CHAPTER IV

INFRASTRUCTURE ISSUES AND NEW DEVELOPMENTS IN THE WAREHOUSING INDUSTRY

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4.1 INTRODUCTION:
The warehousing industry demands for huge initial investment in infrastructure. The entrepreneurs / companies who want to enter into warehousing is to take decision critically about the various issues like location of the warehouse, size and number of warehouses to be established, warehouse layout and design, warehouse measures etc. Warehousing theories have been developed for individual companies’ decision making to establish warehouses for their own use. The same theories could be applied largely to the firms, which want to enter into pure warehousing business. The theories related to this are described below.

4.2 LOCATION ANALYSIS\(^1\) FOR WAREHOUSE:
The site selection decision can be approached from both macro and micro perspective. The macro perspective examines the issue of where to locate warehouses geographically to improve the sourcing of materials/deposits and nearness to the market. The micro perspective examines factors that focus on specific locations within the larger geographic areas.

4.2.1) Macro View of Location Analysis
In his macro approach, Edgar Hoover identified three types of location strategies:

1. Market positioned
2. Production positioned
3. Intermediately positioned

**Market Positioned Warehouse**
The market positioned strategy locates warehouses nearest to the customer. This maximizes customer service levels and enables the firm to use transportation economics. Truck Load shipments from plants or sources to each warehouses near the market areas served considers transportation costs, order cycle time, order size, local transportation availability, and customer service levels.
Production Positioned Warehouses

Production positioned warehouses are located close to sources of supply or production facilities. They serve as collection point or mixing facilities for products manufactured at a number of different plants. Transportation economies result from consolidation of shipment into truck load quantities. The factor that influence the placement of warehouses close to the point of production includes perishability of raw materials, number of products in the product mix, assortment of products ordered by customers and transportation consolidation rates.

Intermediately Positioned Warehouses

The intermediate location strategy places warehouses at a midpoint between the final customer and the producer. Customer services levels for the intermediately positioned warehouses are typically higher than for the production positioned warehouses and lower than for market positioned warehouses. A firm normally follows this strategy if it wants to offer high customer service levels for different goods deposit, sourced from different locations.

Warehousing Models

Warehousing models are classified into two types: external location and internal location. External location models examine the issue of where to actually locate warehouses. Internal location models address the location of items inside the warehouse, that is, layout and design considerations. The external models are often discrete or mixed-integer models.

Von Thunen’s Model

Von Thunen put forth a strategy of facility location based on cost minimization. Specifically, he argued, when locating points of agriculture production, transportation costs should be minimized to result in maximum profits for farmers. His model assumed that market price and production costs would be identical (or nearly so) for any point of production. Since farmer profits equal market price minus production costs and transportation costs, the optimal location would have to be the one that minimized transportation expenditures.
**Weber’s Model**

According to Weber, the optimal site was the location that minimized “Total transportation costs – the costs of transferring raw materials to the plant and finished goods to the market.” Weber classified raw materials to the categories according to how they affected transportation costs: location and processing characteristics. Location referred to the geographical availability of the raw materials. For items with very wide availability, few constraints on facility locations would exist. Processing characteristics were concerned with whether the raw material increased, remained the same, or decreased in weight as it was processed. If it decreased, facilities would best be located near the raw material source because transportation costs of finished goods would be less with lower weights. Conversely, if processing resulted in heavier finished goods, facilities would be best located near customers. If processing resulted in no change in weight, locating at raw material sources or markets for finished goods would be equivalent.

**Hoover’s Model**

Hoover included the factors of demand and profitability in the location decision. He identified that transportation rates and distance does not linearly vary; that is, rates increased with distance but at a decreasing rate. The tapering of rates over greater distances supported the placement of warehouses at the end points of the channel of distribution rather that at some intermediate location. In that regard, Hoover did not fully agree with Weber’s location choices.

**Greenhut’s Model**

It considers factors specific to the company (e.g. environment, security) and profitability elements in the location choice. Greenhut asserted that, the optimal facility location is the one that maximized profits.

**Center-of-gravity Approach**

Center-of-gravity approach, locates a warehouse or distribution center at a point that minimizes transportation costs for products moving between a manufacturing plant and the market. The approach provides general answers to the warehouse location problem, but it must be modified to take into account such factors as geography, time, and customer service levels.
4.2.2) Micro View of Location Analysis

From a micro perspective, more specific factors must be examined. If a firm wants to use private warehousing, it must consider:

1. Quality and variety of transportation carriers serving the site.
2. Quality and quantity of available labour.
3. Labour rates.
5. Potential for expansion.
6. Tax structure.
7. Building codes
8. Nature of the community environment.
10. Costs and availability of utilities.
11. Cost of money locally (Cost of capital).
12. Local government tax allowances.

If the firm wants to use public warehousing as a customer depositor, it will be necessary to consider:

1. Facility characteristics.
2. Warehouse services provided
3. Availability and proximity to motor carrier terminals.
4. Availability of local cartage.
5. Other companies using the facility.
6. Availability of computer services and communications.
7. Type and frequency of inventory reports.

Schmenner proposed an eight-step approach to a warehouse business location search that we can apply to the warehouse site selection decision. The process includes the following steps:

**Schmenner’s Eight-step Approach to Site Selection**

1. After the firm has made the initial decision to establish a facility at new location (not yet determined), it seeks input from expert persons in the company.
2. Management designates a corporate team to examine potential sites and to collect information on selected attributes, such as land availability, labor requirements, transportation options, utilities, environmental factors, and products to be stored.

3. The firm established a separate engineering team to examine potential sites in terms of topography, geology, and facility design.

4. The corporate team develops a list of key criteria for the new location. Such criteria take into account the needs of all functional areas of the business.

5. The team evaluates geographic regions in view of the key criteria established; it identifies potential regional sites.

6. The team identifies specific sites within acceptable regional areas. Typically, it selects 10 or fewer sites for in-depth investigation.

7. The corporate team examines each site, generally with frequent site visits and creates ranks of potential locations.

8. The team selects a specific site from the recommended locations. This decision is often made by the person most directly affected, normally the senior logistics executive.

   Each step in the process is interactive, most firm follow some type of logical process when making a location decision. Use of computers can be made. Computer modeling approaches are the optimization models, in that they attempt to identify the best locations for the facilities.

4.3 FACTORS AFFECTING WAREHOUSE SIZE:

   Warehouse size is often defined in terms of square footage or floor space and sometimes in cubic space of the entire facility. Many warehouses often use square footage dimensions in their advertising and promotional efforts. Square footage measure ignores the capability of warehouses to store merchandize vertically. Cubic space measure seems to be more realistic. It refers to the amount of volume available within a warehouse facility. Some of the important factors affecting the size of the warehouse are as below.

   1. Customer service levels
   2. Size of markets served
   3. Number of different products to be kept
   4. Size of the products
   5. Materials handling system used
6. Throughput rate (i.e. inventory turnover)
7. Production lead time
8. Economics of scale
9. Stock layout
10. Aisle requirements
11. Office area in warehouse
12. Types of racks & shelves used
13. Level and pattern of demand

Normally as the company’s service level increases, it requires more warehousing space to provide storage for higher levels of inventory. As the warehouse servers more market, additional storage space is required, unless cross-docking is used and/ or throughput rates are increased. Generally greater space requirements are necessary when products are large, low throughput rate exists, lead times are long, manual materials handling systems are used, warehouse contains office, sales activities, or demand is erratic and unpredictable.

A type of materials handling equipment a warehouse employs can significantly affect the amount of storage area necessary. Because of different capabilities of handling equipments, a firm can justify the acquisition of more expensive units when they are able to bring about more effective utilization of space.

The warehouse decision maker must examine the cost trade-off involved for each of the variety of available truck systems and determine which alternative is most advantageous from a cost/ service perspective.

**Situations that Increase the Need for Storage Space are as below**

1. Market or companies expansion
2. Shorter product life cycle
3. Increase in number of customers/depositors
4. Service on quick response basis
5. Elimination of distributors
6. Expansion into specialized products
7. Import/ Export items
8. Increase in minimum manufacturing lot size
9. Inflation/ forward buying
Situations that Decrease the Need for Storage Space are as below

1. Decrease in production/ sale
2. Decrease in number of stock keeping units (SKU’s)
3. Less volatile demand (including longer product life cycles)
4. Smaller manufacturing lot sizes
5. Higher inventory turns
6. Quicker transportation
7. Cross-docking
8. Carrier performing consolidations

4.4 FACTORS AFFECTING NUMBER OF WAREHOUSES:

In deciding on the number of warehousing facilities, four factors are significant, namely, they are cost of lost business opportunity, inventory costs, warehousing cost and transportation costs.

Lost business opportunity cost is important to company, though it is most difficult to calculate & predict. Inventory cost increase with the number of facilities, due to the fact that organizations usually stock a minimum amount (safety stock) of all products at every location (although some companies have specific warehouses dedicated to a particular product or product grouping) warehousing costs also increase. Because more warehouses mean more space to be owned, leased or rented. The cost tends to increase at decreasing rate, if the firm leases or rents space. Public and contract warehouses often offer quantity discounts when business firms acquire space in multiple locations. Transportation costs initially decline as number of warehouses increases, but then increases if too many facilities are employed due to combination of inbound and outbound transportation costs. A firm must consider the total delivery cost of its products & not just the cost of moving products to warehouse locations.

