10% (9 out of the total 89) of the total MWC units in 2004\(^2\).

**Land filling**

The growing awareness of environmental problems, such as increased use of synthetic packaging materials results in slow degradation in landfills, has prompted the development of advanced landfill technology, environmental regulations for landfills, and biodegradable packaging materials. Landfills provide environmentally sound disposal of any remaining MSW and the residues of recycling and combustion operations. Modern landfills are well engineered to prevent environmental contamination. The location and operation of landfills are governed and managed to ensure compliance with federal regulations or equivalent state regulations. Today landfills are carefully designed structures in which waste is isolated from the surrounding environment and groundwater.

EPA has established a landfill reclamation approach that enables expansion of existing MSW landfill capacity and preclusion of land acquisition for new landfills (EPA 1997)\(^3\). A properly designed MSW landfill manages leachate and collects landfill gases (methane and others) for potential use as an energy source. Having emerged from landfill waste, leachate contains soluble, suspended, or miscible materials from the waste. For this purpose EPA runs the ‘landfill methane outreach program’, which is a voluntary program that promotes the use of landfill gas as a renewable energy source.

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2 http://ena.gov/osw/wyed/tribal/pdfset/trib-dmg.pdf
Biodegradation has a minor benefit in landfills. So, EPA investigated a modification in landfill design known as a bioreactor that are designed to rapidly degrade organic waste by adding liquid or air to speed microbial processes.

It can enhance aerobic and/or anaerobic degradation of leachate and organic waste (EPA 2006). There are 3 types of bioreactors: aerobic, anaerobic, and hybrid. An initiative by the EPA to identify bioreactor standards or recommend operating parameters is underway.

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1 Kumar, S. and Galkwad, S.A. (2004), Municipal Solid Waste Management in Indian: An Approach for Betterment, Atlantic Publishers & Distributors, New Delhi, p.102
## Table 5.3
Percentage of products generated in MSW from 1960 to 2005

<table>
<thead>
<tr>
<th>Product</th>
<th>Percent of total generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable goods</td>
<td>11.3</td>
</tr>
<tr>
<td>Nondurable goods</td>
<td>19.7</td>
</tr>
<tr>
<td>Containers and packaging</td>
<td></td>
</tr>
<tr>
<td>Glass packaging</td>
<td></td>
</tr>
<tr>
<td>Beer and soft drinks</td>
<td>1.6</td>
</tr>
<tr>
<td>Wine and fruit bottles</td>
<td>1.5</td>
</tr>
<tr>
<td>Food and other bottled drinks</td>
<td>4.2</td>
</tr>
<tr>
<td>Total glass packaging</td>
<td>7.3</td>
</tr>
<tr>
<td>Steel packaging</td>
<td></td>
</tr>
<tr>
<td>Beer and soft drinks</td>
<td>0.7</td>
</tr>
<tr>
<td>Food and other bottled drinks</td>
<td>4.3</td>
</tr>
<tr>
<td>Other steel packaging</td>
<td>0.3</td>
</tr>
<tr>
<td>Total steel packaging</td>
<td>5.3</td>
</tr>
<tr>
<td>Aluminum packaging</td>
<td></td>
</tr>
<tr>
<td>Beer and soft drinks</td>
<td>Neg</td>
</tr>
<tr>
<td>Food and other bottled drinks</td>
<td>4.4</td>
</tr>
<tr>
<td>Other aluminum packaging</td>
<td>1.1</td>
</tr>
<tr>
<td>Total paper and plastic</td>
<td>16.6</td>
</tr>
<tr>
<td>Paper and plastic packaging</td>
<td></td>
</tr>
<tr>
<td>Corrugated boxes</td>
<td>8.5</td>
</tr>
<tr>
<td>Milk cartons</td>
<td>3.5</td>
</tr>
<tr>
<td>Food cartons</td>
<td>2.6</td>
</tr>
<tr>
<td>Other paper/plastic packaging</td>
<td>4.4</td>
</tr>
<tr>
<td>Bags and sacks</td>
<td>2.2</td>
</tr>
<tr>
<td>Wringing paper</td>
<td>0.1</td>
</tr>
<tr>
<td>Other paper/plastic packaging</td>
<td>3.3</td>
</tr>
<tr>
<td>Total paper and plastic</td>
<td>16.0</td>
</tr>
<tr>
<td>Plastic packaging</td>
<td></td>
</tr>
<tr>
<td>Soft drink bottles</td>
<td>0.2</td>
</tr>
<tr>
<td>Milk bottles</td>
<td>0.2</td>
</tr>
<tr>
<td>Other containers</td>
<td>0.1</td>
</tr>
<tr>
<td>Bags and burlap</td>
<td>0.3</td>
</tr>
<tr>
<td>Wreaps</td>
<td>0.6</td>
</tr>
<tr>
<td>Other plastic packaging</td>
<td>0.1</td>
</tr>
<tr>
<td>Total plastic packaging</td>
<td>0.7</td>
</tr>
<tr>
<td>Wood packaging</td>
<td>3.3</td>
</tr>
<tr>
<td>Other misc plastic packaging</td>
<td>0.1</td>
</tr>
<tr>
<td>Total control and total</td>
<td>31.7</td>
</tr>
<tr>
<td>Total paper and plastic</td>
<td>62.0</td>
</tr>
<tr>
<td>Other wastes</td>
<td></td>
</tr>
<tr>
<td>Food scraps</td>
<td>13.8</td>
</tr>
<tr>
<td>Yard trimmings</td>
<td>3.7</td>
</tr>
<tr>
<td>Miscellaneous organics</td>
<td>0.1</td>
</tr>
<tr>
<td>Total other wastes</td>
<td>13.8</td>
</tr>
<tr>
<td>Total MSW generated</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: EPA. 1

