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Chapter 17 Agriculture Engineering and Farm Mechanization

Contents

Agri- Engineering and Farm Machinery

- **Agricultural Engineering** is the field of study and application of engineering science and designs principles for agriculture purposes.
- It deals with the construction, design, and improvement of farming equipment and machinery

Farm Machinery and Power

- Farm power is used for operating different types of machinery like tillage, planting, plant protection, harvesting and threshing machinery and other stationary jobs like operating irrigation equipment, threshers/ shellers / cleaners/ graders, etc.
- The different forms of energy used for agriculture (farm power) in India are Human energy (human power), Animal energy (animal power), Mechanical energy (mechanical power such as Tractors, Power tillers, Self propelled combines, Oil engines), Electrical energy (electrical power), and Renewable energy (Biomass, Solar energy and Wind energy).

Human power

- Human power is the main source of energy for operating small implements and tools at the farm. Stationary work like chaff cutting, water lifting, threshing, winnowing etc. and field work like weeding, broadcasting are also done by manual labour.
- The advantages of human power is that it is easily available and can be used for all types of work.
- However it is the costliest power compared to all other forms of power, very low efficiency, requires full maintenance when not in use and affected by weather condition and seasons.

Animal Power

- The average power developed by a pair of bullocks is about 1 hp for farm operations.
- Bullocks are employed for all types of farm work in all seasons.
- Besides bullocks and buffaloes, other animals like camels, horses, donkeys, mules and elephants are also used at some places.
- The average force a draft animal can exert for farm work is nearly 1/10th of its body weight.
- The **advantages of animal power** are
    - easily available,
    - used for all types of work,
    - low initial investment,
    - supplies manures to the field and fuels to farmers and lives on farm produce.
- **The disadvantages of animal power**; viz.
    - they are not very efficient,
    - seasons and weather affect the efficiency,
    - cannot work continuously,
    - requires full maintenance when not in use and very slow in doing work

Mechanical Power

- Broadly speaking, mechanical power includes stationary oil engines, tractors and power tillers.
- The **internal combustion engine** is a good device for **converting fuel energy (Chemical energy) into useful work (Mechanical energy).**
    - The internal combustion engines are of two types : Diesel engine and Petrol / Kerosene engine. The thermal efficiency of diesel engine varies from 32 to 38 per cent whereas that of petrol engine varies from 25 to 32 per cent.
- In modern days, almost all the tractors and power tillers are operated by diesel engines.
- The diesel engines are used for stationery operations like water lifting, flour mills, oil expellers, vegetable washers, gardeners, mulberry processing equipments, threshers, winnowers, chaff cutter etc.
- The **advantages of mechanical power are**;
    - efficiency is high,
    - not affected by weather,
    - can run at a stretch for longer period,
    - require less space and cheaper source of power.

- The **disadvantages of mechanical power are;**
  - initial capital investment is very high,
  - fuel is costly and scarce,
  - needs technical knowledge for repairs and maintenance.

Electrical power

- Electrical power is the mostly used for operating electrical motors in the farms.
- This is a clean and efficient source of energy.
- The **maintenance and operation of motors needs less attention and care**.
- The **operating cost remains almost constant throughout its life**.
- Electrical power is used for operating pump sets, high-tech nursery, diary industry, cold storage, farm product processing, fruit industry and food processing industries.
- The **advantages o**f electrical power are viz;
  - very cheapest form of power,
  - high efficiency, can work at a stretch continuously for longer periods,
  - maintenance and operating cost is very low and not affected by seasons.
- **The disadvantages** are viz;
  - initial capital investment high,
  - requires good amount of technical knowledge and if handled carelessly, it causes great danger.

Renewable energy

- It is the energy mainly obtained from renewable sources like sun, wind and biomass.
- Biomass energy (biogas, producer gas, ethanol, and biodiesel), wind energy and solar energy are used in agriculture and domestic purposes with suitable devices.
- It can be used for lighting, cooking, water heating, space heating, water distillation, food processing, water pumping, diesel engine operation and electricity generation.
- This type of energy is inexhaustible in nature.

Concept of Farm Mechanization

- The main concept of farm mechanization is **to apply the principles of engineering and technology to do the agricultural operations in a better way to increase crop yield**.
- This includes the **development, application and management of all mechanical aids** for field operation, water control, material handling, storage and processing.
- Mechanical **aids include hand tools, animal drawn implements, power tillers, tractors, engines, electric motors, grain processing and hauling equipment**.

Scope of Farm Mechanization

Improved irrigation facilities, introduction of high yielding varieties, use of higher doses of fertilizers and pesticides have increased the scope for greater farm mechanization.

- Farm mechanization helps for proper utilization of basic inputs like water, seed and fertilizer,
- optimum placement of the seed and fertilizer,
- ploughing,
- removal of weeds,
- leveling of uneven land and land reclamation.

Benefits of Farm Mechanization

- Timeliness of operation
- Precision of operation
- Improvement of work environment.