Size and Number of Warehouses

Determining the size & number of warehouse facilities are interrelated decision. Normally they have an inverse relationship i.e. as the number of warehouses increased, the average size of each warehouse decreases.
4.5 WAREHOUSE LAYOUT AND DESIGN:

A good warehouse layout can 1) increase output, 2) improve product flow, 3) reduce costs, 4) improve service to customers, and 5) provide better employee working conditions.

The optimal warehouse layout and design for an organization will vary by the type of products being stored, availability of financial resources, level and type of competition, and customer needs. Additionally, there are various cost trade-offs between labor, equipment, space, and information.

Within a warehouse, randomized and dedicated storage are two examples of how products can be arranged.

Randomized Storage

In randomized storage or floating slot storage, items are placed in the closest available slot, bin or rack. Products are then retrieved on a first-in, first-out (FIFO) basis. This approach maximizes space utilization, although it requires longer travel times between order-picking locations. Randomized systems often employ a computerized automatic storage and retrieval system (AS/RS), which minimizes labor and handling costs.

Dedicated Storage

In dedicated, or fixed-slot, storage, products are stored in permanent locations within a warehouse. Three methods can be used to implement the dedicated storage approach, including storing items by 1) part number sequence, 2) usage rates 3) activity (e.g., grouping products into classes or families based on their level of activity or throughput rates.)

Compatibility

In terms of overall warehouse layout, products may be grouped according to their compatibility. Compatibility refers to how well products may be stored together. e.g. Food grains and cereals can be stored without harm to each others.

Complementarity

Complementarity refers to how often products are ordered together and therefore stored together. Seeds and fertilizers are example.
Popularity

Popularity refers to the fact that products have different inventory turnover rates or demand rates. Another term used for this turnover rate is velocity. Items that are in greatest demand should be stored closest to shipping/receiving docks. Slow-moving items should be stored elsewhere, at more remote locations.

4.6 WAREHOUSE PERFORMANCE MEASURES:

When the warehousing is considered as a business activity, it is essential to measure the performance of warehouse operations as if each warehouse is a standalone business. Each warehouse is competing with other warehouse operators and any third party warehouse operator who would like to do the job. Warehouse performance can be measured on the basis of financial, productivity, quality and cycle time performance.

Warehouse Financial Performance

Each warehouse can establish a warehouse activity based costing program. Cost for each warehousing activity like receipt, put-away, store, pick, ship & load can be established. The activity costs become the basis for comparing third party warehousing proposals, budgeting, measuring, improvement, and menu based pricing for warehousing etc.

Warehouse Productivity Performance

In productivity performance monitoring the productivity and utilization of the key assets in the warehouse is included like labour, space, material handling systems and warehouse management system. e.g. overall labour productivity is measured as the ratio of units, orders, lines or weight shipped out of the warehouse to the number of hours spent in operation. The warehouse labour utilization is normally, measured as the percent of operating capacity for the workforce. Storage density, the ratio of the amount of inventory storage to the square footage in the warehouse is productivity indicator for floor space. It is normally expressed as the value, cube, pieces or positions of inventory that can be accommodated per square foot. Other measures are the percent of available storage locations that are occupied (location utilization) and the percent of available storage cube that is occupied (cube utilization).
**Warehouse Quality Performance**

The major four key quality indicators for warehouse performance are-

a. Put away accuracy: The percent of items put away correctly.

b. Inventory accuracy: The percent of warehouse locations without inventory discrepancies.

c. Picking accuracy: The percent of order lines picked without errors.

d. Shipping accuracy: The percent of order lines shipped without errors.

**Warehouse Cycle Time Performance**

For cycle time warehouse can track their performance in two key areas.

Dock-To-Stock time (DTS): The elapsed time from when a receipt arrives on the warehouse premises until it is ready for picking or shipping.

Warehouse Order Cycle Time (WOCT): The elapsed time from when an order is released to the warehouse floor until it is picked, packed & ready for shipping.

**4.7 INFORMATION TECHNOLOGY APPLICATIONS IN WAREHOUSING:**

Compared to other sectors of business and industry, technological developments are slow in the warehousing industry over a long period of time. Gradual improvements have been introduced in warehousing construction materials, dunnage materials, quality measurement instruments, preservation and maintenance methodology, identification and coverage of insurable risks etc. Information technology is a late entrant to this industry and is yet to take a firm root. Warehousing industry is at the first phase of IT i.e. automation of existing operations and processes. To introduce Information Technology in warehousing it requires the essential things such as appreciation of the role of IT by top management and thereafter identification and prioritization of IT projects with well defined outcomes. They have to take decisions related to developments and delivery methodology such as step by step changes or changing the whole thing in a single step, whether to go for in-house operations or to outsource IT project adaption or to go for product(a single task), centralized or decentralized or semi -centralized operations, in-house data centre or externally managed data centre, client-server or web services or web applications, integrated enterprise applications or stand-alone application, decisions on databases, languages to be used, testing, piloting, training of the staff and implementation etc.
There are advantages and disadvantages on each of the options and decisions on this have long term consequences. For this well informed decision need to be taken considering other industries experience.

**Warehouse Management System**

Warehouse Management System (WMS) is the combination of software & hardware, such as identification, tracking, labeling, printing and communication technologies, which together provide the warehouse personnel with required capabilities for effective warehousing. An ideal WMS provides proactive and integrated planning and execution capabilities across the warehouse in the broader context of Supply Chain Management (SCM). Usually, WMS solutions include three integrated modules viz., warehouse management with auto id or communication technology, integrated shipping and process tracking. Modern WMS solutions offer breakthrough capabilities such as first-in-first-out, cross-docking, automated pick replenishment, wave picking, lot tracking, yard management, automated data collection, automated material handling equipment, etc.

Advanced web-based WMS functionality goes beyond the normal warehouse capabilities providing visibility into the inventory and logistics information to customers and other partners, suppliers, or customers as well as ERP or other planning systems through the Internet. Intelligent WMS seeks to achieve zero information errors, maximum labor productivity and maximum space utilization, while integrating with other supply chain execution systems offering transportation management, yard management, order management, advanced planning and scheduling, material management, etc. In conjunction with Automated Guided Vehicle System (AGVS), WMS automatically identifies and directs one or more material handling devices or a logistics asset used in the warehouse operations, such as carts or pallet trucks and places them at the appropriate work areas without the requirement for operator intervention.

**Deploying WMS for Warehouse**

Implementing WMS will produce a number of tangible and intangible benefits, which should be considered while developing a business case. Prior to WMS deployment, the project manager has to analyze both tangible and intangible returns. Along with the project manager and consultant, a team of representatives from
accounting and finance, IT, warehouse manager, etc., should estimate Total Cost of Operations (TCOps) and Returns on Investment (RoI). To get a clear picture of these factors, a scientific method that involves cost/benefit analysis through a business case development has to be pursued.

**Labour Productivity through WMS**

As the use of WMS results in improved labour efficiency, most of the material handling activities such as receiving, put-away, picking, shipping, etc., can be completed within the standard working time avoiding the requirement for overtime. Due to system directed execution of operations, time spent on identifying and planning the activities that need to be done is minimized, while time taken to locate, travel and execute the activity reduces increasing the labor productivity. Use of auto id technologies that automatically captures data, such as barcode readers, RF eliminates paperwork and the data entry activities. Further, with the cross-docking ability WMS eliminates the need for put away, storing and picking operations so that labour resources can be effectively used for other activities. Along with the direct labour cost, indirect and administrative cost also reduces.

**Inventory Accuracy through WMS**

WMS, with its capabilities such as auto data capturing, cycle counting and self-checking, provides almost accurate inventory data at any given time. It improves material handling and purchasing activities reducing safely stock requirements. As WMS provides credible inventory information, warehouse managers make informed purchasing that avoid excess stocks. In this way, the overall inventory levels are reduced usually by 5-20%.

**Shipping Efficiency through WMS**

In a warehouse equipped with WMS, the accuracy of shipments increases as it provides for automated order complete verifications, shipment loading confirmation, etc. As the accuracy and time taken for shipping activity improves with the use of WMS, the chances of first time correct order shipment increases. Obviously, the volume of orders returned due to incorrect shipment decreases.

With enhanced accuracy and timely shipment, all the associated costs reduce significantly. Most importantly, the detention charges levied due to delayed shipments
decreases. Similarly, other costs such as expedited order costs and return management costs are also minimized or eliminated.

**Space Utilization Savings through WMS**

One of the significant factors contributing to the reduction of warehouse operating expenses is space utilization. Mismanaged inventory often creates the need for additional storage requirements, which is mostly outsourced. Usually, outside storage space is not available on demand. It has to be leased out for a particular cost for a predetermined period, irrespective of its utilization. When outside storage space is leased, along with the cost of lease other such as insurance and transportation are involved.

As WMS improves space utilization, the need for outside storage capacity reduces, proportionately cutting down the associated costs. Usually, the cost of lease, insurance and transportation associated with it is eliminated or reduced. Even the associated labor costs are reduced as the volume of stocking or unstocking and the need for transporting the inventory back and forth are minimized.

Apart from the above-mentioned quantifiable benefits, other qualitative benefits such as improved customer service, increased customer satisfaction levels, employee satisfaction, etc. add to the savings in terms of reducing the operating expenses and optimization of warehouse value. With fast pay back period, WMS optimizes the RoI, while increasing the sales and employee retention.

NABARD is a implementing agency for the Rural Godown Scheme of the central Government along with NCDC. It has provided guidelines for construction of food grain godowns and economics of capital investment and return on it. It is as below.

