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INDIAN CENTRE FOR PLASTICS IN THE ENVIRONMENT

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Profile of Indian Food Industry and Role of Plastics in Conservation of Food Resources

Reproduced from the Introductory Section of the book – "Plastics in Food Packaging" brought out jointly by ICPE and Indian Institute of Packaging (IIP).

The word 'Food' has been defined in many ways:

- That which is eaten or drunk or absorbed for the growth and repair of organisms and the maintenance of life.
- Any substance containing nutrients, such as carbohydrates, proteins and fats that can be ingested by a living organism and metabolised into energy and body tissue.
- Any substance taken into and assimilated by a plant or animal to keep it alive and enable it to grow and repair tissue and promote nourishment.

From the above definitions a simple fact emerges, i.e., food is a critical need for survival of a living being and is required for growth, physical and mental ability and good health. Food has always played an extra-ordinarily vital role in the rise and growth or the fall and decline of a Nation because of its effect on the health of the population.

India's concern for nutrition is as old as its civilisation. The concept of health as defined by the World Health Organisation (WHO) is "the state of complete physical, social and mental well-being and not merely absence of disease or infirmity".

The nutritional status of a Nation is an outcome of complex and inter-related set of factors such as food adequacy and its distribution, levels of poverty, status of women, rate of population growth and the extent of economic growth. The trend in nutritional level improvement in our country during the last fifteen years has been gradual and modest, despite a steep rise in population.

Sources of Food

Food originate from animals and plants and are complex bio-chemical systems which undergo changes depending upon the environmental conditions.

Animal Food

The most preferred animal food by humans is mutton, beef, pork and poultry as well as their by-products (milk and eggs). Animal food forms an important part of diet of some societies and is a good source of essential amino acids, vitamins and minerals.

Milk is considered as a complete food and is derived mainly from cows and buffaloes. Poultry used for food is generally chicken and the rise in poultry consumption is mainly due to its dietary benefits such as low fat and low cholesterol content of its lean portion.

Eggs are by-products of the poultry industry and are a good source of protein.

Fresh water and marine water fish are available in large varieties and form an important source of food.

Plant Food

Plant food forms a very important and a large part of human food all over the world. Food originating from plant sources includes cereal grains, vegetables, fruits, nuts, sugar, fats and oils. Cereal grains are the most important source of the world's total food. For one-half of the world population, rice is the major part of the diet and it is the staple food of many developing nations supplying about 75% of their calorie intake and 67% of their total protein intake.

Vegetables and fruits make up a significant portion of human diet and supply many nutritive requirements like proteins, starch, fat, minerals, sugar and vitamins. Nuts are also derived from plants and are important source of supply of proteins and fats.

Sugar or sucrose is derived by extraction from sugarcane and sugar beets followed by refining.
Sugar not only provides sweetness to food but also energy to the body.

Oils form an important dietary constituent and comprises of lipids. They also play the role of a vehicle for absorption of fat-soluble vitamins A, D, E and K.

Some other food items derived from plant sources are tea, coffee, cocoa, spices etc.

Food Availability in India

In the last decade, India has moved from an era of scarcity to one of plenty. The Indian economy is predominantly agrarian. Agriculture constitutes 33% of our GDP, supports 64% of work force and earns 19% of our exports. India is the world's second largest producer of food, next to China and has the potential of being the biggest in the world. The estimates of existing production details of raw materials are given in Table 1.

India produces 46 million tonnes of fruits and 80 million tonnes of vegetables and is the second largest producer next to Brazil and China respectively. Some other horticulture products are cashew nuts 400,000 tonnes; Spices – cardamom 11,000 tonnes, coriander 240,000 tonnes, garlic 475,000 tonnes, pepper 60,000 tonnes, turmeric 425,000 tonnes, ginger 180,000 tonnes,

TABLE 1

Production of Raw Food Materials in India
(Year 2001)

Sector	Production (million)
Food grains	225-230 tonnes
Horticulture Produce	126 tonnes
Milk	80 tonnes
Sugarcane	280 tonnes
Oilseeds	25 tonnes
Fish	5.6 tonnes
Livestock	500-520 nos.
Poultry birds	250 nos.
Eggs	35,000 nos.

[Source: Indian Food Industry, March-April 2003, Vol. 22, No. 2]

chillies 860,000 tonnes; tea 816,000 tonnes.

The country produces 80 million tonnes of milk annually and ranks first in the world.

India has the largest livestock population of about 500 to 520 millions. 53% of world's buffaloes population and 45% of sheep is available in India. The country grows nearly 25 million tonnes of oilseeds and produces approximately 200-230 million tonnes of food grains, annually. The crops and their production (in the year 2000) are:

- Rice, second largest producer in the world – 88 million tonnes accounting for over 18% of the total value of output from agriculture.
- Wheat, the second largest cereal grown with the production nearing 75 million tonnes accounting for over 10% value of production.
- Other major crops and their production outputs are sugarcane – 280 million tonnes, maize – 11 million tonnes, gram and other pulses – 7 million tonnes. India has 8,041 kms long coastline; 28,000 kms of rivers and millions of hectares of reservoir oils and brackish water. This serves as potential for the production of marine products and fish resources, which is of the order of 5.6 million tonnes.

This happy situation changes when we look at the other side where colossal losses and wastages are encountered, accompanied by very low level of processing and non-availability of post harvest infrastructure.

Losses and Spoilage of Food

As per the report by Shri M. S. Swaminathan (Planning Commission 1981), up to 40% of certain fruits and vegetables go waste due to their perishable nature and non-availability of appropriate post harvest infrastructure. As per another study (TIFAC - 1996), wastage in certain food is as high as over 30% and in vegetables the losses are up to 20% to 30% at the post-harvest stages due to poor storage, transportation, lack of infrastructure and the inadequacy of the marketing set-up. As per this report, India wastes more fruits and vegetables than are consumed in a country like U.K. The total wastage in all food sectors is high and worth Rs. 500,000 million.

It is also estimated that the wastage cost of fruits and vegetables is Rs. 350,000 millions per year which is four to five times than those of food grains. Even in food grains the loss is reckoned at 5-10% on account of insect infestation and inadequate storage.

Table 2 gives a conservative estimate of losses in the total agro-chain.

The losses/food spoilage are attributed to lack of proper post-harvest handling practices, farm pre-cooling centres, cold storage, infrastructure and bulk storage. Unscientific and inadequate packaging, handling and transportation of grains and other produce, adoption of obsolete technologies in horticulture, fisheries, agriculture, dairy, poultry, meat and other food industries are other factors that are also responsible for food spoilage and losses.

A Food Ministry report reveals that India wastes food worth over Rs 500,000 million in a year, even as one fifth of its population is underfed. The food grains wasted in 1998-1999 could have fed up to 117 million people for a year or the entire country for almost six weeks. Rodents and insects alone polished off the monthly food requirement of 760 million people. A recent estimate by the Ministry of Food and Civil Supplies puts the total preventable losses of food grain at 10 per cent of the total production

TABLE 2

A Conservative Estimate of Losses at Various Points in the Agro-food System and the Possible Impact of their Reduction by 50%

Losses in the Agro-food Chain	Range of Losses (%)	What Happens to 1000 Kg at Present Average (kg)	If Average Loss Reduced by 50% (kg)
Losses due to poor preparation of soil	20-40	700	850
Losses due to poor quality seed	20-50	455	570
Losses due to poor water management	20-30	340	500
Field losses due to avians	10-50	230	425
Field losses due to rodents	20-40	155	360
Losses due to micro-organisms	10-20	105	315
Losses in the post-harvest handling, storage, transport and distribution	20-40	60	260
Losses in milling and processing	6-10	56	250
Losses in conversion of primary-to animal-foods*.	30-60	50	230
By-product losses	10-20	43	210
* Not more than 20-25% of grain is converted into animal feeds at an average.			

[Source: Parpia, H.A.B and B.R.Sinhal]

– or about 20 million tonnes a year. That is roughly the amount of food grains Australia produces annually. Figure 1 illustrates the type of wastage in food grains and the number of people who could have been fed.

Types of Food Spoilage

Food spoilage and contamination are defined as those adverse changes in quality caused by the action of specific conditions or agents that induce physical and chemical changes and also includes micro-organisms, insect, bird and rodent pests. Mechanical damage is also instrumental in spoilage. Bruises and wounds are such defects, which frequently cause chemical and microbial spoilage. The primary causes of food spoilage include the following:

- Biological – these include micro-organisms like bacteria, yeasts and molds, and other agents like insects, rodents and birds
- Chemical – these include enzymatic or non-enzymatic reactions
- Physical – these include breakage, bruises, crushing and cut or otherwise dismembered surfaces

In India, where the Government is progressing towards the regime of market economy and is also pursuing technological excellence, it can ill-afford to continue to waste precious natural and agricultural products like food grains, fruits and vegetables.

Effective Alternate Means

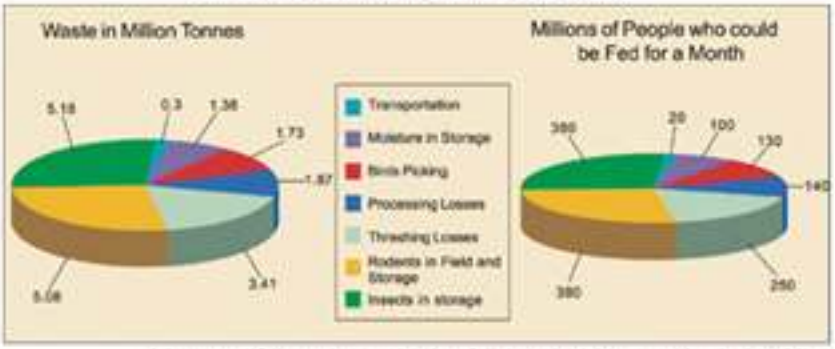
Under the present circumstances the fastest and the most effective alternative means to increase and improve food availability / protect its nutritive value and deliver it to the consumers in a wholesome manner is to adopt the following:

- **Increasing the Level of Processing:** Although India is one of the largest producers of raw materials for the food processing industry in the world, the industry itself is extremely under developed. In India less than 2% of fruits and vegetables production is processed which is very low as compared to 30% in Thailand, 70% in Brazil, 78% in Philippines and 80% in Malaysia. The value-addition in the food sector in India is as low as 7% as against 28% in China, 45% in Philippines and 188% in UK. Food processing becomes critical as this would mop up surpluses at farm level and ensure fair price for the producer.