- Enhancement of safety
- Reduction of drudgery of labour
- Reduction of loss of crops and food products
- Increased productivity of land
- Increased economic return to farmer
- Improved dignity of farmer

Constraints in Farm Mechanisation

- Small land holdings
- Less investing capacity of farmers
- Adequate availability of draft animals
- Lack of suitable farm machine for different operations
- Lack of repair and servicing facilities for machines
- Lack of trained man power
- Lack of coordination between research organization and manufacturer
- High cost of machines
- Inadequate quality control of machine

Land Levelling:

- Land levelling is a measure used in surface irrigation, such as basin and furrow irrigation. It consists of:
- Repairing the irrigation plot in a way that no high and/or low spots disturb the uniform distribution of irrigation water on the field, and
- Ensuring the optimal slope for water movement across a field when irrigated.
- Levelling results in more efficient irrigation and, if fertigation and chemigation are applied, in more efficient use of fertilizers and pesticides. In an unlevelled field, high spots might not be covered by irrigation water, and the dissolved nutrients and/or pesticides might percolate unused into the soil.
- In case of low spots, water and the dissolved nutrients and chemicals might accumulate there and create zones of water logging and nutrient or pesticide accumulation.
- This in turn will disturb soil aeration and water uptake by crops. In either case, the uniformity of the crop cover is disturbed and yields might decrease

Equipment's used for land levelling:

Land Leveling using Draft Animals:

- Levelling board:
- Soil Scoop:
- Buck Scraper:
- Leveller:

Levelling board:

- The leveling board efficiently levels the field and crushes bigger clods, before the harrow tines process the soil. The solid springs prevent the leveling board from overload if hitting a stone.

Soil Scoop:

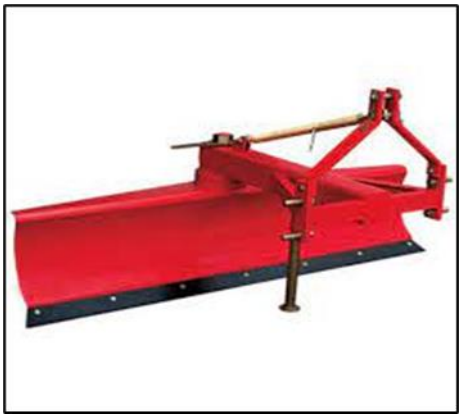
- A soil scoop is a head-mounted gardening tool with a sturdy handle. It is excellent to scoop potting soil, prepare seed furrows, dig, and weed with a perfect edging pressure that cuts through the roots of the plants.

Buck Scraper:

- The meaning of buck scraper is a modified drag scraper having two runners to lift the scoop from the ground when filled.
- Buck scraper is a simple implement for land grading. The operator can control the depth of cut depends upon the load on scraper.

Leveller:

- It is used to break hardpan of the soil, loosening of the soil and helps the water to seep into the soil for improving drainage.



Land Levelling using Machinery:

Leveller

- It is a simple and rugged implement which is directly fitted to tractor. It is basic implement for leveling of land. Very useful for agriculture purpose.

Precision land leveller.

- Laser leveling of a field is accomplished with a dual slope laser that automatically controls the blade of the land leveler to precisely gradeing of land.
- Darsh Palesse Laser land leveler are being used to make the soil more levelled and pulverization of land for making ready for planting of Rice.

Leveller with ripper

- Leveller and ripper both together.

Scappers:

- Tractor scraper is very useful for leveling of unlevel land. It is also used to fill the pits by bringing soil/sand from another place. The scraper is too attached behind to any tractor.

Drag scappers

- A n earth-digging and transporting device consisting of a crescent-shaped bottomless bucket operated along the ground by a cable between a mast and an anchor.

Box scappers:

- It's used primarily for spreading material like soil or gravel, and for grading, leveling, or backfilling an expansive area of land for a driveway, lawn, garden, building site, etc.

Seed bed preparation/Tillage operations:

Tillage

- Mechanical manipulation of soil to provide favorable condition for proper crop growth is called tillage.
- Soil tillage consists of breaking the compact surface of earth to a certain depth and to loosen the soil mass so as to enable the roots of the crops to penetrate and spread into the soil.

Primary tillage:

- The initial major soil working operation designed to plough the soil deeply to reduce soil strength, cover plant materials and rearrange aggregates is called primary tillage.
- The objectives of primary tillage are
    1. To reduce soil strength
    2. To rearrange aggregates

3. To cover plant materials ,burry weeds and To kill insects and pests

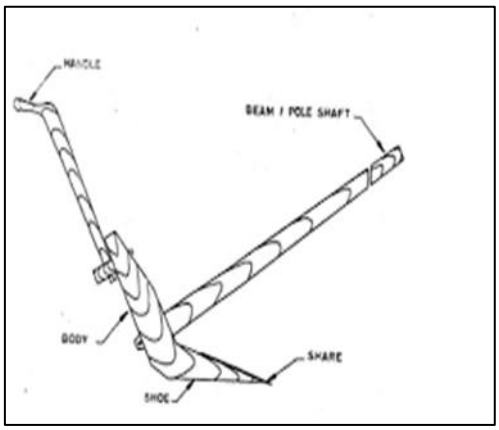
- Implements may be tractor drawn or animal drawn implements.
    - **Animal drawn implements** mostly include indigenous plough and mould-board plough.
    - **Tractor drawn implements include mould-board plough, disc plough, subsoil plough, chisel plough** and other similar implements.