**4.8 REQUIREMENTS OF AN IDEAL GRAIN STORAGE STRUCTURE**

The object of an ideal grain storage structure is to control and reduce the storage losses from rodents, insects and micro-organisms, birds, moisture and heat to a minimum. In designing and constructing a storage structure for food grains following points need to considered.
1. All holes, pipes and ducts and other openings shall be guarded by suitable means, such as gratings, etc., in order to prevent the entry of rats and other vermin.

2. The structure shall have smooth, crack free internal surfaces and shall have no unnecessary cavities and projections to prevent the lodgment from insects and vermin. Periodical fumigation and other treatments should be done to eliminate infestation of grains by insects, fungus etc. The structure shall be designed so as to facilitate its sealing for fumigation or have facility to seal a portion where fumigation has to be carried out, or it may be made completely airtight if required.

3. Godowns should have good ventilation arrangement to prevent moisture accumulation in pockets.

4. The structure shall be designed to make it possible to control moisture. Moisture may be controlled by adopting methods of construction using non-hygroscopic material, by sound wall, roof and floor construction, by the use of vapor barriers, and by the use of aeration.

5. The structure shall be so oriented that it will receive the minimum solar radiation. To reduce the internal temperature reflective external surfaces, insulating materials, sun shades, a minimum of glass surfaces, controlled ventilation and aeration, may be used.

**Capacity and Dimensions**

The Central and all State Warehousing Corporations are following a design on the basis of Indian Standard viz. IS: 607 - 1971 (code of practice for construction of bagged food grain storage structures) with slight alteration. On the basis of this code the godowns are classified as:

1. Small sized godowns: Capacity of less than 1000 MT
2. Medium sized godowns: Capacity above 1000 MT and up to 5000 MT.
3. Large sized godowns: Capacity of 5000 MT and above.

If large capacities are required they will be in the multiples of 1000, 2000, 2500 or 5000 M.T.. For storage capacity of 2500 MT and above the godowns may be divided into suitable compartments, depending upon the availability of land.
The height of a road fed godown is 5.6m and that of a rail fed godown is 6.35m.

The stack size for both 2500 MT and 5000 MT godown is 9.15m X 6.1m X 4.57m.

As per the Indian Standard code of practice for bagged food grain storage structures (IS: 607-1971), the passage between the two stacks is 1.56m, parallel to the width of the building, and 0.76 m in the longitudinal directions and around the stacks at the periphery.

**Location**

The structure shall be located on a raised well-drained site, not liable to flooding and it shall be away from a place likely to be affected by seepage water.

The construction of godowns in the residential areas should be avoided. In selecting the location, maximum attention should be paid to the hygienic and sanitary conditions of the area and the following minimum distances should be maintained:

**TABLE NO. 4.1**

**IDEAL DISTANCE OF FOOD GRAIN GODOWN FROM VARIOUS ORGANIZED ACTIVITIES**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Units</th>
<th>Distance from Godown</th>
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<tbody>
<tr>
<td>1</td>
<td>Kilns, bone-crushing mills, garbage-dumping grounds, slaughter-houses, tanneries and hide-curing centres or such other places, the vicinity of which is deleterious to the safe storage of food grains.</td>
<td>500m</td>
</tr>
<tr>
<td>2</td>
<td>Dairies and poultry farms</td>
<td>300m</td>
</tr>
<tr>
<td>3</td>
<td>Factories and other sources of fire such as workshops, hay stacks, timber stores and petrol pumps.</td>
<td>150m</td>
</tr>
</tbody>
</table>

(Source: NABARD)
There shall be no trees near the structure, the roots of which affect the foundation. The structure should be at least 3 m away from any branches of trees, poles etc. so as to avoid the access by rodents.

The structure should preferably be situated near a transport head or a main road. If the structure is located in the interior, an approach road suitable for the movement of trucks and trolleys shall be provided.

At the site of the structure, there shall be sufficient parking and maneuvering space for vehicle. If the structure is situated at a ferry head, railway station, airport, etc. sufficient berthing, loading and unloading facilities shall be made available.

**Foundation**

Foundation of adequate depth (minimum one meter), depending upon the site conditions and nature of the subsoil, shall be provided. The foundation shall be provided after properly investigating the bearing capacity and up to such a depth that the bearing capacity is adequate enough to withstand the foundation pressure. If necessary, soil tests and soil load tests would have to be conducted. The foundation, in general, shall consist of lean cement concrete (1:5:10) for the walls and reinforced cement concrete (1:2:4) footings for reinforced cement concrete columns according to design. A leveling course of lean cement concrete (1:5:10), at least 75mm thick, shall be provided under the reinforced cement concrete footings. To meet the menace of white ants and rodents, suitable pesticide treatment shall be done in the foundations and the under floors.

**Plinth**

The Plinth shall be generally kept about 80 cm above the finished ground level. Platforms should be provided along the length of the godown in order to facilitate loading and unloading. The minimum width of the platform should be kept at 3.05 m for rail-fed godowns and 2.45 m for road-fed godowns. The platform should be provided with an outward slope of 1 in 40 in order to prevent the rain water from getting inside the godowns through the doors. The platforms shall be preferably covered.
Plinth shall be filled with good and selected earth in layers not exceeding 200 mm; each layer being watered, well rammed and consolidated. The plinth shall be constructed of either stone or brick masonry in lime mortar (1:2) or cement mortar (1:6). It shall be provided with damp proof course of well graded concrete with waterproofing compound (a coat of residual petrol bitumen) to a minimum thickness of 40 mm on brick masonry and 50 mm on stone masonry.

A cement concrete or reinforced cement or stone slab projection of 15 cm to 18 cm at plinth level may be provided at 0.75 m to 0.8m plinth height so that rats and rodents will not be able to enter the godowns. Moveable steps are to be provided so that they can be pulled away from the godown entrances when not required.

Flooring

The flooring in the godown should be damp proof, rigid, durable and free from any cracks and crevices. The flooring should comprise of the following layers:

1. Selected earth filling well consolidated and stabilized to avoid possibility of settlements and cracks,
2. A layer of sand filling 23 cm thick thoroughly watered and well consolidated,
3. A layer of cement concrete (1:5:10) 7.5 cm thick,
4. A layer of bitumen maxphalt 80/100 or equivalent spread uniformly at the rate of 1.7 kg/ m² or a layer of 700 gauge polythene sheet,
5. A further layer of cement concrete (1:5:10) 7.5 cm thick over the waterproofing layer of bitumen,
6. A top wearing coat of 5 cm thick cement concrete (1:2:4) finished with a floating coat of neat cement shall be provided.

The cement concrete flooring shall be laid in panels not exceeding 3.5 m² in area and a length of 2.5 m in any one of the directions. Such panels shall be suitably adjusted so as to avoid transfer of any uneven load at the joints under the stacking bays and alleyways.

Where stone slabs are available at a cheaper rate, the flooring may be of this material.
Walls

The design of the walls shall be in accordance with the general constructional practices (IS: 1905-1969) and care shall be taken that the tensile stresses do not exceed the cracking limit.

The longitudinal walls shall be of brick or stone masonry in cement mortar (1:6) and shall be at least 5.60 m high for road-fed and 6.35 m for rail-fed godowns from the floor level. The walls shall be at least 34 cm thick with RCC columns at a spacing of 4.65 m centre to centre in order to provided support for trusses. For gable walls and partition walls also, RCC columns shall be provided at a distance of 4.9 m centre to centre. The gable wall shall be preferably of brick or stone masonry in cement mortar (1:4) up to a suitable height, and at least 46 cm in thickness. The walls shall be plastered with cement mortar (1:6) and shall be rendered smooth both on the outer and inner surfaces. In seismic areas, criteria for earthquake resistant designs of structures shall be followed.

Roof

Roof shall be of single span structural steel or tubular trusses. These trusses shall be fixed on RCC or stone masonry or brick masonry pillars at a height of 5.60 m for the road-fed and 6.35 m for the rail-fed godown from the floor level to the tie level at the column ends. The roof of the platforms shall be of a cantilever structural steel or tubular trusses fixed on to the RCC columns at a height of 3.35m for road-fed godowns and those fed by meter-gauge railway, and 4.35 m for those fed by broad gauge line. The height shall be measured from the floor level of the godown to the bottom tie of the truss. The design of the trusses shall be in accordance with the general constructional practices and relevant Indian Standards.

The roofing material may be corrugated asbestos sheets or galvanized corrugated sheets, steel sheets or corrugated aluminum sheets. The sheets shall project at least 46 cm from the outer surface of the longitudinal walls. The sheets shall be fixed on the tubular trusses with 'J' hooks.

Doors

A door shall be provided preferably opposite each alleyway. The doors shall normally be steel rolling shutters. The doors shall be not less than 2.45 m X 1.83 m.
Ventilators

In longitudinal walls two steel ventilators of opening not less than 1.494 m X 0.594 m shall be provided in each bay between RCC columns spaced 4.50 m centre to centre. The ventilators shall be fixed 15 cm below the top edge of the wall measured from inside the godown. They shall be provided with glazed centre-hung with fixed wire mesh (3.28 cm X 6.56 cm) shutters. In between these ventilators, air inlets of 0.62 m X 0.62 m glazed openable outside, double hung in each bay shall also be provided at 60 cm from the floor level of the godown except in those bays in which a rolling shutter is provided.

Finishing

The internal surfaces of the walls of godown shall be cement plastered and external faces up to floor level shall be smooth plastered. The internal faces may be white washed and external faces provided with colorwash.