  If an increase in food processing is aimed at from the present 2% to 10% by 2010, it is estimated that wastages would be reduced to the tune of about Rs. 80,000 million and the value addition of food products will grow up to 35%. Value added processed food not only help in generating domestic demand but also boost exports. What is needed urgently is to encourage large units to come up. It is here that the Ministry of Food Processing Industry can play a major role by extending all necessary assistance and fully utilising the increased outlay of Rs. 6,500 million during the 10th plan. The opportunities available in food processing sector are highlighted later in this chapter.
- **Migration from Traditional Packaging Technologies to Improved Technologies to Cater to New Requirements:** These technologies should be aimed at extending the shelf-life of food products and improving nutritional and sensory properties of food. This is covered in details in the following chapter.
- **Better Harnessing of Post Harvest System from Farm Gate to the Consumer:** Produce from an individual farm passes through the hands of at least seven intermediaries before it reaches the retailers. Better storage and handling facilities at the farm level and reduction in the number of intermediaries in the chain can reduce the losses. If even half the wastage could be prevented it would help to provide enough calories to bring the nutritional status of the poor to above subsistence level.

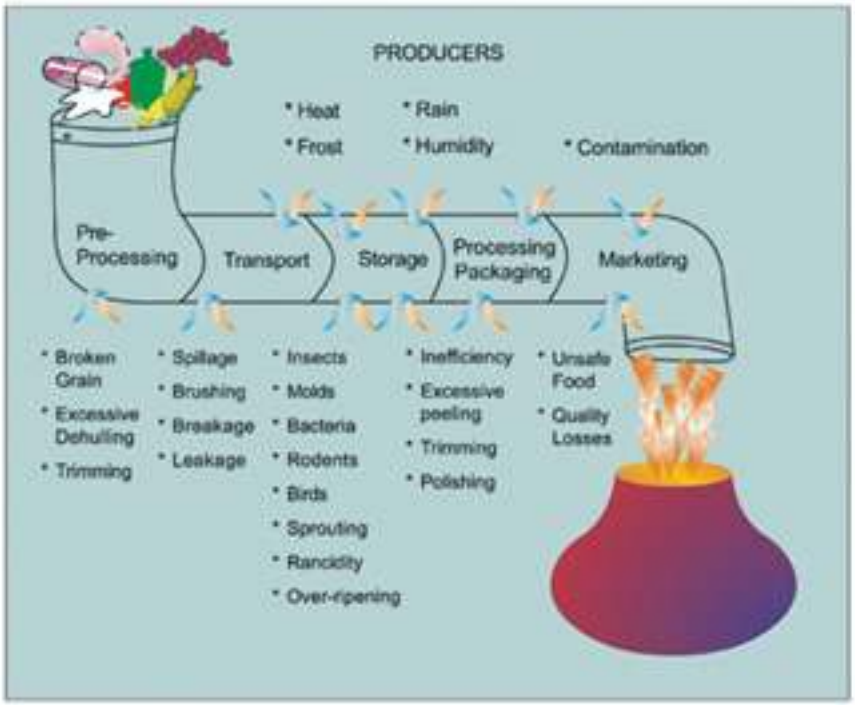
  Packaging is one of the farm-to-consumer food delivery system. It forms an integral part of food manufacture, providing the link between manufacturer and consumer, or in other words, package is a structure designed to contain food produce in order to make it safe during transport by protecting the product against contami-nation and loss.

Figure 1: Foodgrain Wastage, a Lost Opportunity



[Source: Life Cycle Analysis of PP/HDPE Woven Sacks – IIT Delhi and CIPET]

Figure 2: Food Pipeline



Conservation and Preservation of Perishables by Use of Plastics in Packaging

Plastics are perhaps the most versatile group of materials used in packaging. This is because they are basically chemicals, which can be modified to satisfy a broad spectrum of demand. The use of plastic is fast growing in India due to the easy availability of its resins. The consumption of plastics could go up further if used liberally in the field of post harvest technology, since post harvest losses are severe problems in the handling and marketing of highly perishable commodities. Plastics are light in weight, very strong, hygienic and non-conductive, they do not rust, rot or react with most chemicals. The food industry's sustenance depends on the use of plastics in different forms for handling, transporting, packaging and storage.

The traditional method of handling horticulture produce has been:

- Loose in bullock carts or trucks
- Bamboo baskets
- Gunny bags
- Wooden boxes
- Metal boxes (trunks)

The drawbacks of using the above types of packages have been realised as:

- Wooden crates are attacked by fungi and insects and, therefore, unhygienic. Moreover, the use of wood depletes the natural forests' resources.
- Metal trunks are prone to rusting and therefore they are unhygienic. They also cause mechanical damage to the fruits and vegetables.
- These types of materials cannot be cleaned and washed easily and also require periodical maintenance.
- Since they are fabricated by carpenters, considerable time is required for its manufacture and the wooden splinters and the jagged metal corners cause injury to the workers.
- Metal trunks do not provide ventilation to the fresh produce as perforations are difficult.
- During transportation, there is a possibility of collapse of a stack, which could result in injuries and heavy losses.
- They are heavy materials for handling and use.

The above facets evoked the need for improved scientific system keeping in view the following aspects:

- For better yield
- To improve hygienic condition
- To extend the shelf-life of horticulture produce
- For the benefit of the farmer (which should be the prime concern)
- For overall cost effectiveness
- For protection of environ-ment/ maintenance of eco-logical balance

Development of plastic industry responded to such long felt needs which paved the way for its growth. Compared to other materials, plastics are relatively new-comers. Although thermo-setting resins, whose molecular structure is cross linked, have been used since the last century and are still extensively used in coating formulations for packaging, contemporarily use of plastics for primary, secondary, and tertiary package is almost entirely based on thermoplastic materials.

Today, about one third of all plastics manufactured are used in packaging. Those commonly used for packaging include the polyolefins, principally Poly-ethylene and Polypropylene, PVC (Poly Vinyl Chloride), Polystyrene and PET (Polyethylene tere-phthalate). About two thirds of these plastics are used for packing food and beverages.

A wide range of plastic materials available offer properties to meet almost every requirement of the food packaging industry. Plastics, being synthetic materials can be tailorto cater to specific needs or performance requirements. Plastics offer distinct advantages over other materials as they are light in weight, have good mechanical strength, flexibility and re-cyclability. They are non-toxic and hence absolutely safe to use in direct contact with food products. They have excellent barrier properties towards moisture and gases to achieve the required shelf-life.

Some of the plastic-based packages and systems adopted for reduction in losses of fresh produce and food grains are highlighted here.

Plastic Crates

Plastic crates are usually made of high density polyethylene (HDPE) or polypropylene (PP). Polyethylene has a higher impact strength and low degradation by UV radiation, while poly-propylene has a better scratch resistance. The performance of both materials can be improved by adding antioxidants and UV protectants (for sunlight protection).

The advantages of using plastic crates are:

- The crates are made from 100% food grade material and are hygienic, non-toxic, antirust, anti-moth and acid-proof. They are not attacked by fungus or insects and are easy to clean.
- The crates are durable and can withstand rough handling.
- They can be conveniently stacked one above the other as a contoured rim keeps the product safe.
- Perforated plastic crates are available which provide ventilation for maintaining the freshness of the produce and for cold storage applications.
- The crates can withstand extremes of temperatures from minus 30°C to plus 75°C.
- Since they are one piece injection moulded containers, they are maintenance free and can give longer service life.
- Since they can be stacked and nested securely when not in use, saving of valuable storage space is achieved.
- Plastic crates are lighter in weight compared to conventional packages and therefore transportation costs are reduced.
- They facilitate codification / identification by colours / screen printing.

Leno Bags

Leno bags are made from Polypropylene – the versatile material – on circular weaving leno looms. Leno, is a kind of weaving in which adjacent warp tapes are twisted around consecutive weft tapes to form a spiral pair, effectively locking each weft in place. A bag made from this is called a Leno bag or a polymesh bag whose prime characteristics are good aeration and strength.

Leno Bags

Leno bags can be used in bulk packaging of various produce like onion, garlic, potato, peas, citrus fruits and many other horticultural and agricultural produce. Leno bags are being increasingly used the world over. In India too, the trend of using Leno bags has started and its use has picked up in UP, Gujarat, Maharashtra, Karnataka and Tamil Nadu.

The advantages of using leno bags in place of the conventional jute bags are:

- Facilitates excellent aeration of the packed produce which helps storage in the open as well as in cold storages.
- Facilitates easy visual inspection of contents packed.
- Resistant to fungal and insect damage.
- Resistant to moisture and chemicals.
- Does not impart any odour to the packed produce, and is a food grade material.
- Reusable and washable, easy to handle and store.
- Light in weight, as compared to jute and hence cost effective.

Given in Table 3 is a comparison chart for Leno bags Vs traditional jute bags.

Plastic Crates

TABLE 3

Comparison Chart

Property	Leno Bag Vs Traditional Bag
Breathability	Excellent
Visibility	Excellent
Odour	Does not impart any odour to the produce
Bio – resistance	No fungal growth
Hygienic Issues	No issues
Price	Economical by 40%

There are a number of manufacturers of Leno bags spread all over the country. With the growth in the market demand, more potential manufacturers may join in. Today, there are 10 manu-facturers and 51 looms in operation in India. Additional capacity is being generated through expansions and new process development.

Polypropylene Boxes

Polypropylene corrugated board was introduced in India in 1981 as a complementary packaging material to paper board and wood materials. It is now recognised for its added performance and advantages. Boxes fabricated from this material are used for packaging of horticulture produce like apples. Its high strength/weight ratio and good cushioning properties coupled with durability and ability to recover well after rough handling make it an ideal material for multi-trip/ multi-usage application.

Some of the features and advantages of using corrugated PP boxes are listed below:

- High Strength – excellent edge crush, puncture resistance and compression strength.
- Weight reduction by 50% to 300% compared to equivalent corrugated fibre board or wooden box.
- Provides protection from environment as it is waterproof, chemical proof and vermin proof.
- Available in attractive bright colours.
- Durable and hence ideal for multi trip applications.
- Can be easily cleaned.
- Non toxic and therefore hygienic and safe for food contact.
- Offers good thermal insulation properties.

Expanded Polystyrene (EPS) Boxes

Expanded Polystyrene or Polystyrene foam appeared in the Indian market in the late 50's and its application in packaging as moulded boxes started much later in the early 80's, and has now gained tremendous popularity for the following advantages it offers:

- Cushioning effect is provided and, therefore, protects the contents against all static and dynamic loads during transportation and storage
- Has very low thermal conductivity and, therefore, ensures survival of perishables for long distances through adverse climatic conditions
- Can be coloured, printed and labeled for attractive packaging
- Its surface is smooth and abrasion resistant, thus does not injure the delicate skin / tissues of fresh produce
- It is food grade and hygienic
- It is extremely light and saves freight cost

Recently moulded EPS containers have been used for export packaging of fresh mangoes and grapes by air.

