CHAPTER - 7

MATERIAL HANDLING AND PACKAGING

Another important activity centre in the case of physical distribution involves material handling and packaging. Material handling permeates the total physical distribution system. The decision on material handling is to a great deal dependent upon the type of packaging. There is a lot of interaction between material handling and packaging. Thus, this chapter considers the two important components of physical distribution namely packaging and material handling. Section 1 deals with packaging decision while section 2 considers material handling.

SECTION - 1 : PACKAGING

This section initially considers the importance of packaging as a distribution function. The packaging system

1. Material handling and packaging, because of their inter-relationship are considered under the same activity centre. See for example -


concept is then developed. Further, packaging costs are identified and the importance of different packaging materials used for fertilisers is described. Finally, the section deals with packaging by the selected fertiliser units.

A. Packaging as a Distribution Function:

Over the last three decades tremendous progress is seen the world over in the distribution systems adopted for consumer and industrial products. In the distribution system, aspects of storage, transportation and handling play a major role in ensuring the safety of the commodities. But 'packaging', which can improve the system of storage, transportation, handling etc., is still a neglected area in India as compared to the other developing countries which have made rapid strides in the field of packaging. Improved packaging materials, systems and methods contribute to the overall economy and thus there is a need to bring in new materials and technology.

Packaging involves the use of containers and parts, together with the decoration and labelling of a product in order to contain, protect and identify the merchandise and facilitate the use of the product. In fact, packaging means different things to different people.

Production people think in terms of plant running efficiencies.
Marketing people think in terms of attractiveness with good display characteristics and instant appeal to the customer.

Finance personnel are concerned with the cost of the material.

Technologist considers the interaction of the product, package and environment. Average consumer is concerned with the contents in fresh conditions.

In India, in the last few years there has been an increasing trend towards improved packaging of products. The factors responsible for this trend are:

- increase in competition, education and consumer affluence;
- change in living habits;
- migration from rural to urban areas;
- more emphasis given to convenience; and
- better service to consumers etc.

All kinds of products need suitable packaging before distribution. But the methods of packaging depend upon the nature of the product i.e. whether it is liquid, solid, powder or gas etc.

The objectives of packaging the products are:

1) Protecting the products against damage in transit and spoilage.
ii) Convenient handling, transport and storage.

iii) Promoting sales of the product by using an attractive package. It is only the package that attracts public attention, describes product's features, gives the consumer confidence and makes a favourable overall impression.

a) Packaging System :

The properties of the product like size, weight, shape etc. help the design of the packaging system. In the choice of packaging, it is necessary to view packaging, not as mere design of a package from whatever material that is available but to look at it as a total system. The elements of such a system from the producers angle may be any one or all of the following:

1) The primary package containing the product.

2) The intermediate package containing a given number of primary packages.

3) The transportation package containing a certain number of intermediate packages, which is considered the most economical size for distribution.

4) The pallet which is intended to unitise a certain number of bulk packages to facilitate storage and handling; and

5) The container which accommodates a certain combination of pallets for movement by the chosen system of transportation.
From the point of view of the retailer, the elements are:

1) The size and shape of the primary package.
2) The marketing features of the package so that it will move fast and
3) The economical size of the intermediate or bulk package which he could be offered to buy at a time.

From the point of view of the consumer:

1) The primary package must have all the convenience features he looks for; and
2) The package should be easily disposable or reusable.

It is very obvious that the choice of the primary package by the producer will have to take into account much more than the mere characteristics of the product contained. It will have to take into account the entire cycle from the point of production till the consumption and a little beyond, viz. the ultimate disposal of the package. In fact, distribution packaging starts with the design of the product and terminates with the re-use or disposal of the package.

It is further restrained by the systems of production, types of packaging, system of transportation, environmental conditions influencing product life, methods of merchandising, preference and tastes of the consumer, etc. If all these have
to be done economically, care has to be taken for every element of the system so that the product is still competitive in the ultimate analysis.