All steelwork and woodwork shall be provided with two coats of superior quality paint over a coat of primer so as to prevent against rusting and deterioration.

The paint to be used inside the godown for steelwork and steel/ aluminum sheets shall resist the adverse effects of fumigants.

Drainage

Proper arrangement such as cast iron or asbestos cement pipes of diameter not less than 10 cm shall be provided to drain off the rain water from the roofs of main godown and platform. Their diameter shall also be adequate depending upon the intensity of rainfall of the place. Suitable drainage arrangements such as surface or underground drains to drain the rain water from the storage premises shall be made.

Water Supply

Water is required only for drinking, washing and toilet flushing purposes. Where municipal supply of water is not available, an independent source such as a tube well is required. An elevated water tank of required capacity along with underground pipes for water supply distribution has to be provided.

Electric Supply

Electric supply of 220/ 440 volts shall be arranged for water pumping, motors, ventilating fans lighting inside the building and premises lighting.
Roads and Parking
10 m wide roads shall be provided between the godowns and at the sides for movement and parking of trucks during loading and unloading. Sufficient parking areas have to be provided separately for trucks and other vehicles.

Boundary Wall
Adequate height compound wall shall be provided along with a gate.

Miscellaneous equipment required:
Adequate office equipment, laboratory equipment (such as sampling and grading equipment, moisture meter, analytical balance, sieves etc.), communication equipment, weighing equipment and fire fighting equipment should be provided depending upon the site conditions and specific requirements.

Ancillary structures and other amenities:
It is desirable to have certain ancillary structures attached to godowns for its smooth operation and supervision. The necessary ancillary structures include office room, store room, room for storing pesticides, chaukidar-cum-switch room, chaukidar quarters, isolation shed (to keep infested or damaged stocks before they are finally disposed), lavatory block and sanitation installation, drinking water arrangement and fire fighting arrangement. For the fire fighting purpose, a network of water supply pipelines with fire hydrants at suitable locations may be provided to ensure supply of water at any time.

Specimen Capital Investment and Return on it

Repayment Schedule - 100 mt capacity grain storage godown (with subsidy)

Outlay = Rs. 2,00,000 loan/ finance 75 % of the outlay i.e. Rs. 1,50,000

Cost of the project: Amount Rs.
Godown 200,000
Total Rs. 200,000

Means of Finance:

Own Funds 50,000
Bank Term Loan 150,000
Total Rs. 200,000
TABLE NO. 4.2

PROJECTED PROFITABILITY STATEMENT OF 100M.T.GODOWN (WITH SUBSIDY)

<table>
<thead>
<tr>
<th>Year</th>
<th>Income</th>
<th>Expenses</th>
<th>Net Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Godown Rent</td>
<td>Bank Interest</td>
<td>Insurance</td>
</tr>
<tr>
<td>1</td>
<td>60,000</td>
<td>22,770</td>
<td>1,250</td>
</tr>
<tr>
<td>2</td>
<td>60,000</td>
<td>22,228</td>
<td>1,250</td>
</tr>
<tr>
<td>3</td>
<td>60,000</td>
<td>21,125</td>
<td>1,250</td>
</tr>
<tr>
<td>4</td>
<td>66,000</td>
<td>19,835</td>
<td>1,250</td>
</tr>
<tr>
<td>5</td>
<td>66,000</td>
<td>18,327</td>
<td>1,250</td>
</tr>
<tr>
<td>6</td>
<td>66,000</td>
<td>16,563</td>
<td>1,250</td>
</tr>
<tr>
<td>7</td>
<td>72,600</td>
<td>14,500</td>
<td>1,250</td>
</tr>
<tr>
<td>8</td>
<td>79,860</td>
<td>12,088</td>
<td>1,250</td>
</tr>
<tr>
<td>9</td>
<td>87,846</td>
<td>9,268</td>
<td>1,250</td>
</tr>
<tr>
<td>10</td>
<td>96,631</td>
<td>5,970</td>
<td>1,250</td>
</tr>
<tr>
<td>11</td>
<td>106,294</td>
<td>2,113</td>
<td>1,250</td>
</tr>
</tbody>
</table>

(Source: NABARD)

4.9 STORAGE OF FOOD GRAINS: ISSUES & SOLUTIONS

The basic objective of scientific storage is to create the suitable environmental conditions which provide sufficient protection to the product to maintain its quality and its quantity, thus reducing the product and financial loss. Organisms directly responsible for causing loss in stored products are insects, mites, rodents, fungi and bacteria. Though considerable losses occur in the field, both before and during harvest, the greatest losses are noticed during storage. The losses occur to the food grains through loss in quantity and loss in quality.

Loss in Quantity

Losses of the food grains in terms of weight are quantitative losses. Insects, rodents, birds etc. feeds on the product causing weight loss. These weight losses are not always apparent. For example, some insects eat only the centers of grain kernels
so, even though the volume of grain may appear to remain the same, there can be considerable weight loss.

**Loss in Quality**

Losses of this type can be nutritional, chemical, through contamination with toxic moulds or foreign matter. Pests that selectively eat a part of the food-stuff (such as the nutritious germ of the grain) will reduce the value of the food-stuff as a whole. Also, there is the loss of vitamins through the action of sunlight and temperature. Chemical changes are particularly common in fatty foods through the development of rancidity.

General contamination can result in many ways and shows up in the form of insect fragments, rodent hairs, excreta and urine, as well as dust and other materials that enter the product through human mis-handling. The presence of rat urine can cause serious problems as rats are carriers of weils disease. Sieving is often used to reduce the obvious signs of foreign matter contamination.

**Major Factors Affecting Scientific Storage**

Most developing countries are in the tropics, often in areas of high rainfall and humidity. These conditions are ideal for the development of micro-organisms and insects which cause high levels of deterioration of crops in store. This has been observed that quantitative and qualitative -losses in stored food grains may occur due to physical (abiotic), biological (biotic), chemical (breakdown of produce and pesticides) and engineering (structural and mechanical aspects) factors. Grain temperature and moisture are the two important factors which affect the rate of metabolism, growth, development, reproduction and general behavior of stored grain insect pests and fungi.

In order to reduce the amount of food grains loss, the environment in the store needs to be controlled so as to lower the possibility of biological damage by insects, rodents and micro-organisms, chemical damage through rancidity development and flavor changes, physical damage through crushing, breaking, etc.

Good storage thus involves controlling the factors, like temperature, moisture, light, pests and hygiene.
**Temperature**

The temperature within a store is affected by the sun, the cooling effect of radiation from the store, outside air temperature, heat generated by the respiration of both the food in store and any insect pest present.

Most of the micro-organisms thrive between 10° and 60°C temperature where as insects between 16° and 45° centigrade. Normally, in tropics and sub-tropics storage temperature lies between 25° and 35°C which is favorable for them. Improper maintenance of storage temperature can result in biological and chemical damage to the food stuff being stored. Examples include the loss of germination ability in seed materials and the accumulation of sugars in some commodities which need relatively low storage temperatures.

Temperature also controls chemical damage. The speed of chemical change in a food depends upon the temperature and the food's moisture content. A 10°C rise in temperature causes an approximately two-fold increase in the rate of reaction. Thus, cold storage will retard such changes as fat oxidation and vitamin loss. Many dried food grains benefit from even a small reduction in their storage temperature, and cool and dry conditions can greatly reduce the rate of development of brown discoloration and off-flavors.

Physical damage involves melting of fats in the products at high temperatures and crystallization of sugars in sweet foods at low temperatures.

Direct temperature control is not usually possible, so other measures, particularly reducing the moisture content of the stored produce, are necessary. Running is a method of controlling insect pests involving heat. The produce will be laid out in a thin layer in the hot sunlight. At high temperatures (40 to 45° C) the insect pests tend to leave the grain. It should be noted, however, that running does not always destroy eggs or larvae.

**Moisture**

All micro-organisms, including moulds, require moisture to survive and multiply. If the moisture content in a product that is to be stored is low, micro-organisms will be unable to grow, provided that the moisture inside the storage
structure is also kept low. Moisture should therefore, be prevented from entering the store.

All materials that have been dried will try to come back into equilibrium with the climate around them. In tropical countries this usually means absorbing moisture. The moisture level below which micro-organisms cannot grow is referred to as the safe moisture content. The Table 4.3 below lists the safe moisture content levels for cereals and pulses valid to temperatures up to 27° centigrade. Slight variations in safe moisture contents arise depending upon the variety.

<table>
<thead>
<tr>
<th>Agricultural Product</th>
<th>Moisture Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals: Maize (shelled)</td>
<td>13.5</td>
</tr>
<tr>
<td>Maize flour</td>
<td>11.5</td>
</tr>
<tr>
<td>Paddy rice</td>
<td>15.0</td>
</tr>
<tr>
<td>Milled rice</td>
<td>13.0</td>
</tr>
<tr>
<td>Sorghum</td>
<td>13.5</td>
</tr>
<tr>
<td>Millet</td>
<td>16.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>13.5</td>
</tr>
<tr>
<td>Wheat flour</td>
<td>12.0</td>
</tr>
<tr>
<td>Pulses: Broad bean, cow pea</td>
<td>15.0</td>
</tr>
<tr>
<td>Lentil, pea</td>
<td>14.0</td>
</tr>
</tbody>
</table>

(Source: Booklet ‘Storage Technology’ by Dr.K.T.Chandy)

While in general it is essential that all food-stuffs are below their safe moisture content before they enter the store, the safe moisture content is to some extent related to the required storage time. Moisture levels above the safe moisture context can be tolerated if only short storage times are required.

