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08620

Distr.
LIMITED
ID/WG. 282/90
10 October 1978
ENGLISH

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

INTERNATIONAL FORUM ON APPROPRIATE INDUSTRIAL TECHNOLOGY

New Delhi/Anand, India 20–30 November 1978

WORKING GROUP No. 6

APPROPRIATE TECHNOLOGY FOR FOOD STORAGE AND PROCESSING

APPROPRIATE TECHNOLOGY FOR FOOD GRAIN STORAGE

Background Paper

id. 78-6934

APPROPRIATE TECHNOLOGY FOR FOOD GRAIN STORAGE

by

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CONTENT

SUMMARY

The advent of modern technology in agricultural production in India brought about increase in agricultural production and marketed surplus. The storage facilities created to meet the need for subsistence farming have not simultaneously adopted to the change brought about by commercialised farming.

Efficient storage plays a prominent part in not only sustaining and stimulating production but also minimising the inter-temporal and inter-spatial disparities. Increased productivity can not be translated into a proportionate increase in the level of real incomes in an economy in which storage system is in-efficient.

The appropriate technology for foodgrain storage in India, is examined in the context of nature and magnitude of agricultural production and the need of storage at the farm level and market level with special reference to the Government and the public agencies.

The production of foodgrain in India during the last twenty eight years has shown a significant increase, achieving a level of 125 million in 1977-78 from a level of 52 million tonnes in 1950-51. It is expected that the foodgrain production may attain a level of 164 million tonnes by 1985.

Of the total foodgrain production in India, about 60-70 percent is retained on the farms. Marketable surplus which passes through the marketing channel is estimated to be about 30-40 percent.

Farm storage in terms of absolute quantities of foodgrain stored, is still very large compared to both the trade and public storage. The role of public agencies in the storage function has been increasing over the years. The storage capacity owned by three major agencies i.e. Food Corporation of India, Central Warehousing Corporation and State Warehousing Corporations increased from 2.5 million tonnes in 1965-66 to 9.7 million tonnes in 1977-78.

The present paper has been divided into four Sections.

In Section I, the production of foodgrains, characteristic of foodgrain production, marketing system, government programme and policies and the relative importance of farm level storage and public storage has been discussed.

Section II, highlights some of the problems related to foodgrain storage and covers drying, handling, losses and causes of foodgrain losses.

The farm level storage is dealt in Section III covering the indigenous, modern and improvement of existance storage structures. The evaluation of farm level storage structures has been presented on the basis of a recent indepth study by the Administrative Staff College of India.

The appropriate technology for farm level storage has been considered on the basis of three levels of farm storage facilities which exist in India at present.

Keeping in view the diversed agro-climatic socio-economic andcultural environment, the appropriate technology for farm storage has been outlined.

Governmental programmes for minimising storage losses at farm level, their objectives and achievements are also briefly touched upon in this Section.

In Section IV, the appropriate technology for public storage has been discussed. The growth of storage facilities in the public sector has been examined and keeping in view the present programme of the Government to build up a buffer level of 12 or 14 million tonnes, the future requirements have been identified. In order to meet the demand and to keep pace with the advancement of technology, the public storage facilities have grown in types. The conventional godowns, the bulk storage structures, R.C.C. Silos and Cover and Plinth (CAP) have been discussed Criteria for selection of appropriate storage technology have been identified and the comparitive economics of Bag and Bulk Storage facilities has been examined.

An attempt has been made to outline the implications, constraints and the steps taken for the adoption of modern storage technology.

I. INTRODUCTION

The advent of modern technology in agricultural production in India created the need for acceptance of utilisation of improved inputs for higher productivity. The break - through in farm technology brought about the need to allocate the limited resources to the best use and to a greater extent restricted the occurance of uncertainly factor which was normally associated with the pre-dominantly subsistence oriented Indian Agriculture. With the development in farm technology and consequent increase in agricultural production, marketed surplus increased and the storage facilities became inadequate. The storage facilities created to meet the need for subsistance farming have not simultaneously adopted to the change brought about by the commercialised farming.

Efficient storage plays a prominent part in not only sustaining and stimulating production but also minimising the inter-temporal and inter-spatial disparities. Efficiency in storage eliminates waste and helps in conserving national resources. Efficient storage, consequently, is of prime importance in developing economics. Functional improvements, it is true, relating to the science and craft of farming may result in higher productivity and may delay the operation of diminishing returns; however increased productivity can not be translated into a proportionate increase in the level of real incomes in an economy in which storage system is inefficient. Hence, the economic need for an appropriate and efficient storage system is imperative. The appropriate technology for storage is, therefore, examined in the context of nature and magnitude of agricultural production and the need of storage at the farm level and market level with special reference to the Government and the public agencies.

PRODUCTION OF FOODGRAINS

Foodgrains occupy the most important position in India's agricultural economy, accounting for about 75 percent of the gross cropped area. As such, the growth rate of foodgrain production largely determines the growth in agricultural sector.

The production of foodgrains in India over the last 28 years has shown a significant increase, achieving a level of 125 million tonnes in 1977-78 from a level of 52 million tonnes in 1950-51. The break-through in wheat production brought about by the introduction of High-Yielding-Varieties in late sixties contributed largely to the phenomenal increase in foodgrain production. The production of wheat stepped up from a level of 11.4 million tonnes in 1966-67 to 16.5 million tonnes in 1967-68 and 28.8 million tonnes in 1975-76. To sustain the tempo of increased production, simultaneous efforts were made to increase the production of paddy and other cereals by introducing High-Yielding - Varieties, application of fertilizers, insecticides and pesticides.

The production of wheat rice and total foodgrain in the selected years is given in Table-1.

TABLE - 1

PRODUCTION OF WHEAT, RICE AND TOTAL FOODGRAIN IN SELECTED YEARS

Year	Production of Foodgrain (in million tonnes)		
	Wheat	Rice	Total
1951-52	6.2	21.3	52.0
1960-61	11.0	34.6	82.0
1967-68	16.5	37.6	95.1
1970-71	23.8	42.2	108.4
1975-76	28.8	48.7	121.0
1976-77	29.1	42.8	111.6

Source: Directorate of Economics & Statistics Govt. of India.

CHARACTERISTICS OF FOODGRAIN PRODUCTION

Some of the important characteristics of foodgrain production are given below:-

i) Since 1950-51 there has been a significant increase in the production, and it has more than doubled during the last twenty six years.

ii) Foodgrains production has been characterised by year to year fluctuation in production. Agriculture in India has traditionally been a gamble in the monsoon. Out of the total cultivated area only about 30 percent is under irrigation. Failure of monsoon in one year upset the balance and invariably leads to short fall in the production. It is expected that with the extension of irrigation facilities, adoption of drought resistant HYVs and dry farming techniques the fluctuations in production are likely to be less in future. The cyclical pattern in production has no uniformity.

iii) Im-balances in foodgrain production and requirements among different States continue depending upon agro-climatic conditions, farm practices extent of use of inputs and other factors.

iv) Wheat production has attained the break-through stage. It has gone up by 2.5 times from 11.4 million tonnes to 28.8 million tonnes during a span of ten years (1966-67 to 1976-77). Production of rice in 1975-76 at about 49 million tonnes indicates the potential for a similar break through in future.

v) HYV have spread to a large areas specially in irrigated tracts. There has been a rapid expension in the area under HYV indicating high degree of response from farmers.

PROJECTIONS OF FOODGRAIN PRODUCTION

Since the Indian Agriculture largely depends upon the agro-climatic conditions and monsoon performance, the precise forecast of foodgrains production is much difficult. The various organisations like Administrative Staff College of India and National Commission on Agriculture have forecasted the projections of foodgrain production. It is expected that the foodgrain production may attain a level of 164 million tonnes by 1985. Grain wise projections are given below in Table - 2

TABLE - 2

GRAINWISE ESTIMATED PRODUCTION

(Million Tonnes)

Crop	Estimated by ASCI 1985-86		Estimated by		NCA *
	Half span	Full Span	1969-70 to 1971-72	1985	2000
Rice	53.3	51.5	41.9	61.0	[illegible]
Wheat	43.9	35.2	23.5	41.0	57.0
Coarse-grain	34.6@	34.2 @	27.5	40.0	65.0
Total Cereals	131.8	120.9	92.2	142.5	155.0
Total Food-grains	-	-	104.4	164.0	230.0

@ By balancing

* On base level output during the triennium 1969-70 to 1971-72.

Source : ASCI supporting study No. 3

NCA Demand and Supply-Part-III.

MARKETING SYSTEM

Marketing is a critical link in the total agri-business system influencing the income level of farmers, consumers, traders amd other participants in the entire system. Traditionally, innumerable hats and mandiqs, estimated at about 22,000 performed this function with the limited objective of linking sellers with buyers. Though these hats and mandies still continue, about 4145 markets situated either at tehsil headquarters or large villages or towns have been identified to be larger markets. With a view to bringing about orderly marketing of agricultural produce and to regulate the market charges and market practices regulation of markets was initiated. Agricultural Produce Marketing (Regulation) Acts have been in force in 18 states and 4 union territories. Of the total 4145 markets, nearly 3000 markets have already been regulated.

Of the total foodgrain production, in India about 60-70 percent is retained on the farms for family consumption, seed, feed and other purpose. Marketable surplus which passes through the marketing channel is estimated to be about 30-40 percent.

In view of the incessant nature of storage function almost all those engaged in the process of marketing are faced with the problem of storage in varying degrees. The various storage agencies are the producers, the merchants, transport agencies the warehouses, the public and state agencies and the consumers. In view of the wide variations in the object of storage of these various agencies the period and problem of storage vary significantly.

The relative importance of different agencies, infact, determines their storage needs. In India, a major portion, of what is produced, is stored on the farm. Prior to World War II, it is estimated that as much as 80 to 85 percent of the foodgrains produced used to be stored at farms. Over the last few years, growth in agricultural production and the increasing demand for foodgrains from the non-agricultural sector has brought down the level of farm storage to about 60 to 70 percent. In terms of absolute quantities of foodgrains stored, the farm storage is still very large compared to both the trade and public storage.

The private trade has also been playing a major role in the storage of foodgrain marketing. Almost all the marketable surplus passes through this channel. It is estimated that about 70-75 percent of the marketable surplus is stored by the trade although the period and purpose of storage may vary from place to place.

Government's intervention in foodgrains trade has been an established operation since almost three decades, the extent of participation has varied in accordance with the ups and downs in production. The role of public agencies in the storage function has been increasing over the years. The storage facilities with public agencies, consequently, has increased fourfold over the last one and a half decade.

In absolute terms, the total storage capacity owned by the three major agencies i.e. Food Corporation of India Central Warehousing Corporation and State Warehousing Corporations increased from 2.5 million tonnes in 1965-66 to 9.7 million tonnes in 1977-78.

GOVERNMENT PROGRAMMES AND POLICIES

Food Policy

The main objectives of Food Policy adopted at the beginning of the Fourth Five Year Plan as under :

i) to ensure that consumer prices are stabilised and, in particular, that the interests of the low-income consumers are safeguarded;

ii) to ensure that the producers get reasonable prices and continue to have adequate incentives for increasing production; and

iii) to build up an adequate buffer stock of foodgrains with a view to ensuring both the objectives mentioned above by selling from the buffer stock to meet shortages and high prices, or buying for the buffer stock to support falling prices.

Year to year fluctuations in production, inter-state imbalances and disparity in prices, inter and intra seasonal variations in prices and availability and the need to ensure incentive prices to producers and reasonable and stable prices to consumers make the achievements of the objectives complex and challenging. To achieve these objectives a number of measures have been taken from time to time as detailed below :

a) the continuance of the Public Distribution System;

b) the acquisition by the public sector of a sizeable percentage of marketable surplus of foodgrains with a view of meeting the commitments under the Public Distribution System and maintaining the buffer stock at the desired level;

c) the regulation of private trade to curb speculation and hoarding;

d) the imposition of such restrictions on the movement of foodgrains as may be necessary to help the attainment of procurement targets or to prevent, in a condition of shortage, an excessive rise in prices throughout the country;

e) the regulation of bank advances against foodgrains; and

f) the continuance of the ban on forward trading. Judicious mix of these instruments specially such as movement restrictions, regulation of private trade, etc. need to be adopted, depending on the overall food situation in the country from year to year.

The minimum support prices and procurement prices for various foodgrains are fixed by the Government of India on the recommendations of the Agricultural Price Commission. It is accepted that effective implementation of support prices by the Public Agencies during the last decade has infused confidence among the farming community to increase productivity and encouraged a growing rate of capital formation in agricultural sector.

The Public Distribution Programme is an integral part of India's overall food policy. The quantity of foodgrains distributed through the Public Distribution System, has varied from 7.82 million tonnes in 1971 to 14.08 million tonnes in 1966, with an average of over 10 million tonnes per annum. Surpluses and shortfalls in production and difference between the open market prices and controlled prices influence the degree of dependence on the Public Distribution System. At present a net work of 2.4 lakh Fair Price Shops covers 566 million people, both in the rural and urban areas of the country.

Buffer Stock

A target for building up of five million tonnes buffer stock was set in the Fourth Five Year Plan. Later, with increasing production and stock levels with the public agencies, the buffer stock target was raised to seven million tonnes. This revision was followed by shortfalls in production levels and as a result, the revised target could not be achieved.

However, with the easing of the food situation since 1975, the possibility of having buffer reserve was again considered and a Technical Group on Buffer Stock was set up by the Government of India in 1975. The Group recommended a buffer reserve of 12 million tonnes to be built up by the end of 1978-79 to meet shortages arising out of one crop failure. Consequently, the Government of India decided to build up a buffer stock of 12 million tonnes, over and above the operational stock needed for the maintenance of Public Distribution System which range between 3.5 to 3.8 million tonnes in April and 8.2 to 8.8 million tonnes in July.

The Government of India in addition, is also considering the possibility of creating a buffer reserve of 14 million tonnes by 1982-83.

The storage requirement to meet these two buffer level i.e. 12 and 14 million tonnes, the peak operation stock requirement of 9 million tonnes and operational space at 8 percent has been worked out at 23 million tonnes and 25 million tonnes respectively, the details are given in Table-3.

TABLE-3

STORAGE REQUIREMENTS AT ALTERNATIVE BUFFER LEVEL

(in million tonnes)

I. Buffer level	- 12.0	II. Buffer level	- 14.0
Buffer stock	- 12.0	Buffer stock	- 14.0
Operational stock	- 9.0	Operational stock	- 9.0
	21.0		23.0
Operational space @ 8%	1.7	Operational space @ 8%	1.9
Total	22.7 or	Total	24.9 or
	23.0		25.0

II SOME PROBLEMS RELATED TO FOODGRAINS STORAGE

The advent of modern technology in India and its encouraging response from the farmers contributed in bringing foodgrains production to a higher level and infusing a higher degree of stability. The increased production brought alongwith its the post harvest problems. The important post-harvest problems related to foodgrains storage are:

a) Drying

The multiple cropping led to higher moisture content in grain at the time of harvest and coincidence of harvesting with rains in some parts of the country resulting in severe problems of drying and threshing.