Secondary tillage:

- Lighter and finer tillage operations performed in the soil after primary tillage to create proper soil tilt and surface configuration for seeding and planting are called secondary tillage operations.
- Secondary tillage operations are generally done on the surface soil. They do not cause much soil inversion and shifting of soil from one place to other. They consume less power per unit area compared to primary tillage operations**.**
- The main objectives of secondary tillage are
    - To break the big clods and make the soil surface uniform and levelled as needed for a seed bed
    - To destroy grasses and weeds in the field and To cut crop residues and mix them with top soil
- The implements used for secondary tillage operations are called secondary tillage implements. They include different types of **harrow, cultivators, sweeps, clod crushers, levellers, bund formers , Ridge plough,country plough etc**

Indigenous Plough

- It is an animal drawn plough. It penetrates into the soil and breaks it open.
- It forms V shaped furrows with 15-20 cm top width and 12-15 cm depth.
- It can be used for ploughing in dry land, garden land and wetlands.
- The size of the plough is represented by the width of the body and the field capacity is around 0.4 ha per day of 8 hours.
- Except share all other parts are made up of wood



Mould board Plough:

- It is tractor operated implement and it consists of share point, share, mouldboard, landside, and frog, shank, frame and hitch system.
- The share point is of bar type and is made from high carbon steel or low alloy steel. The share is also made from high carbon steel or low alloy steel.
- Both are hardened and tempered to suitable hardness (about 45 ARC). The working of the plough is controlled by hydraulic system of the tractor. Mould board plough is a primary tillage implement.

Mould board and its types.

1. General purpose:
2. Stubble type:
3. Sod or Breaker type:
4. Slat type:

Disc Plough:

- The disc plough is designed to work in all types of soil for functions such as soil breaking, soil raising, soil turning and soil mixing.

- It is used to open the new fields and to process the stony areas.
- It can be used easily at rocky and rooted areas.
- It is specially useful in hard and dry trashy land conditions and in soils where scouring is a major problem.
- It is being produced with 2-3-4 and 5 bottoms with an option for extra kit for furrow addition.
- **Types:**
    1. Standard Disc Plough
    2. Vertical disc plough

Other Kinds of Ploughs:

Chiesel plough:

- Chisel plough is a common tool to get deep tillage (prepared land) with limited soil disruption.
- The main function of this plough is to loosen and aerate the soils while leaving crop residue at top of the soil.
- This plough can be used to reduce effects of compaction and help to break up the ploughpan and hardpan.

Sub soiler:

- A subsoiler or flat lifter is a tractor-mounted farm implement used for deep tillage, loosening and breaking up soil at depths below the levels worked by moldboard ploughs, disc harrows, or rototillers.

Rotary plough:

- Rotary plows or tillers (sometimes called rototillers) have curved cutting knives mounted on a horizontal power-driven shaft.
- The pronged rotary hoe, a plow used chiefly for seedbed and weed control, works well at high speed.

Secondary Tillage Implements

Harrow: animal or tractor drawn

1. Disc Harrows:
    - Single action
    - Double action
    - Tandem
    - Offset disc

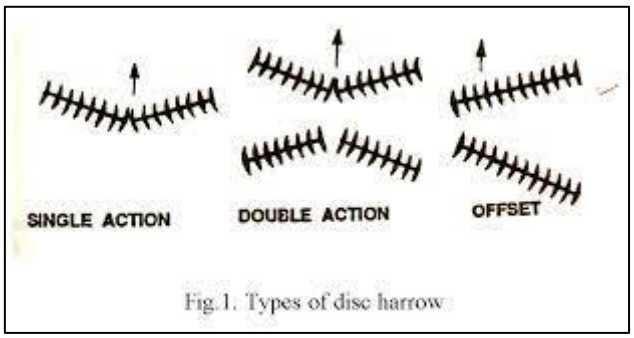


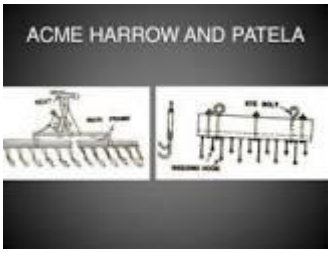
Fig.1. Types of disc harrow

2. Spike tooth Harrow

3. Spring tooth

4. Acme harrow

5. Patella



6. Traingular

Fig.9. Triangular harrow

7. Blade

8. Bodela

9. Power harrow

10. Rotarry tiller

11. Land packer

Other Harrows:

- Roller harrows: Roller harrows look like large spiked tubes and, as the name suggests, are rolled across the soil to help crush the soil and prepare it for seed planting.

- Chain harrows: Chain harrows look like chain nets with spiked attachments. These are run over the surface of the ground to help aerate and spread soil and fertilizer.

- Disc harrows: Disc harrows are the more modern version of spring harrows, and consist of rows of large discs that break up soil and weeds more thoroughly after ploughing.