Condensation of moisture can cause storage problems. If the walls of a store are cooled below their dew point by low night temperature, condensation can occur and increase the moisture content in the layers of the produce. The ventilation of the store is important. As most stored food products are "alive" and respiring, thus giving off moisture, as well as heat.

Aeration is a process of cooling a grain bulk by passing large quantities of untreated air of suitable temperature and humidity, so that the grain in storage remains
in an acceptable condition for long periods. Aeration reduces grain temperatures to minimize mould growth and insect/mite activity. It maintains the grain quality and provides more uniform grain temperatures to prevent convection air movement and moisture transfer. Fumigants may also be distributed by aeration fans.

Stored grains have relatively low thermal conductivity. Daily temperature changes have a very small effect upon grain temperatures, and even seasonal changes from summer to winter are likely to cause pronounced grain temperature variation only in most exposed part of a large grain bulk. The aeration equalizes the temperature of the grain thus arresting multiplication of insect and mould activities as well as moisture migration. Grain aeration is more properly considered as a preventive rather than a remedial measure.

Oxygen and carbon-dioxide of the inter-granular environment influences the respiration of the grain and consequently also the rate of deterioration and heating. Majority of the fungi are storage aerobes. They fail to sporulate, their spores fail to germinate and their mycelium fails to grow when oxygen concentration is below a minimum which is well adequate for yeast growth.

**Light**

Generally, in the stored product, insects seek secluded places and keep well hidden. Stored product insects reaction to light is more varied. Few are attracted towards light while most of the insects avoid it preferring a subdued light or darkness. Different stages of the same species react differently. A stack of gunny bags kept in dark places and most concealed parts, are found to be more severely attacked than those which are exposed to light.

**Damage by Insect Pests**

Much of the damage to stored grains by insect pests is done directly to the kernels. Their larvae destroy many times their own weight of food during their growth period. Besides, many species feed on the germ of the grain, so that its viability is reduced and germination is impaired or destroyed. They frequently cause grain to heat resulting in a musty odor. Deterioration and rotting of the surface grain sets in as a result of grain heating and consequent moisture migration in storage. Degree of damage depends on three factors namely,
i. moisture content of the stored grains;
ii. temperature inside the storage place, and
iii. Oxygen level, besides food supply and human activities.

It has been established that most insects do not thrive below 9 percent moisture content of the grains. So, it is essential that before grains are put into storage, the moisture level should be 8 percent and absorption of the moisture from the air should be prevented. Higher temperature favors the multiplication of insects, hence the inside storage temperature should be maintained low. Oxygen content inside the container under air-tight conditions also has a deciding influence on the infestation of grains and multiplication of insects.

Storage management practices that need to be followed to control pests are as below.

Dunnage: The bags should not be kept on the floor as it restricts the free movement of air and creates a fertile ground for the growth and development of insects and pests. Dunnage comprising either timber pallets, timber squares, matting or a layer of polythene sheet sandwiched between two layers of matting’s shall be laid on each stack space. As far as possible, locally available and cheaper materials should be used for dunnage.

Rodent/ rat proofing: As a permanent solution, the horizontal projections at plinth level should be provided. Otherwise, any suitable chemical control should be adopted as and when there is infestation, but the projection at plinth level is considered as the best.

Anti termite treatment: Where termite infestation is anticipated, proper pre-construction anti-termite treatment should be carried out. Where there is no such provision, anti-termite treatment should be done as and when infestation is noticed. The wooden logs used for dunnage should, however, be treated before stacking.

Bird proofing: The ventilators should be fitted with 25 mm X 51 mm size iron mesh for restricting the birds from coming in.

Fumigation: Pre-monsoon and Post-monsoon fumigation should be essentially done. Also spraying of insecticides and pesticides should be done as and when any infestation is noticed.

Quality checks: There should be provision for checking the quality before receiving any lot for storage. The main quality check is the safe limits of moisture
content for the produce to be stored. Besides moisture content, the lot should be checked for any increase in temperature, fungus attack and cake formation and insect infestation from time to time. This will ensure less damage.

**General Guidelines for Good Storage Practice**

The large stocks of grain in storage pose various problems which are unique and quite different from those of smaller lots. Therefore, adequate attention must be paid in the large scale storage of food-grains. To minimize the storage losses some practices for large scale storage of food grains has been developed.

1. The grains must be checked in the field before harvest to make sure that the grains are free from insects and diseases.
2. The harvesting and transporting equipments must be cleaned before a new crop is harvested.
3. The grains must be harvested and threshed to avoid any breakage of grains, because broken grain will not store well.
4. The threshing yards which are free from insect infestation should be used.
5. Before storage the grains should be cleaned and graded. Unclean grain contains small amounts of straw, weed seeds and dirt, which not only decrease the value of food-grains but also cause the grains to deteriorate during storage.
6. No food-grains with moisture content higher than the safe acceptable level should be accepted for storage. Dry the moist grain before storage because, it respires more quickly and gives off more heat and moisture, which encourages build of insect population and mould growth and hot spots develop in bulk grains.
7. The grains should be spread over plastic sheets or cemented floor while drying, otherwise it will pick up the moisture from the ground. The grains should be kept cool and dry between the time of harvest and storage.

**Storage for Different Periods and Solutions**

The duration of storage is of vital importance in deciding the most appropriate storage practice. Thus, storage can be classified into the following categories.

**A. Transit Storage**

This is the shortest term storage where the grain is being transported from one place to another or where some kind of rotation is practised so that the old stock
moves out as the fresh stock comes in. Many of the Government godowns, godowns at seaports and godowns of retailers are examples of transit storage.

Transit storage has been maintained in a variety of sheds available on an emergency basis, from time immemorial. In these sheds, bag storage has generally been practiced with the bags arranged in stacks. However, the best method will be to have proper godowns with permanent cubicles in which the bagged grain can be suitably stacked. These cubicles should be constructed so that they can be made airtight both for storage and fumigation, as it needs. This would provide ideal storage conditions and also the necessary handling facilities for bags needed for transit storage.

B. Short-term Storage

This type of storage is practiced by cultivators who generally like to store their seed grain from harvest to sowing and food grains from harvest to harvest. Storage structures generally use for short-term are bukhari, kothar, morai, etc., which are examples of non-airtight bulk storage.

From ancient times grain has been stored in India in bulk in mud bins. These earthen structures of various shapes and sizes provide the easiest and most economic methods for the storage of grains under rural conditions in India. However, in this type of storage, one often finds the grains infested with insects. In some places rats also pose a serious problem since they easily cut through the mud walls. In some wet regions of the country, grains are also found to be affected by the high humidity conditions. As a result, the loss of food grains in storage is often quite considerable. With a view to reduce these losses an ideal storage structure has been devised by the Indian Agricultural Research Institute, Pusa Road, New Delhi. It is called the Pusa Bin.

In the Pusa Bin, a thin sheet of polythene film (0.17 - 0.18 mm thick) is embedded in the mud wall of an ordinary earthen structure. The idea behind the sandwiching of the polythene film within the body of the wall is to combine the mechanical strength of the mud wall with the effective imperviousness of polythene films to vapors and gases. Also, this film is impervious enough to oxygen with the result that the oxygen tension within the structures reduced to such an extent that insect multiplication becomes impossible. At the same time, the earthen layers both
inside and outside the polythene film keep the film safe from mechanical injuries due to abrasion and handling stress and strain. Thus, the Pusa Bin combines all three major requirements of safe storage, namely, it is moisture proof, it is sufficiently airtight, and its walls have poor thermal conductivity.

C. Long-term Storage

This type of storage is for long periods as required by large-scale trade stockiest and government agencies desiring to keep buffer stocks or maintain food banks. For long-term storage, careful planning and implementation of the storage practices is required. Prior to the storage of grain, it should be thoroughly dried as the moisture content of the grain is the most vital factor for safe storage. Grain can be dried in the sun but it is highly advisable that a suitable grain dryer be provided for each storage godown.

Air-tight bulk storage is best if the stock has to be maintained on a long-term basis. It is generally in the form of modem silos above ground or as airtight moisture-proof under ground pits. Large-sized structures constructed on the basis of the Pusa bin will also serve well for long-term storage. Such storage structures housed in storage godowns are permanent means of long-term storage. The cost of such storage is quite cheap in the long run. The godowns should have adequate provision for making the whole structure sufficiently air-tight for fumigation and proper aeration after fumigation. This can be easily managed by having ventilation fitted with proper exhaust fans and also a suitable arrangement for closing the ventilator air-tight.

Bulk storage is preferable for wheat, paddy, barley, gram and other coarse grains. To take full advantage of bulk storage the grain should be free from insect infestation, well dried and should be stored in damp-proof and uninfested bins. If infested, grain in bulk can be fumigated at a low cost to prevent further deteriorations and cross-infestation of uninfested stocks. Bulk storage leads to considerable economy in storage space, its maintenance and the cost of gunny bags. After bulking the grain, empty disinfected gunny bags can be re-used.

The bulk grain should be regularly inspected at monthly intervals. Samples should be drawn with the help of thermo-sampler from different levels to know the moisture content, heating, insect infestation, fungus attack and cake formation.

In case of infestation, fumingate the grain with aluminum phosphide at the rate of 3-4 tablets (3 gm each) per tonne, EDCT (Ethylene Dibromide and Carbon
Tetrachloride) at the rate of 35 kg/100m$^3$ and EDB (Ethylene Dibromide) at the rate of 64 gm/tonne with 7 days exposure period. If the commodity shows signs of heating, it should be aerated by the aeration arrangement provided in the structure. Insecticides should not be stored near the bulk grain.