Kharif paddy harvest generally gets affected by rains and drying becomes a necessity in some areas. Further, low dormancy of certain varieties of paddy and the need to harvest early with higher moisture content, so as to fit in a second crop later necessitate provision of mechanical drying of paddy.

Sun drying is largely resorted to at present, in India. Limited number of mechanical dryers are used occassionally for limited quantity.

Handling:

The handling of foodgrain in India is manual. To keep pace with the increased arrivals, efforts are being made to introduce mechanical handling but still these are only at a preliminary stage.

Foodgrain Losses:

There are no ready made methods to estimate a reliable loss level, since the concept of loss has a number of aspects. However, a number of loss estimates available can be used as indicators.

The Government of India Expert Committee on Post-harvest losses (1967) estimates that the foodgrain losses at various stages account for 9.33 per cent of the total production. Storage loss accounts for over two-third (6.58 per cent) of the overall loss. At the stage of threshing, transport and processing, losses account for 1.68 percent, 0.15 percent and 0.92 per cent of the total production respectively.

The storage and transport losses have also been estimated by the Administrative Staff College of India, recently. According to the Study, the breakup of losses was as follows in Table 4

TABLE-4

TOTAL GRAIN LOSSES IN STORAGE AND TRANSPORT

Stage	Percentage of Loss to Quantity Retained/Handled
I. Storage	
Farm level	5.0
Seed grains	10.0
Trade	5.0
Conventional godowns of public agencies	2.0
Silos	1.0
II. Transportation	1.0

Source: ASCI Supporting Study No.12.

Aggregate loss for 100 million tonnes of foodgrains works out to be 5.25 per.cent in these two stages of grain flows i.e. Storage and Transportation. The reliability of these estimates, especially for conventional godowns seems doubtful, as the percentage of losses over a number of years in FCI, as detailed below in Table 5 which includes quantitative losses due to moisture variations, are within the one per cent.

TABLE - 5

STORAGE LOSS

Year	Storage loss as percentage of quantity sold
1971-72	0.7
1972-73	0.4
1973-74	0.5
1974-75	0.5
1975-76	0.3

Source: F.C.I.

The FCI stores major part of the foodgrains in conventional godowns, whether they are owned or hired. The average period of storage in the last four-year period might have been less than one year. Taking into account all these considerations the loss can be estimated to be not more than one per cent. The loss estimates are placed around 0.2 per cent in R.C.C. Silos.

Causes of Losses:

Estimates of grain losses due to various factors have been estimated by various agencies and are given in Table-6.

TABLE - 6

CAUSES OF STORAGE LOSS

Causes for storage loss	Export Committee's estimates per cent For all storage activity	ASCI estimates (per cent)			
		Farm level	Trade	Public Agencies	
				Conventional godowns	Silos
Insects	2.55	3 to 4	3 to 4	0.5 to 1.0	0.5
Rodents	2.50	0.5 to 1.0	0.3 to 1.02	Neg.	Nil
Birds	0.85	Neg.	0.2	0.2	Nil
Moisture/ Dry weight	0.68	Neg.	0.2	0.2	0.2
Others like spillage & water damage	-	-	0.3	0.3	Neg.
Total:	6.58	5.0	5.0	2.0	1.0

Source: i) Interim Report of the Export Committee.

ii) ASCI - Supplementary Study No.12.

INSECTS Insect damage seems to be the dominant cause in both the estimates.

Under Indian conditions, the most important insect pests of stored grains are:-

Sitophilus oryzae Linn (Rice weevil), Rhizopertha dominica Fab. (borer beetle), Trogoderma granarium Everts (Khapra beetle), Sitotroga cerealella Olivier (Grain moth), Corcyra cephalonica Staint (Rice moth), Ephestia (Cadra) Cautella Walker (Fig or Almond moth), Callosobruchus beetle), Oryzaephilus surinamensis Linn) (Saw toothed grain beetle), Lathaticus oryzae Water. (Long headed flour beetle) and Plodia interpunctella Huebn (Meal worm moth).

The ecological conditions may fluctuate the losses in storage due to damage caused by the storage pests.

Temperature is one of the most important factors and the maximum lower temperature at which the stored grain insect pests are able to develop is between 15.5 to 18.3^{0}c.

The moisture content largely contributes to the extent of damage by different insect/pests their rate of metabolism, growth etc. optimum conditions of insect damage are largely obtained when moisture of food reaches 14 per cent. At this moisture level other deteriorative changes also set in and this is therefore; considered the highest level of moisture of safe storage of grain, Generally, insect infestation tend to increase with increase of moisture content above 10 per cent.

Various technologies have been developed and are now available in India to control the insects.

Rodents The role of rodents in problems of food and health of mankind is recognised in the country. Efforts are being made by the Government to reduce the rodent menace in houses, godowns, shops and fields to the minimum. The rodent control measures taken in Government storage, resulted in reducing the losses due to rodents to a negligible quantity.

The rodent control is a social problem, in other words, it is largely a people's problem and people should, therefore, be educated about the fact that rats are undesirable from various angles In addition, certain section of people object to killing animals due to religious or humanitarian grounds. The common rituals and people's sentiments also have to be borne in mind while carrying out the extension work in villages and urban areas. The success of rodent control campaign depends upon the integrated approach involving environmental control, use of poisons, education and involvement of people and training of skilled operators and is of paramount importance in saving the nation's food.

Moisture Moisture is a critical factor in the safe storage of foodgrains but it is not always possible to store foodgrains at the minimum moisture content of 10%. It is when the grains are stored at high moisture content i.e. above 14% or when it absorbs moisture from outside during storage bringing it to the level of 14% or above then the problem arises.

Grain heating

Excess moisture in the stored grain above 15% causes wet grain heating due to the attack of micro-organisms producing temperture as high as 144°F (62.2°C). Grain heating may also be caused by the attack of insects called dry grain heating in which temperture may increase upto 108° F (42.2°C)[2]. Hundred grain of weevilled wheat showed a temperature of 70°F higher than the same weight of weavilled wheat or two weevils per pound of grain produce about as much heat as a pound of grain itself.

Moisture content and relative humidity

There is a fairly well defined relation between water content in the grain and relative humidity of the surrounding air. Higher the relative

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<u>Moisture content and relative humidity</u>

There is a fairly well defined relation between water content in the grain and relative humidity of the surrounding air. Higher the relative humidity of surrounding air, more will be the moisture content of grain.

In the stored grain, the moisture in due course tends to come in equilibrium with the humidity present in the air thus gaining or losing moisture as the relative humidity increases or decreases. There is a characteristic moisture content/relative humidity equilibrium pattern observed in different types of grains. Relative humidities above 65 or 70 per cent is conducesive for fungi development and below 70 per cent for insect breeding.

A moisture content equivalent to a relative humidity of 65% has been suggested for 2 to 3 years storage of grains and grain products held at 60°F to 70°F (15.6-21.1°C) while a moisture level in the substrate in equilibrium with air at 72% RH can store for three months only at the same temperature. Besides, it has also been observed that the grain stored in bags had more moisture than that stored in bulk but not the damage due to fungus attack and heat which was higher in the latter.

Effect of storage structures

Girish et al.[1,2] Srivasteva et al.[2], Doharey et al.[3] recorded great variation in the moisture

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1. Girish, G.K., Goral R.K., Tomer R.P.S. Srivastra P.K. and Krishnamoorthy K. (1972) Pt. I Studies on preservation and losses of foodgrains in underground pits Khattis in U.P. (India) Bull Gr. Tech. 10(1):11.21.

2. Girish, G.K., Tripathi B.P. Tomer RPS and Krishnamoorthy. (1974) IV Conventional grain storage practices and losses in rural areas of U.P. (India) Bull Gr. Tech. 12(3):199.210

3. Srivastva PK Tripathi BP Girish G.K. Krishnamurthy K(1973)III Conventional grain storage practices in rural areas of Western U.P. Bull Gr. Tech. 11(2):129-139
Doharery R.B. Srivastva P.K., Girish G.K. (1975) VIII Studies on the assessment of losses of wheat in Punjab Bull Gr. Tech. 13(3):159-161.

content and temperature in grains stored in Khattis, bags, Pucca and Kucha Kothis, mud containers, wooden box and metal drums in Uttar Pradesh. The high moisture content of 10.1-11.0 per cent in the top layers of 'Kacha Khattis, was responsible for insect damage and lower germination percentage, particularly in maize. The variation of moisture in wheat was maximum in bag storage (9.8-16.4%) followed by Kucha and Pucca Kothi with(11.0-13.8%) and (11.2-13.6%) respectively. The moisture in metal drum only varied from 10.1-12.0 per cent.

Chemical changes in grain

Grain also undergoes chemical changes with the altering moisture in storage. Bayfield and O'Downell showed that wheat containing about 17% moisture lost approximately 30% thiamine in 5 month storage period. The deterioration is related to high moisture content.

At moisture contents above 25% the grain especially maize, tends to become very dark and soft. The grain is tainted and rendered unfit for bread making. With damper grain (18%-20% moisture) the gluten quality is affected and dry matter loss of 2 and 4% for barley at 22 and 35% moisture content respectively is reported.

Loss of viability

Storage of grain above 16% moisture content at comparatively high temperatures may reduce seed viability to a great extent. The germination loss may be related to intrinsic factor such as seed maturity or extrinsic factor like attack of micro-organisms insects etc. which is correlated with moisture. In paddy the critical moisture level for storage is 11% at 24-31°C temperature in metal bins.

III. FARM LEVEL STORAGE

In India, a major portion of the foodgrain produced is stored on the farm. It is estimated from various studies, that 60-70 percent of the grain produced in the country is retained by the farmers while 30-40 per cent of the grain is considered as marketable surplus and goes in the marketing channels. Prime importance is needed to be given to improve the storage facilities at the farm level in view of the fact that large quantity of grain produced in the country is retained by farmers and thestorage losses has been observed to be more at this level.

The farmer stores grain usually in bulk in different type of storage structures constructed from locally available materials. The storage structures vary in size and type in various regions. Some are outdoor and some are indoor structures. Generally speaking, grain meant for long term storage are stored in structures or containers specially meant for it; grain meant for disposal or short-term use are kept in bags or heaped in a corner of the farmer's house itself.

Some of the most common indoor and outdoor structures are made of mud and split bamboo. The mud structures are not completely moisture proof nor air tight. It is also being observed that the platform on which the structure is built, is not high enough and the rodents can find easy access into the structure. In such structures the grain is usually damaged by insects fungus and rodents. Against the fumigation operations these structures also have not been proved to be effective.

The bamboo structures used are generally plastered with mud and mounted on low raised platform and are easily accessable by the rodents.

In general the existing rural storage structures are not rodent, moisture and insect proof. Their life is short and frequent maintenance is necessary. The losses due to rodents, insects and moisture is considerably higher, ultimately the quality gets deteriorated.

MODERN STORAGE STRUCTURES AT FARM LEVEL[1]

The existing storage structures at the farm level are not ideal from scientific storage point of view. The improvement in storage facilities can be brought either by replacing the existing structures by new designs or by improving the existing designs so as to make them suitable for storage of foodgrains.

Continued and consistent efforts are being made by different organisations (I.G.S.I. Hapur, Pusa Institute, New Delhi, C.B.R.I., Roorkee, and Pant Nagar) in the country to develop new designs of storage structures. The Indian Grain

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1. Birewar, B.R. Scientific Storage facilities at farm level. FAO/NORAD Seminar on Farm-Grain Storage in India in collaboration with Govt. of India.

Storage Institute, Hapur developed different designs of indoor and outdoor bins using different materials and techniques for storage of different foodgrains, provided the moisture content of the grain at the time of storage, is within the safe storage limit. The Institute developed number of designs of modern rural storage structures for different capacities ranging from 0.09 to 14.5 metric tonnes for use in rural and urban areas. Some of these designs are under mass production through Agro Industries Corporation, and other agencies in nearly 19 states and one Union Territory for distribution to the farmers under Save Grain Campaign Programme of the Deptt. of Food. The salient features of some of the indoor and outdoor bins developed by Hapur Institute are as follows:-

INDOOR BINS

i) Domestic Designs:-

Different types of domestic designs of metal bins have been developed with a capacity ranging from 3 to 27 5 qtl. for wheat. Different capacities of the bins have been developed using different standard size of G.P. sheets available in the market. These bins are moisture rodent and insect proof and have been found to be suitable for storage of wheat, paddy, maize, pulses and seed grains.

ii) Gharelu Thekka:

With a capacity ranging from 2 to 3 M.Ts. gharelu thakka is a portable and economic type of storage structure. This consists of rock proof metal base rubberised cloth container and bamboo posts.

iii) Pucca Kothi:

Pucca Kothi is constructed using burnt bricks plastered with cement mortar. The structure is constructed in two compartments with a capacity of 10 M.T. each. Depending on the space available the structure can be extended to have more compartments.

iv) Welded Wire Mesh Bin:

The welded wire mesh bin of 4.0 cu m or 2.0 M.T. capacity was designed for storage of grains like paddy and maize even at slightly higher moisture level. The bin is fabricated using wire mesh with hessian cloth living inside so that air may circulate freely through it. The structure is mounted on pre-fabricated steel elevated base to prevent the entry of rodents.

v) R.C.C. Ring Bin:

Consisting of pre-fabricated R.C.C. rings placed one over the other with gripping joints at the edges, R.C.C. ring bin can be errected with or without masonry base. By increasing the number of intermediate rings keeping the bottom and top same, the capacity of the structure can be varied. Although the structure is preferably used for indoor purpose, however, this may also be used as an outdoor structure with adequate moisture proofing.

vi) Paddy Straw Mud Structure:

The proto type unit of improved paddy straw and structure of 400 Kgs. capacity is made from paddy straw rope plastered on both sides with especially prepared mud. The structure is further plastered externally, with water proof mud to prevent the entry of moisture. The structure is provided with suitable outlet and inlet and is mounted on a raised brick masonry platform to prevent entry of rat.