Rotavator

- Rotavator is nothing but Rotary tiller only with minor changes.
- It consists of a steel frame, 3-point hitch system, a rotary shaft on which blades are mounted, power transmission system and a gearbox.
- The blades are of L-shape, made from medium carbon steel or alloy steel, hardened and tempered to suitable hardness It uses the power from tractor PTO.
- Rotavator is used as both primary and secondary tillage operations. A good seedbed and pulverization of the soil is achieved in a single pass of the rotavator.

- It is used in both dry land and wet land conditions. It is also suitable for incorporating straw and manure in the field. The power requirement will vary depending upon the width of the rotavator.

Sowing:

Sowing methods

Broadcasting:

- In agriculture, gardening, and forestry, broadcast seeding is a method of seeding that involves scattering seed, by hand or mechanically, over a relatively large area. This is in contrast to:
  (a) precision seeding, where seed is placed at a precise spacing and depth;
  (b) hydroseeding, where a slurry of seed, mulch and water is sprayed over prepared ground in a uniform layer.
- Broadcast seeding is of particular use in establishing dense plant spacing, as for cover crops and lawns.
- In comparison to traditional drill planting, broadcast seeding will require 10–20% more seed. It is simpler, faster, and easier than traditional row sowing.
- Broadcast seeding works best for plants that do not require singular spacing or that are more easily thinned later.
- After broadcasting, seed is often lightly buried with some type of raking action, often done using vertical tillage tools. Utilizing these tools increases the success rate of germination by increasing seed-to-soil contact.

Dibbling:

- Dibbling is a method of putting a seed or a few seeds or seed materials in a hole or pit or pocket, made at predetermined spacing and depth with a dibble or planter or very often by hand or by any convenient implements such as spade, hoe etc. and covering them with soil.
- The dibbling method is suitable for wider spaced planted crops requiring a specific area for their canopy development or cultural practices such as weeding, earthing up, and irrigation in furrows.
- Seeds may be dibbled in level fields or on ridges or the sides of the ridges or in localized pits or pockets that form hills, rings, or stations distinctly separated from each other.
- A dibber or dibble or dibbler is a pointed wooden stick for making holes in the ground so that seeds, seedlings or small bulbs can be planted. Dibbers come in a variety of designs including the straight dibber, T-handled dibber, trowel dibber, and L-shaped dibber.

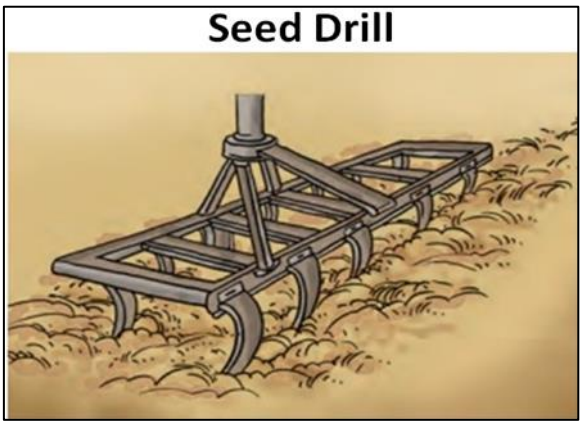
Seed dropping behind the plough:

- It is very common method used in villages wherein, a man drops seeds in the furrow behind the plough. Sowing behind the plough can be done by a device known as malobansa.

- It consists of a bamboo tube provided with a funnel shaped mouth.

Drilling:

- Drilling consists of dropping the seeds in furrow lines in a continuous stream and covering them with soil.
- The spacing between the seeds is not uniform. Seed metering may be done either manually or mechanically.
- This method is very helpful in achieving proper depth of sowing, proper spacing between seeds and proper seed rate.
- Drilling can be done by using seed drills of tractor drawn and animal drawn types.
- Seed drill is a machine used for placing the seeds in a continuous stream in furrows at uniform rate and at controlled depth with an arrangement of covering the seeds with soil.
- In manually metered seed drills a person drops the seeds in the furrows, in mechanically metered seed drills a mechanical device called seed metering mechanism is used to meter the seeds.



Transplanting:

- In agriculture and gardening, transplanting or replanting is the technique of moving a plant from one location to another.
- Most often this takes the form of starting a plant from seed in optimal conditions, such as in a greenhouse or protected nursery bed, then replanting it in another, usually outdoor, growing location.
- This is common in market gardening and truck farming, where setting out or planting out are synonymous with transplanting. In the horticulture of some ornamental plants, transplants are used infrequently and carefully because they carry with them a significant risk of killing the plant

Hill dropping:

- In this method, seeds is dropped at fixed spacing but not in a continuous stream. Unlike drill, the spacing between plant to plant in a row is constant in this method.

Check row planting:

- This method of planting provides uniform row-to-row and plant-to-plant distance.

Weed removal implements

Dry Land Weeder:

- The dry land weeder (peg type) is manually operated weeder suitable for operation between the crop rows.
- It consists of a roller, which has two mild steel discs joined by mild steel rods.
- The small diamonds shaped pegs are welded on the rods in a staggered fashion. The complete roller assembly is made of mild steel.