Prepackaging of Fresh Produce

Prepackaging is defined as packaging of fresh produce at the farm level itself before transportation or at the terminal market. Plastics find maximum use in prepackaging of fresh produce, as this reduces physical and physiological losses. Low density Polyethylene (LDPE) film or High molecular weight high density Polyethylene (HM-HDPE) film with or without vents, breathable micro-porous films, stretch films, shrink films, polypropylene or polyester punnets, etc., are used for prepackaging. The shelf-life of various vegetables is increased by 5-15 days, when prepacked in polyethylene bags with 2-5% ventilation. Wrapping the fruits and vegetables in stretch wrap shows 2-3 folds increase in shelf-life. Use of plastic punnets increases the shelf-life of strawberries and cherries 2-3 folds. The life of baby corn and sweet corn was found to increase from 1-2 days to about 8-10 days when packed in 30µ HM film and stored at 15°C.

Controlled Atmosphere Packaging (CAP)/Modified Atmosphere Packaging (MAP)

In CA storage, the optimum levels of CO_2, O_2 and temperature are maintained for extending the shelf-life of stored produce. This is achieved by continuous monitoring and controlling of storage air composition throughout the period

of storage with the help of external means involving N_2 flushing and CO_2 scrubbing. A refrigeration unit is employed for maintaining the storage temperature.

By adopting CA storage technology, the life of various fruits and vegetables can be increased 2 to 4 times the normal life. However, CA storage produce deteriorate very rapidly when exposed to ambient conditions during marketing, and hence the post-storage life of the produce is shortened.

In view of the existing transport, retail storage and marketing facilities in India, the scope of CA storage technology is restricted to the bulk storage of fruits and vegetables of high commercial value. Generally fruits like apples, pears, peaches are stored under CA.

In MAP technology, the fresh produce is sealed in retail size packages. The packages are made of plastic films which have selective permeability for O_2, CO_2 and N_2. In a properly designed MA package, due to respiration of packaged produce and selective gas permeation through the packaging film, the optimum levels of O_2 and CO_2 get self-established within the package. This results in extension of post-harvest life of MA packaged produce. The applications include prepackaging of produce at farm level as indicated earlier.

Active Packaging

Packaging is called active packaging when it performs an additional role, other than when just used as an inert barrier to external influences. In case of fresh produce, ethylene is produced which not only accelerates the ripening process, but also brings in other undesirable changes such as dis-colouration, sprouting, textural changes, etc. To protect the respiring fruits from such undesirable changes, substances called ethylene absorbers or scavengers are developed. These are either used as small sachets inside the package or are integrated into the packaging material. A typical example in India is the use of ethylene absorbers in the case of banana packages where a plastic film is used in conjunction with the sachet. Another example is the use of grape guards inside the grape packages to extend the shelf-life of fresh grapes. The grape guards are coated materials used inside a plastic package (wrapper or bag) which releases sulphur dioxide during refrigerated storage and prevents the growth of the fungus Botrytis cineara on the stem of the grape bunches.

Bulk Packaging of Food Grains and Sugar in Plastic Woven Sacks

Traditionally, jute has been the packaging material for bulk commodities like food grains, sugar, cement, fertilizers, chemicals, etc. With the increasing growth of these commodities over the last few decades, there has been a quest to look at alternate packaging materials due to the stagnant jute production (refer Table 4). Commodity production has increased by 70%, whereas jute production has remained stagnant. Plastic woven sacks (PWS) have the potential to fulfill this need in a cost-effective manner, thereby offering a tough competition to Jute bags.

Packaging and storage of food grains and sugar is a challenging job. Both are hygroscopic and thermally active. An ideal packaging system should have sufficient tensile strength, weather resistance, resistance to handling abuse and conducive to grain metabolism. Large quantities of food-grains are produced in India every year. About 30% of the produce is procured by the Government and Semi Government agencies from the farmers in accordance with Government policy. Such food-grains are stored in jute bags in the conventional godowns. Since production of jute has been stagnant, cost of importing these bags is prohibitive. The procurement/storage of food-grains is becoming a costly affair for the Government. As an alternative, Polypropylene (PP bags) and High Density Polyethylene (HDPE) bags as per BIS specifications are being manufactured and can be used for our food grains (with proper shelf-life studies). These bags are already used for procurement and storage of cement, sugar, salt and fertilizers, etc., in the country. Compatibility/ shelf-life study of storing grains in PP/HDPE bags is being carried out by various bodies. Comments by Indian Grain Storage and Management Institute (IGMRI) for the two options of grain storing as shown in Table 5 is quite interesting.

TABLE 4
Change in Comodity Production in Relation to Jute Production

Production	Units	1987-1988	1997-1998	1998-1999	1999-2000
Commodities	Million tonnes	212	343	346	369
Raw Jute	Million bales	8	11	10	9
Jute and Jute Product Imports	'000 tonnes	20	54	111	121*
* Estimated (Net Import of Jute (111,000 MT imported in 98/99) to fulfill domestic demand under JPMA.)					

(Source: Plastics for Environment and Sustainable Development- ICPE and CIPET)

Food Processing Industry in India

Food processing involves any type of value addition to the agricultural produce starting at the post-harvest level. It includes even primary processing like grading, sorting, cutting, seeding, packaging, etc.

The 70 billion dollar Indian Food Processing Industry including 22 billion dollar value added products is characterised by the predominance of small units spread all over the country. The agro-food industry today employs about 20% of the country's labour force and contributes 15.19% of the total industrial output.

India produces 601 million tonnes of food as against 608 million tonnes in the US. The Indian food industry structure is shown in Figure 3, which indicates that 42% are in the unorganised sector, 33% are small scale units and only 25% are in the organised sector.

Figure 3 reveals that only 58% of food production is contributed by the small scale and organised sectors, while 42% is being produced by the unorganised sector. Only few large and medium companies are involved.

Plastic Woven Sacks

Segments of Food Industry

A profile of the food processing industry segments is given in Table 6, and Table 7 gives the composition of the food processing industry.

Cereals and Grains

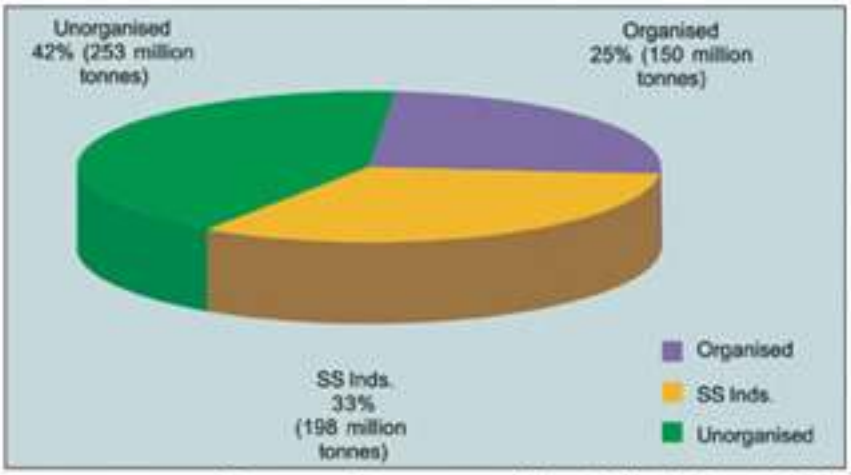
The grain processing is one of the major components of the food sector. The major food grains are rice, wheat and pulses. The grain

TABLE 5
Options in Grain Storing

Description	Jute Bags	HDPE/PP Bags
Mass of bag	665 gms	135 gms
Moisture regain	22%	Nil
Max oil content on dry decilled material basis	3% max by weight	Nil
Basic price per bag (excluding sales tax)	Rs. 17.05 (Average of last 5 months and inclusive of excise duty)	Rs. 10.44 (incl. of 16% excise duty and freight)
Cost of packing 1 MMT of wheat / rice	Rs. 37.50 crores @ Rs. 18.75 per bag (i.e. 17.05 + Rs. 1.70)	Rs. 20.88 crores @ Rs. 10.44 per bag
Packing cost of 20 MMT of wheat by FCI	Rs. 750.00 crores	Rs. 417.60 crores
Packing cost of 20 MMT of rice by FCI	Rs. 750.00 crores	Rs. 417.00 crores
Aeration	Good	Good (when not laminated)
Problems/quality complaints	Supplies are generally not strictly as per delivery schedule and have been carried over to next months in the past inspite of pre-inspections by Quality Assurance Wing of DGS&D complaints about poor texture of bags leading to spoilage of grain and variations in length/ width of bags are there. Besides, complaints about damage by water/rains during transit are also very frequent.	Good, - no moulds, cake formation, condensation or musty smell on rice, wheat Raw material available in plenty. No disturbance in supply schedule. The quality checks may be easier to enforce on HDPE/PP bags and the possibilities of bags getting damaged by water/rains during transit will be lesser.
Other advantages/ disadvantages	1. Not resistant to water, seepage and contamination is very high. 2. Contamination of food grains by jute batching oils - (a hydrocarbon and suspected carcinogen) present in the jute bag cannot be ruled out 3. Cost of transportation is higher than of HDPE/PP bags which are almost 1/5th in weight of the jute bags 4. Rough handling may result in burst/tear of bags	1. Resistant to water. 2. No jute batching oil present and therefore no such possibility on contamination of grains. 3. Cost of transportation will be much lesser than the jute bags. 4. During trials no burst/tear of bags so far noticed on rough handling of bags.

Woven Sacks for Packaging of Food Grains

Figure 3: Indian Food Industry Structure (2001)
(Total 601 million tonnes) Unorganised



[Source: Beverage and Food World, Sept. 2002]

processing industry in India is largely in the unorganised sector, although there are a few processors in the organised sector too. There is significant scope for modernisation of production technologies. Rapidly changing lifestyles have resulted in an increased demand for packaged and branded food products.

India produces and consumes about 22% of the total world rice. Raw rice and par boiled rice are generally preferred. Rice milling is reserved for the small scale sector and is governed by the Rice Milling Industry Act. One of the significant changes has been to increase the value of by-products of rice milling. Rice bran is now used in the production of rice bran oil. Rice is usually sold loose or under local brand names. A small quantity of premium quality rice is sold in small packs under nationally recognised brands.

The processing of wheat falls under both organised and unorgansied sectors. The products manufactured are maida (white flour), rava (semolina), atta (whole meal flour) and bran.

TABLE 6
Profile of Food Processing Industry Segments (Year 2001)
Rs. million

Industry Segment	Industry Size – Rs. 7,70,000 million
Oil and Vanaspati	1,70,000
Liquid Milk	1,35,000
Sugar	85,000
Bakery	40,000
Cereals	34,000
Indian Sweets	27,000
Tea and Coffee	24,000
Confectionery	20,000
Spices	4,000
Total market share of the industries (As specified above)	70%
Others	30%

[Source: Express Investment]

Around 80% of the production is consumed directly by the household sector where as the remaining is used for producing bakery and confectionery products (bread, biscuit and other products), pasta products, breakfast food and other Indian food. Wheat flour is generally sold loose. A small portion is packed in consumer packs under nationally recognised brands.