OUTDOOR BINS:

i) Flat and Hopper Bottom Metal Bins:

Using either steel or aluminium metal sheets for different capacities ranging from 2.0 to 10.5 M.T., these bins are fabricated and can be either erected on brick masonry base, brick masonry columns or pre-fabricated steel elevated base. There is adequate facility provided for loading the grain manually through simple lifting device provided. The bins are found to be suitable for storage of wheat, paddy and maize under different climatic conditions, its aluminium is rust proof, periodical maintenance is not necessary. Its reflecting surface has an additional advantage in keeping the grain cool by radiating the heat quickly.

ii) Composite Bins:

These are the outdoor flat bottom storage bins fabricated using steel and timber in combination, The use of timber battons at the wall and roof joints will resist the lateral pressure partially and thus use of thin sheets is possible in this design. In this design, the structures of 12 different capacities ranging from 3 to 14.5 M.T. for wheat can be fabricated. This design has been developed with a view to conserve the use of steel and to make the structure economical.

iii) <u>R.B. Bins:</u>

This design consists of two layers of brick masonry walls 4½ thick each with moisture barrier in between. The outer layer is provided with steel reinforcement and plastered both sides with cement mortar. It has flat floor at the bottom and RCC roof at the top. In this design, the structures with four different capacities ranging from 3.5 to 10.25 M.T. may be constructed.

iv) Partly underground and Partly <u>aboveground storage structures:</u>

A prototype structure of 10 cu m or 7.5 M.T. capacity which is partly underground and partly above-ground has been designed and constructed. The underground part of the structure is of RCC/brick while the aboveground part of the structure is of G.P. sheets. Facility for unloading the grain mechanically as well as manually has been provided. This bin is suitable for construction in shallow water table areas.

v) Hermetically sealed underground structures:

In a hermetically sealed storage structure, moulds do not develop on damp grain and the grain remains mould free. Similarly the insects also get killed due to low oxygen concentration developed. In order to facilitate the storage of grain free from insect and mould damage the prototype units of hermetically sealed under ground welded steel structure of 1.4 M.T. capacity and RCC structure of 3.4 M.T. capacity were developed. The metal structure is fabricated from mild steel sheets with welded joints and the structure is painted externally with two coats of bitumen paint. Similarly the RCC structure is also painted with two coats of bitumen paint. Both the structures are placed below the ground level leaving the top 500 mm above the ground level. Adequate sealing arrangements are provided at the inlet.

D. Urban/Seed Storage Bins:

These are either circular or square in shape with 6 different capacities ranging from 90 to 300 Kgs using different standard size of G.P. sheets. The height may be either 0.5 metre or 1 metre. In small capacity bins having the height of 0.5 metre no outlets are provided. The circular bins are easy and economical to fabricate while the square bins are convenient to keep in the corner of the room without loosing flour space. These bins of small capacities are developed specifically for use in urban areas where small quantity of grain is required to be stored for domestic use. These are also preferred in rural areas for storage of seed grains.

An effort is also being made in other organisations to evaluate low cost storage structures like mud structure, ferro cement bin, high density polythene structure, timber structure etc.

The ferro cement bins of capacities ranging from 0.6 to 3.0 M.T. for indoor and outdoor use have been developed by Structural Engineering Research Centre, Roorkee and some other organizations. The bins are constructed using rich cement mortar and closely spaced chicken wire-mesh. The bin is cylindrical in shape and has flat bottom and dome shaped roof. The thickness of the structure is normally 25 mm. The bins, particularly outdoor are required to be treated externally with suitable moisture proofing paint, like bituminous aluminium paint to make the same moisture proof. The outdoor bins are required to be placed on a pre-constructed raised brick masonry platform. They are lighter in weight than the cement concrete structure and frequent maintenance is not necessary. This design may also prove to be promising at the farmers level.

The Pusa bin has been developed by Indian Agricultural Research Institute, New Delhi for indoor use. This design consists of two brick wall of 4½" thick each using sun dried bricks with polythene sheet sand-witched in between. The structure is constructed on a brick masonry platform plastered with cement mortar. The mud slab is provided at the top on a wooden frame structure. The polythene sheet is also provided at the top and the base to make the structure completely moisture proof and air light.

Improvement of Existing Storage Structures:

A number of improvements have been suggested in the existing storage structures earlier by different workers. Indian Standards Institution suggested improvements in underground storage structures. The suggested improvements include the use of bitumen, polythene sheet and dense cement concrete in the construction of a structure to make the same impervious to subsoil water. The Indian Standards Institution has also published codes of practices for construction of farmers grain storage structures like 'bukhari', 'murai', 'kothari' etc. At the Indian Grain Storage Institute necessary technical improvements have been carried out in respect of certain existing storage structure like puri, gade, mud structures, earthern pots, and oil drums.

i) Puri:

The local puri is an outdoor storage structure from paddy straw, The paddy in such local storage structure is usually damaged due to rodent andground moisture/water. The improvement has been made in the local structure by introducing water and rodent proof base constructed using different locally available materials like steel, cement concrete, bricks etc. The base is cylindrical in shape in the form of ring which is nearly 600 mm above the ground level. The floor part of the base is constructed using either brick, stone or cement concrete with a 600 gauge polythene sheet embeded in it to prevent the entry of sub-soil moisture. The pre-constructed base provides the stability to the 'puri' structure and also helps to maintain its true shape.

ii) Gade:

The 'gade' is an outdoor as well as indoor structure made of split bamboo and is usually placed on a low raised platform. This type of structures are quite common in different parts of the country. Such structure is usually attacked by rats. The improvements has been made by introducing different types of rat-proof raised platforms using different locally available materials. The improvements proposed include (i) A timber platform with anti-rat steel cones provided on the legs to prevent the entry of rats, (ii) provision of timber platform with steel base at the bottom of the structure, and (iii) brick orstone masonry platform with stone or concrete slab.

iii) Mud Structure:

The mud structures are found common in different parts of the country particularly in Bihar and Punjab States for indoor use. The structures are found to be usually placed on a low raised platform. The grain stored in such indoor type storage structure is unusually get damaged by moisture, insects and rats. The structures do not have adequate facility for unloading. The necessary improvements have been suggested to make the structure moisture-proof, rat-proof and suitable for fumigation purpose. The improvements suggested in such structure include: (i) a brick masonry base of sufficient height, (ii) application of water-proof mud plaster externally, and (iii) a suitable outlet to take out the grain conveniently.

iv) Earthern Pots:

These structures are found to be quite common in Bihar and other parts of the country and are used for storage of small quantity of foodgrains inside the houses. These earthern pots are either kept above-ground or underground. The structure is not moisture proof and the grain may get damaged due to insects and fungus. In order to prevent the entry of moisture inside the stturcute two coats of bitumen paint externally proved to be suitable to prevent the entry of moisture in the structure.

v) Oil Drums:

By little modification the empty oil drum can be converted into grain storage structure. The modification includes: (i) adequate provision of air-tight inlet, and (ii) suitable outlet with locking arrangement.

EVALUATION:

A number of studies have been carried out on evaluation of different farm level storage structure from the point of view of grain losses occuring in them. Although the results of these studies could help in an understanding of the various causes of grain loss in farm storage yet they do not lead to any estimates for either a given region or the country as a whole of different aspects of storage.

The Administrative Staff College of India, carried out a study in 1976, to get estimates regarding the quantities stored, purpose, pattern of usage, grain loss incidence and improvement desirable. Punjab and Andhra Pradesh the two major states producing the two crops wheat and rice respectively[1]. Some salient findings of the study are presented in the following parts.

Structures/containers in use:

There are various types of structures and containers in use specially meant for storing grains. The indigenous structures can generally be classified into various groups based primarily on the materials of construction. The specific names by which they are known in the different regions of the country vary. Capacities too can be marginally different from region to region.

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1. A.S.C.I. Farm Level Storage, all India grain and distribution, a study sponsored by the Department of Food Aug.'76 - Supporting Study 11.

The indigenous storage structures in use are given in Table 7 .

TABLE -7

INDIGENOUS STORAGE STRUCTURES IN USE

Generic name for the group	Salient features of the structures	Some other names in common use.
1. Mud Bin	Made of unburnt clay mixed with straw, oval cylindrical or chimney shaped with a small capacity of 2 quintals, life three to five years.	Kothi, Kuthla, Bharola.
2. Pucca Kothi	Brick Masonry, rectangular fixed; capacity ranging from 10 quintals to 30 quintals,. life ten to fifteen years.	Pucca Bukhari Kotha, Kanja
3. Bamboo/ Straw Structures	Wicker or melting by plaiting together straw stalks bamboos, date palm leaves for body, mud cowdung mixture for base and plastering of walls, of various capacities and life periods either fixed or portable.	Palla, Dholi, Gummi, Gade, Puri, Kup.
4. Thekka	Gunny or Cotton cloth, cylindrical or oblong shape with a capacity upto 80 quintals indoor and portable.	Palli, Hapur Thekka.
5. Wooden structures	Rectangular, on a raised platform of different capacities.	Kothar, Arah
6. Cement Bins	Indoor, fixed rectangular, upto 30 quintals with a life of ten years.	
7. Steel drums	Old tin containers, an average capacity of 1.5 quintals.	

The relevant particulers of the various types of structures, as materiale of construction, shape, grain holding capacity, life and the prevalent local cost as well as the different names by which they are known in the various states of the country is given in Appendix-I. The relative importance of the different types of storage facilities was assessed on the basis of the quantities actually stored in them. The structure-wise distribution of actual stocks is given in Table-3.

Storage in living room, most of grain in bulk form is the most widely used method in Ludhiana District of Punjab State. All the marketable surplus is stored this way, ease in holding being the biggest advantage. Although the Punjab farmers, in general, are eware of the existence of the improved structures, mud bin usage is still prevalent among the small farmers because of its relatively low cost.

Metal bin usage is resorted to only by the big farmers. Grains meant for household consumption, which last longer than six months in most cases are stored in metal or cement bins. Seed grains are stored in bag form but dried in bhusa which is known to give very good protection against moisture migration.

TABLE-8

STRUCTURE-WISE DISTRIBUTION OF ACTUAL STOCKS

Farmers category	Average Quantity in Qtls.	Percentage Distribution					
		Living room bulk & bag	Mud Bin	Cement bin	Metal bin	Bamboo straw structures	Pucca Kothi
PUNJAB							
Ludhiana Distt.							
Rabi							
Small	12	68	17	4	11	-	-
Medium	23	64	15	13	8	-	-
Big	33	60	3	14	23	-	-
Distt. Estimate	23	65	13	9	13	-	-
Kharif							
Small	6	92	4	2	2	-	-
Medium	11	87	5	6	2	-	-
Big	15	82	5	7	6	-	-
Distt. Estimate	11	88	5	4	3	-	-
Rabi & Kharif Combined							
Distt. Estimate	33	73	10	7	10	-	-
ANDHRA PRADESH							
West Godavari Distt.							
Small	22	46	-	2		50	2
Medium	58	51	-	-		45	1
Big	94	29	-	-		63	8
Distt. Estimates	38	44	-	1		52	3
Medak Distt.							
Small	14	42	4	-		54	-
Medium	31	52	3	1		44	-
Big	56	59	-	1		40	-
Distt. Estimates	28	48	3	1		48	-

Grains are almost equally distributed between the living room/and bamboo straw structures which come in various types in the case of Andhra Districts. Puri, gade, and small baskets are the types in use in West Godavari and Gummu is the type in Medok.

The prevalent rural structures, in general are not rodent, moisture and insect proof. Their life is short and frequent maintenance is necessary. The losses due rat, insect and moisture is considerable and ultimately the quality gets deteriorated.

Data given in Table- 9 indicates the structures in the order of increasing loss incidence.

TABLE-9
RANKING OF STRUCTURES/DEVICES BASED ON GRAIN LOSS

Particulars		Range of loss in Percentage
Wheat Storage		
1.	Bags in Bhusa-minimum loss	0.07-0-09
2.	Metal bin	2.33- 2.80
3.	Improved mud bin, old steel drum	1.82- 3.40
4.	Pucca Kothi, Room bulk, Cement bin Thekka	3.17- 4.82
5.	Room bag, Mud bin- Maximum Low.	6.20-6.35
Paddy Storage		
1.	Metal bin-Minimum Loss	upto 0.20
2.	Improved puri, Improved gade	more than 2.00
3.	Gade, Buttalu, Collalu	2.07-3.15
4.	Room-bulk or bag, Puri, Gummu-Maximum Loss	3.34-5.46

Appendix-II gives the structure, type-wise data on the loss incidence for different periods of storages upto 3 months, 3 to 6 months and over 6 months. Different sets of estimates arising from the various studies are given, as well the specific figures on which the structures have been ranked. Ranking is done separately for structures used for wheat and paddy.

The relative economics in the use of different farm storage structures was attempted by the study taking into account the life of different structures, in addition to their initial investment costs and grains loss characteristics. Taking a 15 years period as the basis for comparision (The life of present structures varies from 1-15 years) the total investment involved in using a given type of structure was calculated. The present value of the total costs were derived on the basis of discounting at 20 per cent, the rate which the farmers generally pay to local money lenders.

In view of multiple use of certain storage structure, for example, the rooms meant for bag and bulk storage are often used for farmer's living purposes, cost involved in having an equivalent capacity of one tonnes was considered in such case. The investment at every replacement of the structure was also assumed to be same for all structure and the present value of total grain lost was calculated over a fifteen years period for all structures.

The relative costs of storage structures are given in Table-10

TABLE-10
RELATIVE COSTS OF STORAGE STRUCTURES

Structure	Average capacity (in Qtls.)	Investment Cost/ Tonnes Rs.	Normal Life in Years	Present value dis-counted at 20% for 15 years life Rs.	Cost of grain loss dis-counted at 20% for 15 years life Rs.	Total Cost Rs.
Wheat						
Improved Mud Bin	2	100	4	179.82	192.96	372.78
Pucca Kothi	300	200	15	200.00	179.91	379.91
Room (Bulk)	300	200	15	200.00	209.99	409.99
Steel drums	2	250	10	263.43	192.96	456.39
Mud bin	2	50	3	112.00	360.39	472.39
Metal bin	10	330	10	347.73	158.94	506.67
Cement bin	30	330	10	347.73	273.55	621.28
Room (bag)	300	260	15	343.00	351.87	686.27
Paddy						
Improved Gade	7.5	75	6	104.28	141.89	246.17
Puri	10	10	1	56.75	189.56	246.31
Gade	7.5	45	4	81.87	170.26	252.13
Improved puri	10	40	2	122.84	141.09	264.13
Mud bin	2	50	3	112.00	178.78	290.78
Pucca Kothi	300	200	15	200.00	99.32	299.32
Buttalu	12	62.50	3	139.90	169.15	309.12
Room (bulk)	300	200	15	200.00	190.69	390.69
Gummu	15	40	3	89.60	309.88	399.48
Metal bins	10	300	10	347.73	85.13	432.86
Room (bag)	300	260	15	334.40	238.37	572.77

Although from the data provided by A.S.C.I. study indicates that the use of improvised indigenous structure is more economical than that of metal bin, yet this inference may not be very realistic. Experience at Hapur has shown that the average life of a metal bin may be over 20 years. Consequently, if the life of metal bin is taken to be 20 years, the relative economics will change in favour of metal bins.

The farmers desired the following measures:

Short term Measures :

a) Mud Bins: Making them moisture proof by polythene lining, replacing, old bins by used wooden tea chests.

b) Bag Storage: Stacking them on wooden planks or bricks and covering them with a polythene sheet.

c) Room Storage: Cement plastering of walls and floor cracks.

Long term measures:

a) purchasing a metal bin.
b) constructing a rat proof cement bin.
c) Cement plastering of Kutcha mud/stone structure.
d) constructing a pucca rodent proof platform for stacking bags.
e) constructing a separate pucca room for grain storage.