Even though, packaging is a tangible element in physical distribution system, it seldom gets the attention it deserves. Today, many companies in India still look upon the package as a marketing device or as some thing that merely contains and protects the product. The role of packaging must be examined in its proper inter-relationship with all the different elements of the distribution system. For example, a cheap or good looking package causes real headache for those who have to move it through the distribution system on way to the customer, an unnecessarily low density package increases transportation costs, a package with inadequate stocking strength takes up extra ground space in a warehouse. Thus a package must provide optimum service to all the elements of distribution system when the system is considered as a whole.

b) Packaging Cost:

As in other aspects of physical distribution, the company should achieve a balance between costs and service reliability. Generally speaking, cost of packaging varies with the degree of reliability as shown in curve A (See Graph 7.1). As reliability approaches 100 per cent, it requires increasingly greater
Graph- 7.1
COST VERSUS RELIABILITY CURVES

Cost

Reliability

Optimum Cost-Reliability point
Minimum Cost
Maintenance Cost
Packaging Cost

A

B

C
increments of cost to accomplish a given increase in reliability. The cost of maintaining the protection given by the packaging, which includes the cost of repacking when necessary decreases as reliability increases, as shown by curve C in Graph 7.1. The curve C represents the total cost which is minimum at the lowest point of the curve. But a substantial increase in reliability can be achieved at a very modest increase in cost. Thus cost of packaging is an important consideration. In many products packaging contributes to a high proportion of the cost of the products. The cost of packaging depends upon the material used as well as the method employed—machine or hand packed.

Package should be compatible and appropriate to the value of the product. Selection of the right standard of packaging is based on past experience but successful design of other aspects is closely related to finding the right shape and size of the package. To complete the design it is necessary to choose materials with adequate strength and properties required.

B. Packaging of Fertilisers:

Packaging plays an important role in distribution of fertilisers also. A fertiliser is a chemical product of relatively low cost, granular in structure, high bulk, with hygroscopic property and an acidic nature of varying degree depending on the type of the fertilizer. The packaging materials to be used for fertiliser should, therefore, be not
only cheap, but also strong enough to prevent damage during handling, transportation and stocking of filled packs. It should provide adequate barrier to the ingress of moisture and remain unaffected by the chemical action of fertiliser over a reasonably long period.

a) Packaging Materials:

The materials generally used for packing fertiliser by manufacturing industries are: low density polyethylene film (LDPE); high density polyethylene (HDPE); polypropylene (PP); tape woven fabric laminated with LDPE film and a jute fabric laminated with LDPE film. While the first three types are mainly used in most of the countries, the last one is predominant in India and certain other jute producing countries. A comparative study of these different packaging materials used for fertilisers has been given in Chart-7.1.

1) Jute:

Jute and the different varieties of jute based bags in general have versatile use and as such have been accepted in various industries, probably over a century. But this system has come into practice particularly in the absence of availability of newer and more adaptable materials at that stage. As is known, India has one of the oldest industries in jute and
<table>
<thead>
<tr>
<th>Type of Materials</th>
<th>Strength</th>
<th>Corrosive reaction with fertiliser</th>
<th>Hygroscopicity</th>
<th>Printing and marking</th>
<th>After use benefits</th>
<th>Weight of empties</th>
<th>Stacking</th>
<th>Handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE (High density polyethylene)</td>
<td>Very strong</td>
<td>Nil</td>
<td>Highly resistant to water</td>
<td>Easy and distinct</td>
<td>Numerous</td>
<td>Moderate</td>
<td>Less easier</td>
<td>Damaged by using hooks</td>
</tr>
<tr>
<td>JUTE</td>
<td>Less stronger</td>
<td>Coroded by phosphatic</td>
<td>Less resistant to water</td>
<td>Mosaic</td>
<td>Fewer</td>
<td>Maximum</td>
<td>Very easy</td>
<td>Less damage by using hooks</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>Very strong</td>
<td>Nil</td>
<td>Highly resistant to water</td>
<td>Easy and distinct</td>
<td>Numerous</td>
<td>Minimum</td>
<td>Less easier</td>
<td>Damaged by using hooks</td>
</tr>
</tbody>
</table>
this continues to be commonly used media of flexible bulk packaging. Jute by itself cannot be used for packaging of a number of commodities. Fertiliser is one such commodity and therefore, jute bags for fertiliser in India are laminated internally with a low density polyethylene (LDPE) film which is bonded to jute with molten bitumen. These bags are used for nitrogenous and mixed fertiliser of most types. For phosphatic fertiliser, however, jute bags are not found suitable as these cannot stand their strong corrosive action. Jute is generally light in weight, amenable to handling system and facilitates high stacking. When hooks are used in handling, it does not affect the jute bag much, and hence losses are reduced. But being cellulosic in nature, it suffers from a number of disadvantages such as sensitivity to fungus and micro-organisms which reduce strength over a period of time particularly when exposed to moisture and light. The other major disadvantage with jute based material is that it being a natural fabric is sensitive by itself to atmospheric degradation resulting in yellowing of the fabric and reduction in the ultimate strength of the material, which in turn affects the performance of the made-up bags. Further, it has, comparatively, a poor print effect.