The processing of pulses is entirely under the unorganised sector, estimated to be over 10,000 dal mills in India. Most of the secondary processing is also confined to unorganised sector. The cereal processed products production is on the increase.

Fruits and Vegetables

The processed fruits and vegetables sector has shown a steady increasing growth from 0.28 million tonnes in 1991 to 0.99 million tonnes in 2001 as shown in Figure 4.

It is growing at the rate of 15% per year and is estimated to grow into an Rs.20,000 million market by 2005.

The breakof the production of processed fruits and vegetables products is given in Table 8.

The products recently added to the list are:

TABLE 7
Composition of Food Processing Industry
(Year 2001)

Industry	Percentage
Oil and Fats	36.00
Dairy Products	18.90
Cold Beverages	15.60
Beverages	15.30
Indian Foods	1.40
Western Foods	1.50
Bakery Products	6.50
Confectionery	3.50
Fruits and Vegetables	1.30

[Source: MFPI, Data Bank Indian Food Industry]

- Frozen pulps and vegetables
- Freeze dried fruits and vegetables
- Fruit concentrates and aromas
- Packaged vegetable curries
- Canned mushroom and mushroom products
- Tomato paste

Milk and Dairy

About 15% of the milk produced is being processed in the organised sector. As far as the consumption pattern is concerned, 46% is consumed as liquid milk, 28% as ghee, 7% as curd, 6% as butter, 6% as khoa and others 7%. The consumption pattern of milk is given in Figure 5.

The country produced 0.23 lakh tonnes milk powder including infant milk food, 5000 tonnes cheese, 6000 tonnes malted milk food and 11,000 tonnes condensed milk in 1999. The dairy industry has been growing at the rate of 5% per year mainly because of the co-operative movement "Operation Flood".

Spices

India is known as the "Home of Spices" and is the largest producer (2.5 million tonnes) accounting for 61% of world production, largest consumer (2.28 million tonnes) and largest exporter (0.28 million tonnes) accounting for 39% of the world export. Pepper the "King of Spices" earns the major export share, both in quantity as well as in value.

Edible Oils

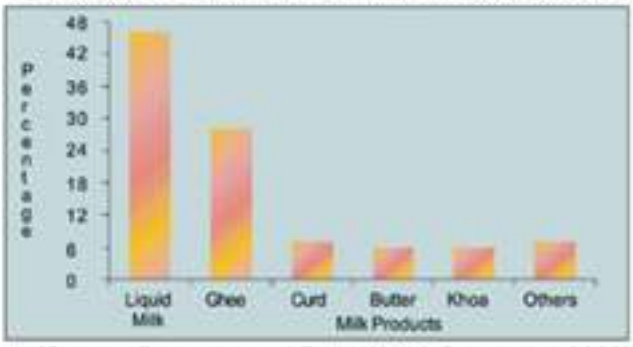
India is one of the largest producers and consumer of edible oils in the world. The composition of the Indian vegetable oil industry is shown in Table 9.

Meat and Poultry Processing

The production of meat is steadily increasing with an annual production of 4.5 million tonnes, which is contributed mainly by pigs followed by sheep, goat, buffalo and poultry meat. Meat producing industry in India is largely confined to the unorganised sector and there is very limited upgradation of technology.

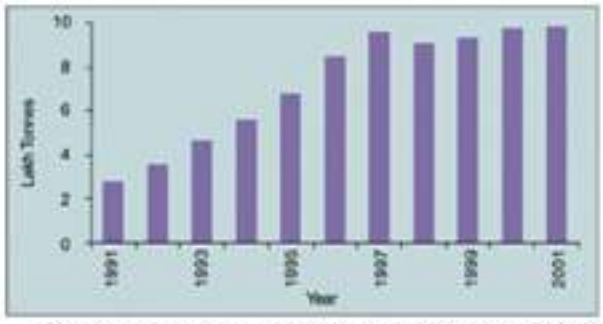
The constraints are absence of farms for rearing meat producing animals

Figure 5: Consumption Pattern of Milk Products (Year 2001)



[Source: Beverage and Food World, September 2002]

Figure 4: Production Pattern of Fruit and Vegetable Products



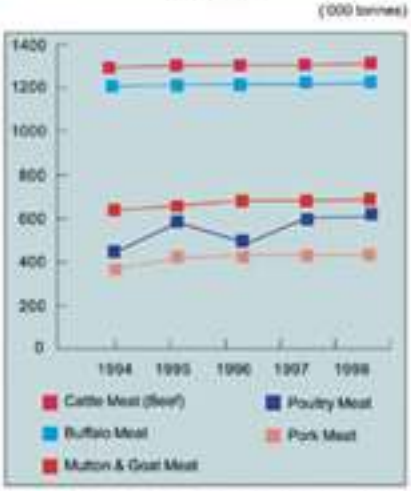
[Source: Beverage and Food World, September , 2002]

TABLE 8

Production of Processed Fruits and Vegetables

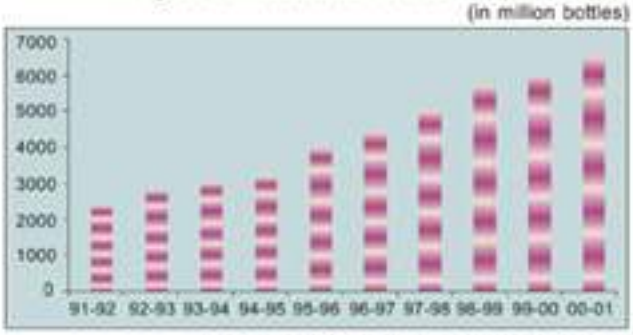
Food Products	Percentage
RTS Beverages	27.00
Canned and Bottled Fruits and Vegetables	3.69
Fruit Juices	3.28
Fruit Pulps	22.51
Jams / Squashes / Syrups	7.45
Fruit Juice Concentrate	0 95
Pickles, Preserves and Chutneys	11.00
Dehydrated Fruits and Vegetables	2.22
Frozen Fruits and Vegetables	9.36
Tomato Products, including Tomato Ketchup and Sauce	8.05
Others	4 49

Figure 6: Production of Meat and Meat Products



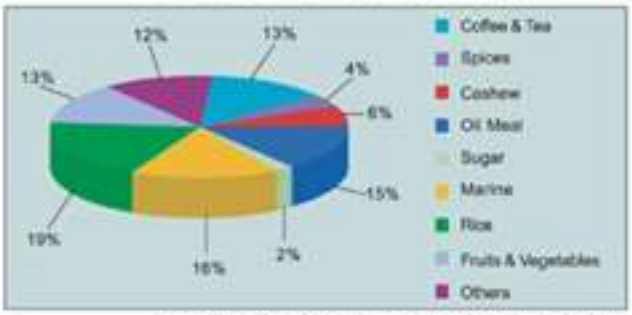
[Source: Annual Report 2000-2001, Dept. of Food Processing, Ministry of Agriculture]

Figure 7: Production of Soft Drinks



[Source: Annual Report 2000-2001, Dept. of Food Processing, Ministry of Agriculture]

Figure 8: Food Export Profile
Total Rs. 275 billion (Year 2001-2002)



[Source: Indian Food Industry, Mar-Apr 2003, Vol. 22, No. 2.]

and absence of cold-chain facilities. The market for scientifically and hygienically produced meat products is expected to grow rapidly due to constantly developing urbanisation. As a result of changing lifestyles, the demand for readyfood is growing rapidly. Overall very little of meat production is scientifically produced, processed and packaged as branded products. Most meat consumed in India is in fresh form. Less than 1% of meat is processed into value-added products like sausages, ham, bacon, luncheon meat, kababs meat balls, etc. Figure 6 gives the production of meat and meat products.

During the last decade, poultry farming has been established in the organised sector. A number of private sector companies have integrated their facilities both backward and forward, as a result a number of poultry breeding farms, processing plants for production of poultry products for the Indian market and a few value added products have been established.

Fish Processing

The range of marine fish includes prawns, shrimps, tuna, cuttlefish, squids, octopus, ribbon fish, mackerel, lobsters and many other varieties. Most of the units exist in the small scale sector. Over the last decade, the organised corporate sector has become increasingly involved in preservation, processing and export of coastal fish, but the wide variety found in Indian inland waters, coastal areas and deep seas stuff remain grossly under utilised. Processed fish products include conventional block frozen products, Individual Quick Frozen (IQF) products, mincedfish products like fish sausages, cutlets, surimi, texturised products, etc. Some quantities of dry fish are also sold. The processing units are primarily located around important fish landing centers. Substantial investment in fisheries has resulted due to the vast potential and attractive incentives by the Government. The canned and frozen marine products are almost entirely for the export market.

Soft Drinks

The production of soft drinks has increased from 5670 million bottles in 1998-99 to 6230 million bottles in 1999-2000. The major product groups are non alcoholic flavoured/ sweetened beverages and carbonated drinks. Growth in production of soft drinks is given in Figure 7.

Indian soft drinks market in the year 1999-2000 was worth Rs. 22 billion. It is estimated that 65% of consumers prefer nondrinks. The soft drink segment is expected to grow to Rs.105 billion by the year 2005. Tetrapak drinks market is currently growing at the rate of 10%.

Table 10 gives the overview of the Indian Processed Food Markets.

Exports of Food Products

India exports a wide range of food products to countries all over the world earning considerable foreign exchange. Food exports form a sizeable chunk of the country's international trade though significant volume of food is also imported. Out of Rs. 2025 billion exports, food constitutes about 17% valued at Rs. 275 billion annually. Figure 8 gives the food export profile.