THE APPROPRIATE TECHNOLOGY FOR FARM STORAGE

In India, at present, three level of farm storage facilities exist. These are :

a) Storage in traditional structures.
b) Storage in improved existing structures.

c) Modern Storage structures.

The traditional structures suffer from a number of Shortcomings which are as follows :

a) Structures are not always rodent, insect and weather proof.

b) Structural material allows free flow of heat water vapour and air from surroundings.

c) Strength of structures and their functional requirement are not properly taken into account in its design and construction (there have been cases of collapse of structures resulting in injury/ death.)

d) Fumigation is difficult and also dangerous because structures are not leak proof.

In view of the above inherent defects, storage in traditional structure is neither economic nor scientific.

The adoption of modern storage structures at farm level has been a slow process in India, which has diverse agro-climatic, socio-economic and cultural environments. Although, the modern storage structures are currently in use, yet these are not very popular. Economic, cultural and social constraints of the farmers and limited availability of these structures have largely been the inhibiting factors in large scale adoption of modern storage structures.

A number of studies conducted support the views. In a study[1] conducted, during 1968-73,

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1. 'Farm and Community Grain Storage Development Projects' in India undertaken by F.A.O. during 1968-73.

the Food and Agricultural Organisation of the U.N., reviewed the work done on the development of improved storage bins. The FAO, in its report stated:

"Initially attention was given to the use of metal because of ease of fabrication and hence assured quality of construction. It was subsequently realised that only 5to 10 per cent of farmers could afford to pay for a structure even at a subsidised price. Later models were, therefore, designed to use indigenous local materials, including precast concrete rings."2.

The Government ofIndia's Evaluation Committee in 1974, commented:

"It would be desirable to give more emphasis to the evaluation of structures suggesting improvements in the existing practices of storage instead of inventing new structures for which raw materials are not readily available. Non-metalic structures should therefore be given priority."

In the context of Indian situation, a unidirectional approach may not be feasible. Whils on one hand, there is a great need for adoption of modern storage structures, the need for improving the existing structures is imperative, on the other hand. A proper-mix of the two approaches, resultantly may be the appropriate technology for improving farm level storage in the country.

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2. Terminal report on the study Sept. 1973.

GOVERNMENTAL PROGRAMMES FOR MINIMISING STORAGE LOSSES AT FARM LEVEL

The application of science and technology to traditional agriculture in recent years is resulting in a steady increase in the production of foodgrains in the country. The upward trend in the production of foodgrains will continue with increased land brought under foodgrains crops, with adequate supplies of fertilisers, pesticides and provision of irrigation facilities, pest control management, high yielding varieties, modern technology, credit etc. to the farmers.

On examination of post harvesting handling and storage in the country, it is revealed that considerable quantities of foodgrains are lost during these operations. Major portion of the foodgrains produced in the country is stored at the level of farmers, the quantity being 60-70% of the produce. The storage methods of farmers' level are not satisfactory and losses take place both in quantity and quality. Insects, rodents, moisture, fungus, mites and birds are the main enemies of the stored grain. With a view to help the farmers to minimise the losses, the Department of Food, Government of India, launched the "Save Grain Campaign" as a country-wide programme, during 1965-66 as a pilot project and from 1969-70 as a regular Plan Scheme. Under the Save Grain Campaign, research, developmental, extension and training activities are carried out.

The Indian Grain Storage Institute at Hapur (U.P.) and its field stations, one at Bapatla

(Andhra Pradesh) and another at Ludhiana (Punjab) are engaged in research and developmental work on different aspects of post harvest problems. The main objectives of the Indian Grain Storage Institute are :

(a) To carry out applied research on important aspects of foodgrains storage and preservation;

(b) To design and develop improved type of storage structures suitable for adoption under different climatic conditions;

(c) To coordinate all India research on foodgrain storage problems;

(d) To undertake apex level training for the trainers and others, engaged in the handling and storage of foodgrains; and

(e) To carry out orientation and review programmes in this field.

The main emphasis is to develop a package of storage practices for use in rural areas. The recommended storage practices include improvement of existing storage structures using readily available material, use of metal bins of different designs and capacities, use of non-metal bins, viz. R.C.C. bins, brick mansory bins, etc. The methods recommended for control of insects are use of EDB or EDB + (Carbon tetrachloride ampules in conjunction with EDB) storage hygiene etc. Anticoagulant, anticoagulant +, Zinc phosphide and Aluminium phosphide tablets are recommended for control of rats in the houses and in the surroundings. Reguler training programmes are carried out at the Institute at a higher level for the benefit of representatives of State Governments, Warehousing Corporations, pest control operators, pesticdes manufacturing agencies and private individuals.

At I.G.S.I. designs of various metallic, non-metallic, indoor, outdoor, underground and partly underground bins have been developed. Non-metallic bins developed are Pucca Kothi, R.C.C. bin and R.J. bin. In addition, improvements of the existing storage structures viz. Puri, Grade, Kotlu, Kothi, and Pathara have been made. Simple design has been developed to utilise discarded tar-coal drums for storage of foodgrains. In collaborative programme, data have been collected on storage losses, insect famna distribution in different regions, problem of field infestation and quality of grain marketed.

The extension programmes are being carrid out with the help of 11 offices established in different parts of the country under the Save Grain Campaign Scheme. Six more offices of Save Grain Campaign Scheme will st rt functioning in different parts of the Country shortly. The main objectives of Save Grain Campaign are :

(a) To impart training to the farmers, traders and extension officials at the block level in the practical aspects of storage and preservation of foodgrains;

(b) To extend scientific techniques of traders, etc. through demonstration and wide publicity and develop selected villages to serve as model villages;

(c) To arrange credit facilities to farmers for purchase of improved types of storage structures; and

(d) To maintain liaison with State Governments and to arrange for steady supply line of storage strutures and pesticides to the users.

The ultimate aim of various programmes is to help in the reduction of avoidable losses to foodgrains in storage, so as to make available more foodgrains for human consumption.

The eleven Central Government Offices are situated at Pune, Madras, Bhopal, Ghaziabad, Hyderabad, Patna, Udaipur, Bhubaneswar, Chandigarh, Calcutta and Lucknow. Six new offices will be situated at Gauhati, Bangalore, Ahmedabad, Trivandrum, Raipur and Varanasi. All these offices work in close collaboration with (a) State Government departments of Plant Protection, Rural development, etc. and also (b) farmers and village level worker training centres. Demonstration, training and publicity programmes are regularly being arranged to motivate, persuade and educate the farmers to adopt scientific methods of grain storage.

Under the Save Grain Campaign Scheme, the following programmes have been completed during the Fifth Five Year Plan upto March, 1978:
(a) 9380 farmers have been trained in stipendiary training programmes (21 days duration), while 17,204 VLWs (one week duration), 54,140 volunteers (2-3 days duration) have been given training under non-stipendiary training courses; (b) under demonstration programmes, 1,08,349 grain fumigations, 39,21,812 rat burrow fumigations, 2,93,166 domestic rodent control operations and 1,66,850 prophylactic treatments have been given in farmers' premises; (c) Under publicity programmes 589 radio talks, 62 TV programmes, 1101 press reports, 783 exhibitions, 1494 film shows, 62349 stencilling of slogans etc. have been carried out. In addition, 60,390 postal/personal technical advice have been given to the farmers.

Under the bin programme, Rs. 161 lakhs have been given as loan to 19 States and one Union

Terribry since 1972. During the Fourth Plan, Rs. 98 lakhs and during the Fifth Plan Rs. 63 lakhs have been given as loan. Till March, 1978, 77,405 bins have been manufactured and 72,478 bins have been sold to the farmers. It is estimated that an equal number, if not more, has been sold by other agencies during this period.

The designs developed at I.G.S.I., which are being popularised in S.G.C., are in great demand in other developing countries. Through FAO/UNDP/UNICEF, requests have been received from Kenya, Austria, Nepal, Zambia, etc. to whom the designs have been sent.

The programmes of SGC have attracted international organisations etc. to give assistance for strengthening this programme UNICEF has given an assistance of about Rs. 50 lakhs for this programme. The European Economic Community (EEC) has agreed to provide as grant upto a limit of 5550 million units of Accounts (U.A.) (Rs. 5,45.00 lakhs) for financing of the Intensive Grain Storage Project, India.

The FAO organized a seminar on Farm Grain Storage and 14 participants from the neighbouring countries in the Far East and about 10 observers from other countries participated in the seminar. It was organized with a view to assist the participants to study the research and development work and large scale implementation programmes on modernising storage facilities in rural areas at the farmers' level. This would help them to develop their ability to plan and conduct programmes to reduce storage losses.

As a part of the Fifth Plan programme, four State Governments of Andhra Pradesh, Uttar Pradesh, West Bengal and Haryana, who intimated their acceptance, are being provided financial assistance to set up their own Save Grain Campaign teams at district and block levels for intensive popularisation of scientific storage technique. The assistance would be on a tapering basis and the States would meet the expenditure entirely after the end of the Fifth Plan Period.

Further, 100 Farmers Training Centres have been included in a programme for promoting scientific storage at domestic level during the Fifth Plan. The department of Food is meeting the cost of appointing a Lady Demonstrator at each centre to work in nearby villages for educating the farm women, to train the instructional staff of the Centres to enable inclusion of storage in their syllabus and to supply necessary pesticides and publicity equipment.

IV. FOODGRAIN STORAGE BY PUBLIC AGENCIES

As a major instrument of national food policy, the public agencies have come to occupy most vital role in the foodgrains' trade in India. The public agencies consequently are involved in the entire marketing process and perform the functions of procurement, transportation, storage and distribution of foodgrains specially wheat and rice. The function of storage is coterminus with the entire marketing process. It helps in regularising supply and thereby, in regulating prices. The storage by public agencies is, consequently, of vital importance since it not only helps in conserving resources, regulating supplies and influence the general price level but also in evening out inter-temporal and inter-spatial anomalies both in availability of foodgrains and their price levels.

In India, the public storage function is mainly confined to the Food Corporation of India, Central Warehousing Corporation, State Warehousing Corporations, State Governments and Cooperatives. The Food Corporation of India, which was set up in 1965, is the largest public undertaking handling and storing foodgrains on behalf of the Central Government.

GROWTH OF STORAGE FACILITIES IN THE PUBLIC SECTOR

The main public agencies involved in the storage of foodgrains viz. FCI, State Govts., State Warehousing Corporations, Central Warehousing Corporation and Civil Supplies Corporations of various states, handle indigeneously procured and imported grains for public distribution and exports. The State Warehousing Corporations and the Central Warehousing Corporation however store foodgrains and other commodities on the custom basis.

The programmes for expansion of storage facilities with the public agencies were taken up during the Second Five Year Plan Period. At the end of Second Five Year Plan period (1961-62) the Central Government had owned storage capacity of about 7 lakh tonnes. In the Third Plan it was proposed to increase the capacity to about 35 lakh tonnes with the public and cooperative sectors. However, due to various constraints, such as shortage of construction materials and equipments, difficulties in the acquisition of land etc., the storage capacity envisaged could not be accomplished.

It was only after the creation of Food Corporation of India in 1965 which gradually took over all the storage accommodation from the Central Govt. by 1969, that public agencies had constructed new storage facilities to meet the growing demand. FCI launched successive crash programmes on construction of storage structures. The other agencies dealing in foodgrains also followed suit and stepped up the construction programme. However the growth pattern and the investments made on new constructions have not matched the demand in the past decade or so.

In the absence of adequate covered storage capacity, the Food Corporation of India resorted to large scale open storage popularly known as cover and plinth (CAP) storage. This CAP storage, which has been a new and cheap technique, had become a landmark in the storage technology developed by the FCI to meet the emergency requirements for short duration storage of foodgrains.

Agency-wise growth of owned storage capacity over selected years is shown in table below. Year-wise position is given in Annexure I.

TABLE - GROWTH OF OWNED STORAGE CAPACITY WITH PUBLIC AGENCIES

(Figures in Lakh Tonnes)

Year/Agency	FCI	CWC	SWCs	FCI+CWC +SWCs	STATE GOVTS.
1965-66	19.53	4.15	1.76	25.44	NA
1970-77	34.75	8 .13	2.88	45.76	15.55
1975-76	54.71	12.38	8.98	76.07	18.01
1977-78	64.81	15.93	16.47	97.21	18.01
Annual Compound growth rate (1965-66 to 1977-78) (percentage)	9.60	10.90	14.70	10.90	2.10

Overall storage capacity with three public agencies viz. FCI, CWC and SWCs has increased four-fold within a span of 12-13 years i.e., from 25 lakh tonnes in 1965-66 to 97 lakh tonne in 1977-78. The growth of storage facilities with state governments or their agencies has been rather slow. The storage capacities available with Cooperative sector are largely of small size located in interior rural areas and are generally used for storing agricultural inputs like seeds, fertilizers, pesticides etc.

It is relevant to mention that only 60 per cent of the total storage capacities with Central Warehousing Corporation and State Warehousing Corporations are utilised for storage of foodgrains by public agencies. The rest is used for storing other agricultural commodities and farm inputs. Agency-wise break-up of existing storage capacity in various regions is shown in Annexure II.

Total Storage Requirements Of Public Agencies

The growth of owned storage facilities with public agencies in general and FCI in particular, is likely to gain further momentum in the coming years. Total storage requirements for foodgrains in the public sector are estimated to be 23 to 25 million tonnes. This aggregate storage requirement consists of a buffer stock of 12 to 14 million tonne and a peak operational stock of 9 million tonne.

As against the above requirements, the built up storage capacity available for foodgrains with different agencies as on 1.4.78 was 10.2 million tonnes. Besides, a number of construction programmes are in progress to augment the storage capacities. Such programmes are expected to provide additional capacity of 4.7 million tonnes, by the end of March 1983. Agency-wise programme-wise break-up could be seen in Annexure III.

Types Of Storage Facilities

Foodgrains are handled, transported and stored in bags in India. Accordingly, the entire marketing and storage facilities are attuned to bag handling system only. Existing storage capacities with public agencies in the country are mostly in the form of conventional godowns, suitable only for bag storage. However, since the foodgrain by their very nature are amenable for transportation and storage in bulk, such bulk storage facilities have been brought up at a few selected centres. However, bulk storage facilities in India constitute a very small fraction of the total storage availability with the public sector.

It is thus, apparent that so far the country has been mainly dependent upon the traditional storage technology which permitted creation of bag storage facilities.