2) HDPE:

With the establishment of a number of petrochemical based industries in the country, plastic based packaging materials have
made their appearance in India and their growth as a packaging media has been substantial particularly in the last two decades. About a decade and half back, the HDPE woven fabric entered the Indian scene. The usage started with the packing of ammonium sulphate in GSFC (Gujarat State Fertilisers Co. Ltd.). Initially, however, the labour force protested against the usages as the bags were slippery and the workers' hands were getting bruised. Later on, starting from about 1980, the industry started using HDPE bags in a big way even for other fertilisers like urea, DAP, complexes and CAN etc. The workers got used to the handling and the HDPE bags were accepted as a better and more useful packing by the farmers. The main advantage of using HDPE bags in fertiliser packing is that it gives a better protection against hygroscopicity, because the material is highly resistant to water. HDPE also increases the shelf life of fertilisers. Since fertilisers are seasonal products which may necessitate long periods of storage, it is desirable that packing should be in a position to withstand storage for a longer period. Since conditions of warehousing in India are also not ideal, HDPE bags are preferred. Further the cleanliness of the fabric material gives a good appearance and amenability to better marking and printing. The other advantage of HDPE packing which a farmer gets is the after use value of the bag. A used bag of 50 kg. capacity can be sold upto Rs.2.50 to Rs.3.00 per bag against Re.1.00 to Rs. 1.50 for a used jute bags. This means that he
can get back up to Rs. 50.00 to Rs. 60.00 per tonne from the price he has paid for a tonne of fertiliser packed in HDPE bag. This is a big saving.

3) Polypropylene:

Polypropylene (PP) tape-woven bags are widely used for packing fertiliser, particularly in developed countries. Basically polypropylene woven material has a high mechanical and physical strength. They offer the same advantages as HDPE material and have comparatively lower weight.

In actual practice, presently in India, packaging of fertilisers is directed by the government. As per the Fertiliser Control Order (1957), fertiliser manufacturers are obliged to comply with certain requirements relating to packing and marking of fertiliser bags, size of the bag, information to be printed and the type of cloth to be used for making bags. As per direction of the government of India, fertiliser industry has been using jute bags for packing fertilisers. The bags are of 36" x 24" size for 50 kg net weight of contents (urea bag). The information regarding name of product, percentage of nutrients, net and gross weight, name and address of the manufacturer etc., is printed on the bag. However, the Indian fertiliser manufacturers have been giving preference to HDPE bags because of their easy availability, uninterrupted supply
by HDPE manufacturing units, generally lower price (as compared to jute bags), longer shelf life, and requirement of less storage space for empty bags etc. These HDPE bags are well accepted by the farmers not because of the attractive appearance, but for the advantages like better protection of contents against moisture, and manifold after use benefits, as well as good after use value. Since 1988, the use of HDPE bags has been restricted by the Ministry of Textile, Government of India and manufacturers are forced to use only jute bags for packing nitrogenous fertilisers in order to boost the indigenous jute industry.

C. Packaging of Fertilisers by the Selected Firms:

The three selected firms for this study i.e. NFL, IFFCO and SFC, have no alternative but to use jute bags for packing of nitrogenous fertilisers, as per direction of the government of India. The standard bag is of 50 kg, and the size of the bag is 36" x 24". National Fertilisers Limited and Shriram Fertilisers and Chemicals are using only 50 kg bags for packaging their fertiliser material. NFL, Panipat has attempted factory gate sales in bulk to farmers who carry the same in bulk in tractor, trolleys or second hand gunny bags etc. IFFCO has started the 28 kg packing on an experimental basis at Kalol and is planning similar packings for Phulpur and Aonla also, because recently there has been a demand for supply of IFFCO
fertilisers in smaller packs of 25 kgs. and even 10 kgs. and 5 kgs. bag etc. In tribal areas and hilly areas IFFCO has made some material available in smaller packs of 10 kgs and 5 kgs each. IFFCO is marketing DAP in 40 kgs bags also in some of the southern states.