1 Kenneth Dr. J. N. (2007), “Food Packaging-Roles, Material and Environmental issues,” *Journal of Food Science, IFT publication, Chicago, Volume 72, p.78*
### Table 5.4

**Impact of packaging materials and recycling on MSW 2005**

<table>
<thead>
<tr>
<th>Materials</th>
<th>Weight generated (million tons)</th>
<th>Weight recovered (million tons)</th>
<th>Discards (million tons)</th>
<th>Recovery as percentage of generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper and paperboards (3.4%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td>27.5</td>
<td>22.9</td>
<td>16.1</td>
<td>58.8</td>
</tr>
<tr>
<td>Nonpackaging</td>
<td>44.9</td>
<td>19.0</td>
<td>25.9</td>
<td>42.4</td>
</tr>
<tr>
<td>Total</td>
<td>53.9</td>
<td>42.9</td>
<td>41.9</td>
<td>50.0</td>
</tr>
<tr>
<td>Metals (7.6%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td>4.3</td>
<td>2.2</td>
<td>2.1</td>
<td>51.3</td>
</tr>
<tr>
<td>Nonpackaging</td>
<td>14.5</td>
<td>4.7</td>
<td>9.7</td>
<td>33.0</td>
</tr>
<tr>
<td>Total</td>
<td>18.8</td>
<td>6.9</td>
<td>11.8</td>
<td>36.8</td>
</tr>
<tr>
<td>Plastics (1.8%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td>1.7</td>
<td>1.3</td>
<td>12.4</td>
<td>9.4</td>
</tr>
<tr>
<td>Nonpackaging</td>
<td>1.3</td>
<td>0.4</td>
<td>14.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Total</td>
<td>3.0</td>
<td>1.7</td>
<td>27.3</td>
<td>5.7</td>
</tr>
<tr>
<td>Glass (5.2%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td>1.9</td>
<td>2.8</td>
<td>6.2</td>
<td>25.3</td>
</tr>
<tr>
<td>Nonpackaging</td>
<td>8.5</td>
<td>Neg</td>
<td>1.8</td>
<td>Neg</td>
</tr>
<tr>
<td>Total</td>
<td>10.4</td>
<td>2.8</td>
<td>10.0</td>
<td>21.6</td>
</tr>
<tr>
<td>Wood packaging (3.7%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td>8.5</td>
<td>1.3</td>
<td>18.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Nonpackaging</td>
<td>4.4</td>
<td>Neg</td>
<td>5.4</td>
<td>Neg</td>
</tr>
<tr>
<td>Total</td>
<td>13.9</td>
<td>1.3</td>
<td>12.6</td>
<td>9.4</td>
</tr>
<tr>
<td>Other miscellaneous (1.9%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td>0.8</td>
<td>Neg</td>
<td>0.3</td>
<td>Neg</td>
</tr>
<tr>
<td>Nonpackaging</td>
<td>4.9</td>
<td>1.2</td>
<td>3.3</td>
<td>27.9</td>
</tr>
<tr>
<td>Total</td>
<td>5.7</td>
<td>2.2</td>
<td>5.6</td>
<td>26.1</td>
</tr>
<tr>
<td>Rubber and leather (2.7%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0.7</td>
<td>1.0</td>
<td>5.7</td>
<td>14.3</td>
</tr>
<tr>
<td>Textiles (4.5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.1</td>
<td>1.7</td>
<td>9.4</td>
<td>15.3</td>
</tr>
<tr>
<td>Yard wastes (13.1%)</td>
<td>12.2</td>
<td>19.9</td>
<td>12.3</td>
<td>62.0</td>
</tr>
<tr>
<td>Food wastes (11.9%)</td>
<td>25.2</td>
<td>2.7</td>
<td>26.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Other wastes (1.5%)</td>
<td>3.7</td>
<td>Neg</td>
<td>5.7</td>
<td>Neg</td>
</tr>
<tr>
<td>Total VSW</td>
<td>44.2</td>
<td>39.2</td>
<td>166.5</td>
<td>35.5</td>
</tr>
<tr>
<td>Total packaging</td>
<td>44.1</td>
<td>33.6</td>
<td>46.1</td>
<td>39.9</td>
</tr>
<tr>
<td>Total nonpackaging</td>
<td>129.2</td>
<td>48.6</td>
<td>120.4</td>
<td>38.8</td>
</tr>
</tbody>
</table>