The dependence on conventional storage technology could largely be attributed to the pressing demands for storage and comparative ease of provisioning, by local resources as compared to the advanced technology of bulk storage structures. Moreover, the existing infrastructure facilities, easy and cheap availability of labour, the existing foodgrain marketing handling, trans portation and storage facilities have been the inhibiting factors in the adoption of modern or advanced technology of bulk storage, widely practiced in developed countries like USA, Canada, Australia. Since foodgrains are not purchased by the consumers in the grain form in the developed countries, these are handled, transported and stored in bulk. It is only in India, Pakistan and Bangladesh that foodgrains are handled in bags. Though, it has been realised that advanced storage technology of foodgrain storage in bulk in vertical silos has a number of advantages the existing bulk storage facilities in the country are meager. These bulk storage facilities, though existing for quite a number of years now, have not yet gained wide popularity and have not been used on large scale because of various inherent difficulties. It is only since early seventies that modern storage technology received some impetus and vertical R.C.C. Silos are being set up at selected centres.

The types of storage facilities* that have been created/planned till date, are as under:

1. Conventional Godowns for storage in bags
2. Bulk Storage Structures

   Steel Silos
   RCC Circular bins
   RCC Hexagonal bins
   RCC Vertical Silos
3. CAP (Cover & Plinth) open Storage

Conventional Godowns

Conventional godown is a rectangular structure known as a "flat warehouse" according to Western Terminology and as a godown in India. It is suitable for storage of different commodities and foodgrains. Standard basic unit of a conventional godown is 5000 tonne capacity. The layout plan of different depot complexes are generally designed to conform to the configurations of the land area and the inflow needs by road&rail.

Being on a raised platform, the standard design makes it a rodent proof structure. These godowns essentially for bag storage, provide immense flexibility for storing different grains/other commodities, different varieties of the same grain, different grains of varying quality and condition and is accessible to both inflows and outflows for any means of transport such as bullock-cart, motor truck, rail etc. All the handling operations in such godowns are performed manually.

* Some of the storage structures with public agencies can be seen vide Exhibits. VIII - X

The dimensions of each godown are 21.8 m X 127.6 m X 6.35 m., For a 50,000 tonne capacity unit each warehouse is divided by solid partitions into three equal compartments. The rated capacity for wheat per building is 5000 tonne when the bags are stacked 15 layers high.

The conventional godown for grain storage in bags are designed to fulfil the following requirements :

i) entirely weather proof
ii) gas tight to enable fumigation of entire contents
iii) proofed against entry of rodents, birds and subsoil moisture and
iv) provision for natural aeration.

Most of the single span modified conventional godowns of 5000 tonne capacity and more generally satisfy the above conditions by provision of the following specifications : -

i) Floor : The main consideration in the design of floor is the load factor and damp proofing. The floor is designed for peak load factor of quintal bags stocked 22 bag high.

ii) Height of Roof : In the case of conventional godowns, the clear height of roof over the floor at the longitudinal walls is 18'6". This is based on stack height and the clear space required for operational purposes. Considering manual operations standard stack height for design purpose should be 16 high leaving a clear height of 4'6". This provides additional space at peak seasons for stacking 20 to 22 bag high.

iii) Walls : In the present bag storage structures the standard thickness of the wall is

13½" (1½ bricks in cement mortar 1:6) with cement plaster on either side, and the roof rests on RCC columns. The godowns of 5000 tonnes generally have three compartments seperated by two partition walls in addition to the two gable walls. The door opening is covered by rolling shutters and ventilation is covered by glaze shutters.

iv) Width of Platform : Generally one side platform is adequate and the width restricted to 6'. On the other side, platforms can be provided, for issue purposes, only in front of the doors.

Bulk Storage Structures :

Steel Silos
RCC Circular Bins
RCC Hexagonal Bins
RCC Vertical Silos

There is no standard bulk storage design which could be adopted for all locations and for all conditions in India. There are wide variations in the specifications of designs so far used.

Steel silos at Hapur and Calcutta were built first, followed by RCC Circular bins at Borivilli, Manmad and Kanpur. Steel silos are considered obsolete in view of its high requirements of scarce steel.

RCC Circular Bins :

RCC Circular bins are for small storages i.e., of capacity around 4000 Metric Tonnes. These bins are circular in shape and are constructed on the platform which is kept 3'6"(1.1m) above the ground. The diameter is 77'-4" and side walls are 35'-0" high. An RCC dome serves as the roof over the bin. The Flooring consists of R.C.C. slab laid to slope over 3" (75mm)layer of lean concrete 1:5:10. A layer of polythene/alkathene 700 gauge is sandwitched between lean concrete and sand filling underneath.

The feeding of the grain to godown is done through a pneumatic plant. The grain is dumped into a hopper from where the pneumatic equipment forces it to the bin automatically. Similarly when the grain is to be taken out the same pneumatic equipment can be used. The aeration is done through a aeration duct. Fumigation is resorted to through 1/2"(12mm) dia G.I. pipes inserted at equal intervals on the periphery by means of stainless steel nozzles. There is also provision of recording temperature inside the bins. RCC Circular bins and hexagonal bins have the inherent limitations of slow receipt, despatch; storage of different varieties of grain and drying facilities. Therefore they are found to be unsuitable for high turnover operations.

RCC Silos

Subsequently, RCC Vertical silos were built at Faridabad, Naraina and Calcutta port. These new system of vertical RCC Silos are similar to Western grain elevators and are constructed in concrete reinforced with steel. These are quite tall and having large diameters depending upon the capacity which generally is beyond 10,000 tonnes. A conical hopper bottom is provided at the bottom 13'-4" above the ground. The feeding is done from the top by a feeding conveyor which receives the material by a belt conveyor connected to a hopper in which the bags are emptied. Similarly recleimation is done by a conveyor running underneath the hoppers. These conveyors are fully covered from top and sides by AC/CGI sheets. Aeration is done from the top by aeration fans, installed in the head house and the air escapes through the openings in the hopper bottom. These silos are also provided with the temperature recording system. Recently improved type of these designs are being built in Punjab & U.P.

Compared to hopper bottom silos, the flat bottom has 25 percent additional capacity. But it has the limitation of slow emptying and use of hand labour in cleaning out. Therefore, to achieve high throughputs the feasible preposition is hopper bottom vertical silos with built in electrical and mechanical equipment for grain handling.

Vertical silos, which have been recognised as the best form of bulk storage from the point of view of better aeration and faster handling are quite expensive. These form part of the overall system and are not mutually exclusive of handling and transportation system. These need to be adopted, if at all, at strategic locations like ports etc. only..

C.A.P. (Cover And Plinth) Storage

CAP Storage or open storage techniques were devised and developed by FCI to store stocks in space available in the warehouse compounds. CAP storage was evolved out of necessity as a short term measure for transit purpose in 1971-72. It has all the essential features to meet the urgent need of storage in arid areas and low rainfall areas for all cereal grain which are hardy and non-hygroscopic. CAP Storage is a simulated condition of pucca godowns. It provides reasonable protection against normal weather conditions and pests. However CAP Storage requires more care and efforts to preserve stocks.

In CAP Storage, the grain, largely wheat, is stored in bags on brick plinth with wooden crates. Each unit containing 1500 bags in number and 15 to 20 bag high, in pyramid shape more or less, on an area of 20'x30'. The stacks are covered with black polythene covers and tied up with nylon rpoes against wind and storm.

CAP Storage or open storage technique which can effectively be controlled by regular inspections of surrounding areas and fumigating the rat burrows. It can also attract bird trouble which can be controlled by regular use of bird scarer and beat of drums and empty tins.

The stocks can be given regular aeration on fair weather days to help maintaining satisfactory condition of stock without causing discolouration, damage and rancidity.

The success of indigenous procurement in surplus states, depends to a great extent on how quickly the stocks are moved and stored. It is difficult to move all stocks from procuring centres due to limitations in rail transport facilities specially supply of wagons and capacity of railway tracks. Under such conditions CAP Storage has proved extremely helpful and it has occupied a key position for peak period storage requirements in many states.

CRITERIA FOR SELECTION OF APPROPRIATE STORAGE TECHNOLOGY AND COMPARATIVE ECONOMICS OF BAG & BULK STORAGE FACILITIES

Selection Criteria :

Choice on the selection and recommendation of appropriate storage technology suitable to Indian conditions is influenced inter-alia by various factors/criteria which are enumerated below : -

i) Whether the grains are required to be handled in bulk or in bags ?

ii) The likely period of storage, purpose of storage and type of grain.

iii) Wheather the storage facility is meant exclusively for a particular grain or different grains ?

iv) Involvement of capital investment. Initial construction costs vary considerably because their being either capital intensive or labour intensive.

v) Operating/recurring cost per tonne of grain handled in different structures depending upon possible turnovers.

vi) Storage-worthiness of different structures or storability and incidence of storage losses and preservation costs.

vii) Operating returns from different structures in terms of savings by not hiring private sector capacities.

viii) Demand time for storage facility and construction period required for different structures before being used.

ix) Existing type-mix of storage facilities and

x) Above all the existence of the types of infra-structural facilities and practices of marketing, transportation and storage.

Comparative Economics Of Bag And Bulk Storage

Comparative economics of bag versus bulk storage facilities could be evaluated in the context of various selection criteria mentioned in the foregoing para. These could broadly be discussed under the following parameters in view : -

i) Initial Investment

ii) Construction Period

iii) Storability and Preservation Cost

iv) Operating Costs and Returns.

For the sake of convenience and better comparison, comparative economics are considered for units/complexes of 50,000 Tonnes with all the infra-structural facilities such as railway siding, ancillary building etc.

i) Initial Investment

It is estimated that the initial capital construction cost per tonne inclusive of costs of engineering services/supervision and contigencies are : -

	TYPE	Rs./per tonne
i)	Conventional Godown complex	400
ii)	Bulk storage structures RCC Silos (Inland/ Interior)	1200
	RCC Silos (High Turnover Port Silos)	2500

Silos are highly capital intensive as the initial construction costs including cost of provisioning mechanical handling equipment have been estimated to be around Rs. 1200 per tonne for inland/ interior silos and Rs. 2500 per tonne for high turn-over Port Silos. Comparatively, conventional godowns are much less capital demanding.

Nevertheless, it is relevant to point out that initial capital construction costs on bulk storage structures are not the only costs i.e.; creation of silos alone would not be adequate.

To make successful operations and utilisation of such bulk storage structures, matching parallel infrastructure facilities would also have to be created at huge investments. In India, such matching facilities for bulk handling and transportation are not available.

ii) Construction Period

The estimated period required in construction of different types of structures is :

(Months)

TYPE	Preparatory period	Construction period	Total period
Bag Storage Structures			
Conventional godown complex	6	18	24
Bulk Storage Structures			
RCC Silos	6-12	36	42-48

NOTES :

i) Preparatory period includes time required for finalisation of designs, drawings, tenders etc.

ii) Construction period describes the period from the start of the works till their completion in all respects.

iii) In case of conventional godowns, units being of 5000 Tonne capacity, it is possible to partially use some units as they are completed even before the completion of all works on all units in a depot complex.

Suitability, Storeability And Preservation Costs

Suitability :

It is relevant to consider this basic factor of suitability of different grains for different storage facilities. Because of the grain characterstics, bulk storage facilities are not suitable for storage of milled rice, some millets and pulses for which bag storage is most appropriate. It is only for wheat and other cereals including their milled products that bulk structures are feasible and suitable.

Storeability:

The storage worthiness of various storage structures is another important factor which influences the choice on adoption of different storage technologies for future constructions of bag or bulk storage facilities, if buffer stock are likely to be held for periods beyond 3 to 4 years. It is accepted that grains stored in bags are relatively more succeptible to damage by pests. Even with all the precautions, therefore, there is a limitation of storage span of grain held in bags.

Technical opinion about storage in bags in conventional godowns reveals that grains can be kept satisfactorily upto 2 years under most suitable dry climatic conditions. However, in coastal areas detioration is faster and grain can be stored for period varying between 8 and 12 months only. On the other hand, the shelf life of the grains stored in bulk structures (namely silos) can be upto 5 years practically without any damage irrespective of the location.*

No precise data is available about the loss of weight in storage in different storage structures for storage of grains over varying durations. The estimated loss levels indicate storage loss of about

* "Handling & Storage of Foodgrains"-ICAR Publications, New Delhi. Author Dr. S.V. Pingale, Ed. 76.

1 percent in conventional godowns for storage over a period of one year while these loss levels are estimated to be 0.2% in case of bulk storage silos irrespective of period of storage. Considering these estimates the conventional godowns would entail comparatively much more storage losses for holding buffer stocks for longer durations. Such storage losses beyond aforesaid levels cannot be ruled out for storage period exceeding one year in case of conventional godowns though these would remain constant in silos. Thus the incidence of storage losses and consequent preservation costs are much lower in bulk storage structures compared to conventional godowns.

Realising the need for holding buffer stock for longer durations it is felt that foodgrains, if stored in conventional structures would necessitate rotational problem after every two years or so and therefore conventional storage technology may not be suitable for buffer management. In bulk storage structures such rotational problems can be avoided and operational and handling costs can be reduced. In fact the advanced storage technology provides the answer which is technically most suited but for considerations of huge capital investments not only on silo structures but on creation of parallel facilities and need for drastic change in the entire foodgrains marketing and handling systems.

Operating Costs And Returns :

Another important consideration which requires adequate attention is the 'operating costs' in bag or bulk storage facilities. Economic viability of various structures would be more influenced by the level of operating costs per tonne as these indirectly determine the operating returns. Such operating costs vary substantially in bag or bulk storage facilities because of their being either more capital and less labour intensive (bulk facilities) or less capital and more labour intensive (conventional facilities) and operations being performed either mechanically or by manual handling.

Considering costs of various factors such as storage losses, grain preservation, interest on initial capital investment, depreciation and maintenance costs etc., it might appear apparantly that the operating costs would be less in case of conventional godowns due to their being labour oriented. But operational economies of larger throughput with less handling costs, storage losses coupled with less preservation costs make the unit costs go down considerably with each additional turnover in case of silos. The handling capacity of silos is very high and it is likely that these structures have more than one turnover. In the absence of adequate experience on operation of silos or integrated bulk handling, transportation and storage it has not been possible to quantify these returns. Nevertheless, these are expected to be comparatively much less.

Advantages of Modern Storage Technology :

Some advantages of integrated system of handling transportation and storage can be described as under : -

i Handling of grains is quicker

ii There is no access to rodents and insects;

iii Aeration and fumigation in bag storage is very tedious and slow because of the gunny bag cover. In case of bulk storage, the treatment of grain is direct and more efficient. The aeration can be controlled as it is mechanical aeration through perforated pipes ;

iv Effective usable area compared to total area is 70-80% in the case of bagged storage and 90-95% in the case of bulk storage;

v Land requirement in case of bulk storage is much less especially when silos are used. In case of silos land required is approximately one hectare of land for 20,000 tonnes, whereas it is 3.6 hectares for the same storage in bags ;

vi Once bulk storage and handling facilities are available, bulk movement of grain will be cheaper by rail or road, and less time-consuming and less open to pilferage, enroute;

vii More importantly, whereas the foodgrains can be stored in bulk silos up to three/five years, the foodgrains stored in bags in flat stores are required to be replaced/rotated every two years as they deteriorate in quality very quickly ;

viii Even though the initial cost of bulk silos or other bulk storages and provision of mechanican handling equipment is high, the operational cost is lower. The main elements providing a reduction in cost are :

a. Elimination of bags (during Storage)

b. Dunnage not required

c. Losses considerably reduced

d. Less establishment and handling cost.