However, most of the fertiliser manufacturers, (including these three selected firms) have allowed the institutional agencies marketing their products, to supply their own packing bags. These institutional agencies are mainly using HDPE bags, because of their preferential demand over jute bags and lower costs.

Because of a phenomenal increase of 115 per cent in a short span of 10 years (i.e. from 224.4 million in 1978-79 to 482.5 million in 1988-89)\(^1\) in the demand of empties for packing fertilisers, a closer look on the total aspect of fertiliser packaging has become necessary. The need becomes all the more urgent when one finds that some of the individual fertiliser units require around one lac bags per day for packaging their fertiliser material. Thus a continuous development resulting in production of more suitable and more economical packing is much needed at present. Selection of packing material must

also take into consideration the after use benefits as well as the resale value. The size and capacity of the bag may be modified according to the requirements of different regions such as dryland and the hilly areas. It is necessitated because of the preference for the smaller packing in the hilly areas and for bulk containers in the agricultural belt. Some of the cost areas such as those relating to the internal lining of the bag, the method and cost of stitching, the strength of the bag and its rough handling ability are very important in total cost consideration.

SECTION-II : MATERIAL HANDLING

This section initially considers the concept of material handling as a distribution function. Under this the objectives of the material handling and the criteria for measuring the efficiency of the function are highlighted. The section further highlights the fact that material handling is important both for shipping and in the warehouses. The section subsequently looks at the status of material handling in the Indian fertiliser industry and in the selected fertiliser units.

A. Material Handling and the Distribution Function :

Material handling is one of the important responsibilities
of the physical distribution department. The improved handling of material is not confined to production only but applies to all phases of physical movement. For example, proper equipment not only speeds the operations in shipping and receiving, but it can make efficient use of storage space and reduce the cost of handling. The benefits of material handling are not solely confined to the producer but to the consignee as well. In cooperation with the marketing department the movement of goods can be arranged in pallets or in other unitized lots so that the consignee can avoid damage during handling. In fact, material handling is undertaken at every stage of logistics activities and is an integral part of the other elements of logistics function. The efficiency of material handling has an important bearing on cost and flow of goods. By designing a proper material handling system, it would be possible to cut down material handling costs and thus reduce the cost of the product and increase the overall profitability of the company. Thus, a proper design of material handling system is required for each individual element of physical distribution function. This would ensure cost reduction in the operation of the overall material handling function, and increased efficiency of each individual function of physical distribution.

The main objectives of material handling in physical distribution of goods are:

- Reduction of labour costs
- Increase of storage capacity
- Improvement in storage layout
- Reduced fatigue and improved personnel comforts
- Improvement in routing facilities
- Increase in product availability.

Through the application of improved material handling, the cost of movement and storage of materials could be reduced to a considerable extent.

The efficiency of material handling is measured by the number of units - such as tons, pieces, or other units of measurement - handled per man hour. In computing the performance of the equipment plus the labour involved, tons-per-man-hour are used. This is secured by taking the total weight of the material handled in tonnes during a given period of time and dividing it by the actual number of man-hours used. However, this ratio is useful only in comparisons of operations handling similar materials. The relative efficiency of two material handling crews can be determined by having each crew do exactly the same work, use the same equipment, and travel the same route in the same lapse of time. One of the classification of material handling is in terms of the materials handled:

1. Unit materials handled, which include boxed, cartoned, and packaged goods.

2. Bulk materials handled, which include loose bulk materials, such as coal, grain, fertilisers, liquids and similar materials.
3. Parts handled, including such items as castings, sub-assemblies, bar stock and sheet metal etc.

Each of these three broad types represent important phases where method improvement can be effected. The most widely recognised one, out of these, is that of unit materials handling.

After completing the production process, in the distribution of finished products the material handling is to be arranged for:

(i) Facilitating loading and unloading of trucks, wagons or ship for shipping and receiving of goods.

(ii) Facilitating handling and storage of goods in the warehouses/plants.

a) Material Handling to Facilitate Loading and Unloading for Shipping and Receiving:

The loading and unloading of goods should be examined from the viewpoint of speed of loading and unloading, convenience and the saving on damage during loading/unloading operations. Normally, road trucks, rail wagons or ships can be loaded and unloaded manually. But when the volume of material to be handled is large, the manual system becomes unwieldy. Thus in order to speed up the loading and unloading of material and to make it convenient and even cheaper, handling equipments can be used. The following factors must be
considered before the selection of material handling equipment is made for use in shipping and receiving docks:

- Type and amount of material to be handled, whether in bulk or in packages.