**Bag Storage**

Bag storage is largely practiced in the trade godowns, mainly because of the ease in handling and transport. Bagged grain should be stacked on racks, at least 30 cm from the walls of the warehouse and far enough apart to allow inspection and cleaning. Infested bags, if any, can be easily segregated and treated. Bags made of paper, paper laminated to cloth or back-filled fabrics, and cartons of fiber board offer more resistance to insect penetration than ordinary cotton or jute bags.

Although storing grains in bags is not very ideal, it is one of the common mode of storage. Often, the bags themselves serve as a source of infestation. Hence, it is advisable to use new bags or put old sacks in boiling water and dry them in bright sun light before use. Bags of uniform size and weight should be chosen. If there are any holes they should be mended. Fill insect free, clean, cool and dry grain in the bags. Each kind of grain should be put in a separate bag. The mouth of the filled bags should be stitched. In case of machine stitching, five stitches in 2.5 cm should be used. The godown should be kept thoroughly cleaned and sweeping should be collected from time to time, should be sieved, winnowed, cleaned and sound grain recovered should be blended with the rest of the bagged grains. The remnants of the sweeping after recovery of the sound food grains should be disposed of by burning, dumping or for industrial or manure purpose. The fertilizers or the pesticides should not be stored along with the food grains.

The maximum permissible height of stacks for major food grains like wheat, barley, oat, maize, gram, pulses, jowar and other millets is 20 layers while in case of rice and milled pulses it is 16 layers.

**D. Underground Storage**

In the underground storage the grain is more free from the seasonal changes of the temperature and humidity provided seepage does not occur, and is safer from various external sources of damage inducing theft. On the other hand, above ground
storage is more convenient for inspection and handling of the grain and can be maintained in more hygienic conditions.

F. Ventilated Granaries

In this type of granary, the peasant farmers usually store their unthreshed cereals, because in this way, they are afforded better protection against insect and are less susceptible to damage by water infiltration. Rice is generally not threshed but kept in the form of paddy, while groundnuts are kept in their shells. These granaries are cylindrical, or sometimes rectangular. The grain is removed via a small opening in the side, closed by means of a door made of boards or flat metal. The dimensions vary from village to village and their capacity ranges between a tonne and a tonne and half. These granaries are used for unthreshed cereals, provide good ventilation of the grain and there is little insect infestation of their contents. They are vulnerable to rats, but, to deter them, one should refrain from constructing them under trees.

Normally, the design of bulk storage structures depends upon the local climatic conditions, material availability and commodities grown. India, being a vast country with various resources and climatic conditions, a single design cannot cater the requirements of farmers of different regions. Keeping this practical consideration in view, the Indian Grain Storage Institute which is a National Institute dealing exclusively with the storage problems, has designed and tested number of structures. They are classified into two categories.

The first category is indoor and outdoor structures and the second category is metallic and non-metallic. Designs were evolved by combination of these two categories.

Examples of indoor metallic structures are Domestic bins, Urban bins, Spiral lock seam tube bins. An indoor non-metallic structure includes Pucca kothi, Cavity wall bin, and Plywood bins. Outdoor metallic structures include flat and hopper bottom module bins, corrugated galvanized sheet bin, outdoor flat bottom bin, and Composite bin. Outdoor non-metallic structures includes Reinforced cement concrete ring bin, Reinforced brick bin, Hollow block bin.
G. Silos

Silos are usually constructed of steel or reinforced concrete and comprise high cells of various cross-sections placed side-by-side. They have inlets and hoppers for loading and unloading respectively. Mechanical management is also provided for loading and unloading in case of large capacity silos.

The basic layout of vertical silo installation has the following components.

i. Reception pit: The materials brought to the place are tipped into this.

ii. Elevator: For raising the material from reception pit to the top conveyor of silo for loading into silos.

iii. Loading belt conveyor: For loading into the silos a belt conveyor is used which is installed on the top.

iv. Unloading belt conveyor: For unloading from silos, the belt conveyor is used which is installed below the outlet of the hopper bottom.

v. Hopper bottom: Large scale silos are provided with hopper bottom. The hopper bottom should ensure easy gravity flow.

Types of Silos

Broadly, there are the following types of silos.

Reinforced Concrete Silos

They can be extremely large having height of 50, 75 and even 100 meters.

Cylindrical Silos with Corrugated Steel Sheets

These silos are made of either corrugated or flat galvanized steel sheets; the thickness of the sheet depends on the capacity of silos. They are pre-fabricated for easy erection at site.

In the developing countries like India, the silos commonly in use are briefly mentioned here.

Steel Silos

These are the bulk storage metallic silos. These silos are around 7 m in diameter and 23 m in height having a capacity up to 500 tonnes. There is a head house having a diameter of 8.5 m and height of 47.3 m. Head houses contain grain elevators, auxiliary tanks, grain cleaning and disinfecting equipment, grain drier and weighing
machines. A drying arrangement for reduction of moisture content is also provided. There are provisions for recording temperature fluctuations in the silos aeration and fumigation.

**Flat Storage Plant**

These plants can have capacity up to 55,000 tonnes. They have elevators and screw type conveyors. They have provisions of temperature recording and aeration.

**Concrete Bins**

Concrete bins can have capacities of 2000 and 4000 tonnes. Such kinds of bins are constructed in India in 1965. Subsequently, more bins are added to increase the capacity of this type of storage. These are constructed in Madhya Pradesh and Maharashtra.

**Horizontal Silos**

The horizontal silos have large diameter and lesser height. These silos are preferred if the ground area available is large and the height of the handling equipment is to be smaller. But normally vertical silos are preferred than the horizontal silos as they are economical.

**Hexagonal Silos**

The capacities of this kind of structures may vary between 500 tonnes to 2000 tonnes. Here, the walls are constructed with bricks and cement mortar having thickness of 400 mm. The hopper bottom is provided with reinforced cement concrete which is 150 mm thick. The whole structure is supported by concrete columns.

**4.10 WORKING OF SILOS IN INDIA:**

India experienced working with SILOS for food grain storage from year 1959. Four SILOS under FCI management have been working in Calcutta, Madras, Mumbai and Hapur-Ghaziabad. The storage capacity of this station, for instance, in Hapur is 10,160 tons. This system of storage of grain in bulk has been provided with mechanical operation for receiving and issuing out grain with the help of elevators system on scientific lines. This superstructure consists of twenty cylindrical SILOS with a capacity of 508 tonnes each. Each of these SILOS is about 22 feet in diameter and 76 feet high. At the starting point (head) of this SILO system, there is a head
house which is of 30 feet in diameter and 156 feet high. In the head house there are grain elevators, auxiliary shipping tanks; grain cleaners automatic weighing machines, man lift etc. are located.

Grain arrives either in wagon through the railway siding provided on one side of the SILOS or by road on the other side. The grain is dumped into the rail hoppers or the truck dumps, as the case may be, and by means of conveyor belts, it is brought to the elevator pit. There the grain is lifted by the elevator to the height of 175 feet and after initial weight, it passes through the cleaning machines and then to automatically integrated weighing process, which indicates the quality of grain that has been fed into each bin. Then the grain drops on to another conveyor belt which conveys it to various storage bins through tripper.

For taking out the stored grains, conveyor belts are situated at the bottom of the SILOS which takes grain to the elevator pit from there it is lifted to shipping tanks. From here, it is automatically weighted and shifted either in bulk transport or to bags as necessary. There are automatic weighing machines and stitching machines for shipping out the grain in bags at the rate of 80 to 100 tons per hour.

The silos are also provided with drier tank along the side of the head house which is capable of handling ten tonnes of grain per hour and dries the moisture in the grain by heated air produced from an oil diesel burner. The steel bins are also provided with electric thermocouple temperature cables and with the help of potential meter temperature is recorded monthly, which enable a watch being kept on the condition of grain. The grains are also cooled down by drawing in air by aeration fans when they get unduly heated. There is a provision of fumigating the grain, when necessary. The silo bins are proof against attack of insect’s pests or other kinds of infestation.

Power required for running of the elevators and other parts of the plant is provided by three diesel electric generators, installed specifically for the purpose as a part of the plant. Each generator has a capacity of 100 K.V.A. Operation of the plant is controlled by a remote control system and there is a arrangement of inter locking and sequence control in the switch room panel.
Advantages of Grain Silo Elevators

1. Quicker handling of grain. The elevator is capable of handing about 180 tonnes per hour, for both the operations (Storage and Issue simultaneously).
2. Simultaneous storage of different kinds of grain, such as wheat, paddy, gram, bajra, maize in the different bins at the same time.
3. Mechanical Operation. All loading, unloading, weighing etc. are done mechanically.
4. Long storage without deterioration or loss. There is no access to insects or rodents. Aeration and fumigation can be done when necessary to preserve the condition of grain. Grain can be stored as long as five years.
5. There is provision for thermocouple temperature record system in the plant itself.
6. Space requirement is less. The area of land is required for Silo storage is only about one fifth of that for conventional storage godown.
7. Full proof arrangement in respect of physical checking of food grain stored in silo bins.
8. Consumption of fumigant is very nominal.
9. Saving in sacks (Gunni) & Skilled handling labourers at the time of storage.