NEED FOR SELECTION/ADOPTION OF APPROPRIATE STORAGE TECHNOLOGY

It is particularly in the context of country's shift from the era dominated by scarcities and imports to an era of surplus production and consequent increase in the magnitude of transactions and stocks built up with the public agencies that the need for advanced storage technology has been realised. Unlike in the past grain stocks are required to be retained in storage for much longer periods now. Estimate of age of wheat stocks already held by public agencies has been reckoned as more than three years. Moreover, the management of buffer stock of 12 to 14 million tonnes on a permanent basis over and above the peak operational stock level of about 9 million tonnes has also necessitated reconsideration of the need for appropriate storage technology and planning for future constructions.

The need for further augmentation of owned storage facilities with public agencies has been increasingly felt. The overall storage gaps have been identified to the level of not less than 3-4 million tonnes. The choice of storage structures bag or bulk, has attracted attention of all concerned, because of varied implicationsif switch over is contemplated.

IMPLICATIONS AND CONSTRAINTS ON SHIFTING TO ADVANCED STORAGE TECHNOLOGY

Although, it is recognised that the advanced storage technology of handling, transportation and storage in bulk will have a number of advantages yet a number of constraints restrict the pace for shift from the traditional technology to modern technology.

These are briefly discussed below:-

i) Prevalent marketing practices and the complete range of operations from assembling to distribution viz. cleaning, weighment, handling, transportation, storage, and distribution are principally designed for bag handling, All such operations are done mostly through manual labour.

Mechalisation of all such operations would have adverse repercussions on the employment of such unskilled labour force which is available in abundance in India.

ii) Bulk storage systems form part of the overall system and are not mutually exclusive of handling and transportation system. In the absence of bulk handling and transportation by rail or road (Bulk carrier/trucks or vehicles) systems to feed the silos, there would obviously be under-utilisation of such facilities.

iii) Silos are highly capital intensive installations. These also require huge investments on creation of necessary other related infra-structure facilities. Under the present conditions diversion of the scarce capital resources to this sector may deprive other equally or more important sectors to have required investment.

iv) Unlike in other advanced countries large scale or collective farms are rare in India. Instead fragmentation of farm land in India is rampant. Much of the grain is retained by farmers/traders for speculative motives. As a result there is inadequancy of bulk or large scale movements of foodgrains from fields to the markets excepting in few surplus pockets. Under such suitations availing of economies of large scale operations through bulk storage may not be possible.

v) Peak marketing periods both of Rabi and Kharif crops are concentrated over a short span of two to three months. Bulk movements and storage may be justifying the costs during this period but use of such facilities during slack or lean periods may not be economical.

vi) Inadequate availability of high level technical skills to operate the bulk systems, likely constraints on availability of construction materials such as cement, steel etc., the longer time span required in sophisticated constructions etc. would restraint the progress of any such switchover.

Since constraints on immediate switch over of the storage technology would be too many with severe repurcussions on the economy, it has therefore been considered appropriate that such a transformation be introduced steadily and in a gradual manner to suitably fit in the Indian conditions.

In the light of various constraints on the exclusive adoption of advanced technology of bulk storage systems which the existing set of conditions do not warrant, the problem of choice of appropriate storage technology assumes vital importance is storage planning.

STEPS TAKEN FOR THE INTRODUCTION OR ADOPTION OF ADVANCED STORAGE TECHNOLOGY

A few silo/bin structures have been set-up in the past few years on experimental basis. At present, bulk storage capacity of 3,83,000 tonnes exists at twelve centres in the country. In addition a programme for construction of additional silo installations has been initiated with the financial assistance of the World Bank under Wheat Storage Project. Under this project five R.C.C. Silos of 20,000 tonnes each are being constructed in Punjab and U.P.

Bulk transportation of grain is an essential element in an integrated system of grain procurement and storage in bulk and its distribution in bulk or bag. To enable proper link up between producing area silos and distribution silos and also to enable operation of an integrated bulk handling and movement system through all the stages a Pilot Project has also been taken up recently under the World Bank Assistance Programme.

Under this project few rural grain procurement centres are expected to be provided with facilities for mechanical handling and portable grain handling equipment in Punjab, Haryana, Uttar Pradesh, Andhra Pradesh and Tamil Nadu. Such proposed facilities would eliminate the need for bagging and the grain would be procured in bulk and transferred to the centres. Alternatively grain may be delivered directly by the farmers to the procurement centres where the grains would be graded, weighed and conveyed into the elevated steel hopper bins where it will be kept in bulk until bulk carriers/trucks transport it to bulk storage points. The pilot project also envisages provision of bulk road cariers to move the grain from market yards to the nearby rail-head terminal. Programme for improvisation of flat bulk railway wagons for carrying bulk grain and provision of special bulk grain wagons for one unit train has also been envisaged.

Construction of two more high-turnover R.C.C. Silos in port areas of Madras (25,000 tonnes capacity) and Haldia (50,000 tonne capacity) have been taken up under the World Bank Assistance

Programme in the second phase.

Construction of bulk-cum-bag storage structures at about 20 centres in various states is also being embarked upon. Such storage structures are constructed for the first time in the country. These structures are expected to provide dual economics of bag and bulk storage as the name itself highlights. In strict sense of storage technology these structures cannot either be classified as traditional or advanced. As discussed later such structures could appropriately be grouped under 'Intermediate Storage Technology' as it incorporates characterstics of both the traditional and advanced technologies.

APPROPRIATE STORAGE TECHNOLOGY
SUITING INDIAN CONDITIONS

Conventional Storage technology most suitable for bag handling by manual labour, on the one hand, and advanced storage technology of bulk storage in vertical silo installations highly capital intensive and suitable for mechanical handling, on the other hand, are on the cross points in so far as choice has to be made in the context of prevailing Indian conditions.

The economic environment is fast changing when one notices large scale urbanisation, technological advancements, rise in standards of living and additions to knowledge of human nutrition. On the food management front the Govt's decision for operation of fair size foodgrain buffer calls for the need to change the traditional methods of handling and storage of foodgrain to keep pace with the changing economic climate and in order to speed up and accelerate the pace of operations on handling, transportation and storage. Conventional storage technology though relatively much less capital intensive cannot be considered appropriate in so far as it restricts on the operational efficiencies and economies of larger throughout apart from poor-storability for longer storage periods and unsuitable for changing environment etc.

Advanced storage technology, though widely adopted in advanced countries does not exactly fit in the present set of Indian conditions unless introduced in a phased manner. Removal of various constraints for the successful operation of advanced storage technology necessitates brining about basic economic decisions leading to fundamental/ structural changes in the foodgrains marketing, handling and movement systems. Such changes would mean enormous involvement of investments. It is considered appropriate in this context, to think of a via-media whereby we may have the advantages of advanced storage technology and yet not have to invest so much so as in silo constructions and related infra-structural requirements. Such an approach suggests adoption of an ideal combination of conventional and advanced storage technology for all future storage construction programmes.

With a mixed strategy in view, designs for "Convertible - bulk - cum - bag" flat storage structure were once considered may be quite appropriate. Such structures were to provide bagged storage facility straight-away & converted, later, into bulk storage with certain additions alternations and mechanisation etc. They cost comparatively less than silo installations. Such a technology envisages construction of basically wide span structures essentially to hold substantial quantities of grain in bulk. Initially used for bagged storage, the capacity for bulk storage will be much more. Mechanical handling facilities could be incorporated later for intake and issue of grain. For practical considerations, therefore, the building works necessary for the warehouse portion only are to be constructed for the present and additional construction works and mechanical equipment installations could be carried out when bulk storage and movement are introduced.

Since considerable steps have already been taken up in the direction of developing bulk handling and transportation facilities in major surplus states it is considered that the adoption of "Intermediate Storage Technology" of "Bulk-cum-bag" storage structures with the provision of complete mechanical handling facilities, may be appropriate in the context of Indian conditions. These structures would be open to the choice of storing grain both in bag or bulk form, depending upon developm nt of infra-structure facilities from region to region and actual needs from time to time. These facilities could also better meet varying requirements of procurement, distribution, long-term buffer storage and rotational needs of stock either in bulk or bag form and would also well suit to requirements of both surplus or consuming/deficit regions.

Bulk-cum-bag storage structures would facilitate receiving and despatching the foodgrains both in the form of bulk as well as in bags. Arrangements for aeration and fumigation of grain and temperature detection etc. could appropriately be made based on the successful experiences of Australia where this technology is being practiced for over two decades.

In effect, such warehouses would function like silos providing the same facilities at reduced rate of handling and at a substantially less capital cost. A begining has already been made to set up Bulk-cum-Bag structures at 20 locations in the country under the World Bank Assistance Programme.

The storage gap identified today is primarily due to the increased storage requirements for holding buffer stock of foodgrains by public agencies. Operation of buffer stocks would avoid emergent needs for faste /rapid handling of foodgrains to rush stocks immediately wherever required in times of adversities. Storage planning for all future constructions should not only consider the choice of storage techniques but also economies of scale which flow from different capacity godowns or complexes. In this regard particularly large size units/complexes are suggested to be set up depending upon requirements from region to region.

IMPROVED & INDIGENEOUS STORAGE FACILITIES

Generic Name of Structure/ Container	Materials of Construction	Specific names in use along with Regions		Shape	TYPE				Capacity in qtls.	Cost	Normal life of structure
					In-door	Out-door	Fixed	Portable			
1. MUD BIN	Made of burnt or unburnt clay	Jala Matka Matou Nand	All States	Pot	/	-	-	/	0.4-1.2		Three Years
		Golalu	AP	Pot	/	-	-	/	0.5-2.5	Rs.6.20	
	Unburnt clay mixed	Kothi	Bihar	Oval, Cylinderical or Chimney shaped with a hole slightly above the base; with circular lid; slightly elevated from ground							
	-do-	Bharola or Bharoli	Punjab	Various shapes including chimney shape	/	-	-	/	0.8-1.2		
	-do-	Kutcha Kothi	Punjab UP	Square or oblong usually elevated from ground or 15 cm higher plinth	/	-	/	-			
	Unburnt pond clay	Potti	Punjab	Box shaped; may have partition	/	-	-	/	2.0-2.5		
		Roonda	Orrissa Bengal								
IMPROVED MUD BIN	Same as those of mud bin but with polythene film embeded within the walls	Pusa bin		Similar to mud bin	/	-	/	-	5-40	Rs.45-95 (Pradhan & Mookerjee) Cost of improvement Rs.15 per four years (Muzumdar S.K.)	
2. PUCCA KOTHI	Brick masonary	Pucca Kothi	Punjab UP	Similar to Kutcha	/	/	/	-	40-120		
	-do-	Pucca Bhukari	Punjab	Cylinderical	/	/	/	-	1.60-160		
	Partition of living rooms with walls of 120 cm to 180 cm height	Kanaja	Mysore	Rectangular	/	-	/	-	10-100		
	Small rooms masonary	Kotha	Punjab UP	Rectangular, square/sometimes two storeyed, grain being stored in upper storey	/	/	/	-	90-360		
	Brick Masonary	Kotlu	AP		/	-	/	-	60-300	Rs.5940/30 tons Rs.2745/7.5 tons (Lipton et al 1976)	15 Years
3. BAMBOO/ STRAW STRUCTURE	Wicker or netting by plaiting together with straw stalks, bamboo date palm leaves for body; mud cow dung mixture for base and plastering of walls	Palla Dholi Bharzi Potti Kangni Gummi	Bihar, Bengal MP Orissa Punjab Mysore AP	Cylinderical	/	-	-	/	2-20		

Contd.....

1.	2.	3.		4.	5.	6.	7.	8.	9.	10.	11.
	Straw ropes	Muro	Bihar	Straw bundles oral shaped	-	/	-	/	0.8-2.4		
		Puro	Orissa								
		Mudho	Kashmir								
		Kacheri	Mysore								
		Lotno Moode									
	Walls, roof straw floor-mud or stone	Puri Polgoda	AP Assam	Cylindorical	-	/	/	-	3.0-15	Rs.10/ ton	One Year
	Made of straw ropes built on elevated plateform	Golghor	Bihar								
		Patai	Orissa								
		Kup	Punjab								
	Roop Conical	Kupo, Masol, Seir,Pattari	Tamil-Nadu								
	Bamboo	Buttelu	AP	Cylindorical	/	-	/	-	8-12	Rs.45-75	Two-Six years
	Riased plateform-platoform of timber plants,bamboo or bamboo splits walls of timber or bamboo matting or stems of "Ikri" floor and wall are plastered with mud cow dung. Roof conical framework of bamboo and thatched with dry weeds or stalks of wheat, Paddy etc.			Cylindorical	-	/	/	-	30-360		
		Dhokani	Bengal								
		Dholi or Dhols	Bihar Delhi								
		Kana	Rajasthan								
		Paton	Vindhya-Pradesh								
		Gudo Gads	Maharashtra AP	Cylindarical	-	/	/	-	5,6-500	Rs.40-45/ ton(Lipton et al 1974)	Three to fifteen yrs.
	Palmore strips with cow dung or mud loating	Gummu	AP	Cylindorical	/	-	-	/	0.5-15	Rs.6-60	Two 10 Five years.
3A IMPROVED Puri	Same as Puri raised pucca platform		AP	Cylindorical	-	/	/	-	3.0-15	Rs.15/ ton	Two Years
4. THEKKA	Cloth funny or cotton & gunny cloth	Thokka	Punjab UP	Cylindurical or oblong	/	-	-	/	upto 80		
4A.PALLI OR HAPUR THEKKA	Cylinder supported by vertical bamboo and is secured to the metal trough	Palli or Hapur Thokka	Punjab UP		/	-	-	/	10-20	Rs.100/ton	
5.WOODEN STRUCTURE	Wood.	Kothar	Kashmir	Rectangular plateform raised 60-90cm above ground	/	-	/	-	3.0-360.0		
		Arah	HP,UP Kerala								
		Patharom	Kerala	-do-	/	-	/	-	4.0-10.0		
		Melpura	Kerala	-do-	/	-	/	-	50-200		
6.TIN DRUMS	Tin	Tin drums	All States	Square	/	-	-	/	upto 0.20		
7.STEEL DRUMS	Steel	Old oil drums	"	Drum	/	-	-	/	1.50avg.	Rs.20/ 29	Ten years.
8.STEEL BINS	Steel	Metal Bins	Punjab UP etc.	Drum	/	-	-	/	20 avg.	Rs.330/ ton	Ten years.
9.CEMENT BINS	Cement,Brick	Cement Bin	Punjab UP etc.	Reclongular	/	-	/	-	800-30.00	Rs.500/ 2 Ton	Ten yrs.