- Availability of properly designed docks for loading/unloading of road trucks, adequate length of a platform of a proper design for loading/unloading rail wagons, and an adequate number of berths or wharfs of suitable design for ships.

- The distance, which the goods must travel from docks to departments where used.

- Whether unit loads are used, such as palletizing, and the methods of packaging.

- The types of carriers used—trucks, rails, ships etc.

There are many different types of material handling equipments, such as, forklifts, cranes, pay loaders, conveyers etc. One of the most widely used material handling equipment is the utilization of pallets and forklift trucks. Some advantages of palletization to the physical distribution manager are:

- Loading and unloading are efficient and convenient.

- Palletization eliminates, to a great degree, inaccuracies in counting and inventory control.

- It is not necessary to mark each package.

- Palletization lends itself to tight loading in carrier vehicles because the nature of palletization dictates the need for bonded block method, a recognized method of stocking.

- Palletization can reduce claims.
- Palletization makes for easier efficient warehousing, uniform placement of stock, neat aisles and clean floors and allows for proper lighting, as well as utilization of full ceiling height.

In fact, the pallets combine the packages into a unit, which is one of the important methods of preventing damage in loading and unloading. The mechanical handling of pallets also reduces the number of usings which the packages would otherwise have. Different type of unit loading devices widely used (specially in developed countries) are skids, standard pallets, disposable pallets, steel strappings, glued loads and pallet packs. The unit loading of packages can be speeded by the use of mechanical handling devices such as industrial trucks, tow conveyors, tractor-trailer, trains etc.

In order to speed up the loading/unloading of materials packages without unitization or loose bulk commodities, handling machinery can be installed on truck docks, railway platforms and wharfs. Handling machinery is of two types. Fixed machinery, such as gantry cranes, or fixed cranes which have a certain reach and they require the vehicle to come close to them for loading and unloading of material. If a given dock, platform or wharf is occupied for one reason or other, the fixed type of handling equipments can not be utilised for loading/unloading. The second type of handling equipments move into or near the vehicle. In this category fall the various types of mobile
cranes or forklifts or pay loaders, which lift the material from the truck, wagon or ship and move it to a specified location and vice-versa. To speed up the operations, various types of conveyor systems can also be installed.

b) Material Handling in the Warehouses:

The greater part of the work performed in a warehouse is actually the handling of the goods it contains. A high proportion of the handling of materials in warehouses is performed manually as hands co-ordinated by the human brain are the most flexible and efficient handling means available to mankind. Wherever practicable an attempt has been made to lighten the human effort and increase its effectiveness by mechanical aids. The planning of equipment and facilities in the warehouse must first of all, take into account 'suitability for purpose'. It is essential to decide into which of three categories the warehouse falls i.e. whether the warehouse is for slow moving materials or fast moving materials or for a combination of both fast and slow-moving goods, because there can be a wide difference in the equipment and facilities required for maximum efficiency, dependent on this prime factor. The nature of goods to be stored and their physical characteristics must also be considered.

Material handling is largely a cost absorbing activity,
though it has some impact on order cycle time and therefore customer service. Thus, the objectives for material handling are cost centered, that is, to reduce handling cost and to increase space utilization. Improved materials-handling efficiency develops along these four lines: (1) load utilization, (2) space layout, (3) storage equipment choice and (4) movement equipment choice.

(1) Load Utilization: A fundamental principle in material handling is: "Material handling economy is generally directly proportional to the size of load handled".\(^1\) That is, as the size of load increases, the fewer the number of trips required to store a given quantity of goods, the greater the economy. The number of trips relates directly to the labour time necessary to move the goods as well as the time that the materials handling equipment is in service. Efficiency often can be improved by consolidating a number of small packages into a single load and then handling the consolidated load. This is referred to as a load unitization and is most commonly accomplished through palletization and containerization. Palletization has already been discussed earlier in this chapter. It is an added cost item to the material handling system. Therefore, it must be justified on the basis of the savings achieved by its use. Containers are large boxes in which the goods are stored and transported. Standardized materials-

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2) Space Layout : Location of stock in the warehouse directly affects the total material handling expense of all goods moving through the warehouse. In the internal design of a warehouse, the storage space and order picking considerations are specific. Since the usual flow pattern in a warehouse is that goods come into the warehouse in larger unit than they leave, order picking considerations become prime determinates of warehouse layout. A disproportionate amount of labour time can be spent on filling orders than on receiving and storage. This order picking travel time can be reduced by using specialized order picking equipments, such as conveyors, flow racks and other material handling equipments.