Source: EPA (2006a):
1 Data may not add to totals because of rounding.
2 Percentages are based on non-recycled VSW.
3 Neg negligible.

1 Kenneth Dr. J. N. (2007), "Food Packaging-Roles, Material and Environmental issues," *Journal of Food Science*, IFT publication, Chicago, Volume 72, p.79
Limitations of solid waste management practices

Proper waste management requires careful planning, financing, collection, and transportation. Solid waste generation increases with population expansion and economic development, which poses several challenges. Few limitations of solid waste management system are as follows:

1) Source reduction compared to convenience
2) Land filling compared to the environment
3) Combustion compared to the environment
4) Consideration for use of different packaging materials
5) Product characteristics

1) Source reduction compared to convenience

Source reduction and convenience are often opposing pressures in food packaging. Convenience features such as unit packages, dispensability, and microwaability usually require additional packaging, which is directly at odds with source reduction efforts. Similarly, tamper indication features also add to the amount of waste generated.

Industry will produce according to consumers demand if it can be done profitably. Source reduction can be accelerated if consumers are willing to accept the loss of convenience and modify their buying habit. At some point, consumers need to evaluate whether the convenience and added safety are worth the increase in materials. Refillable plastic containers have been developed as a strategy for source reduction but their use has declined in favor of non returnable containers.

Two competing trends influence source reduction of packaging materials are as follows:

- One trend is toward more economical bulk packs that need less packaging material per unit of product. If the ratio of package dimensions remains constant, increased size will increase the enclosure dimensions as a square


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function and increase the volume as a cube function. Therefore, the volume increases more rapidly, resulting in less packaging per unit volume. The trend toward larger sizes therefore represents a source reduction. The competing trend is for convenience and portion servings, in which individual portions are packaged, thereby increasing packaging usage. If all of the food is consumed, unit packaging would increase MSW. However, large portion sizes for small families can lead to food waste (food becomes unacceptable by physical, chemical, or biological means) and thus increase total discards.

- Materials for reuse and recycling must be sufficiently cleaned to remove any safety hazard posed by contaminants. The materials are often washed with powerful (usually caustic) detergents that create liquid waste that must be properly treated. Furthermore, transportation costs can be high, depending on the proximity of each plant. Shipment of reusable or recyclable containers over long distances may require more energy and it is saved by refilling. Glass is a heavy material, and recycling crushed glass requires transportation of post consumer glass for manufacturing facilities. Lifecycle analysis studies can help to determine the environmental impacts and resource demands of different waste management scenarios.