Source : Except for the references cited, the rest of the details are from
(1) Ram sivan et al (1966)
(2) Our field studies(1975)

PERCENTAGE WEIGHT LOSS-WHEAT

S.No	Structure	DATA SOURCES 1: 3 Months Storage	1: 6 Months Storage	2: 3 Months Storage	2: 6 Months Storage	3: 3 Months Storage	3: 6 Months Storage	4: 3 Months Storage	4: 6 Months Storage	5: 3 Months Storage	5: 6 Months Storage	6: 3 Months Storage	6: 6 Months Storage	7: 3 Months Storage	7: 6 Months Storage	8: 3 Months Storage	8: 6 Months Storage	Final estimate used for ranking: 3 Months Storage	Final estimate used for ranking: 6 Months Storage
1.	Mud Bin	3.08	8.12	1.20	3.43					4.60	9.70	2.05	3.72			2.38	4.32	3.08	4.32
2.	Improved mud bin	0.46	0.58	0.23	0.26	1.11	1.82											1.11	1.82
3.	Pucca Kothi									1.86	3.43	1.98	4.84					1.98	4.84
4.	Steel drums					1.11	1.82			1.30	2.80							1.30	2.80
5.	Metal bins	0.67	0.74	0.31	0.24			0.75	1.17					0.50	1.00	1.49	2.08	0.75	2.08
6.	Bags in bhusa											3.71	3.31	0.07	0.09			0.07	0.09
7.	Room bulk	1.22										2.40	1.20	1.20	3.10	2.89	3.22	2.89	3.22
8.	Room bag	1.35	2.10							2.20	2.95	2.32	5.37	1.35	2.15	2.98	4.49	2.98	4.69
9.	Treated bag													0.28	0.50			0.28	0.50
10.	Cement bin			1.21	2.89	1.11	1.82									1.83	3.56	1.83	3.86

Data source details :

1. Ramaiyan et al (1968)
2. Zutshi (1966)
3. Bhatnagar et al (1975)
4. Khare (1976)
5. Pant Nagar Study Ref. to Pingale (1976)
6. Punjab Study, Ref. to Pingale (1976)
7. Srivastava et al (1973)
8. Giriah et al (1975)
9. Wilson et al (1970)
10. Our field surveys (1975)

Notes :

1. The steel bins and metal bins referred to in Bhatnagar (1975) appear to be the same except that the former are manufactured by PAU and the latter by a private firm; so they are combined.
2. Some of the estimates which did not appear to be compatible with the general pattern have been ignored.

PERCENTAGE WEIGHT LOSS 3 MONTHS STORAGE-PADDY

S. No.	Structure	DATA SOURCES					Final estimates used for Ranking
		1.	2.	3.	4.	5.	
1.	Mud bin (Golalu)			1.60	1.73	1.25	1.73
2.	Pucca Kothi (Kothi)			1.18			1.18
3.	Bamboo/ Straw						
3A	Puri		2.70	2.21			2.70
3B	Gummu				2.66		2.66
3C	Buttalo			1.95			1.95
3D	Gade			1.86			1.86
4.	Improved Puri		2.00				2.00
5.	Room bulk			2.52	3.30		2.52
6.	Room bag			2.78	3.47		2.78
7.	Metal bins		0.30				0.30

PERCENTAGE WEIGHT LOSS
6 MONTHS STORAGE-PADDY

S. No.	Structures	DATA SOURCES					Final
		1.	2.	3.	4.	5.	
1.	Mud bin (Golalu)			2.54	2.55		2.54
2.	Pucca Kothi (Kothi)			1.69			1.69
3.	Bamboo/ Straw						
3A.	Puri	2.70		1.99			2.99
3B.	Gummu				4.95		4.95
3C.	Buttalu			2.66			2.66
3D.	Gade	9.30	3.50	2.64			2.64
4.	Improved Puri	4.60					4.60
5.	Room Bulk			3.11	5.29		3.11
6.	Room bag			3.77	8.36		3.77

PERCENTAGE WEIGHT LOSS
MORE THAN 6 MONTHS-Paddy

S. No.	Structures	DATA SOURCES					Final
		1.	2.	3.	4.	5.	
1.	Mud bin (Golalu)			2.54	3.15	2.25	3.15
2.	Pucca Kothi (Kothi)			1.79			1.79
3.	Bamboo/ Straw						
3A.	Puri			2.34		1.25	3.34
3B.	Gummu				5.46		5.46
3C.	Buttalu			2.98			2.98
3D.	Gade			2.87			2.87
4.	Improved puri					0.50	-
5.	Room bulk			3.36	5.88		3.36
6.	Room bag			4.20	11.91		4.20
7.	Treated bag					1.00	1.00

PERCENTAGE WEIGHT LOSS-WHEAT (MORE THAN 6 MONTHS STORAGE)

S.No	Structure	DATA SOURCES 1	2	3	4	5	6	7	8	9	10	Final Estimate used for ranking.
1.	Mud bin	8.56	0.84	10.63	6.55						6.35	6.35
2.	Improved mud bin			0.71	0.26	3.40						3.40
3.	Pucca Kothi	3.17										3.17
4.	Steel Drum					3.40						3.40
5.	Metal bins		2.80	0.46	0.24		2.33				2.70	2.80
6.	Room bulk		15.00								3.98	3.98
7.	Room bag		3.00								6.20	6.20
8.	Treated bag	2.25										2.25
9.	Cement bin				4.32	3.40					4.82	4.82
10.	Thekka		4.00									4.00

ANNEXURE I

GROWTH PATTERN OF OWNED STORAGE FACILITIES WITH PUBLIC AGENCIES

thousands of tons

Year/ Agency	FCI	CWC	SWCs	FCI+ SWC+CWC	STATE GOVTs.
1965-66	1953.2	415.1	176.0	2544.3	NA
1966-67	2037.9(4.33)	582.5(40.32)	210.9 (19.82)	2831.3(11.28)	NA
1967-68	2104.1(3.24)	651.6(40.60)	227.5 (7.87)	2983.2(17.25)	1396.2
1968-69	2424.9(15.24)	656.7(37.07)	239.0 (5.05)	3320.6(11.31)	1447.86
1969-70	2812.7(15.99)	771.7(17.51)	248.0 (3.76)	3832.4(15.41)	1500.91
1970-71	3475.4(23.56)	813.6(5.42)	287.6 (15.96)	4576.6(19.41)	1555.36
1971-72	4045.6(16.40)	848.3(4.26)	360.0 (25.17)	6253.9(14.79)	1612.61
1972-73	4705.4(16.30)	1051.1(23.90)	474.0 (31.66)	6230.5(18.59)	1672.65
1973-74	5146.8(9.38)	1144.7(8.90)	602.0 (27.00)	6893.5(10.64)	1735.47
1974-75	5344.2(3.83)	1179.8(3.06)	744.9 (23.73)	7268.9(5.44)	1601.2
1975-76	5471.0	1237.8	898.4	7607.2	1801.2
1976-77	5857.1	1359.0	NA	NA	1801.2
1977-78	6481.1	1593.0	1647.0	9721.1	1801.2
Annual Compound Growth Rate (In percentage)	9.60	10.90	14.70	10.90	2.10

Note : Figures in paranthesis indicate percentage growth over previous years

Source: FCI & ASCI Study No. 14.

ANNEXURE II

REGION-WISE EXISTING COVERED STORAGE CAPACITIES WITH PUBLIC AGENCIES FOR FOODGRAINS

(FIGURES IN thousands of tons

(As on 1.4.78)

State Union Territory	F.C.I. (as on 30.4	C.W.C. (60%)	S.W.Cs (60%)	STATE GOVTs	TOTAL
Punjab	1149.34	56.40	112.20	124.66	1442.60
Haryana	354.01	36.00	102.60	124.89	617.50
H. P.	-	-	-	8.97	8.97
J & K	13.84	-	-	75.04	88.88
U. P.	797.50	73.20	258.60	56.73	1186.03
Rajasthan	331.00	38.40	88.20	-	457.60
Delhi	165.77	22.80	-	60.20	248.77
A. P.	372.25	260.40	46.20	56.80	735.65
Tamil Nadu	331.17	191.40	73.20	-	595.77
Kerala	290.84	11.40	28.20	37.62	368.06
Karnataka	89.02	36.60	52.80	42.75	221.17
Gujrat	196.35	61.20	29.40	171.37	458.32
M. P.	400.25	63.00	81.60	86.93	631.78
Maharashtra	814.70	51.00	67.80	547.71	1481.21
Assam	170.40	14.40	29.40	72.46	286.66
Bihar	282.85	15.60	4.80	12.15	315.40
W. Bengal	616.78	6.00	7.80	267.40	897.98
Orissa	86.99	15.00	4.20	40.97	147.16
N E F Region	18.00	3.00	1.20	52.88	75.08
ALL - INDIA	6481.07	955.80	988.20	1839.53	10264.60

SOURCE : FCI / CWC

ANNEXURE III

STORAGE MIX OF EXISTING ONGOING AND APPROVED PROGRAMMES WITH PUBLIC AGENCIES

(Figures in Lakh Tonnes)

Agency/Facility	Types of storage facility: Conventional Godowns	Bulk-cum-bag structures	Silos: Port Silos	Silos: Inland Silos/Bins	Silos: Rice Mill Silos	Total
EXISTING FACILITIES						
Public Agencies						
FCI (as on 1.4.78) Available for foodgrains	60.77	-	.19	3.42	.22	64.60
CWC (as on 1.4.78)	10.10	-	-	-	-	10.10
SWC (as on 1.4.78)	9.90	-	-	-	-	9.90
State Govts.	18.00	-	-	-	-	18.00
TOTAL A	98.77	-	.19	3.42	.22	102.60
ONGOING CONSTRUCTION						
APPROVED PROGRAMMES						
Public Agencies						
FCI (i) Ongoing constructions under Crash Programmes VII & VIII	4.50	-	-	-	-	4.50
(ii) Programmes Under Constructions under World Bank Assistance Phase I	-	-	-	1.00	-	1. 00
Phase II	25.00	10.00	.75	-	-	35.75
(iii) Programme Under Consideration under Australian Aid	-	-	-	1.50	-	1.50
CWC Constructions ongoing for 3 lakh tonnes	1.80	-	-	-	-	1.80
SWC Constructions ongoing for 5.6 lakh tonnes	3.30	-	-	-	-	3.30
TOTAL B	34.60	10.00	.75	2.50	-	47.85
GRAND TOTAL (A+B)	133.37	10.00	.94	5.92	.22	150.45

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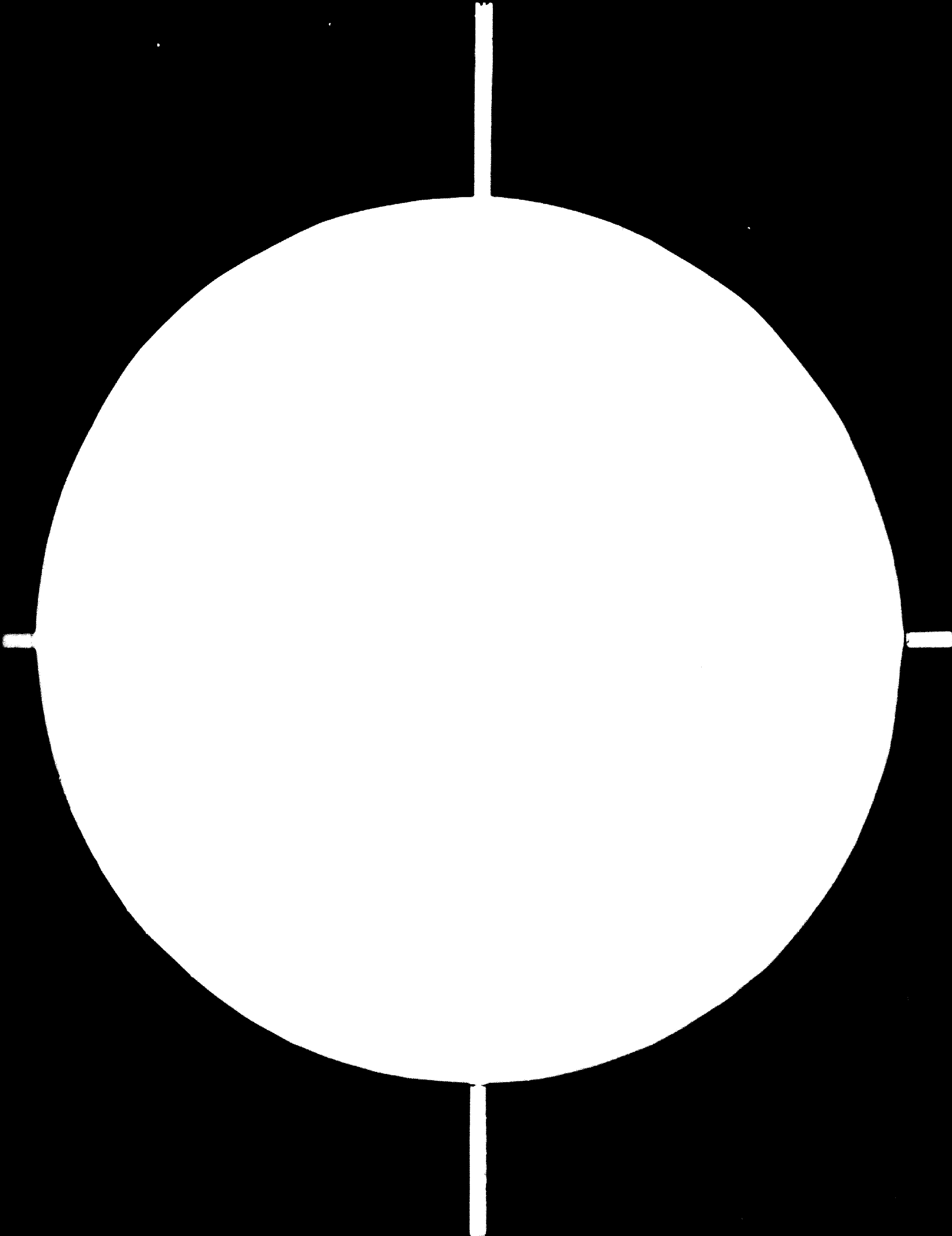

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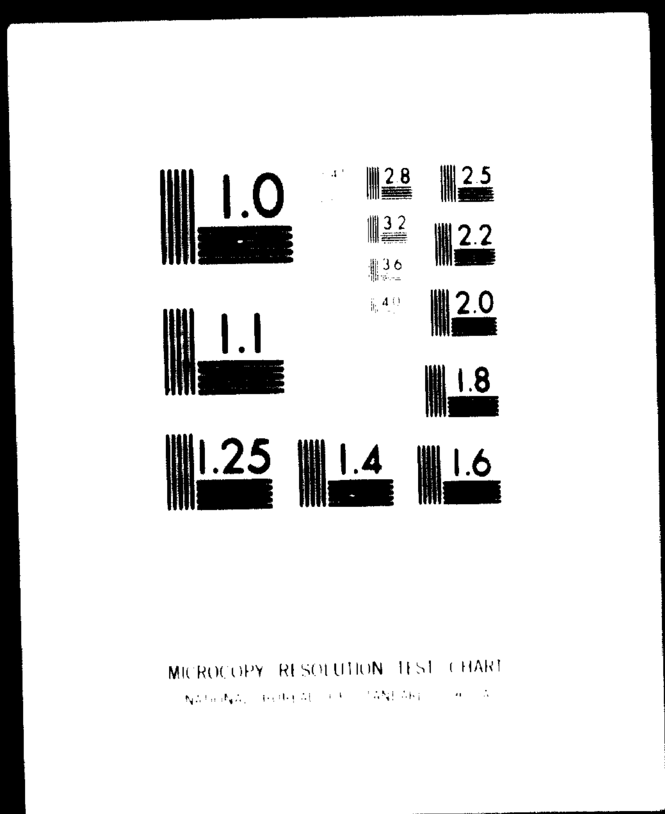

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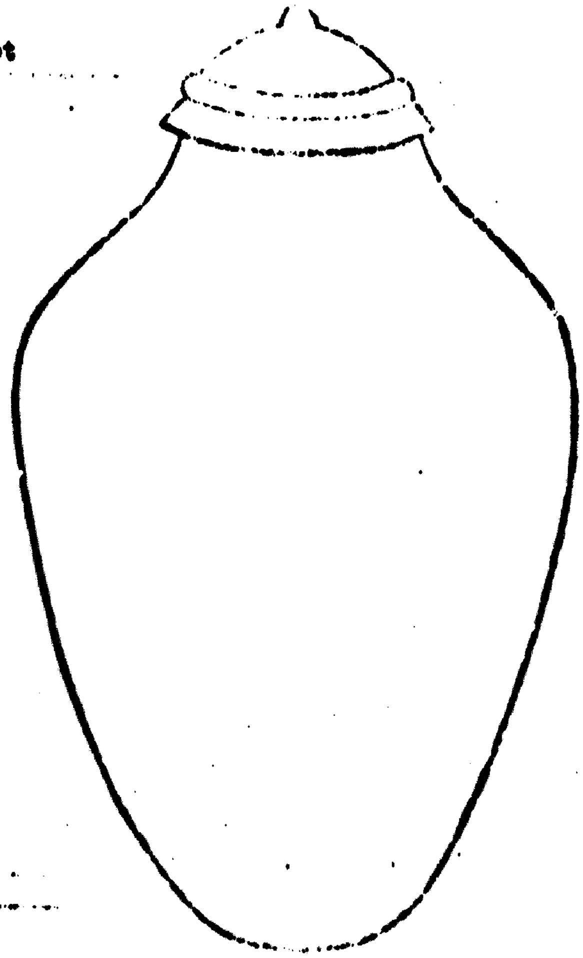
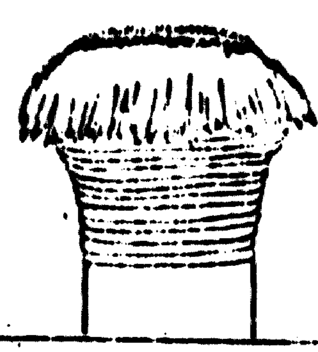
Earthenware Pot



Ex. - 1

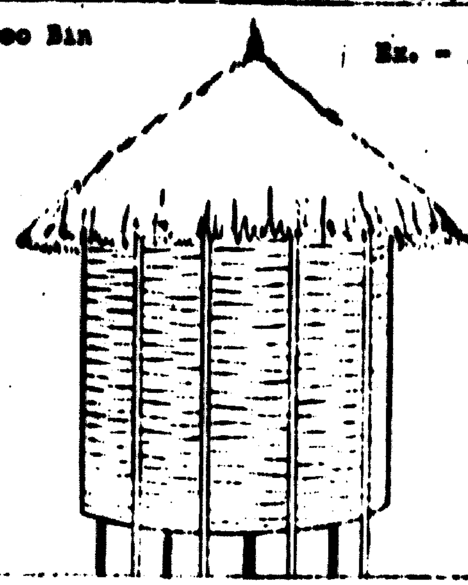
Improved [illegible]

Ex. - 2



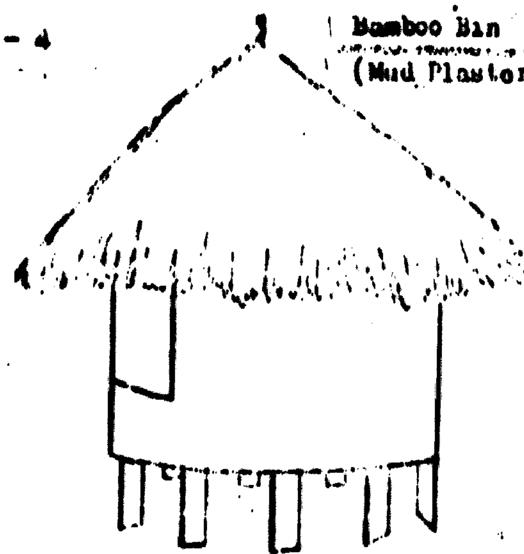
Bamboo Bin

Ex. - 3



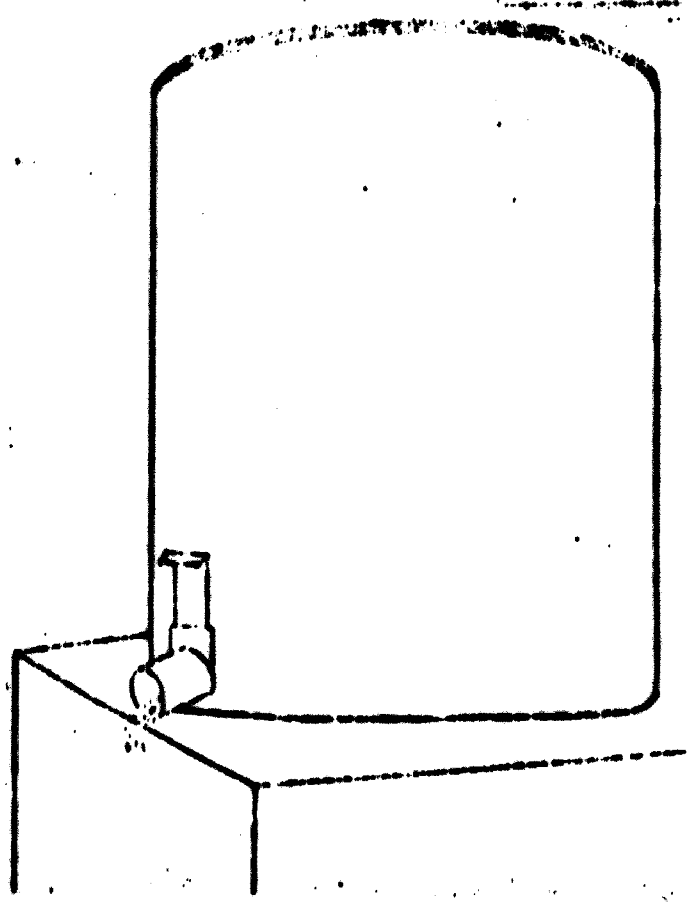
Ex. - 4

Bamboo Bin
(Mud Plastered)

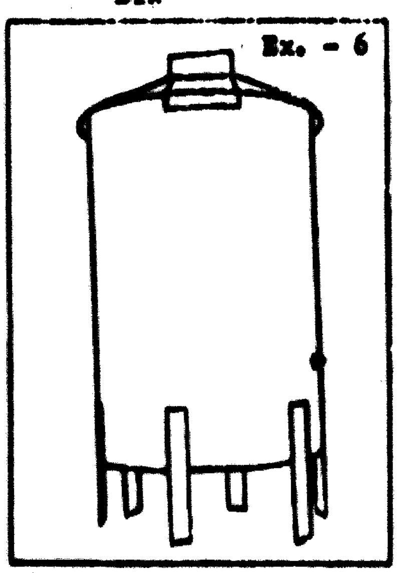


Metal Bin Store

Ex. - 5

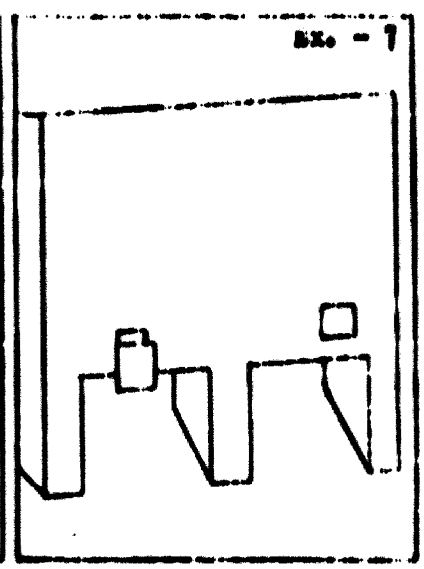


FLAT + HOPPER BOTTOM METAL BIN



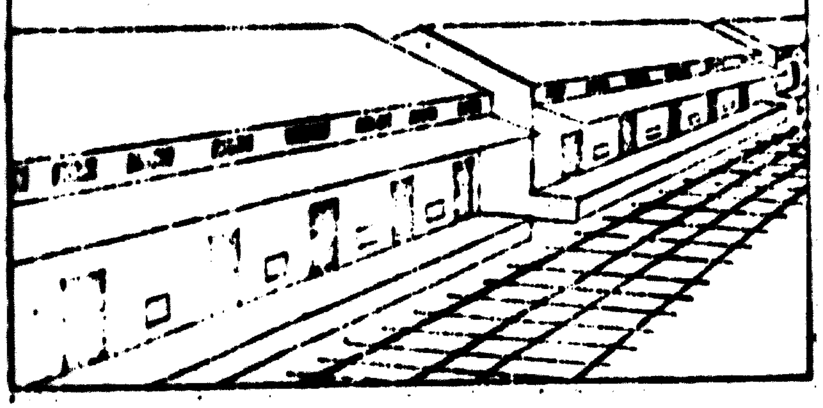
Ex. - 6

PUCCA KOTHI



Ex. - 7

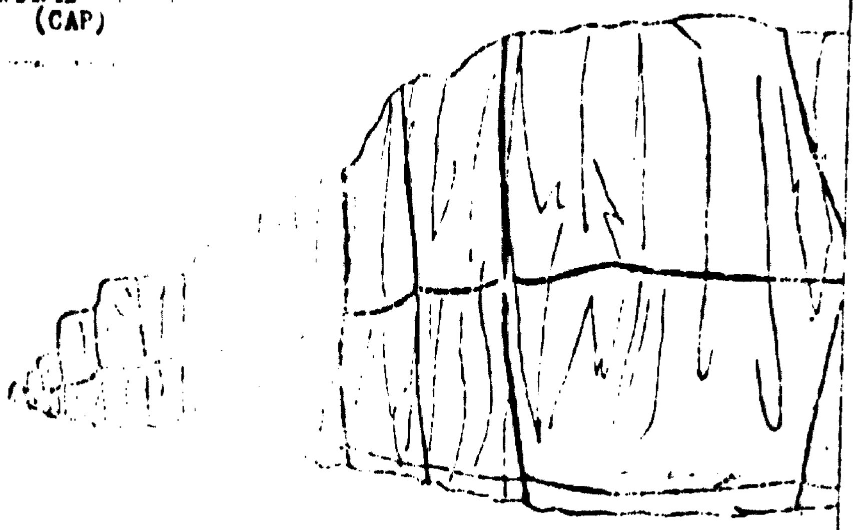
Conventional Godowns Ex. - 8



Ex. - 10

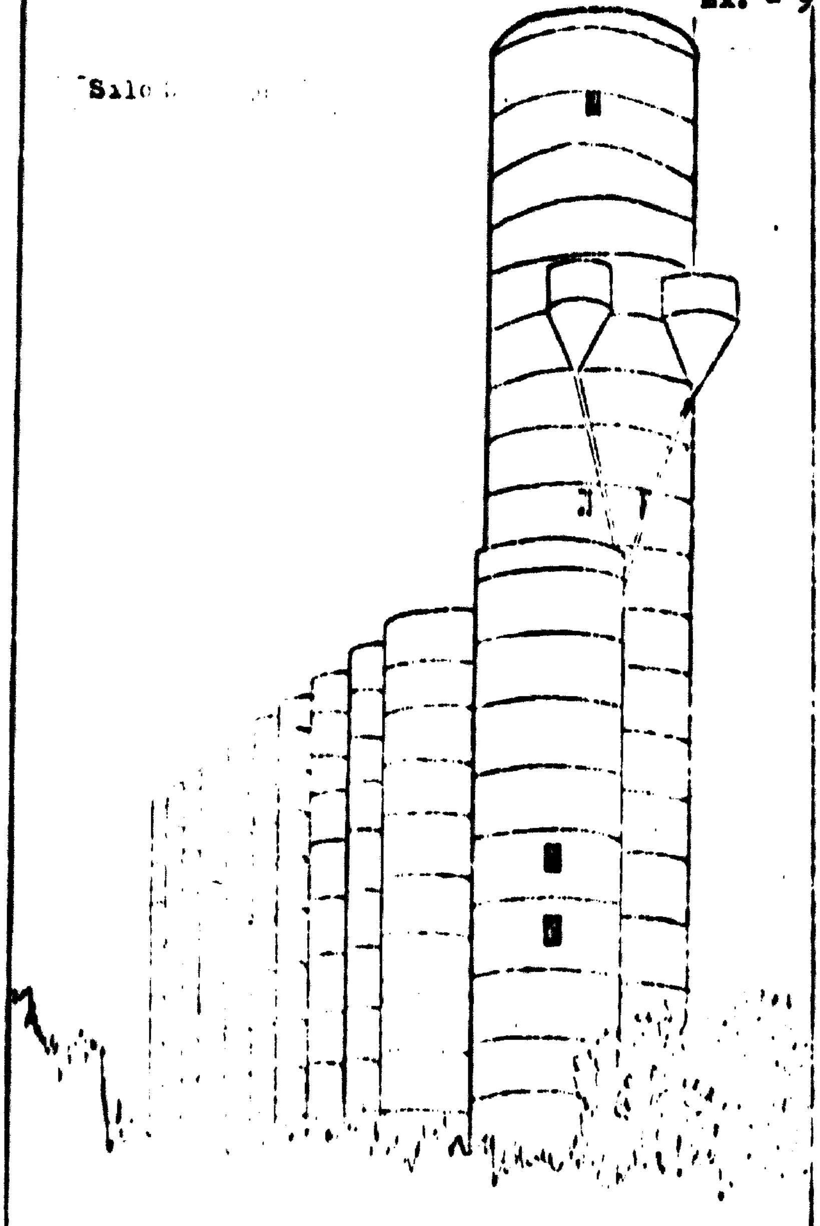
Cover and Plinth Stor...

(CAP)



Ex. - 9

Salo...



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