3) Storage Equipment Choice : Storage aids (equipments) promote the full utilization of space and improve the efficiency of material handling. The most important and common storage equipment is the 'rack'. Racks are shelves usually of angle iron on which goods are stored. For storing a wide variety of items in small quantities, stocking loads one on top of another is inefficient. Racks promote floor to ceiling stocking, and the items on the bottom shelf are as accessible as those on the
though items with high turnover should be placed near the bottom to reduce total service time at the rack. A number of other storage equipments like shelf boxes, horizontal and vertical dunnage etc. are also available. All these equipment assists the orderly storage and handling of products of irregular shapes.

4) Movement Equipment Choices: A large variety of mechanical equipment for loading and unloading, picking orders, and moving goods in the warehouse can be used. The three broad categories of movement equipments are:

   i) manual equipment;
   ii) power assisted equipment;
   iii) fully mechanized equipments.

A mixture of these categories is generally found within a material handling system rather than a single category used exclusively.

   1) Hand-operated material-handling equipments such as two-wheel hand trucks and four-wheel platform trucks, provide some mechanical advantage in movement of goods and require only a modest investment. In general, the flexibility and low cost makes these manual equipments valuable when the product mix in a warehouse is dynamic and when investment in more mechanized
equipment is not desirable.

ii) Material handling can be speeded up and the output per man-hour can be increased with the use of power-assisted materials handling equipment. Such equipment includes cranes, industrial trucks, elevators etc. However, the main equipment of warehouse industry is the forklift truck and its varied forms. The pallet-forklift truck materials-handling system has high flexibility. The pallet permits a variety of goods to be moved with standard handling equipment. This system is a popular one, as it requires only a modest investment.

iii) Fully mechanized material handling systems, with computerized control and sophisticated conveyors, automated cranes etc. are not good alternatives for most warehouse operations, unless a constant and substantial volume flows through a warehouse. It is also difficult to justify the large investment required.

In India, the only reliable material handling tools available were the common hand shovel and the hoist, until some years ago. The transformation from this hand shovel stage to the mechanical equipment stage is being carried out rapidly. A diverse range of equipment such as conveyors, wagon tipplers, cranes, crawlers, tractors, dumpers, loaders, motorised scrapers, and excavators, are being manufactured in the country
today. However, the capabilities to manufacture various types of equipment has not been fully utilized because of ideological and financial reservations on the part of some managers that mechanical material handling is not in the interest of the country or not suited to the country in view of the availability of abundant, cheap manpower. Mechanisation at the same time envisages saving in time, daily input of money, and avoids the damage to goods. Therefore, a careful selection and blend of man and machines can show better results, especially in a country like ours where labour is cheaper and easily available.

B. Material Handling in the Indian Fertiliser Industry and the Selected Units:

As has been discussed earlier also, in India the fertiliser materials are being distributed in 50 kg. bags. A fertiliser bag is to be handled at least at four places from plant up to the farmer. The number of handlings involved in the process are as follows:

(i) Three handlings at the plant, viz., receipt from bagging, stacking at platform and loading into wagons.

(ii) Six handlings at the nodal point viz., unloading, stacking at platform, loading in trucks, unloading from trucks, stacking at warehouse and reloading in trucks.
(iii) Unloading at the field warehouses, stacking and then delivery to a dealer.

(iv) Unloading at dealers place, stacking and loading in buyer's transport.

From the above it can be seen that when fertiliser is moved by rail, a bag has to suffer up to fifteen handlings, during shipping, receiving and storage in warehouses, before it is delivered to a farmer. The movement and handling pattern generally involved in distribution of fertilisers from plant to the farmers is shown in Fig. 7.1. Indian fertiliser industry is using only the manual system for handling the fertiliser materials during transportation (i.e. inshipping and receiving the material) and in storage. But with the expected increase in production and consumption of fertilisers in India in the coming years, there is a need for the fertiliser industry to make an indepth study of the handling system involved in transportation and warehousing of fertilisers and come up with conceptual changes in the system. In fact, mechanisation would have to be resorted to in a significant way and transportation in bulk by rail and road will have to be visualised. Storage in bulk at field godown levels would have to be thought of and development of a bulk delivery system at the farm levels would have to be evolved. The urgency of working in these areas has been realised with the coming on stream of a number of giant
Fig. 7.1: Movement and Handling Pattern involved in Fertiliser Distribution