An unintended negative consequence of bottles is the entry of potentially contaminated materials into a food environment when the beverage containers are brought in for redemption. For example, if a bottle were used for garden chemicals, gasoline transfer, or any other nonfood use prior to return, this contamination could pose a hazard at the place of return if it were a food establishment.

Furthermore, if the bottle were not adequately cleaned before recycling, the contamination could ultimately transfer to a new package made with the recycled materials. Used soft drink bottles can also attract insects and other pests into a food establishment and foster the growth of microorganisms. This concern exists among many food establishments. These potential problems can be resolved, but the costs subtract from the realized benefits.
2) **Land filling compared to the environment**

Landfills have the potential to contaminate air and groundwater, so, proper design, construction, and management are essential to prevent environmental damage. Prior to 1970, landfills were sited on the most convenient, least expensive lands, such as wetlands, marshes, quarries, spent mines, and gravel pits\(^1\). Environmental impact with regard to generation of toxic matter was not considered. The only environmental consideration was to cover the solid waste with soil to reduce odors, litter, and rodents.

In 1991, the emergence of evidence that siting landfills in wetland areas created groundwater contamination caused the promulgation of MSW Landfills Criteria\(^2\). The standards address location restrictions, operating practices, and requirements for composite liners, leachate collection and removal, and groundwater monitoring. Improperly designed landfills contaminate groundwater for example—water from rain or the waste itself permeates the landfill and dissolves substances in the waste. Acidic/alkaline conditions can enhance the extraction of certain substances. Limiting air and water permeation of waste hinders the degradation of organic material within landfills with this some other efforts also been made to minimize groundwater contamination.

Many MSW landfills are also subject to air emission standards. Landfill gas emissions contain methane, carbon dioxide, and more than 100 different non-methane organic compounds such as vinyl chloride, toluene, and benzene\(^3\).

Air emission standards require gas collection and treatment system also a system that incorporate energy recovery.

The siting problem is therefore not only an issue of technical significance but also of economic, social, and political issues. Effective public involvement is a significant component of a comprehensive siting strategy.

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3) **Combustion compared to the environment**

With the continued decline in landfill capacity, combustion—especially waste-to-energy combustion—is becoming a widely used method to address increased MSW disposal needs (166.7 million tons in 2005)\(^1\). However, with the exception of modular combustors, incinerators require considerable initial capital, and construction takes 3 to 5 years. In addition, incineration results in air emissions that must be considered and controlled. Carbon dioxide, a greenhouse gas, is released when products derived from fossil fuels (such as plastics) are burned. Pollution concerns include the emission of acidic gases (particularly sulfur dioxide and nitrogen oxides), heavy metals, halogens, dioxins, and products of incomplete combustion. Dioxins and halogens are released from incineration of chlorinated polymers, the most abundant of which is PVC, constituting approximately 1% of MSW\(^2\). Incomplete combustion of the organic components of MSW is also possible with suboptimal operation of an incinerator.

4) **Considerations for use of different packaging materials**

The key to successful packaging is to select the package material and design that best satisfy competing needs with regard to product characteristics, marketing considerations (including distribution needs and consumer needs), cost, environmental issues and waste management issues. Balancing of different factors not only difficult but also it requires a different analysis for each product. This analysis is done by considering various factors such as the properties of the packaging material, the type of food to be packaged, possible food/package interactions, the intended market for the product, desired product shelf-life, environmental conditions during storage and distribution, product end use, eventual package disposal, and costs related to the package throughout the production and distribution process. Some of these factors are interrelated: for

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\(^1\) [http://www.cpcb.nic.in/Highlights/2006/MUNICIPALSOLIDWASTEMANAGEMENT5B1%D.pdf](http://www.cpcb.nic.in/Highlights/2006/MUNICIPALSOLIDWASTEMANAGEMENT5B1%D.pdf)

\(^2\) [http://edugreen.teri.res.in/explore/soIwaste/compost.htm](http://edugreen.teri.res.in/explore/soIwaste/compost.htm)
example, the type of food and the properties of the packaging material determine the nature of food-package interactions during storage. Some times, factors are odds with each other: for example, single-serving packaging meets consumer needs, but bulk packaging is better for environmental reasons. Table-5.2 provides an overview of the variety of factors at play in package selection.