Noting the advantage and benefits of using SILOs, in the light of large scale criticism for loss of food grains due to deterioration and damage, government of India is making headway towards adoption of SILOs on large scale for food grain storage. The location of silos shall be considered on the basis of wheat procurement and off-take in a revenue district. Each silo will have a capacity of either 25,000 tonnes or 50,000 tonnes depending upon the availability of space approved by high level committee under the Private Entrepreneur Guarantee Scheme. Each State has to provide the space for construction of godowns. The panel has recommended creation of 51.25 lakh tonnes capacity in Punjab and 38.8 lakh tonnes in Haryana.

In the wheat procuring-cum-consuming regions of Madhya Pradesh, Uttar Pradesh and Bihar, silos have been sanctioned for additional capacity. Proposal for creation of 19.52 lakh tonnes in Madhya Pradesh and for 6.40 lakh tonnes in Bihar has been approved by the high level committee. Proposal for creation of additional storage capacity is awaited from Uttar Pradesh.
In the consuming regions of Maharashtra, West Bengal, Assam, Kerala and Gujarat, it has been decided that the silos should have at least four-month storage capacity. The States which have not been able to sanction the capacity or start construction work for silos will have to let go and transfer their sanctioned capacity to another State, the Board has decided.

On approval of the locations, the States will have to provide land and invite tenders within three months.

4.11 DEVELOPMENT AND OPERATIONAL ISSUES OF WAREHOUSING:

Development Issue

At present in India, professional warehousing is dominated by Central Warehousing Corporation & State Warehousing Corporations. Considering scales of operations of these organizations no big private group is active in this area which can be considered as a competitive to these organizations. Investment required for creating good quality storage is huge, which government cannot put alone to have an adequate growth of industry & therefore it should come from private entrepreneurs. The basic reason behind it is that the warehousing infrastructure is a capital intensive project. It needs huge investments in land and construction of storage structures. Along with that, it needs recurring expenditure on maintenance of the infrastructure and manpower cost for operating it. With this situation, if the returns are not adequate or if there is doubt about business viability, it is difficult to attract private investment.

This problem could be overcome by developing warehousing as a well structured & well regulated market. If this is done then, one can have a system to create value in the entire proposition. With this system, goods can be tradable on an electronic platform on Pan India basis & there is a well structured exchange to conduct such trading backed by a central government regulator in the form of warehousing authority. With such development serious private investment will come in this field, because the viability of warehouses will be guaranteed by the exchange.

The private investment can be attracted by increasing marketability of warehousing facility. If we see the present practice adopted by farmers and small traders then it is observed that they prefer to keep their stock with them in their home or in the nearby structures, where cost of storage is almost zero. Instead of this if they
keep their produce in professional warehouses then they will be required to pay storage cost. Again at the sales time they have to bear additional transportation and handling cost for their produce. Then it is obvious that considering all these expenses, if they are going to get some monetary advantage by keeping their produce in professional warehousing then only they will select these warehouses for their goods to keep.

Need for Development of Sound System to Trade Warehouse Receipt

Though, warehouse receipts presently are negotiable, transferrable or tradable in India, in absence of any sound nationwide platform providing such trading mechanism, which can consider the small quantities brought by individual farmers to the warehouses, they will be of limited use for the farmers. The important factors for increasing marketability of warehousing facilities are as below.

1. Warehouse receipts should be traded on a national level platform with guaranteed payment. This will promote the farmer to keep his produce in professional warehouse who feels that instead of immediate sale of his harvested produce in traditional market, if he holds the produce for some period then he is going to benefit from it. Then he will deposit the goods in a professional warehouse, obtain a warehouse receipt and later on whenever he so desires, can sell the warehouse receipt on such national level trading platform.

2. Warehouse receipt should be bankable asset, which means that the depositor should be able to obtain loan against pledge of warehouse receipts.

3. Banks should be at ease to finance against warehouse receipts and they will be, if they know that there is an electronic platform where they can sell pledged warehouse receipt easily without risk, in case, if depositor doesn’t turn to the bank to repay his loan taken on warehouse receipt.

4. Counter party guarantee backed by settlement guarantee fund, which means in case of any problem, the depositor will get his goods or value equivalent to his goods immediately. The depositor need to get assured with a thing that in case of any default may be, because of warehouseman or another party, there is a centralized clearing house or exchange, which guarantees delivery and payments as per schedule.
The spot exchanges also could be able to attract private investment in warehousing infrastructure. Spot exchanges can create their own warehousing infrastructure for running their delivery based business. The value proposition that can be offered by the spot exchange to promote investment in rural warehousing is as follows.

1. The designation of a warehouse as approved designated delivery center, creates local business for the warehouse, as all the buyers & sellers have to use such warehouse for giving or taking delivery from the exchange. This will provide recurring business for the warehouse.

2. Spot exchanges hire the warehouses either on the basis of monthly rental or on revenue sharing model. This provides an assured monthly income to the warehouse and reduces his business risk.

3. Spot exchanges enter into long term lease agreement with the warehouses with guaranteed monthly rent. This helps the banks to finance construction of warehouse by linking monthly rental with the bank installment, which is directly paid to the bank.

To develop reliable system for negotiability and bankability of warehouse receipt with counterparty guarantee, is to set up national level institutionalized spot exchanges. These spot exchanges should create electronic platform for trading in negotiable warehouse receipts. In the working of spot exchanges, the physical stock is handled by a third party, while warehouse receipt gets transferred between the trading parties, with sufficient discharge of obligations. The exchange here monitors the transfer and takes the responsibility for proper upkeep of goods as well as for counterparty defaults. Thus spot exchanges can become a seamless way of negotiation of warehouse receipts, by people located across the country.

**Development of electronic spot exchanges in India**

The Government and FMC (Forwards Market Commission) have allowed the national commodity exchanges to set up three spot exchanges in the country, namely the National Spot Exchange Ltd.(NSEL), NCDEX Spot Exchange Ltd.(NSPOT) and National Agriculture Produce Marketing Company Of India Ltd(NAPMC). During 2009, there was significant expansion of spot exchanges trading facilities in India. These spot exchanges have created an opportunity for direct market linkage
among farmers, processors, exporters & end users with a view to reducing the cost of intermediation & enhancing price realization by farmers. They would also provide the most efficient spot exchanges, which would cover many commodities across the country & creates an advantage of an electronic spot trading platform to all market participants in the agricultural & non-agricultural segments. On the agricultural side, the exchanges enables farmers to trade seamlessly on the price information and a simplified delivery process, thereby ensuring them the all users of the commodities in the commodity value chain would have simultaneous access to the exchange, which would be able to procure at the best possible prices. Therefore, the efficiency levels attained as a result of such seamless spot transactions would result in major benefits for both producers & consumers. Thus the exchanges would enhance the efficiency of the existing markets in the country.

The agricultural commodities traded on the spot exchange platform are cotton, castor seed, desi channa, guar seed, RM seed, wheat, barley, red arecanut, maize, yellow peas, urad, lemon tur, soya bean, jeera, ground nut, sugar, moong & pepper. In the process, farmers’ realization has increased by 4-5 percent. The total turnover of the three exchanges during 2009 was Rs. 2,810 crore.

The government has created regulatory framework for monitoring trading, delivery and settlement at spot exchanges. The government through NSEL has appointed National Securities Depository (NSDL) and Central Depository services India (CDSL) as its clearing house for settlement of traders pertaining to warehouse receipts for commodities.

Trading, Clearing and Settlement Mechanism through Spot Exchanges

NSEL spot exchanges have specific, location based contracts. Each contract is displayed on the terminals with price quotes, so that buyers can choose the best deal. Buyer & seller will have to deliver and lift the commodity at the delivery point specified in the contract. It is the responsibility of seller to deliver the material at the specified location. Similarly, buyers will have to lift the material from the NSEL’s specific warehouse at the delivery centre, the quality of the material will be checked according to contract specifications notified by NSEL and if the material delivered is accepted at the warehouse, the seller will be issued warehouse receipts. NSEL will collect payment from the buying member through electronic debit and it will endorse
warehouse receipts in favor of the buyer and credit the sales proceeds into the account of the seller. The money transaction will be done electronically.

Flow Chart Showing Trade through Spot Exchanges

The spot exchange accredits warehouses, which are hired and managed by it. These warehouses are approved by major financial institution for warehouse receipt funding. All these warehouses are well connected with road and have facilities of Weigh Bridge, transportation and labor. Exchange provides the services of grading, quality certification & warehouse receipt funding. Normally all these warehouses are open to the other physical traders/stockiest to store the commodities by paying rents.

Example of Trading through Commodity Exchanges

Example of how farmer can be benefited by entering into the trade through commodity exchange can be understood by maize trading. Food processing industry needs maize in large quantities. 40% of total maize production is used by cattle feed industry & rest is used by processing industry. If there is significant difference in
spot prices and futures prices of maize & futures prices are high, then instead of immediate sale, farmer can enter into futures contract.

**Table No 4.4 : MONTHLY AVERAGE PRICES OF MAIZE PER QUINTALS FROM YEAR 2005 TO 2010**

<table>
<thead>
<tr>
<th>Month</th>
<th>Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>708</td>
</tr>
<tr>
<td>February</td>
<td>710</td>
</tr>
<tr>
<td>March</td>
<td>707</td>
</tr>
<tr>
<td>April</td>
<td>712</td>
</tr>
<tr>
<td>May</td>
<td>713</td>
</tr>
<tr>
<td>June</td>
<td>768</td>
</tr>
<tr>
<td>July</td>
<td>821</td>
</tr>
<tr>
<td>August</td>
<td>848</td>
</tr>
<tr>
<td>September</td>
<td>832</td>
</tr>
<tr>
<td>October</td>
<td>733</td>
</tr>
<tr>
<td>November</td>
<td>753</td>
</tr>
<tr>
<td>December</td>
<td>756</td>
</tr>
</tbody>
</table>

(Source: NCDEX spot prices for Nijamabad)

e.g. If farmer has maize at his disposal in month of February when prices are suppose, Rs. 710/- per quintal and futures prices in February for the month of August, suppose they are Rs. 840/- per quintal, then there is a difference of Rs. 130/-. This increase is more than 18% than the prices in February. Thus he is going to get benefit from entering into futures contract. Therefore he should enter into the futures contract.