Power Rotary Weeder:

- Power Weeder is a piece of agricultural equipment or the tool which is popularly being used to carry our farm-based activities mainly it is used to replenish the soil growth by enhancing its fertility.
- A power weeder is a supplementary tillage instrument used in agriculture.

Cono Weeder

- It is a manually operated weeder used to remove weeds in paddy crops. The Cono Weeder is designed for weeding paddy fields.
- The product is manually operated and the weeds are uprooted by the teeth of the weeder and buried in the mud by the push and pull operations.

Hoes:

- A garden tool with a long handle that is used for turning the soil and for removing plants that you do not want

Khurpi

- Khurpi is the most versatile hand hoe for removal of weeds.
- It takes 300-700 man-hours to cover one hectare, depending upon crop, soil and weed infestation.
- The yield is affected to the extent of 20-60% if weeds are not controlled.
- Use of long handle weeders, (wheel hoe and peg type weeders) reduce this weeding time to 25-110 hours per hectare.

Long Handle Weeders

- Hand hoes exert greater strain on the operator because of the short handle which necessitates the operator to do weeding job in bent posture.
- To avoid this nowadays long handles are used in hoes and hence they are called as long handle weeders. The popular long handle weeders available are a) star type weeder b) peg type weeder.
- These weeders are also called as dry land weeders since they are used in dry lands.

Cultivators

- It is an implement used for inter cultivation with laterally adjustable tines or discs to work between crop rows.
- This can be used for seed bed preparation and for sowing with seeding attachment.

Types of cultivators

1. Disc cultivator (It is a cultivator fitted with disc)
2. Rotary cultivator (It is a cultivator with tines or blades mounted on a power-driven horizontal shaft)
3. Tine cultivator (It is a cultivator fitted with tines having shovels.

Types of tractors drawn cultivators:

1.Trailed cultivator

- It consists of a main frame which carries a number of cross members to which tines are fitted. At the forward end of the cultivator, there is a hitch arrangement for hitching purpose.

- A pair of wheels are provided in the cultivator. The life is operated by both wheels simultaneously so that draft remains even and uniform.

2.Mounted Cultivator:

- Tractors fitted with hydraulic lift operate the mounted type cultivators. A rectangular frame of angle iron is mounted on three-point hydraulic linkage of the tractor.
- The cross members carry the tines in two staggered lines.

Tractor Attachments

Ploughs

- A plough is a large tractor attachment that drags behind the tractor, using long blades to cut furrows in the soil. This process not only loosens and turns the soil, but it also helps kill off any surface vegetation that is not intended to be there.
- Three most common types of ploughs:

Mouldboard ploughs:

- Mouldboard ploughs consist of wing-shaped blades, which are specifically designed to cut into and turn the soil.
- This is an ideal type of plough for shallow but thorough soil turning, which is often necessary for land that hasn't been used for crop production for several years.

Disc ploughs:

- Disc ploughs consist of rows of discs that work to turn the soil and cut up weeds.
- These are less common than mouldboard ploughs as they are less effective at turning the soil, but disc ploughs may be more useful for soil that is particularly sticky or rocky.

Chisel ploughs:

- Chisel ploughs consist of exceptionally long shanks.
- These shanks turn the soil at a depth of a foot or more. This is often necessary for land that has been used for consistent crop production.

Tractor

- Tractor is a self-propelled power unit having wheels or tracks for operating agricultural implements and machines .

Classification of Tractors

Tractors can be classified into three classes on the basis of structural design

1. **Wheel tractor** : Tractors having three or four pneumatic wheels are called wheel tractors. Four wheel tractors are popular everywhere

2. **crawler tractor :** This type is also called Track type tractor or Chain type tractor. In such tractors , there is endless chain or track in place of pneumatic wheels.

3. **walking type tractor :** Power tiller is a walking type tractor. This tractor is usually fitted with two wheels only. The direction of travel and its controls for field operation is performed by the operator, walking behind the tractor

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Fertilizer Spreaders

- they spread fertilizer across a field.
- There are multiple types of fertilizer spreaders,
  - **Broadcast spreader:** Possibly the most common fertilizer spreader is the broadcast spreader, which works by taking fertilizer and dispersing it using gravity.
  - **Manure spreader:** Manure spreaders take solid manure from livestock and spread it across a field. This is an easy way of utilizing manure effectively, though the solid manure will often need to be run over with a harrow to break it up and mix it in with the soil.
  - **Slurry spreader**: Liquid manure spreaders are also known as slurry spreaders, which spray a slurry of liquid manure across a field

Seeders

- Seeders, as the name would suggest, are designed to spread seeds across large plots of land quickly and efficiently.
- While small farms may use small mechanical seeders or even hand-seeding methods, tractor-pulled seeders are most commonly used in large-scale farms today.
- There are different machines used in agriculture seeding such as
  - **Broadcast seeders:** Broadcast seeders are also known as seeders or rotary spreaders, and they come in all sizes. These **seeders work by placing seeds inside a hopper.** Inside the hopper, a plate turns, taking seeds in for dispersing across the field. While this method is very effective to plant cover crops and grasses, it is not ideal for garden crops that need more organization, such as to be laid out in rows.