5) **Product characteristics**

A thorough knowledge of product characteristics, including deterioration mechanisms, distribution needs and potential interactions with the package, is essential for package design and development. These characteristics determine physical, chemical, biochemical, and microbiological nature of the product. Materials that provide optimum protection of product quality and safety are most preferred. Similarly, distribution systems and conditions help to determine the type of packaging material used. Food-package interaction plays an important role in the proper selection of packaging materials for various food applications. Each packaging material has different inherent properties (e.g., rigidity & permeability to gases). These properties affect the selection of which material is best for a particular food, given the characteristics of that food (e.g. - acidity & light sensitivity).

Food-package interaction involves the transportation of low molecular weight compounds such as gases or vapors and water from\(^1\):

1) The food through the package
2) The environment through the package
3) The food into the package
4) The package into the food

It may also include chemical changes in the food and package or both. These interactions result in food contamination (a potential health issue), loss of package integrity (a potential safety issue) or decrease in quality.

\(^1\) http://www.nestle.com/products/food_packaging.html
The most common food-package interactions are the migration of low molecular weight substances such as stabilizers, plasticizers, antioxidants, monomers, and oligomers from plastic packaging materials into food. Furthermore, low molecular weight compounds (volatile and nonvolatile) may migrate from food into packaging materials through the sorption mechanism\(^1\). The volatile substances such as flavors and aromas directly affect food quality while the nonvolatile compounds such as fat and pigments affect the package.

5.2 PACKAGING LEGISLATION

Food packaging is living proof that some of the most wonderful, life-enhancing, freedom-increasing innovations happen in some of the most mundane-seeming areas. Most of the people don't find food packaging very interesting and people who don't appreciate the crucial role that food packaging plays in our lives are unlikely to spend much time critically in evaluating the regulations that the food packaging industry lives under, or feel outrage when such regulations go overboard. Many people have strong feeling in general about the FDA. Some folks excoriate the FDA for allowing people to take drugs that can kill them, while others bash the FDA for not allowing people to take drugs that might save them. Most of these people are silent when it comes to FDA regulation of food packaging.

The silent miracles of food packaging innovation touch the lives of every customer. Food packaging is the field where the FDA is most reasonable and gets it right most consistently. Still, there are some major problems, which are in the context of recycled plastics.

Most of the people probably already know the surprising, counter-intuitive and nature of food packaging law. Packaging isn't a food, it's not a drug, and it's not a cosmetic, but the FDA still regulates it under the Food, Drug, and Cosmetic Act\(^2\).

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\(^1\) http://www.fastonline.org/CD3WD_40/ASDB_SMARTSAN/Kumar.pdf

Officially, food packaging is regulated as a food additive. Food packaging isn't intended to do anything to the food but according to the second law of thermodynamics, substances diffuse over time, for example- the components of the Coke bottle will become part of Coke, and vice versa. So the components of food packaging law are regulated as "indirect food additives."

The most surprising aspect of food packaging law as it relates to recycled materials is that there isn't really any. The Food, Drug, and Cosmetic Act don't mandate any special regulatory review or additional FDA clearance for recycled materials. This is because the FDA regulates food-contact materials based on their composition, identity and amount of the material that can migrate to food. It is based on whether the materials are virgin or recycled plastic. Any recycled material can be used if it complies with current regulatory requirements.

The trouble is that the people who wrote the original regulations weren't really thinking about recycled materials. The regulations assume that packaging is being made out of virgin materials, or out of materials that come from a controlled source (rather than recycled materials, which could come from thousands of unknown sources). Materials have to be "suitably pure," but the regulation doesn't say how "suitable" is "suitable." For instance, the regulations officially allow recycled paper and paperboard as long as neither "bears or contains any poisonous or deleterious substance, which is retained in the recovered pulp and that migrates to the food." This is a very general statement, and could be interpreted as requiring a zero tolerance for contaminants. In fact, FDA regulation of recycled materials has been a mixture of discretion, rulemaking, and informal opinion letters. These informal opinion letters are called "non-objection letters."

Food packaging developers didn't have much guidance from the FDA regarding the expectation. They submitted their best guess as to what the FDA wanted, and hoped that the FDA would issue a non-objection letter. Sometimes, the FDA would respond by asking for more information, and the whole process took several

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months. The FDA issued guidance documents, which informally established that chemicals with dietary concentrations below 0.5 parts per billion (ppb)\(^1\). That is, chemicals which could be expected to be less than one two-billionth of your entire diet were O.K. In reality because of the conservatism of the FDA testing procedures, the actual dietary concentration is much, much lower than whatever the testing might reveal. As the FDA put it, testing assumed various worst-case and all material entering the waste stream was assumed to be contaminated.

In October 1993, the FDA announced to adopt a "threshold of regulation" for food additives. This rule became final in July 1995\(^2\). The FDA has already been following this rule informally for a few years. Under the threshold of regulation policy, certain substances are formally exempted from regulation as food additives. To qualify for the exemption following are the few conditions\(^3\):

- The substance shouldn't be carcinogenic because the use of carcinogens as food additives is prohibited by the Delaney Clause. There should also be no reason to suspect, based on the substance's chemical composition that it might be a carcinogen.
- The expected concentration of the substance in the diet should be less than 0.5 ppb. If the substance is already also being regulated as a direct food additive, then the amount of the substance that gets into food through the packaging should be no more than 1 percent of that substance.
- The substance should have no technical effect in or on the food.
- The use of the substance should have no significant adverse effect on the environment.

Thresholds of regulation are necessary because with advancing technology, instruments can detect smaller and smaller amounts of any substance. The thresholds of regulation standards are the ones now being used to judge non-objection letter requests. Substances that fail these conditions can still be

\(^1\) http://www.naturalnews.com/the_FDA.html  
\(^2\) http://www.hc-sc.gc.ca/fn-an/legislation/guide-ld/recycled_guidelines-directives_recycle01-eng.php#fn1  
\(^3\) http://www.naturalnews.com/the_FDA.html
approved, but they need to go through the regular food additive process, which takes a pretty long time.

According to researchers, food packaging regulation is one of the most reasonably regulated areas among the entire regulated field by the FDA\(^1\). The reason is that it recognizes that the small dose makes the poison, and a chemical which is dangerous in high concentrations might be harmless at low ones. FDA became more and more willing to say "this is so small that we don't care."

FDA food packaging regulations are even less troublesome than they might be. They still exaggerate risk, and they do so consistently. As a general rule, it makes sense that recycled material should be more suspect than virgin material. Recycled material usually comes from many sources. Recycled plastics are less "pure" than virgin plastics, because they may contain trace amounts of the original contents of the package, or whatever the previous consumer happened to store in the container such as pesticides, gasoline, rat poison, and so on.

One problem under the new, finalized threshold of regulation policy\(^2\) is an environmental assessment has to be done before a non-objection letter is issued. If the review goes well, the FDA issues a "Finding Of No Significant Impact" (FONSI). Otherwise, the FDA conducts a full-blown "Environmental Impact Statement" (EIS). EISs take a very long time; for instance, the FDA has spent seven years not completing an EIS on polyvinyl chloride (PVC) bottles. The FDA had conducted an EIS twice in the last 30 years. But the less rigorous environmental assessments take about three to six months times. Now the time required is doubled to get a non-objection letter.

FDA's threshold of regulation continues to be conservative in other ways. The Delaney Clause prevents the FDA from approving a substance that causes cancer in any laboratory animal except under certain circumstances, even though it's a very large leap from cancer at high doses in a laboratory animal and cancer at low

\(^1\) http://www.greenstar.co.uk/packaging_regulations.aspx
\(^2\) http://www.naturalnews.com/023850.html
doses in a person. If something causes cancer in any laboratory animal, the FDA assumes that it causes cancer in people, even though tests on mice and rats give contradictory results 25 percent of the time. People are more different from mice, rats than mice and rats are from each other. Many studies have been done on the same chemical and the FDA chooses the most sensitive species, sex, and organ combination for its carcinogenic potency. The FDA assumes that there is no threshold below which a chemical is harmless. If testing methods don't find a chemical, the FDA doesn't assume that it's not there; instead, it assumes that the concentration of the chemical is just the limit of the detection method. In other words, if a testing method can detect anything larger than 50 ppb, then a negative result is interpreted to mean a concentration of exactly 50 ppb.