- **Plant/Port**
  - By Rail in rake loads
- **Rake points/Nodal points**
  - By Road
- **Rake point/Nodal point Warehouses**
  - By Road
- **Field Warehouses**
  - By Road
- **Dealers at the Consumption Centre**
  - By farmers transport like tractors, bullock carts etc.
  - Can be by road upto (say) 250 k.m.
- **Farmer**
  - By hand
- **Farmer's Farm**
gas based fertiliser units at various places, which need planning for the movement of very large quantity of fertiliser materials (say over 4000 tonnes) per day. The conventional manual system would come under severe strain for handling such a large quantity of fertilisers. Even industrial relations problems at the bagging and loading/unloading points could affect the distribution of the fertiliser materials if the present manual system continues. Besides storage, transportation and handling of fertilisers in bulk, the fertiliser industry would also have to view the possibility of intermediate technology, that is, the use of higher capacity polythene bags (1-2 tonne capacity) and also palletisation and containerisation with a view to mechanise the loading and unloading operations.

In case of bulk distribution of fertilisers, some of the major benefits that are likely to accrue are:

- The cost of bags and bagging operations could be avoided and fertilisers could be made available to farmers at a lower cost.

- The losses in handling would be significantly reduced.

- It would be possible to ensure the delivery of exact quantity of fertiliser material to the farmer according to his needs.
The productivity of specially designed railway wagons and specially designed road lorries would be higher due to the mechanised system of loading and unloading at both ends.

Of these the most significant advantage would be the saving of bagging costs and a partial saving on distribution margins. At the current rates the cost of bags would be Rs.180 per tonne (20 bags per tonne plus 5 per cent wastage at the rate of Rs.8.50 per bag) and bagging and standardisation cost Rs.10 per tonne approximately. Further the savings in distribution margin would be around Rs.100 giving a total saving of Rs.290 per tonne. If delivery is given at the factory gate the transportation cost to the manufacturer can be completely saved. Even if the delivery is given from the depots of the manufacturers the transportation costs could be reduced significantly. However, the bulk vending cannot be introduced in a big way to start with and will have to be encouraged over a period of a decade or two.

The advanced countries are using specially designed railway wagons for the movement of fertilisers in bulk. These railway hopper wagons have sliding roofs at the top which can open mechanically and loading of fertilisers in bulk can be completed in few minutes. In these wagons there are two types
of discharge arrangements viz., central bottom discharge and side discharge arrangements. The rate of discharge in the former case is faster and the entire wagon is unloaded within a few seconds. In the side discharge arrangement the hopper wagon has three sides discharge doors. Corresponding to these, there are three devices on the ground which fit into the side discharge doors of the railway hopper wagon and fertiliser are discharged through these devices directly on to the belt conveyors running alongside the fixed structures.

In India also a fleet of such specially designed hopper wagons could be introduced for the movement of fertilisers between factories/ports and the inland bulk handling rail nodal points in the consumption areas. Such a wagon equipped with bottom discharge facility has been designed by Research Design and Standards Organisation of Indian Railways and some trials have been conducted to determine its suitability. But mechanised arrangements for loading and unloading of bulk material will have to be installed both at plants/ports and the terminal ends. It is also necessary to evolve a system of farm level distribution of fertilisers in bulk from these nodal points. Only then the costs of bagging which are significant can be saved, otherwise the bagging facilities would have to be planned at all bulk handling depots at selected railway nodal points and the material will reach the ultimate consumer in bags.
In India IEL Ltd. has done some research in this area by developing mini-bulk bags which can be re-used 6-7 times. The trucks carrying such bags are provided with simple pulley arrangement for loading and unloading. Such bags can also be transported in open rail cars. GSFC, Baroda has tried out a thick canvas bag of the type used for postal bags of 100 Kg. capacity for the purpose of reusing such bags. The upper flap where stitching takes place is kept one foot longer. After filling 100 Kg. of fertiliser material, stitching can be done leaving the upper flap space for repeated stitching. With the longer size of the bag, after one operation on a bag which has already been stitched once, the upper flap can be cut off and the same can be reused by stitching at a slightly lower level. The other option being experimented by GSFC, Baroda is to device bulk storage containers mounted on a platform which can be filled from a special tanker road lorry with pressurised dispensing system.