- **Air seeders:** Air seeders are very large seeders **that use compressed air to shoot seeds into the ground.** Though highly effective, air seeders **can only be used on small, round seeds** because of the way they operate, which limits their utility.
- **Box drill seeders:** Box drills are the preferred seeder for most farming operations due to the fact that they are easy to use and work with a wide variety of seed types. These **attachments drill into the soil and drop seeds at a specific depth.**
- **Planters:** Planters are the **most accurate seeders, though they also tend to be the most expensive**. Planters consist of several blades and wheels topped with seedboxes that contain the seeds to be planted. The planter works by cutting into the ground, dropping individual seeds, then closing the ground behind them, all in quick succession.

Other Tractor Attachments

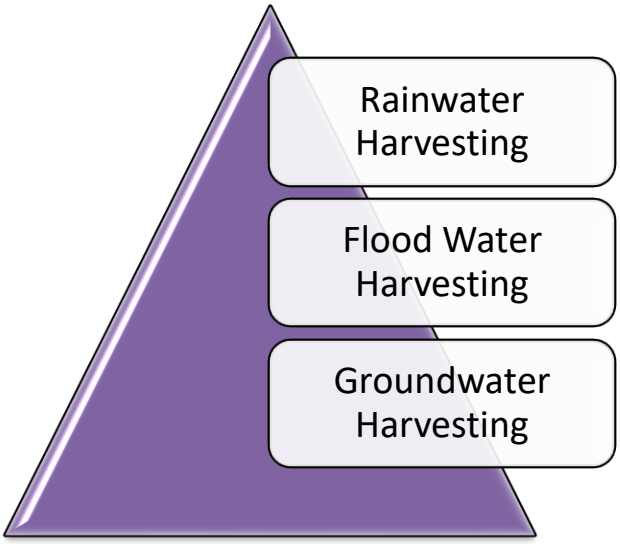
- **Sprayers:** Sprayer attachments can be used to **spray pesticides, fertilizers and other substances across large areas**.
- **Mowers:** cuts (mows) grass or other plants that grow on the ground.There are a variety of mower types to meet a range of farm needs from **grass management to harvesting.**
- **Transplanters:** Tractor-pulled transplanters make transplanting easy by taking large **quantities of growing plants, digging holes for them and depositing them**, all using machinery.
- **Cultivators**: Cultivators are **used for soil cultivation, specifically in the area of weed control.** These are used for shallow tilling and are often used in smaller farming operations.
- **Plastic mulch layers**: For large-scale farms that use methods involving plasticulture, a plastic mulch layer tractor attachment is a necessity. This equipment takes a ream of plastic and lays it flat along the bed using a series of wheels.
- **Rakes:** It is used for gathering hay or grain into piles; for clearing fields, lawns, and yards; and for stirring and spreading soil. Several types of rakes are available as pull-behind attachments, including wheel rakes, parallel-bar rakes, rotary rakes and belt rake

Water Harvesting :

Water harvesting enables efficient collection and storage of rainwater, makes it accessible and substitute for poor quality water. There are a number of ways by which water harvesting can benefit a community.

- Improvement in the quality of ground water,
- Rise in the water levels in wells and bore wells that are drying up,
- Mitigation of the effects of drought and attainment of drought proofing,
- An ideal solution in areas having inadequate water resources,
- Reduction in the soil erosion as the surface runoff is reduced,

Types of water harvesting



Rainwater Harvesting:

Rainwater harvesting is defined as the method for inducing,collecting, storing and conserving local surface runoff for agriculture in arid and semi-arid regions. Three types of water harvesting are covered by rainwater harvesting.

- Water collected from roof tops, courtyards and similar compacted or treated surfaces is used for domestic purpose or garden crops.
- **Micro-catchment water harvesting** is a method of collecting surface runoff from a small catchment area and storing it in the root zone of an adjacent infiltration basin. The basin is planted with a tree, a bush or with annual crops.

- **Macro-catchment water harvesting**, also called harvesting from external catchments is the case where runoff from hill-slope catchments is conveyed to the cropping area located at foothill on flat terrain.

Flood Water Harvesting

- Flood water harvesting can be defined as the collection and storage of creek flow for irrigation use. Flood water harvesting, also known as **'large catchment water harvesting' or 'Spate Irrigation',** may be classified into following two forms:
    - In case **of 'flood water harvesting within stream bed'**, the water flow is dammed and as a result, inundates the valley bottom of the flood plain. The water is forced to infiltrate and the wetted area can be used for agriculture or pasture improvement.
    - In case of **'flood water diversion'**, the wadi water is forced to leave its natural course and conveyed to nearby cropping fields.