TABLE 9
Indian Vegetable Oil Industry

Type of Units	Number of Units	Production Capacity
Oilseed Crushing	1,50,000	425 lakh tonnes
Solvent Extraction	800	345 lakh tonnes
Refineries	300	50 lakh tonnes
Vanaspati	205	32 lakh tonnes

TABLE 10

Indian Processed Food Markets (Year 2000)

Product	Volume	Value (Rs billion)	Major Players
Basic Foods			
Packaged wheat flour (incl. branded flour)	1 MMT	0.36	Hindustan Lever Ltd., Pillsbury, Bestfoods India Ltd.
Spices	2.45 MMT	170.1	Regional
Edible oil	8 MMT	396.9	ITC Agrotech, Marico Industries, Hindustan Lever Ltd. National Dairy Development Board, Ahmed Oil Mills Ltd
Salt	0.5 MMT	2.7	Gujarat Salt Federation, Hindustan Salt Works, Tata Chemicals, Bestfoods India Ltd.
Sugar	15 MMT	321.7	Government Co-operatives
Eggs	33 billion numbers	35.1	Government Poultry Corporations, Egg Co-ordination Committee
Poultry Meat	0.55 MMT	n.a	Government Poultry Corporations
Milk (total)	73.5 million	315 (liquid milk)	National Dairy Development Board
Bakery Products (incl. unorganized sector)			
Biscuits and Cakes	1million (biscuits) 0.5 million (cakes)	34.87	Britannia Industries Ltd., Parle Products, Bakeman's
Bread	1.5 million	15.75	Britannia Industries Ltd., Modern Industries (now with Hindustan Lever Ltd.), Spencer's
Indian Dairy Foods			
Ghee (butter oil) (organized only)	0.085 MMT	n.a	Gujarat Co-operative Milk Marketing Federation, Vijaya
Indian milk sweets (incl. Unorganized sector)	> 0.3 MMT	15.75	Small players

Product	Volume	Value (US $ Million)	Major Players
Western dairy foods (organized only)			
Ice cream	50 million litres	5.4	Hindustan Lever Ltd., Gujarat Co-operative Milk Marketing Federation, Hatsun Agro
Butter	0.08 MMT	9	Gujarat Co-operative Milk Marketing Federation, Britannia Industries Ltd.
Cheese	0.012 MMT	1.35	Britannia Industries Ltd., Gujarat Co-operative Milk Marketing Federation
Dairy Whitener	0.048 MMT	3.82	Nestle India Ltd., Gujarat Co-operative Milk Marketing Federation
Milk Powder	0.1 MMT	4.5	Gujarat Co-operative Milk Marketing Federation, Nestle India Ltd.
Malted Food Drinks	0.065 MMT	6.3	Cadbury India Ltd., SmithKline Beecham Consumer Products, Nestle India Ltd.
Processed Fruit and Vegetable Products			
Pickles	0.12 MMT	1.26	Nestle India Ltd., American Dry Fruits, Ruchi, Bedekar s, Priya
Fruit Beverages	0.13 MMT	3.6	Hindustan Lever Ltd., Parle Products, Enkay, Texofoods
Fruit spreads, Sauces and Ketchup	0.05 MMT	1.93	Hindustan Lever Ltd., Marico Industries
Convenience Foods (organized sector)			
Instant Noodles	0.03 MMT	1.48	Nestle India Ltd., Indo-Nissin Foods
Instant Soups	0.0005 MMT	0.31	Nestle India Ltd., Bestfoods India Ltd.
Breakfast Cereal	0.003 MMT	0.63	Kellogg India, Mohun Meakins
Confectionery (incl. unorganized sector)			
Chocolate	0.02 MMT	4.27	Cadbury India Ltd., Nestle India Ltd.
Sugar-boiled Confectionery	0.08 MMT	12.6	Parry's Confectionery, Nestle India Ltd., Cadbury India Ltd.
Chewing/Bubble gum	0.02 MMT	2.47	Warner Lambert, Wrigley's Perfetti
Snack Foods			
Traditional Indian Snacks (incl. small players)	>0.31 MMT	13.27	Haldiram's, Pepsi Foods
Western Snacks (incl. branded potato chips = 5,000 metric tons)	0.04 MMT	1.35	Frito-Lay India, Uncle Chipps, Procter and Gamble

[Source : Market Research Report of Promar International – 2001]

More than 75% of this export basket is made up of agricultural commodities with very low value addition and technology content. The exports have shown a rising trend. It has increased from Rs. 72,710 millions in 1997-98 to almost Rs. 100,000 million in 2001-2002. Table 11 indicates exports of food products in terms of tonnage and value for three years.

Besides the above products, during the year 2001-2002, 41,8070 tonnes of marine products were also exported. India's exports of milk products have also registered a significant increase at Rs. 840 million in 2001-2002 from Rs. 375 million during 1999-2000. The exports of spices is valued at Rs. 16,254 million in the year 2001-2002.

Figures 9 to 13 show the export of major product groups/major markets with percentage share.

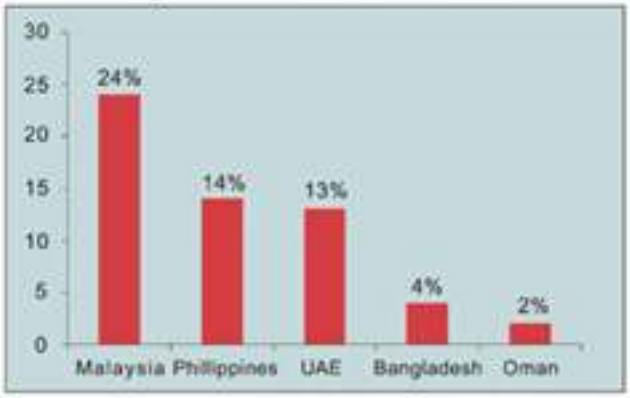
Market Trends

Growing urbanisation, globali-sation, rapidly changing social structures including the traditional joint family system and growing consumerism have had a major impact on the middle income group population in urban and rural India. The Indian middle class (refers to the middle income group of population numbering approxi-mately 120 million), which is considered to be one of the fastest growing in the world, with rapidly changing food consump-tion patterns has triggered dramatic changes in the agribusiness sector. A number of international companies have started operations in India in the sector and Indian companies have enhanced production capacities to address growing customer demand. The post globalisation era has brought an unprecedented number of mega mergers and acquisitions in the processed food industry in India.

A recent survey by Indian leading food and consumer products company highlights the following as major trends affecting consumption patterns in India:

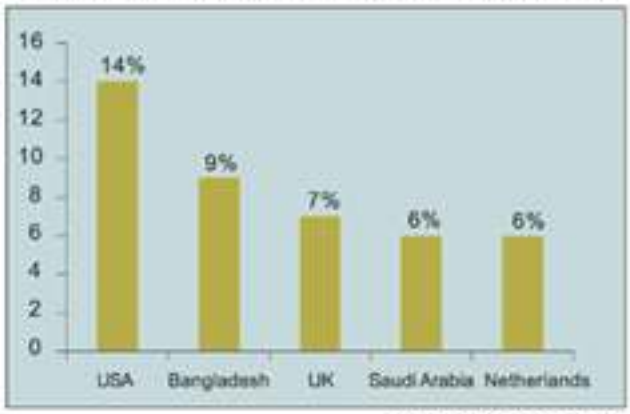
- A shift from self denial to affordable indulgence, as a result of changing values and higher incomes in society
- Desire for quality time, which translates into an increased need for convenience

Figure 9: Livestock Products



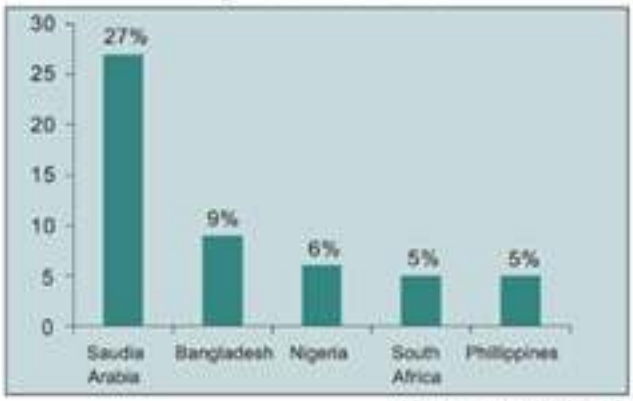
[Source: APEDA]

Figure 10: Processed Fruits and Vegetables



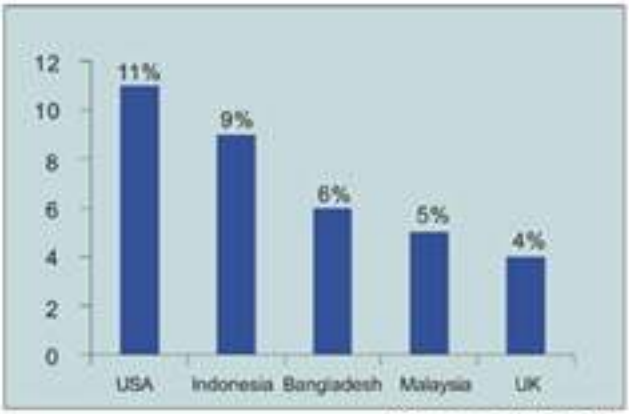
[Source: APEDA]

Figure 11: Cereals



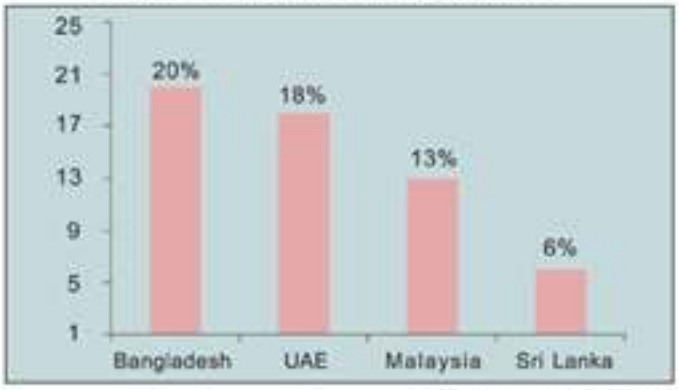
[Source: APEDA]

Figure 12: Other Processed Foods



[Source: APEDA]

Figure 13: Fruits and Vegetables



[Source: APEDA]

TABLE 13
Branded Processed Food Priorities

Product	Market Growth	Market Size	Infrastructure Bottlenecks	Government Influences
Bakery Products	High	Large	Some/Few	Some
Indian Dairy products	High	Large	Many/Some	Many
Indian Snacks	High	Large	Some	Some
Processed Fruits and Vegetables	Medium	Small/Medium	Many	Some
Convenience Foods	Medium/High	Small/Medium	Some/Few	Some
Western Dairy Products	High	Medium	Many/Some	Many

- Increased awareness about personal health and vitality, which is no more restricted to urban centres
- The social trends which may have bearing on consumer/business of the future
- Inflexion point in rural demand attributed to rising literacy and improved connectivity (which makes peoples' aspirations homogenous)
- Government initiatives and good monsoons for several years
- Globalisation – leading to consumers demand for global standards of performance and quality (often at local cost).