Out of the three selected firms for the present study, Panipat unit of 'NFL' has attempted factory gate sales in bulk to farmers. Otherwise these units are using the conventional method of packing in 50 Kg. bag for distributing the fertiliser materials which is being handled manually during loading, unloading and stocking. The bagged fertiliser could be handled more efficiently by using pallets. Stacks of bags can be
arranged on wooden platforms or pellets and the entire stack can be protected by polythene sheets which can be shrink-wrapped. Such pellets are easy to load and unload by means of forklifts. The additional advantage is that being water proof they can be stored in the open. However, palletisation is not being used by Indian fertiliser manufacturing units.

Thus to meet the challenges of the coming decades successfully it is necessary to modernise the present material handling system of the Indian fertiliser industry by using specially designed wagons with necessary facilities of loading/unloading, using large sized bags carried in open wagons, using containers and pallets.

The chapter thus analyses that packaging ensures the safety of commodities in addition to improving the system of storage, transportation and handling. Increase in competition, urbanisation and changes in living habits, demand an improved packaging of productions. Basically packaging helps in protection, transport, storage and sales of the product. In distribution, packaging starts with the design of the product and terminates with the re-use or disposal of the package. The negligible attention given to this element in distribution system suggests re-examination of the role of packaging in its proper inter-relationship with all the activities of distribution system. Like other activities the balance between packaging costs and
Reliability is a must and it has been found that the cost increases with increasing reliability. In general the packaging cost must be compatible and appropriate to the value of the product.

Packaging needs special care in case of fertiliser as the material to be handled is in large quantities, corrosive and has relatively lower costs as well as susceptible to gaining moisture from the environment. Commonly LDPE, HDPE, PP and Jute bags are being used for fertiliser packaging. Of these HDPE and PP are found to be more suitable but in order to boost the jute industry in the country, the government has made it compulsory to use jute for fertiliser packaging. The three selected firms are therefore, using jute bags for packaging nitrogenous fertilisers. However, these firms have allowed the institutional agencies marketing their products, to supply their own packing bags. These agencies mainly use HDPE bags because of their preferential demand, lower costs and better resale value.

The size of the bag to be used along with the design and marking are also prescribed by the packaging order. However, experiments are being done with either smaller packs for hilly areas, or with larger packs for areas having higher consumption of fertilisers. NFL and SFC are using only the specified bags whereas IFFCO has started using 28 kg packs on an experimental basis. IFFCO is also experimenting with smaller packs of 10 kgs
and 5 kgs each in hilly and tribal areas. Recently NFL has attempted factory gate sales in bulk to farmers directly.

Because of a phenomenal increase in demand of empties for packing fertilisers, a continuous development resulting in production of more suitable and economical packing material is much needed. The size and capacity of the bag may be modified depending upon the specific conditions of the area and due stress must be given to the strength of the bag and its rough handling capacity.

The type of packaging design also affects the material handling system. Material handling is an important function of physical distribution as it not only speeds up the operations but also make efficient and full use of storage facilities, reducing the cost of the product. It envisages reduction of labour costs, increase of storage capacity as well as an increase in product availability. It also helps in reducing costs of movement and storage of the products.

Material handling involves loading and unloading of goods. This function is evaluated by the speed and the savings on damages during the process. A number of equipments are available for the purpose but the most widely used are forklift trucks and pallets.

Material handling in the warehouse is of utmost importance.
It is found to be cost absorbing but it has a direct effect on customer service as it reduces the order cycle time. Load utilisation, space layouts, storage equipment and movement equipment choice are found to have a direct influence in the material handling capacity. In India, the fertilisers are mostly handled manually due to the easy availability of labour at cheap rates.

The increasing trends in consumption of fertilisers are suggestive to an indepth study of material handling systems in India. Mechanised handling and bulk movements in specially designed vehicles are required to be taken up in order to meet these increasing demands. Gate delivery systems, mechanisation in the warehouses and at loading and unloading points as well as palletisation are the urgent needs of fertiliser industry in India. Further, not much attention has been paid to reduce material handling costs. Criteria need to be evolved to measure these costs and standardize them. Use of work-study techniques are suggested in this regard.¹