Groundwater Harvesting

- Groundwater harvesting is a rather new term and employed to cover traditional as well as unconventional ways of ground water extraction.
- **Qanat systems, underground dams and special types of wells** are a few examples of the groundwater harvesting techniques.
- Groundwater dams like '**Subsurface Dams' and 'Sand Storage Dams'** are other fine examples of groundwater harvesting. They **obstruct the flow of ephemeral streams in a river bed; the water is stored in the sediment below ground surface and can be used for aquifer recharge.**

Water Harvesting Technique/Structures

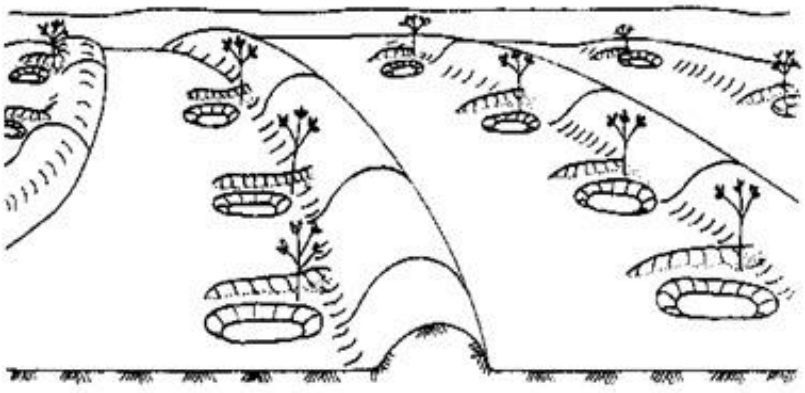
This includes runoff harvesting, flood water harvesting and groundwater harvesting

Runoff Harvesting

Short Term Runoff Harvesting Techniques

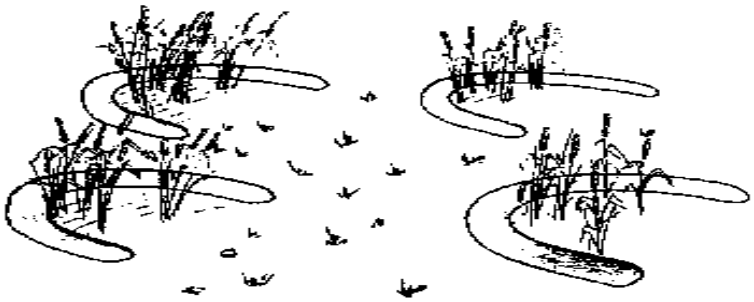
Contour Bunds:

- This method involves the construction of bunds on the contour of the catchment area.These bunds hold the flowing surface runoff in the area located between two adjacent bunds.
- The height of the bund determines the storage capacity of its upstream area.



Semi-circular Hoop:

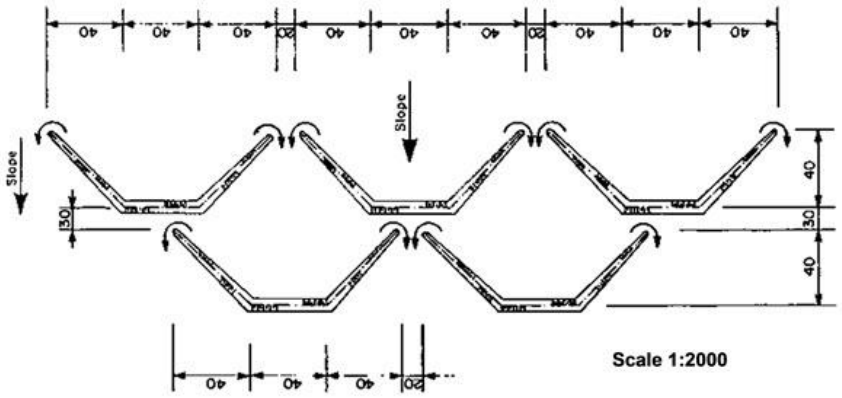
- This type of structure consists of an earthen impartment constructed in the shape of a semicircle.
- The tips of the semi-circular hoop are furnished on the contour.
- The water contributed from the area is collected within the hoop to a maximum depth equal to the height of the embankment.
- The rows of semi-circular hoops are arranged in a staggered form so that the over flowing water from the upper row can be easily interrupted by the lower row.



Trapezoidal Bunds:

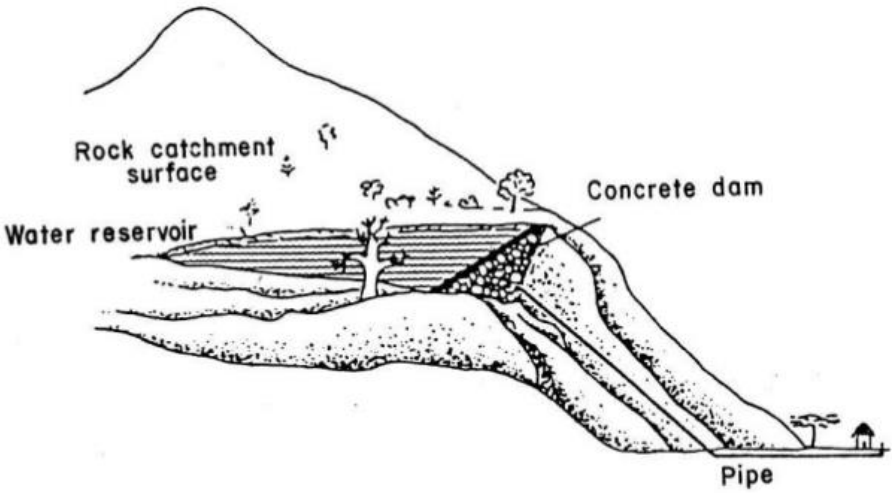
- Such bunds also consist of an **earthen embankment, constructed in the shape of trapezoids.** The tips of the bund wings are placed on the contour.
- The runoff water yielded from the watershed is collected into the covered area. The excess water overflows around the tips.