Opportunities in Food Processing

The food processing sector in India has been accorded high priority by the Government of India, with a number of fiscal incentives, to encourage commercialisation and value addition to agricultural produce. Since liberalisation in August 1999, until February 2001, proposals for projects of over Rs. 600 billion, have been proposed in various segments of the food and agro-processing industry. Besides this, the government has also approved proposals

TABLE 11
Export of Agricultural and Processed Food Products

Qty: in thousand tonnes Value: in Rs. million

	1997-1998		1998-1999		2000-2001	
Products	Qty	Value	Qty	Value	Qty	Value
Floriculture and Seeds						
Floriculture		812		972		1321
Fruits and Vegetables Seeds	5.85	559	6.56	761	12.30	675
Subtotal	5.85	1371	1250.21	1733	12.30	1996
Fruits and Vegetables						
Fresh Onions	333.35	2024	216.49	1608	343.25	2762
Other Fresh Vegetables	98.35	1141	792.73	1120	133.99	1908
Walnuts	3.89	565	10.32	690	7.74	1099
Fresh Mangoes	42.90	736	45.19	794	37.12	686
Fresh Grapes	23.81	660	10.72	378	20.65	830
Other Fresh Fruits	64.61	727	80.16	738	81.24	1155
Subtotal	566.91	5853	1155.61	5528	623.99	8440
Processed Fruits and Vegetables						
Dried and Preserved Vegetables	200.26	4799	1587.32	3803	286.93	7383
Mango Pulp	45.88	1253	1885.35	1389	57.30	2638
Pickles and Chutneys	24.37	767	20.90	740	40.70	1365
Other Processed Fruits and Vegetables	28.42	796	1936.04	1127	70.82	2069
Subtotal	298.93	7615	5429.61	7059	455.75	13455
Animal Products						
Buffalo Meat	176.33	7293	155.32	6917	288.03	13750
Sheep/Goat Meat	7.55	626	2403.30	772	11.90	781
Poultry Products	11.04	888	14.14	640	15.84	862
Dairy Products	2.38	134	2.33	136	11.07	839
Animal Casings	0.37	120	1.15	141	0.57	123
Processed Meat	0.26	22	0.96	29	0.13	16
Subtotal	197.93	9083	2577.20	8635	327.54	16371
Other Processed Foods						
Groundnuts	245.13	5663	55.57	1385	137.06	3164
Guar Gum	102.73	5450	90.53	7248	129.53	6030
Jaggery and Confectionery	83.04	1279	31.84	158	209.22	2770
Cocoa Products	1.04	93	0.67	83	1.30	131
Cereal Preparations	22.70	1160	18.70	1014	30.21	1774
Alcoholic Beverages	37.07	704	31.32	700	87.35	1634
Miscellaneous Preparations	8.89	386	20.75	516	15.79	997
Milled Products	23.11	216	7.21	81	307.47	1481
Subtotal	523.71	14951	256.79	11185.00	917.93	17981
Cereals						
Basmati Rice	592.68	16850	606.72	18828	851.72	21660
Non Basmati Rice	1796.28	16860	4395.87	43659	682.76	7775
Wheat	-	0.00	3.52	27	813.49	4151
Other Cereals	15.35	126	9.41	90	45.13	389
Subtotal	2404.31	33836	5015.52	62604	2393.10	33975
Grand Total	3997.84	72709	15894.94	96744	4730.61	92218

[Source: APEDA]

TABLE 12
Basic Food Priorities

Product	Market Growth	Market Size	Infrastructure Bottlenecks	Government Influences
Wheat Flour	High	Medium	Some	Some
Poultry	High	Large	Many	Some
Milk	High	Large	Some/Many	Many
Fresh Fruits and Vegetables	High	Large	Many	Some/Many
Edible Oils	Medium	Medium/Large	Some	Some/Many

for joint ventures, foreign collaboration, industrial licenses and 100% export oriented units envisaging an investment of Rs. 216 billion during the same period. Out of this, foreign investment is over Rs.820 billion.

The segments covered under this are milk and milk products, fruits and vegetables, cereals and grains, meat and meat products, marine products, packages food products and alcoholic beverages.

Policy Initiatives in the Food Processing Sector

- Food processing industry declared a priority area
- Full repatriation of profits/capital allowed
- Almost entire sector is de-licensed
- Automatic approvals for foreign investment up to 100%, except in few cases and also technology transfer
- Zero duty import of capital goods and raw material for 100% export oriented units
- Agro based 100% export oriented units allowed sale up to 50% in domestic tariff area
- Export earnings are exempted from corporate tax
- All processed fruits and vegetables products exempted from Central Excise Duty
- Government grant given for setting up of common facilities in Agro Food Park
- Full duty exemption on all imports for units in Export Processing Zones

Opportunities

- Dehydration and canning, frozen juice/frozen vegetables, fruit juice and concentrates/pulps, ready to serve/eat vegetables, mushroom cultivation and processing
- Meat and poultry products, integrated abattoirs-cum-meat processing units, frozen and processed sea foods
- Milk products – cheese, frozen desserts, yoghurt, whey, protein, casein
- Energy foods/energy health drinks, wine, snack foods
- Post-harvest technology for preservation, packaging technologies and materials, transportation of fresh and processed foods/cold chain, bulk storage and movement of food grains, cold storage and cargo

handling facilities at international airports.

- Biotechnology – extensive pool of germ plasm, trained breeders and scientific manpower available in India.

Priorities

As per the market research report by Promar International key food markets on four factors (market growth, market size, government influences and infrastructure bottlenecks.) are given in Tables 12 and 13 for basic foods and branded processed foods respectively.

Conclusion

Packaging and processing are the most effective means to preserve, increase and improve food availability. Packaging helps keep our food fresh and safe, and protects it against spoilage.

Plastic in packaging provides a hygienic and safe environment for food and medicines by protecting them against contamination while keeping food fresh throughout use.

Plastics allow packaging to perform necessary tasks and provide strength and stiffness, barrier to oxygen transmission and moisture, resistance to food component attack, and flexibility. Innovation in rigid plastic packaging adds quality and variety to food packaging.

References

1. Indian Food Industry, Jul-Aug '01 Vol. 20, No.4, A Policy and Strategy for Integrated Development of Agro-Food Industry, by H. A. B. Parpai, CFTRI Mysore Ex-Director.
2. Modern Food Packaging, IIP Publication, Food Spoilage, Preservation, Techniques and Role of Packaging, by Rekha S. Singhal and Pushpa R. Kulkarni, UDCT, Mumbai.
3. Beverage and Food World, Sep '02, Present Scenario of the Processed Food Industry in India Vis-à-Vis Quality Control, by K.S. Premavalli and A.S. Bawa, DFRL, Mysore.
4. Indian Food Industry, Mar-Apr '03, Vol 22, No. 2, Indian Food Industry: Will the Sun Ever Rise?, by V.H. Potty, Diversified Food Technologies (India).
5. Indian Food Industry, Jul-Aug '01, Vol. 20 No. 4, A Strategic Assessment of Food, Beverage and Agribusiness Opportunities in India, Promar International.
6. APEDA Information Brochure.
7. www.tradepatners.gov.uk
8. Working Group Report by IIP for MFPI.
9. Plastic for Environment and Sustainable Development, ICPE Publication.
10. Indian Food Packer, Jan-Feb '01, Food Processing Industry, Current Scene and Prospects, Omesh Saigal, Secretary DFPI.
11. www.mofpi.nic.in
12. Modern Food Packaging, IIP Publication, Indian Food Sector and Packaging, An Overview.
13. Life Cycle Analysis, Centre for Polymer Science and Engineering, IIT, Delhi.

Questions & Answers in the Lok Sabha of Indian Parliament on Plastics and the Environment

Reproduced here are parts of the question related to plastics.

LOK SABHA

National Policy on Petrochemicals

Starred Question No. 294
Answered on 19.3.2007

Shri Sunil Khan, Shri E. G. Sugavanam :

Will the Minister of Chemicals and Fertilizers be pleased to state:

(c) The details of the plastic products which is hazards for environment;

(d) The per-capita consumption of plastic goods in the country.

Answer:

Shri Ram Vilas Paswan, Minister of Chemicals and Fertilizers & Minister of Steel:

(c) Plastics are chemically inert materials and are generally not hazardous substance per-se. Most of the plastics are re-processable and recyclable in nature. However, inadequate segregation and collection of post-consumer plastic waste may create problems for environment.

(d) The average per capita consumption in India is 4.5 kgs.

Disposal of Plastic waste through Co-processing in Cement Kilns

Update

Due to its multifaceted benefits, use of plastics in a variety of applications has been increasing at a galloping rate all around the world, including India. Though plastics contribute various benefits to the modern world from providing safe and hygienic packaging materials for food and food products, to conserving land, water, forests and energy resources and practically in all areas of our daily life, the management of the waste created by discarded used plastic items, especially the ones used for packaging applications has become a challenging task in developing countries. The increased use of plastics products, about 50% of which go for packaging applications alone and hence are discarded immediately after using the content, has increased the quantity of plastics in the solid waste stream to a great extent. Recycling has now assumed great importance in the context of solid waste management.

The new technologies and economics have come to play an important role in plastics recycling. Recycling principally refers to Recovery, which is divided into Material Recycling and Energy Recovery. Material Recycling is again divided into Mechanical and Feedstock Recycling. The choice between Mechanical Recycling, Feedstock Recycling or Energy Recovery depends on the types of plastics waste and the relative ease / difficulty in total or partial segregation from other plastics and / or other waste materials.

Mechanical recycling includes a wide variety of processing techniques and a broad range of processing methods. Pure grade production scrap may only have to be reground and reprocessed, mixed plastics have to be mechanically separated and, if contaminated, also elaborately washed and cleaned. All these steps increase the cost depending on the degree of contamination.

After collection of the portions that can be recycled by mechanical recycling, there remain numerous very small, heavily contaminated articles, multi-layered composites or cross-linked products, which are mostly unattended and allowed to remain in the waste stream causing solid waste problem. The best way of reutilizing these portions is to incinerate them instead of dumping them diffusely on landfills. This recovers their calorific values and at the same time disposes of the waste in scientific manner without causing any environmental hazards.

References are available that developed countries are disposing these otherwise difficult to recycle plastics waste, through co-processing in Cement Kilns (Energy Recovery) and using in Blast Furnaces of Steel Industries (Feedstock Recycling) in a scientific and environmental-friendly manner – a brief of which was reported in April-June, 2006 issue of Eco-Echoes.

ICPE and ACC Ltd. have entered into an MoU to undertake an Industrial Research Project to find out the possibilities disposing various types of post-consumer plastic waste through co-processing in cement kiln. The result of the project is expected by the end of this year.

Discussions in progress to firm up the MoU.
From L to R: Mr. Ed Vrhaanne, Senior Consultant, Holcim, Switzerland; Mr. U.V. Parlikar, Vice-President- AFR, ACC Ltd.; Mr. T.K. Bandopadhyay, ICPE; Dr. A. Biswas, Member, ICPE Advisory Committee; Mr. R. K. Suri, Jr. President - AFR, ACC Ltd.