**Use of Hedging Tool to Get the Expected Price**

At the time of sowing in the month of July, when farmer decides to take crop of maize in his farm, the rate of maize is suppose Rs. 820/- then he may expects the same price for his produce in the month of December, after harvesting the crop. For this, he will observe the futures prices for the month of December, in July itself. Suppose on 12th July the price is Rs. 810/- then he decides to sale produce at this price and therefore tells his broker to enter into the futures contract of sale.
In the month of December, now the farmer has to do two transactions. First is to close the futures contract which was done on 12th July. For this, on the last day of the contract when spot & futures prices are almost equal, suppose they are Rs. 750/- the farmer purchase the similar contract and closes down the futures contract done in the month of July. The maize which is at his disposal after the harvest, he sale it to Rs. 750/- on the spot market.

All these transaction are on paper & actual physical transfer doesn’t takes place. If any loss happens to farmer due to some difference in spot and futures prices on the last day of contract, he has to pay it to the broker. (Commission also has to be paid to the broker)

Transaction:

- Amount accrued by the sales of futures contract = Rs. 810/-
- Amount spent for purchase of contract on the last day of contract = Rs.750/-
- Sales proceed after the sale of maize on spot market = Rs.750/-
- The money realized to farmer after all transaction = (810-750) + 750
- The money realized to farmer after all transaction = 810/-

As the actual physical deliveries are almost not taking place through futures contract at the designated place, as it is costly, the hedging is providing protection from price fluctuation to a large extent\textsuperscript{14} and helps to get near expected price of a commodity.

**Warehouse Receipt Based Finance Scheme of a Private Bank**

HDFC bank and National Agricultural Cooperative Marketing Federation (NAFED) have signed a memorandum of Agreement on 01Feb 2005\textsuperscript{15}. They entered into a contract for providing finance to farmers through HDFC against pledging Warehouse Receipt with them through their local member co-operatives. The features of this scheme are as follows.

It is available to farmers, village level aggregators & NAFED associated co-operatives. These borrowers can get secured short term rupee loan through this scheme. The warehouses in which they have to store goods are central warehousing corporation and state warehousing corporations. Interest rate of 12% per annum for daily balancing method is calculated. Borrowers can keep goods for four months to
six months period. For their work NAFED & associated co-operatives share 3% fees. The amount of loan given is 80% for nonperishable on their value.

The procedure adopted for implementing this warehouse receipt finance scheme is as follows

a) Identification of potential commodities which have shelf life of more than 60 days and where there is a seasonality pattern.
b) Identification of locations where the commodities short listed above are grown and where the warehousing space (CWC/SWC) is available.
c) Identification of potential cooperative societies willing to work in association with NAFED for implementation of the scheme.
d) Identification of warehouses (CWC/SWC) in the identified locations for accepting the stocks in consultation with HDFC Bank.
e) Promotion of the scheme in consultation with society concerned and HDFC Bank’s team.
f) The society will complete the documentation formalities;
g) HDFC Bank personnel will conduct a training programme covering entire scheme including the documentation aspects.
h) Monitoring prices of underlying commodity and HDFC Bank decides for issuing margin call if necessary.
i) The society has to open a Current Account with the nearest Branch of the HDFC Bank. The society has to arrange for delivery of the stocks once outstanding amounts are cleared.
j) In an unlikely situation of a default, liquidation of the stock to be initiated as stipulated in the MOA entered into HDFC Bank.

Initially the scheme had been launched at few pilot locations by forming a joint scheme with representation from NAFED and HDFC Bank, which identified the commodity, location, cooperative society and warehouse.

4.12 THIRD PARTY LOGISTICS & WAREHOUSING:

A third party logistics provider is a firm that provides service to its customers of outsourced logistics services for part, or all of their supply chain management functions.
Third party logistics providers typically specialize in integrated operation; warehousing & transportation services that can be scaled & customized to customers’ needs, based on market conditions and the demands and delivery service requirements for their products.

A typical third party warehousing can provide services of Inbound receiving, container de-stuffing & cross-dock, storage facilities, order fulfillment-pick & pack, price ticketing-swift tag or stick-on, processing customer returns etc.

A warehouse is a planned space reserved for storing and/or handling products. Third party warehousing is the outsourcing of this function & its associated services. Outsourcing the warehousing function in the supply chain is a practice that has been growing steadily and is projected to increase by 5% over next few years. The 3rd party warehousing can take any one of several forms including public warehousing, contract warehousing, or private warehousing.

Services offered through 3rd party warehousing can be having common features as well as specialized services like temperature controlled environment and handling hazardous materials. Other services offered by 3rd party warehouse are cross docking, inventory control, pick and pack etc.

For making the decision whether to hire third party warehousing, warehousing requirements of the business firm is considered, then the costs associated with performing these requirement by the firm itself are considered. The structure, labour, administration are the overhead expenses that are taken into account.

The advantage to the business firm which is involved in its own warehousing is the complete control it maintains over all the operations. In addition to that, if there is unused space, that may be leased to other business at profit. The disadvantage in having build warehouse & operate it is the enormous capital cost and expenditure required to maintain it.

For most of the businesses, warehousing in particular is not profit building function. Instead, most companies can save money through outsourcing and can go for business expansion. Third party warehousing can lower inventory costs, improve management through industry specific technology & improve customer service. So business firms now a days are going for a trade-off consideration whether to have own warehouse requirements or to go for third party warehouse & arrive at a proper decision.
4.13 FREE TRADE WAREHOUSING ZONE\(^{17}\) (FTWZ):

The Government of India had announced in the Foreign Trade Policy 2004-09 to set up Free Trade and Warehousing Zones (FTWZ) to create trade related infrastructure to facilitate the import and export of goods and services with freedom to carry out trade transactions in free currency. On June 23, 2005, the Parliament of India, passed the Special Economic Zones Act 2005 and on February 10, 2006 Government of India notified Special Economic Zones Rules 2006. This is a special category of Special Economic Zone and is governed by the provisions of the SEZ Act and the Rules.

FTWZ is a ‘Sanitized’ zone designated as Foreign Territory for carrying on business and it is considered as ‘International Trading Hubs’. Each Zone would provide ‘World Class’ Infrastructure for -warehousing of various kinds of products, handling and transportation equipment, commercial office space, all related utilities – telecom, power, water. One stop clearance of Import and Export of goods etc.

100% Foreign Direct Investment is permitted in development and establishment of FTWZ. It is considered as deemed foreign territory and all equipments and materials sourced from the Domestic Tariff Area will be considered as Imports by the FTWZ and vice versa.

Minimum size of the warehousing stipulated at 1 lakh sq. mtrs. All benefits available to the SEZs shall be applicable to the FTWZs.

The FTWZ is under the administrative control of the Development commissioner.

**FTWZ – Benefits for the Business Firm Includes:**

Custom Duty deferment benefits for products requiring longer storage time, Income tax (section 80IA) and Service Tax exemptions for developers and users of the zone. It reduces logistics costs for users of the zone. Excise duty exemption for products sourced from the domestic markets, including goods, spares, diesel generator sets, packing materials, etc.

Infrastructure benefits include single product storage facilities, shared warehousing and shared equipments which help users to save on capital investments by leasing equipments provided by the zone.

Administrative Benefits include- Reduction in custom clearance time and better logistics connectivity leading to improved delivery time, Provision of efficient
management services and international expertise along with support facilities such as banking, insurance etc.

Free trade warehousing is redefining logistics in this country. Now with this zone, India will act as hub instead of Singapore or Dubai which will help not only to distribute products in India but also for Middle East & Asian markets. Now with this infrastructure put in place, companies could provide an integrated solution by substantially reducing the cost of distributing the product, which is one of the highest in India as compared to any other country. One of the companies, Arshiya International, plans to launch 5 new FTWZ in India.

By boosting FTWZ activities, country is expected to benefit through increase in export, direct foreign investment, employment and competitiveness among industries.

4.14 CONCLUDING REMARKS:

There are macro and micro factors that need to be considered while selecting the place and locality for warehouses. Warehouse performance measures are the tools to evaluate the working of warehouse professionally and thereby improving its competitiveness. Warehouse management software has a role to play in designing and working of modern warehouses.

While constructing the food grains godown various standards need to be followed, so that management of the godowns could be effective and beneficial. Controlling temperature and humidity are the major things while maintaining the food grain stock. Methods of scientific storage practice are available so as to minimize the loss in agricultural produce. Noting the benefits of SILO storages, it is essential to go for adopting it for large scale food grain storage.

To make Indian farmers to realize benefits of high commodity prices and to reduce the middleman’s share, Government of India is putting its efforts in right direction by promoting commodity exchanges and spot exchanges to trade agricultural produce. Supporting platforms for trading of warehouse receipts and clearing and settlement mechanism through spot exchanges has been developed.
REFERENCES:


