STATUS OF CEREAL PROCESSING AND PRESERVATION IN INDIA

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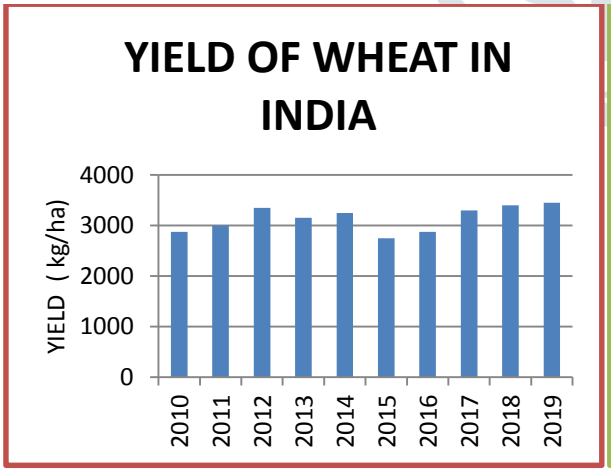
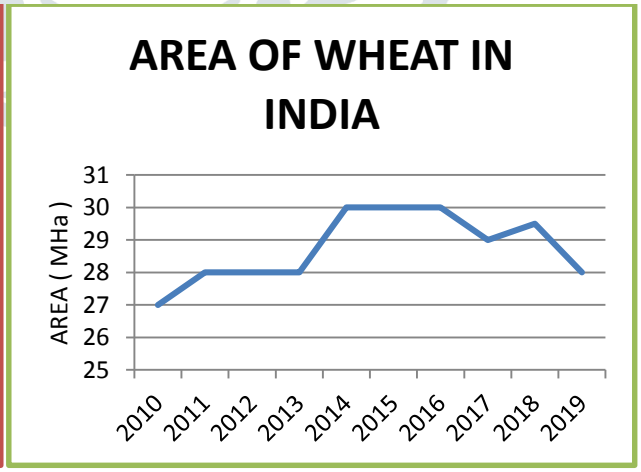
Abstract: Wheat and rice form the staple diet in India and most of the produced crop gets utilized in India itself.
Corn accounts for the major share of India's coarse grain production and is also utilized widely. The use of technology and modern inputs has increased the crop yield to many folds in comparison to the increase in the input costs. Segregation of the grain from the panicle, sorting the grain from the straw and winnowing the chaff from the grain are the chief operations. Milling comprises of the chief procedure of processing. Dry milling segregates the outer fibrous material and germ, which are considered by products of grain endosperm. In contrast, wet milling is mainly used for production of starch and gluten and every cereal grain can be wet milled with the use of appropriate modification or processing but is primarily used for corn & wheat .Malting, is a process of controlled germination, to activate the enzyme of resting grain for conversion of cereal starch to fermentable sugar, partial hydrolysis of cereal proteins and other macromolecules. The preservation and storage of these cereals is also of prime importance for the country because post harvest losses are very high in India. Insects are the major cause of damage and losses, they cause quantitative, qualitative and structural storage container damage losses. The modern method for storage includes Silos for large volume and bulk storage, godowns and warehouses are also specifically designed in manner to protect quantity and quality of the stored product.

INTRODUCTION

Grain crops provide fundamental supplements and vitality in the ordinary human eating regimen through direct human utilization especially in developing nations, as it comprises high level of calories and protein admission.
World production of 8 significant grains has been consistently going up from year to year. During 1950's the normal yield of cereals was 633 Million tons with increment 341 million tons in 10 years. As indicated by Food and Agriculture Organization (FAO), all out harvest production during 2016 arrived at 2577.85 million tons, for coarse grains arrived at 1330.02 million tons. In India heading for third back to back record wheat harvest with marketing year 2019-20 production conjecture at 100 million metric tons after 2 successive records gathers marketing year 2019-20. Rice's production is conjecture at 112 Million Metric tons. Still the fourth most elevated yield on record.
The term cereals allude to individuals from graminae family and govern 8 species which are Wheat, Rice, Millet, Sorghum, Maize, Rye, Barley, and Oats.





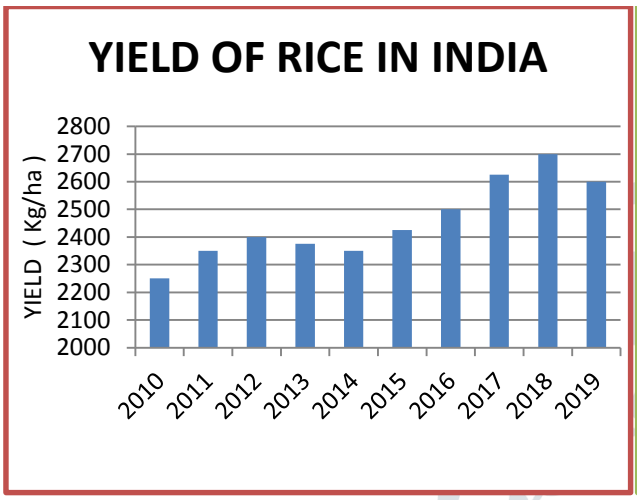
1. *WHEAT (Triticum)*

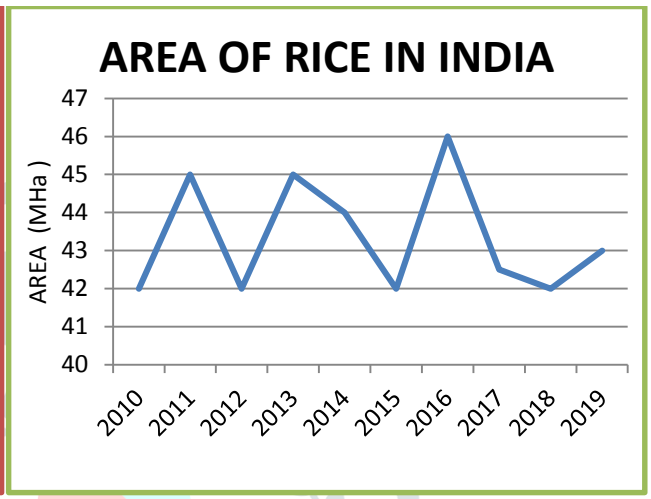
Wheat is the main human utilization cereal. It is granulated into powder, flour which is at that point utilized for creation of breads and other pastry kitchen items. It is utilized as "chapatti" (unleavened pan heated bread) in India. It's utilization in industrial zones and as animal fodder is restricted, because of its significant expenses. Wheat is placed in the genus *Triticum* and there are more than 30,000 species and varieties. The important wheats of trade are the normal or bread wheat (*T. aestivum*), macaroni wheat (*T.durum*) and club wheat (*T. compactum*). Wheat has been cultivating in India since last 4000-5000 years .Most of the wheat processed in India is the bread and macaroni varieties. India is positioned fourth in area and fifth in production among the wheat developing nations of the world. There

has been an expansion in the amount of wheat production; this isn't only the consequence of increment in the territory for agrarian development, yet in addition, the increment in yield per hectare. The majority of wheat produced in India gets spent here itself.

2. *Rice (Oryza sativa)*

Rice is staple eating regimen for the greater part of the total populace of the world and is expended primarily in Asia. Rice constitutes upto 80% of the food uptake in certain nations and in India represents over 40% of the world's food grain production. Rice is principally a kharif season crop, as it requires critical water for transplanting and during major vegetative development stage. Rice is developed in the tropics where rain and daylight are plenteous, 90% of the world territory under rice development is in Asia. It develops under assorted conditions and in the swamps, submerged and on dry lands. There has been a consistent increment in the world production of rice, the figure going from 300 million tons in 1971-72 to 628 million tons in 2004-2005. In India in the marketing year 2018-19 rice is evaluated at a record 114 maximum marketing trade, from 43.5 MHa because of significantly high yields of kharif rice in southern and eastern states.





3. ***MAIZE (Zea mays)***

Maize otherwise called corn, has a high level of carbohydrate, lipid and protein content and is nutritious for human utilization. It is additionally utilized in the manufacturing of starch, sugar (corn sugar, dextrin), syrup (corn syrup), industrial liquor and mixed drinks. Corn represents the significant portion of India's coarse grain production and has indicated a consistent upward pattern in the most recent decade on the course of developing demand and improved efficiency.

4. *MILLETS*

Millets are tough plants fit for developing where most other cereal grains fail, as in region with low rainfall, poor irrigation system and low fruitfulness. The significant millet crops of India are pearl millet (bajra) and finger millet (ragi). Other minor millets are common or proso millet, foxtail millet, kodo millet. These millets alongside maize and sorghum are considered as 'coarse grains' and form the food of monetarily more vulnerable segment of India's populace. Millet development has been declining because of diminished productivity contrasted with significant oats and other contending crops.

5. *BARLEY (Hordeum vulgare)*

Barley is lavishly utilized as food; steers feed and for malting and fermenting and by a long shot the most significant cereal grain for malting. Trade source reports that some malting and brewing firms are encouraging the cultivation of malting-grade barley assortments under agreement farming (buy-back arrangement) in the traditional developing territories of Rajasthan, Punjab and Haryana.

6. *Oats (Avena sativa)*

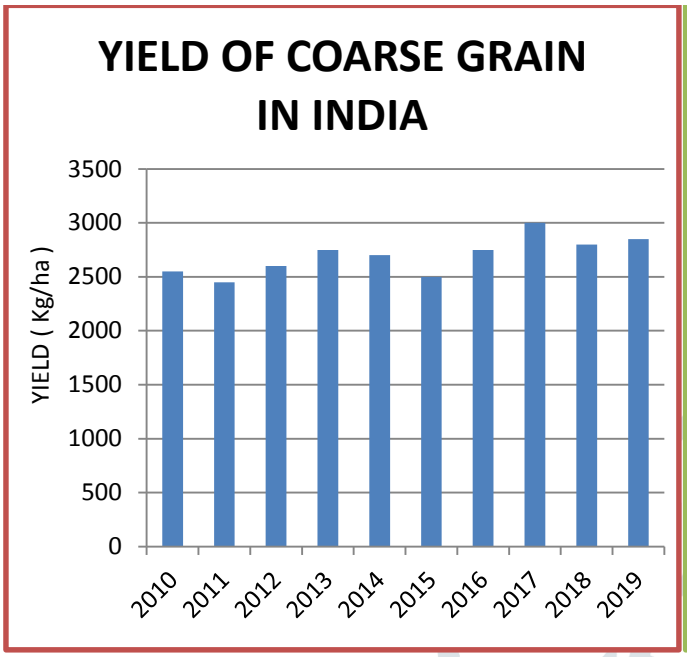
Oats constitutes one of the most nutritious of all grains for human use. Oats flour isn't appropriate for bread making. Oats are a wellspring of low calories, high protein and high fiber. Oats is commonly developed in India for grub purposes however endeavors are currently being made to create oat assortments which could give high feed yield just as grain yield.

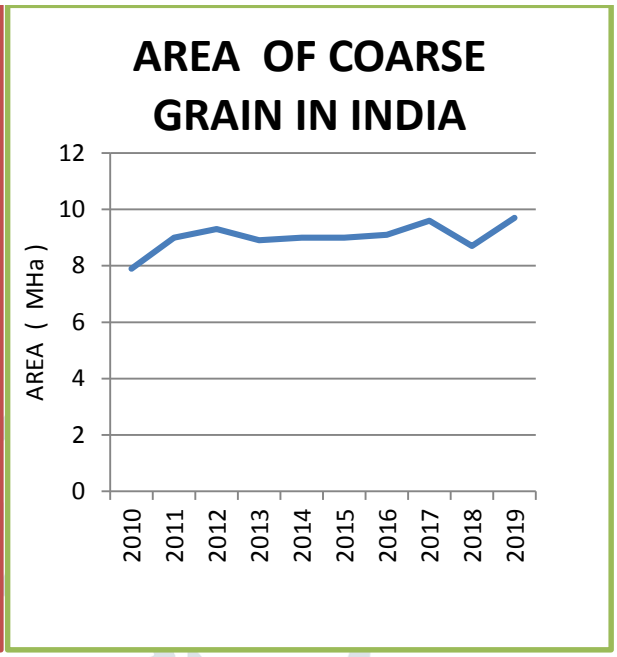
7. *Sorghum (Sorghum bicolor)*

It is a unique kind of cereal because of its drought resilience and adjustment to tropical conditions. As a result of these qualities, sorghum is mainly used as a subsistence and cash crop in parched area. India contributes about 16% of the sorghum cultivation. Sorghum are developed to a great extent under unirrigated conditions in moderately dry land territories, production vacillates year to year contingent upon the performance of the rainstorm.

8. *Rye (Secale cereal)*

Rye is a grass plant that is normally fall sown and developed around the world. Rye grain is fundamentally utilized for feed and food and furthermore for ethanol creation.





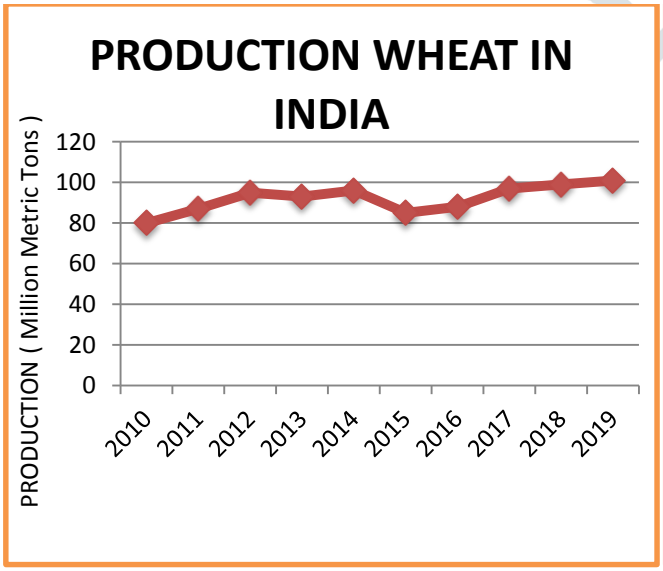
PROCESSING IN INDIA

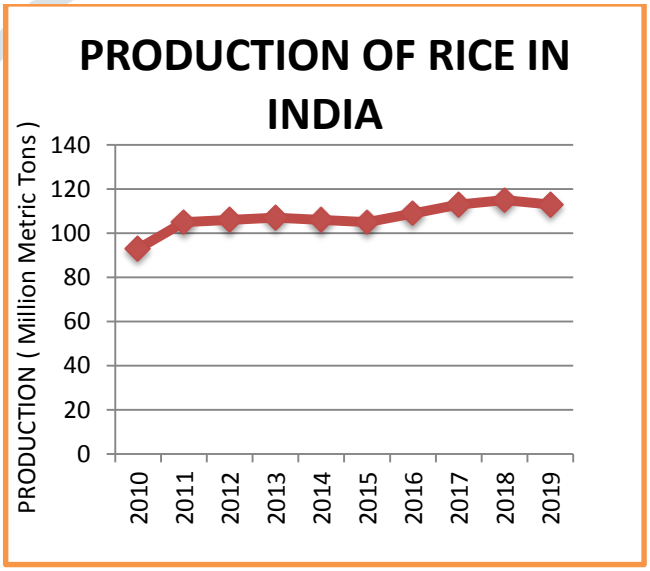
Grain processing comprises a significant piece of food production chain. Each kind of grain requires a particular post-harvest treatment. They experience various handling stages between harvest and storage.

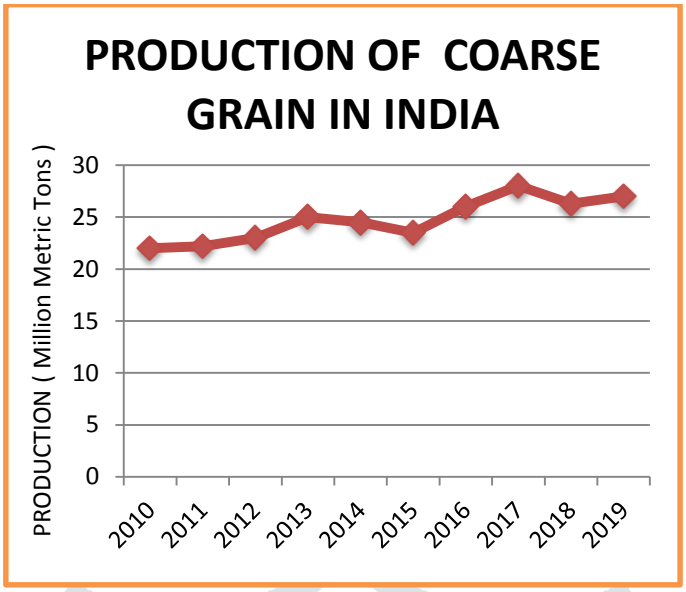
Post harvest System has three distinct areas of approach: First is the readiness of the yield for Storage. It incorporates **harvesting**, ***threshing, winnowing, drying, storage.*** Second is essential handling which includes further treatment of grain to clean it. It includes ***cleaning, grinding, hulling, pounding/milling, parboiling, drying, storage***. Third is the transformation of grains into consumable items.

HARVESTING

Cereals are harvested and gathered at an ideal time, which relies on the maturity of the yield and climatic conditions. Harvesting regularly starts before the grain is ripe and proceeds until mold and insect damage are pervasive. Unriped grain contains a higher percentage of moisture and will fall apart more rapidly than fully developed grains because of the active enzyme system. Also, if grains stay in the field even after optimum maturation it might ruin through wetting brought about by morning dew, rain showers and insect damage. They are traditionally manually harvested. Three main types of harvesting equipments for small level producers are either manual, animal powered or engine powered.







THRESHING

It is the expulsion of grains from the remainder of the plant. It includes three distinct activities: Detachment of the grain from the panicle, remove the straw from grain, winnowing the chaff from the kernel. Detachment of grain from panicle is the most vitality requesting of the three procedures. Removing the straw from grain is generally simple, yet is hard to automate.

CLEANING, WINNOWING & HULLING

Winnowing is the removal of chaff from the grain. It is traditionally executed by using lifting and tossing the threshed material in order that lighter chaff gets blown to one side and heavier seeds fall vertically down. Before more processing, grains are wiped clean and graded with respect to their size. A decorticator is used to remove the palatable husk and shell of several grains.

MILLING

Milling represents the principle technique in post harvest system of cereals. It can be categorized as Dry Milling and Wet Milling. Dry milling segregates the outer fibrous materials and germ, which can be taken into consideration as by products of grain endosperm. On the contrary, starch and gluten are produced in wet milling. Conditioning or tempering is the technique in the course of which the Kernels are moistened with controlled addition of water. Its objective is to prevent breakage of bran & enables at some point of milling as well as also improves the sieving efficiency.

DRY MILLING

It is one of the oldest methods of the milling enterprise to provide milled fractions of cereal grains. Cleaning and conditioning of grains precedes milling. Cleaning is crucial due to the fact that the grain obtained in bulk incorporates grain impurities. The fundamental grain impurities following formal definition are shriveled grains, pest damaged grains, grains which have discoloured germ, sprouted grains, miscellaneous impurities which includes dead insects, damaged grain, husk, ergots, etc. In general, corn's dry milling results in many products and by products. Despite exclusive attempts to categorise and define products of maize processing, a worldwide terminology for dry-milled maize product is not but standardized. For wheat after conditioning, the wheat kernels are first passed through an abrasive machine that gets rid of impurities present on pericarp and break damaged kernels. The break rollers break the wheat kernel and get rid of the endosperm and germ from the pericarp. Whereas the reduction rollers reduce in addition the sizing and middings into flour. Milling of oats calls for a thermal treatment after which a dehulling step of the grains to produce naked caryopsis referred to as groats before milling.

WET MILLING

In contrast to dry milling, wet milling includes grinding the soaked Grain and then separating the grain chemical compounds (starch, protein, fiber and oil). Primary product of wet milling is represented with the aid of starch. It is produced in the form of regular, waxy and excessive amylose starch relying on the amylose content of the Primary source. It specifically contains processes of various physical chemical, biochemical and mechanical operation. Every cereal grain may be wet milled if appropriate modification of device or processing is made however this method is used typically for corn and secondarily for wheat. Steeping of corn generally lasts from 30 to 48 hours. Steeping is performed by means of soaking the kernels in a warm solution containing sulphur dioxide, that's a reducing agent to soften the corn structure. Objective of Maize's wet milling is to extract the maximum feasible quantity of starch granules that are undamaged. The final moisture content at some stage in this step reaches round 48-50% of kernel weight and at some point of steeping 5-

7% corn solids are solubilized. After steeping comes first milling step, in which moistened corn grains are wet milled in plate or disc attrition turbines into huge portions so that germ is released. During second milling step the denser endosperm pieces that can also contain pericarp tissues are milled to liberate the pericarp in flakes. Endosperm is milled to liberate starch granules and protein matrix. Proteins are separated via centrifugation from starch.
Important portions of wheat are directed to wet milling industries to produce crucial gluten and starch. Wet milling methods differ in size of the aggregated protein particles from aggregate of flour and water initially subjected to fractionation and in the mode of isolating starch from gluten.

MALTING

It is a controlled germination method which activates the enzymes of the resting grain for the conversion of cereal starch into fermented sugar, partial hydrolysis of cereal proteins and other macromolecules. The procedure starts with the drying of the grain in KILN DRYER so that moisture content of the grain is in among 10 to 14% which hastens the maturing of grain and from time to time improves malting quality. After the process of drying and cleaning the grain is kept for about three weeks before malting to allow secondary ripening of the grain to occur. Then these grains that were stored are steeped. Generally steeping maintains for a few 50 to 70 hours, after which the excess water is drained off and grains are spread on the ground for 7 to 8 days at the same time as germination takes place. The grain malt is kiln dried to arrest enzymatic activity, without destroying the enzyme. This final product, cleaned and dried is called malt. Barley is the grain most generally used in the production of malt which discovers its industrial uses in breweries and distilleries. Malting isn't just of barley, but also of different cereals along with wheat and rye. Although malt is particularly used as a primary component in beer and whisky, it has found application in the production of meals, malted shakes, flavored liquids and baked goods also. Floating kernels in the steeping vessel at some point of the steeping method represent by products and are collected in an overflow and offered as low fee animal feedstuff. Another by made from malting is barley malt sprouts which are isolated from kilned malt after kilning process.

PAR BOILING

Generally, coarse and medium sized rice of tender structure, are parboiled because such rice suffer excessive loss when milled raw. The process involves soaking of paddy for some time in water, followed by steam heating once or twice and then drying before milling. Parboiling can be carried out by two processes i.e., conventional process and hot soaking process. In conventional method paddy is soaked in cold water for 2-3 days in large cement tanks, then steamed for 5-10 minutes and drying under sun. On the other hand hot soaking process involves steeping in hot water 65-70℃ for 3-4 hours, then soaked paddy is steamed in the same vessel for 5-10 minutes. Finally drying of the paddy in the sun or in mechanical driers. Parboiling shortens and broadens the milled rice. There is a reduction in losses as the grain becomes tougher and more resistant to insects and fungal infections. This makes the process of dehusking easier. These rice swell more when cooked to desired softness. They will not turn into a glutenous mass when cooked.

PRESERVATION: STORAGE TECHNIQUE

Preservation of grains implies to their storage. It is the way toward conveying surplus creation for future utilization. It incorporates all sort of storage whether conventional/indigenous scientific method of storage whether ambient and maintained by private or public companies. Cereal grains consisting of wheat, corn, rye, oat, rice etc. are vital nutritional and energy assets for humans. They should be stored, transport and passed on utilizing strategies that protect their quality. Storage varies with the duration of time ranging from short time period storage on farm for drying to long term storage for strategic reserves. India's grain production has step by step increased because of advances in technology, however post harvest loss is constant. Losses at some stage in storage account for around 6% of the entire losses as right storage facilities are not available. Small scale Indian farmers use traditional storage structures. Government organization like Food Corporation of India (FCI), central and state warehousing corporation stored the surplus grains. Microbial, pest, enzymatic activities, foreign matter damages and heat problems result in quality loss in grains at some stage in storage, can be averted with the aid of right storage strategies using proper machine and equipment. Upto today, numerous storage strategies have been utilized for a very long time. However the aim of storing grain is to ensure the nature of grains, forestall grain misfortunes and ration the item in an appropriate manner. A major trouble for cereal safety is the post harvest loss due to climatic regions and use of limited use of infrastructure and technology for storage. Safe grain harvest and storage plays essential position to save losses caused specifically with the aid of beetles, moth, rodents etc. Before storage of cereals, there are numerous protectional points from damages including harvesting of crop on time, drying of plants on farm without waiting, setting of recent and old plants separately, cleaning of crops from foreign material etc.

TYPES OF STORAGE LOSSES

Different kind of losses are caused by insects

1. Quantitative loss

- Loss in weight of stored grain is caused by direct feeding of insects.
- During maturing period of rice, 14mg out of 20mg of grain is eaten by rice weevil.
- *Sitotrogacerealella,* a gravid female can destroy 50g of rice totally in 3 ages.

2. Qualitative loss

- In grain content Chemical changes takes place.
- Grains Contamination with moult skin and body parts.
- Spreading the pathogenic microorganisms.
- Seed losses their viability.

3. Damage to storage structures

- The ability of Insects like lesser grain borer to destroy the wooden storage structures, container, and polythene lined bags etc.
- Food losses- Direct (disappearance of food by spillage or consumption) or Indirect loss (lowering of quality to the point where people refuse to eat it).

STORAGE STRUCTURES IN INDIA

In India grain are kept at farmers, traders and industrial levels. In all parts of the globe technologies for handling and storage of pulses are being developed. Grain storage structures are a group of devices for storing grains, after harvesting, safely until their consumption and transport. Grain storage structures are classified as follows:

1. Traditional/ Conventional Structure

About 60-70% grain storage is done in primeval storage structures at farms and home level. **L**ocally available raw materials, like paddy straw, wheat straw, wood, bamboo, mud, bricks , cow dung etc., are used by the farmers to develop traditional structure different in design , shape , size and functions to store food. The different conventional storage structures used are:

Morai type storage structure- In rural areas of eastern and southern regions of India, Morai type structures are used for the storage of paddy, maize and sorghum. They resemble an inverted cone. It has a 3.5 to 18 tonnes capacity. A circular wooden plank floor raised on pillar by timber joints forms an important type.

Bukhari type storage structure- Sorghum , Wheat , Paddy , Maize etc. are stored in cylindrical shaped storage container having a capacity of 3.5 to 18 tonnes, made up of mud alone or by mud and bamboo. They are raised above the ground by wooden or masonry platform. In the improved version of bukhari type or masonry structure, the basic shape is the same but the material and method of construction are more safe and durable.

Kothar type storage structure – Used to store paddy, maize, sorghum, wheat etc., have a capacity varying from 9 to 35 tonnes. It is a wooden box and stelled on pillars, with a thatched placed over it to protect it from sun or rain. In the improved structure, wooden planks and beams are 5cm thick with no gap between the walls.

Mudbin/kothi and kuthla – They are quite common in rural areas of Bihar and Uttar Pradesh, for storing grains and other seeds, with 1 to 50 tonnes capacity, composed of mud mixed with dung and straw or burnt mud. Commonly found in rectangular or cylindrical shapes.

Bag storage structure –Generally storage of upto 25 to 500 tonnes of grains can be done using these structures. There is enough space in this structure to store about 600 bags (500 tonnes) of grain. Different capacities of bags (35, 50, 75 and 100kg) with or without plastic lining are used.

Metal Bin – generally R.C.C., aluminium, steel are used to make these bins which are used for storing grains both inside and outside house. These commercial scale bins have long durability and capacity range of 50kg to 10tonnes.

2. IMPROVED STORAGE STRUCTURES

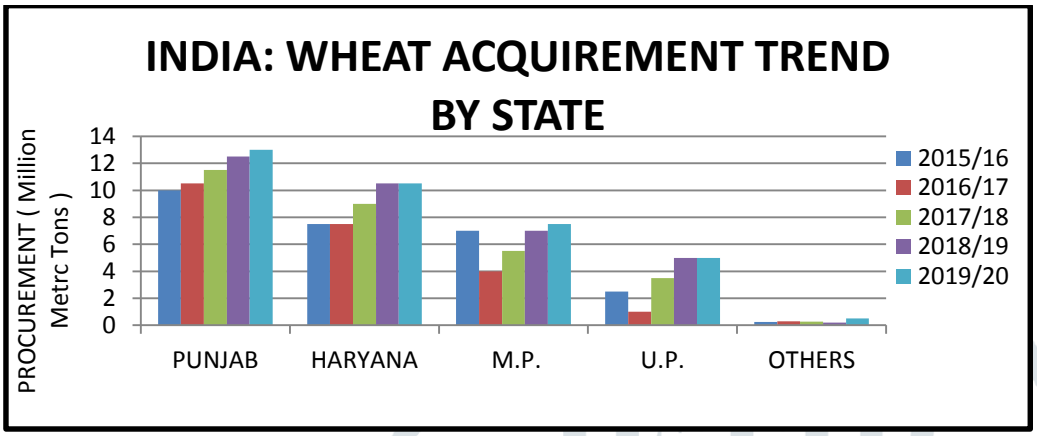
In this type of storage structures there are a few upgrades made in conventional storage structures. This sort of storage structures having a higher limit of storage and long term storage of food grains than conventional structures. The storage of grain is generally done in one of the accompanying storage structures in various rural and urban districts of India:

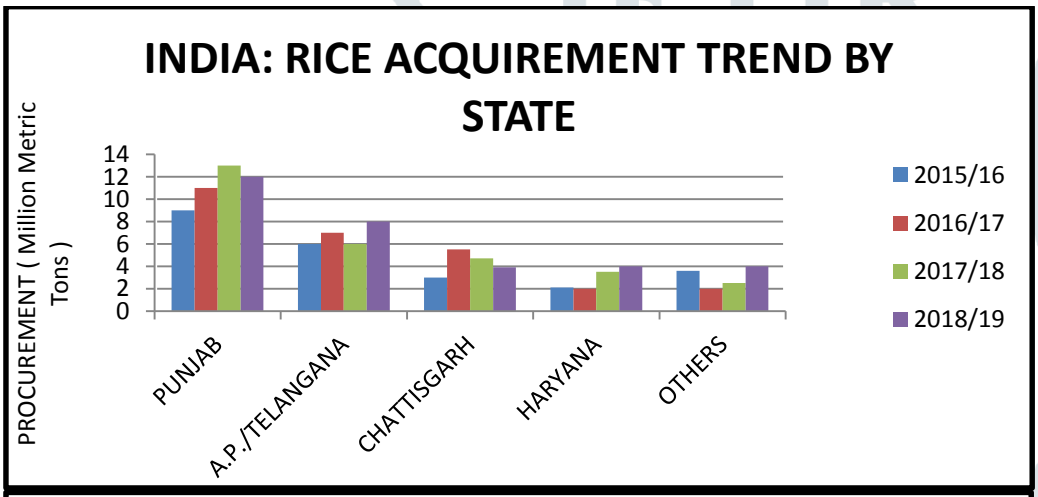
PUSA BIN – It resembles other customary storage structures made of mud. One structure comprises of the floor and lower part of the walls burnt with the layer of plastic sheeting embedded between two bricklayers. This shields grain from moisture and stop air from entering.

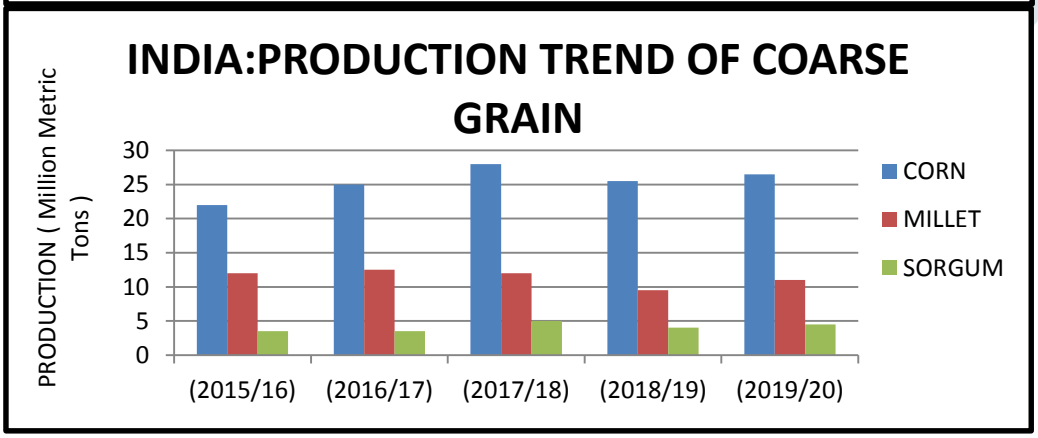
PAU BIN – This is a startled metal iron structure. Its volume ranges from 1.5 to 15 quintals. Invented by Punjab Agricultural University.

HAPUR TEKKA – It is a cylindrical shaped rubber treated cloth structure upheld by bamboo poles on a metal cylinder base, and has a little gap in the bottom through which grain can be expelled.

CAP (Cover and plinth) storage structure - This kind of open storage is considered as transit storage and serves the need of storage of food grains in sacks for short period. It includes the construction of brick pillars with grooves into which wooden crates are fixed for stacking of packs of food grain. Food grains like wheat, maize, gram, paddy and sorghum are generally stored for 6-12 months of time span.







3. COMMERCIAL /MODERN STORAGE STRUCTURES

In India for significant volume of food grains are to be stored in mass in silo and ordinary godowns for bagged stockpile. The advanced permanent storage system should be chosen for the safe keeping of stored grains and other products. The commercial storage structures should be chosen on the basis of first on quality and afterward on the basis of cost. There are following types of commercial storage structures:

Silos – They are built from steel or strengthened cement. There is a group of abutting silos in any modern large processing plant. There are four silos in India i.e., Calcutta, Madras, Bombay and Hapur-Ghaziabad. Farm silos are a ranch structure used to store and protect the animal fodder with the goal that it is preserved in a perfect condition for livestock.

Shed/Godown – Warehouses are storage structures particularly built for the security of the quantity and quality of stored products. The godown side dividers are of bricks stone masonry and sloped roofing in asbestos or corrugated galvanized iron (CGI) sheets over steel support. Generally, a horizontal sheds have been used to give low cost and huge capacity storage. For storing and other products a very huge capacity sheds have also been built by central warehousing corporation.

4. ADVANCED STORAGE METHODS

Advanced storage techniques for example aeration, refrigerated storage, modified atmosphere, hermetic storage frameworks are now acquired in many developed countries and India.

Grain Aeration – Aeration is broadly utilized for preservation of stored grain. It is the constrained movement of ambient air of suitable quality, through a grain for enhancement of grain storability. It lessens the commodity temperature by utilizing mechanical air circulation by means of fans. This framework is appropriate for low humid environment. On commercial scale, forced aeration plays significant and effective role to preserve grains.

Refrigerated storage – In this method, encompassing air is cooled and afterward passed the mass by means of existing aeration system. Refrigerated air circulation has been utilized for cooling dry grain in subtropical climates when ambient temperature are too high for fruitful insect control by air circulation with untreated air.

Modified Atmosphere Storage – Several analysts have been studied various atmospheric arrangements for the security of grain. Modified Atmosphere (MA) and controlled atmosphere (CA) offer option in contrast to the utilization of conventional residue producing chemical fumigants for controlling insect pests attacking stored grain, oilseeds, processed commodities and some packaged foods. The CA framework also stops fungal growth and maintains product quality.

Hermetic storage - An air proof or sealed storage is named as "hermetic storage" or "sacrificial sealed storage". The techniques empower insects and other aerobic organisms in the commodity to generate the modified Atmosphere by decreasing oxygen and expanding carbon dioxide concentration through respiratory metabolism.

CONCLUSION

The grain production has been on rise with better facilities in terms of seeds technology, fertilizers, pesticides and irrigation. Cereals require various post harvest treatments. Three areas of post harvest concern being - Preparation the crop, Primary processing/treatment to clean the grain and Transformation of grains to edible products. Cereal processing becomes a major part of food production chain. The grains are exposed to threshing, cleaning, and winnowing and hulling, post harvest. Milling (dry and wet), malting, parboiling (in case of rice) are the principal procedures in the cereal industry. Storage and preservation is a major area of concern as natural contamination of food grains is influenced by the type of storage, temperature, moisture etc. The decision of the most appropriate and cost effective stockpiling method has incredible significance on storage period of grains to prevent decay brought about by physical, chemical and biological factors. 60-70% of grains are stored in the farm in traditional structures like kanaja, kothi, sanduka, earthen pots, gummi and kacheri. However indigenous storage structures are not suitable for storing grains for very long periods. The most favored stockpiling method is to store in silo, particularly produced using stirred steel. Need of the hour is to strengthen traditional means of storage with modern inputs and to provide cheaper storage to farmer so as to prevent enormous storage losses.

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