Mr. Sujit Banerji, Executive Secretary / Member, Executive Committee, ICPE, and Mr. R. K. Suri, Jr. President - AFR, ACC Ltd., exchanging the MoU documents.

Asia Pacific Conference on Recycling of Plastics

23rd February, 2007 – Mumbai

Address by Guest of Honour

Mr. K. G. Ramanathan

President, Chemicals & Petrochemicals Manufacturers' Association (CPMA) & President, GC, Indian Centre for Plastics in the Environment (ICPE)

As reported in the Proceedings of IPI Conference

The technique of recycling is scientific in nature and is economical. The problems are not to do with plastics per se, but more to do with solid waste management. Plastics account for only six per cent of the total solid waste. So even if you ban plastics, one still has to deal with the remaining 94 per cent. The anti-plastic call, according to him, boils down to waste disposal issues. "The government needs to put in place recycling infrastructure and make segregation of waste at source, mandatory. Industry cannot act as policemen, for ensuring implementation of responsible use of plastics, but it could be brought on board through initiatives by the government and non-government organisations in this direction," he said.

Plastics has gained widespread application from common household goods to high technology instruments. However, there are three or four criticisms against plastics. First, it is said that plastics are derived from non-renewable resources, viz, oil and hence the usage of plastics should be curbed. He pointed out that only 4% of crude oil is used in the entire chain of petrochemicals of which plastics is only a part. While the economy of usage of crude oil is always welcome, curbing the use of plastics is not the solution.

The second aspect of criticism always relates to the alleged health hazards arising out of usage of plastics. Mr. Ramanathan explained that plastic products are being subjected to in-depth scientific analysis and they have clearly proved that plastics do not cause any such health hazards. In fact, plastic products have been implanted into vital organ like heart, clearly disproving the myths. Moreover there are clear international and national regulations/standards for usage of plastics that come into contact with food, water, etc. Therefore, much of the alleged health hazards is pure scare mongering and not based on scientific facts. The issue of dioxin emanating from burning of plastics has also been well studied and documented.

The third major criticism against plastics is its non-biodegradability. While it is true that plastics are not amenable to biodegradability like other organic matters, many alternate materials such as glass, metals are also not biodegradable. Moreover, many of the applications for plastics arise from the need for the product to belong lasting. Again, LCA studies carried out the world over clearly prove that the energy required for production of plastics is relatively lower than other competing materials. Thus, the production and usage of plastics demand minimum energy in comparison to other materials and therefore non-biodegradability alone cannot be a consideration while deciding on the appropriate needs of a material.

Lastly, management of plastics waste is held against the usage of plastics. Undoubtedly this is a serious issue mainly due to the social habit of our people and poor infrastructure for management of solid waste. The solution lies in segregation of dry and wet solid waste at the source, creation of efficient solid waste management infrastructure coupled with establishment of recycling centers as plastics can be recycled several times before it reaches its end of life. This is where a fruitful partnership between Government agencies, plastics industry and consuming public will have to be developed. ICPE had in fact demonstrated in last 5 years how this multiparty effort can yield results in India and also changed age-old habits of solid waste disposal in areas of cities and towns. Educational programmes against littering and segregation and disposal of plastic waste will have to be launched. Creation of an efficient solid waste management system can be attempted with the partnership of industry. The recycling industry also needs to be upgraded by technical inputs and financial incentives. The industry should be a part of the solid waste management process by local bodies. With the help of NGO's, educational programmes can be created and awareness against litter and waste can be widened in all parts of our country. Plastics are here to stay, they have important uses across all sectors of our economy and worldwide their use will grow, the aim should be to monitor its usage and handling of the waste so more can be recycled.

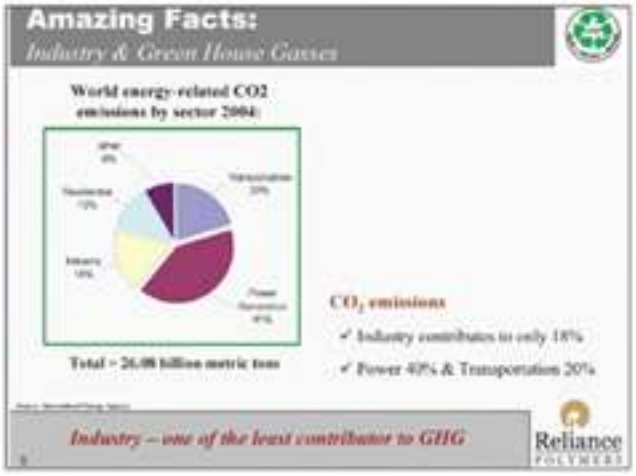
Asia Pacific Conference on Recycling of Plastics

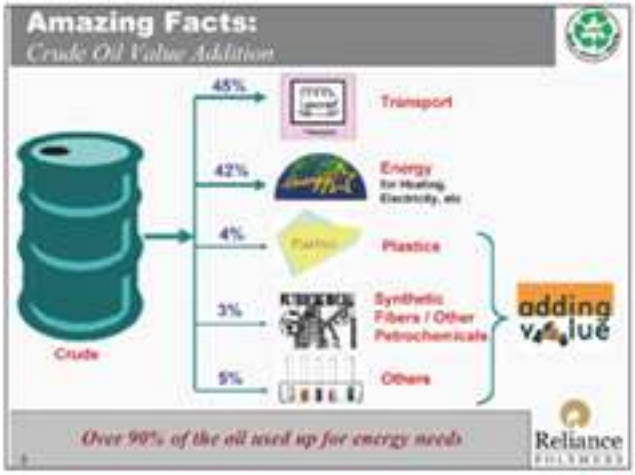
23rd February, 2007 – Mumbai

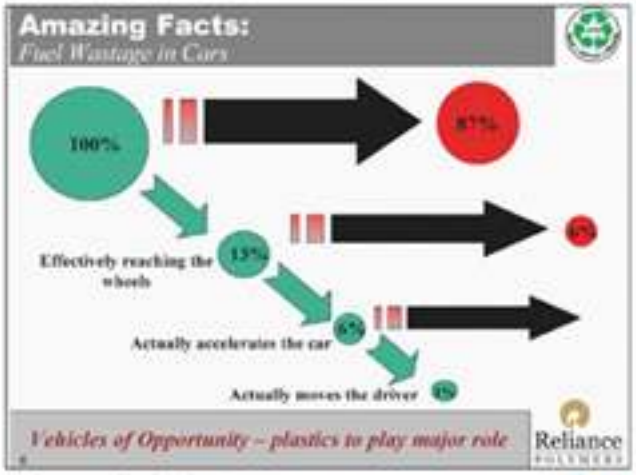
Keynote Address by

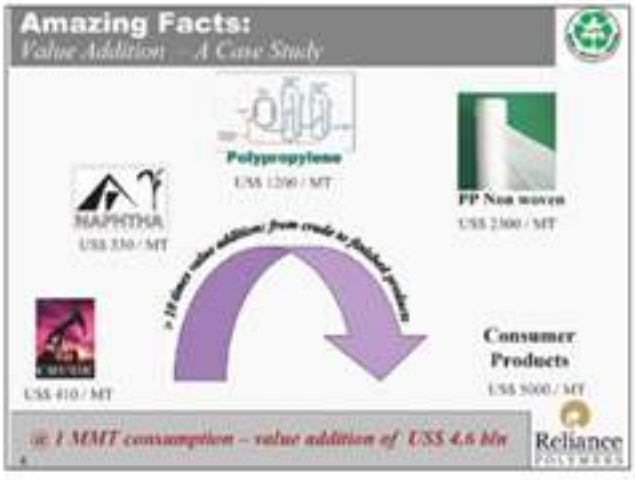
Mr. Sujit Banerji

President-Polymers Business & Head Integrated R&T,
Reliance Industries Limited &
Executive Secretary / Member, Executive Committee, ICPE









Amazing Facts:
Crude Oil Usage

"It took us 125 years to use the first trillion barrels of oil.

We'll use the next trillion in 30"

Conserving fuel -
– Recycling complementing the rest

Reliance POLYMERS

Recycling:
Three Pronged Approach

Innovative & cost effective commercial solution

Reliance POLYMERS

Recycling

The most preferred option …
For Waste Management

Reliance POLYMERS

Carbon Recycling:
Recovering Hydrocarbons

- Carbon Recycling – recycling of carbon waste streams at molecular level
- Carbon containing wastes - broken down through gasification into Carbon & Hydrogen
- Re-assembled to produce Chemicals & Fuels
- Utilised as Fuel to produce Power (and / or steam)
- Key Features
  - ✓ Reduce up to 95% - avoid transport costs, min. environmental damage
  - ✓ Generate substantial amount of electricity - avoid transmission costs
  - ✓ Zero NOx, SOx and dioxins – minimising environmental impacts
  - ✓ Inert residual ash –range of valuable uses
  - ✓ Tried & tested technology
  - ✓ Small modular plants – for inside the fence installations

Carbon Recycling – for green energy

Reliance POLYMERS

Recycling:
Plastic Fantastic

resource	optimization
feedstock	reduction
production	re-use
transport	recycling
use	energy recovery
Maximum efficiency	Minimum waste

- Reduced total material requirement
- Low energy requirement in production
- Less fuel consumed in transportation
- Pollutants at minuscule level (Both during production & recycling)
- Minimal waste at the end of life due to recyclability

Improving quality of life through protection & conservation

Reliance POLYMERS

Carbon Recycling:
PET Recycling a Success Story

- Current PET consumption – 160 KTA
- 95% PET recycled to Value Added Products
- Recycling centers across the country
- Participation of End users along with the industry

Marks & Spencer story:

- Staff uniforms and men's fleeces made from recycled PET bottles
- Switching over to recyclate - use of 22mln 2-litre bottles
- Saving Crude oil from going into virgin polyester.

Efforts through all sections of the industry

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Recycling
Integrated Waste Management - imperative

- IWM system - to manage waste in an environmentally & economically sustainable way
- Cost effective option in-lieu of traditional methods of Landfill.
- Addresses - energy from Waste, Value added products, Public Education & Shared Responsibility.
- Participants – Plastics Value Chain, Consumers & Local Government.
- Aimed at - increased recycling & energy recovery.

An issue that needs to be addressed effectively...