The FDA has noted that the threshold of regulation, which was supposed to lighten the agency's workload by loosening regulations, may in fact end up tightening the regulations instead, and increasing the agency's workload. Any chemical with a concentration under 50 ppb only required a rodent feeding study. A threshold level of 0.5 ppb would focus regulatory attention on exposures far below 50 ppb.

Numbers like 0.5 ppb and 1 percent of the diet, while they may be nice, round numbers, are in fact drawn out of thin air. They were derived, in a circuitous way, from the standard assumption that risks below one-in-a-million are acceptable while risks above one-in-a-million aren't, but even that number is drawn out of thin air. It's a convenient number to use, but it plays into the myth that one need to have one standard for everything and everyone, even though the food inside the package may be far more dangerous than the package itself, even though unregulated natural chemicals may pose far greater risks than the regulated manmade ones and even though people willingly, without giving it a second thought, expose themselves to risks greater than one-in-a-million every day.

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1 http://www.foodprocessing.com/articles/2003/102.html
2 http://www.fdareview.org/history.shtml
3 http://www.naturalnews.com/the_FDA.html
4 http://www.foodprocessing.com/articles/2003/102.html
These, in short, are the main problems behind the FDA's risk assessment. According to former FDA general counsel Peter Barton Hutt, the system is "archaic," "unnecessarily demanding," and "inefficient in the use of manpower and scarce resources" and indirect additives need "a completely separate and different process, with far less government involvement." Reforming these areas should make a significant difference to the development of new technologies, including recycled content food packaging applications.

5.3 FINANCIAL CONSTRAINTS

"To counter volume and operating margin pressures, most companies are implementing various cost cutting measures including rationalizing manufacturing capacity, improving operating efficiencies, and sourcing raw materials from low-cost locations overseas," S&P stated.

Companies have successfully restructured through the sale of its under performing businesses. Larger global players have focused on making their supply chains more efficient and on reconfiguring its global geographic reach. Sealed air strategy has been to invest in new production capacity in developing markets around the world, and to improve the operating efficiencies of existing facilities. The company has also invested in new technologies to drive additional productivity increases, S&P said.

Most of the packaging companies rated by S&P cater to stable segments. However nearly 30 per cent of the 28 rated packaging companies have significant exposure to less stable markets such as industrial and protective packaging segments, S&P noted. These companies tend to be among the hardest hit by slowing growth in the manufacturing sector, and as a result, could potentially face financial problems in the future.

1 http://www.fdareview.org/history.shtml
2 http://www.claymore.com/uit/fund/crocx
3 http://www2.standardandpoors.com/portal/site/sp/en/us/page.topic/researchlearning_spivn/3,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.html
In addition, the price of raw materials used for making plastics has compounded the adverse effects of lower volumes. Plastic resins such as polyethylene, polypropylene, and polyvinyl chloride (PVC) are key the raw materials for plastic packaging companies, the cost of which has risen dramatically during the past two years.\(^1\)

Prices of plastic resins have declined slightly since August 2006, in line with lower prices of oil and natural gas, although still remain at elevated levels.\(^2\)

"Most of the companies do not have contracts with customers that allow for a pass through of raw material price fluctuations, unlike the contractual pass-through arrangements widely prevalent in the rigid plastic packaging and metal and glass packaging segments," S&P stated.

Given the commodity-type product mix and intense competitive pressures, the conjunction of events has resulted in a further squeeze to already low operating margins of around 10 per cent for most companies, S&P stated. S&P has given negative outlooks on the ratings of half the companies involved in the industrial and protective packaging segments. One is on Credit Watch with negative implications.

Companies should be better able to withstand short-term pressures given their strong business profiles, S&P stated.\(^3\) These companies benefit from leadership positions and branded products, contributions from some differentiated products, geographic and customer diversity, and consistent cash generation from operations.

"However, the broader credit trends for the remainder of 2006 and 2007 are likely to be unfavorable, with the growing potential for a slowdown in the cyclical industrial economy expected to be a negative factor," S&P concludes.\(^4\)

\(^{1}\) http://www.plastemart.com/plasticrawmaterialpricechange.asp
\(^{2}\) http://www.fao.org/WAIRDOCS/X5403E/x5403e06.htm
\(^{3}\) http://www.claymore.com/uit/fund/croccx
\(^{4}\) http://www.claymore.com/uit/fund/croccx