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Carbon Recycling:
Wax from Plastics Waste

- Low Molecular PE Wax
- Project along with UDCT, Mumbai
- Lab scale trials - successful
- Need for commercialization

Chemicals from plastics waste

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Carbon Recycling:
Fuel from Plastic Waste

Maharashtra signs MoU to produce fuel from plastic

Waste to Diesel:

- 1 MT waste yielding 900 ltrs of Diesel
- Conforming to Highest Quality EN 590 diesel
- Patented Process

GR Technologies, Korea

Axiom Energy Ltd., Australia

Energy-Hanford, California

cynar plc

Carbon Recycling – for green energy

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Carbon Recycling:
Fuel from Plastic Waste

- Pellets of recycled plastics used in firing power stations in Japan
- Plastic waste can replace ~15% of fossil fuel in Cement Kilns
- 1 MMT cement plant can consume 10 to 30 KTA of plastic waste

1 bln lbs/yr of Plastics** (with heat of combustion of 20,000BTU/lb) **equivalent to Heat of Combustion of 9,630 barrels of Crude

Turning environmental issue into valuable resource

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Carbon Recycling:
Fuel from Plastic Waste

Industry Initiatives:

- Trials taken – utility proven
- IOC R&D – notified suitability of hydrocarbon fuel from plastic waste for power generation.
- Commercially feasible process
- Industry ready to contribute up to Rs. 1 Cr. For fuels from plastics waste

Regulatory Support:

- Encouragement to develop technology
- Fiscal benefits and support for such projects

Reducing load on nation's fuel bill

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Carbon Recycling:
Fuel from Plastic Waste

Industry Initiatives:

- Identified as leading Technology Development Programme by ICPE's research Council
- CPCB has allowed trials in Cement Kilns under controlled conditions and supervision
- ICPE working closely with National Council for Building Materials (NCB), Ballabgarh
- In dialogue with ACC / Lafarge for industrial trials
- Provision of Rs. 50 Lacs for the project

Waste Management through Energy Recovery

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Carbon Recycling:
Power from Plastic Waste

- Area coverage - 23 wards
- MSW generated - 4 MT/Year
- Collection points- 250,000 nos.
- 22 incinerators in operation (2004)
- Power generation 104 Mw (2004)

The Tokyo Experience

❖ In 1996, Japan's 130 incinerators produced 640 mW of power, equaling total power requirement of Delhi

Plastics in MSW (Max 4%) contents highest Heat Content & lowest Ash & Moisture content

Techno-economic alternative to conventional recycling

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Carbon Recycling:
Plastic Waste in Steel Making

Australian scientists use plastic to make steel

- Carbon (Coke & Coal) used to add strength to Steel
- Recycled Plastics contain high Carbon Content suitable for steel making
- Technique to use waste plastics in steel making by New South Wales Univ.
- Recycled Plastics – used as alternate source of Carbon

Carbon Recycling – for green energy

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Carbon Recycling:
Power from Plastic Waste

Industry Initiatives:

- Committed to set up a pilot incinerator to taste VOC emissions
- ICPE to take Lead

Regulatory Support:

- Help from local bodies

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Carbon Recycling:
Plastic Waste in Steel Blast Furnace

Industry Initiatives:

- CPCB allowed use of plastic waste as fuel and reducing agent in steel plants
- In dialogue with Tata, Jamshedpur for Project
- Provision of Rs. 50 Lacs for the project

Deriving value from waste

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Unconventional Recycling:
Road Network Essential for Growth

- 2nd Largest road network in the world
- Total network of 3.3 million km
  - USA (6.4 million km) & China (1.8 million km)
- Highway network density (km/ sq. km of land)
  - India: 0.66 – comparable to USA (0.65)
  - Far better than China (0.16) & Brazil (0.2)
- Accounts for India's -
  - 90% of passenger traffic
  - 65% of total freight (~ 900 million tons / km-yr.)

It's a matter of pride

Est ..... Annual loss to economy on account of congestion & poor roads: 3 to 6 billion US$

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Unconventional Recycling:
Co-mingled Waste

- Recycling of co-mingled waste into (lumber) – a wood substitute
- Used for landscaping products
- Rot proof, water proof, long lasting

Would help conserve trees

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Unconventional Recycling:
Use of Plastics Waste for Better Roads

अब सड़क निर्माण में काम आएगा पॉलिथीन का कचरा

Green light for plastic roads

Plastic waste to be used in asphalt mixture

Proven on the roads in Madurai & Mumbai

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Unconventional Recycling: :
Co-

Industry Initiatives:

- Project with UDCT, Mumbai
- Technology development

Regulatory Support:

- Support from local governing bodies for use of such products for landscaping

Solicit support for implementation

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Unconventional Recycling: :
Plastics Waste for Better Roads – A live Case

Tar Road laying

Road after 7 days

Road after 6 months

Advantages:

- Better binding properties
- Withstand Higher temperatures
- Withstand Higher loads
- Resists permeation of water

Benefits:

- @ 10% bitumen replacement
- 1 km of 7ft wide road – 1MT of plastic waste
- Av. Savings of 8,000 Rs/km

Even if 10% rural roads covered – 2.6 lacs km
Savings of – Rs. 2 billion

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Conventional Recycling

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Unconventional Recycling: :
Plastics Waste for Better Roads – A live Case

Industry Initiatives:

- Trials taken – utility proven
- Studies in coordination with,
  - Centre for Transport Engg. Bangalore University
  - Tamilnadu project at Thiagarajar College of Engg., Madurai
  - CRRI Project in Road Modification
- Industry contributed Rs. 21 Lacs

Regulatory Support:

- Support for more trials in the rural areas
- NHAI / CRRI support for research & Spec-ins

Improving infrastructure

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Conventional Recycling:
Recycling Industry – Indian Uniqueness

Indian BPO / Service Industry:

- Reckoned as global leader
- In Services / IT and Research Outsourcing

Indian Manufacturing Industry:

- Growing @ double digit growth rate
- Moving towards global leadership

Indian Recycling Industry:

- Recycling 60% of Waste – highest in the world
- World Average of 22%

India – drawing the roadmap

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Conventional Recycling:
Recycling Industry – Socio-Economic Value Added

Turnover: > Rs. 5,000 Cr.

Value Add.: > Rs.1,600 Cr.

Volume Recycled: 1.3 MMT

No. of Units: ~ 2300

Pelletizers: ~ 4500

Employment: > 3.5 Million

Rag pickers Employed: > 1.3 Million

Creating Employment & Business opportunities

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Conventional Recycling:
Plastics Waste for Shelter for Poor

Delivering value at every stage

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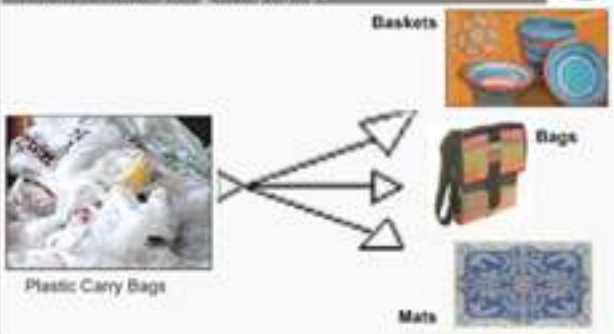
Conventional Recycling:
Plastics Waste for Quality of life



Value added aesthetic products – for the masses

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Conventional Recycling:
The Essentials

Industry Initiatives:

- Technology Development for SME
- Better Working Environment
- Re-Skill & Training

Regulatory Support:

- Allocation of dedicated recycling zone/ Park with fiscal benefits
- Buy back Schemes
- Preferential Excise Duty

Industry need to actively participate

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Conventional Recycling:
Technology Upgradation - imperative

National Petrochemical Policy
(National Programme on Plastics Technology & Applications)

- Need to implement NPP on fast track
- Plastic Technology Upgradation Fund (PTUF) under Plastics Development Council (PDC)
- For Technology Upgradation, Cost reduction & Quality improvement
- Imperative for Capabilities development

Necessary for recycling industry to be world class

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Conventional Recycling:
New Technology Development

New Technologies.

- PolyMag® - Process to separate more than two components using different amount of magnetic additive
- Optoelectronic sorting of plastic granulates contaminated with agglomerates -
- Erema T-3D technology to separate material processing steps from extruder feeding
- Restabilization with: **Ciba® RECYCLOSTAB®, Ciba® RECYCLOSSORB®** and **Ciba® RECYCLOBLEND®** provide improved: Mechanical properties & Stability

Technology mapping – key to success

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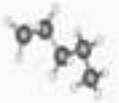
Conventional Recycling:
Public Private Partnership

Partnering National & Industry Needs

New Millennium Indian Technology Leadership Initiatives
(NMITLI)



- National Level R&T Platform
- Industry driven projects for developing Processes & Technologies
- Need to have focused programmes on recycling

Industry need to leverage in these initiatives

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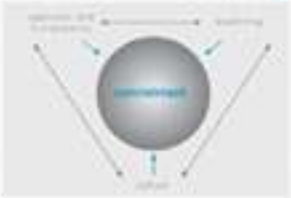

Industry Commitment to Notifications

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Commitment to Notifications:
Implementation Imperative

- Strict implementation of
  - ✓ Gazette Notification.
  - ✓ Packaging Guidelines.
  - ✓ BIS - Recycling Standards
- Formulate collection plan - along with the end user industries
- Mass communication Programmes
- All stake holders to contribute
- Replicate PET model to other recycling projects

Collaborative initiatives across value chain – need of the hour

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Commitment to Notifications:
Industry Initiatives – Programmes for bin Culture

- Educating Citizens & Students
- Inculcating bin culture
- "Litter Bins" donated to Markets / Schools.
- Projects successfully implemented at South Mumbai, Matheran, Mahabaleswar
- ICPE contribution Rs. 10 Lacs for waste management in Mumbai

Need to emulate across the nation

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Commitment to Notifications:
Industry Initiatives – Bin Culture: Making it a reality

- Pilot project with NGO's - Integrated Municipal Waste Management.
- Working at 5 locations

- Proto type compactor installed at Mumbai Central.
- Low cost Technology Developed by ICPE

Industry taking the lead

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Commitment to Notifications:
Industry Initiatives – Improving Working Conditions

- Providing micro compactors to the rag pickers.
- Providing them with personal safety equipments like gloves, boots, masks etc.

Industry need to take initiative

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Commitment to Notifications:
Expectations from the Regulatory Bodies

- Effective implementation of "Municipal Solid Wastes (Management & Handling) Rules" 2000
- For effective implementation of the gazette notifications (Recycled Plastics manufacture & usage rules - 2003) the local / civic authorities must be involved / empowered. (The Maharashtra model)
- Mulit partite initiatives – Local / Civic authorities / NGOs / Industry / Public

For effective recycling

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Summing Up:
Society, Research & Chemical Industry

Research,
is for the Benefit of ***Society***

Even when pursuing ***very basic research,***
a connection to ***industry*** is essential.

Prof. Richard Ernst
Nobel Laureate

Without chemistry - no living !

Without chemical industry - no outliving !

For chemistry to succeed –
Recycling has to succeed !!!

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"Let's Make Recycling - a Way of Life - for Generations Next"

Thank You !

Reliance POLYMERS

(As reported in the Proceedings of IPI Conference)

Indian Centre for Plastics in the Environment

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