- In this system of water harvesting the rows of bunds are also arranged in staggered form to intercept the overflow of water from the adjacent upstream areas.
- Trapezoidal bund technique is **suitable for the areas where the rainfall intensity is too high and causes large surface flow to damage the contour bunds.**
- This technique of water harvesting is widely used for irrigating crops, grasses, shrubs, trees etc.



Rock Catchment:

- The rock catchments are the exposed rock surfaces, used for collecting the runoff water in a part as depressed area.
- when rainfall occurs on the exposed rock surface, runoff takes place very rapidly because there is very little loss. The runoff is drained towards the lowest point called storage tank and the harvested water is stored there.



Ground Catchment:

- In this method, a **large area of ground is used as catchment for runoff yield.** The runoff is diverted into a storage tank where it is stored.

- The ground is cleared from vegetation and compacted very well.
- The channels are as well compacted to reduce the seepage or percolation loss and sometimes they are also covered with gravel.
- **Ground catchments are also called roaded catchments. This process is also called runoff inducement.**

Long Term Runoff Harvesting Techniques

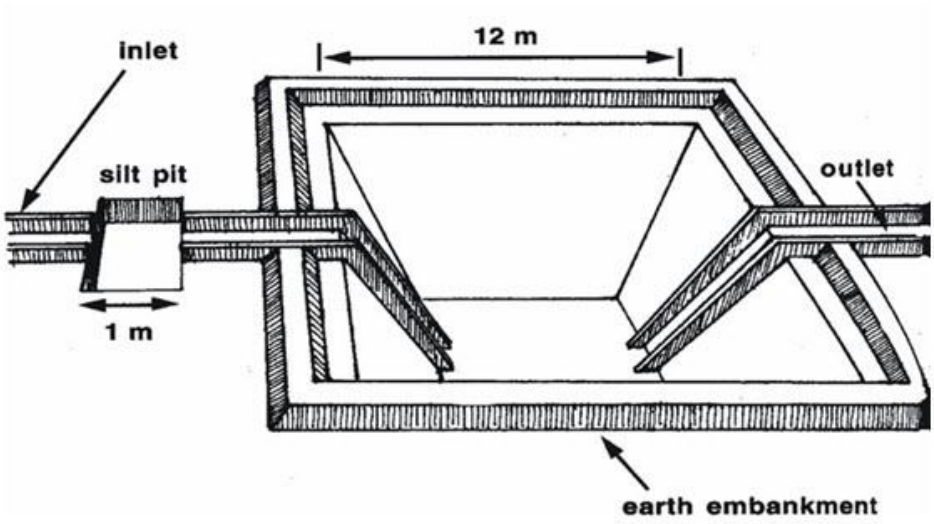
The long term runoff harvesting is done for building a large water storage for the purpose of irrigation, fish farming, electricity generation etc. It is done by constructing reservoirs and big ponds in the area.

The most common long term runoff harvesting structures are

- Dugout Ponds
- Embankment Type Reservoirs

Dugout Ponds:

- dugout ponds are **constructed by excavating the soil from the ground surface**. These ponds may be fed by ground water or surface runoff or by both.
- Construction of these ponds is limited to those areas which have land slope less than 4% and where water table lies within 1.5-2 meters depth from the ground surface .
- Dugout ponds involve more construction cost, therefore these are generally recommended when embankment type ponds are not economically feasible.
- This type of ponds **require brick lining with cement plastering to ensure maximum storage by reducing the seepage loss.**



Embankment Type Reservoir

- These types of reservoirs are **constructed by forming a dam or embankment on the valley or depression of the catchment area**. The runoff water is collected into this reservoir and is used as per requirement.
- The storage capacity of the reservoir is determined on the basis of water requirement for various demands and available surface runoff from the catchment.
- Embankment type reservoirs are again classified as given below according to the purpose for which they are meant.
    - **Irrigation Dam:** The irrigation dams are mainly **meant to store the surface water for irrigating the crops.**
    - **Silt Detention Dam:** The basic purpose of silt detention dam is **to detain the silt load coming along with the runoff water** from the catchment area and simultaneously to harvest water.
    - **High Level Pond:** Such dams are **located at the head of the valley to form the shape of a water tank or pond**. The stored water in the pond is used to irrigate the area lying downstream.
    - **Farm Pond**: Farm ponds are constructed for **multi-purpose objectives, such as for irrigation, live-stock, water supply to the cattle feed, fish production** etc.
    - **Water Harvesting Pond**: The farm ponds can be considered as water harvesting ponds. They may be dugout or embankment type.

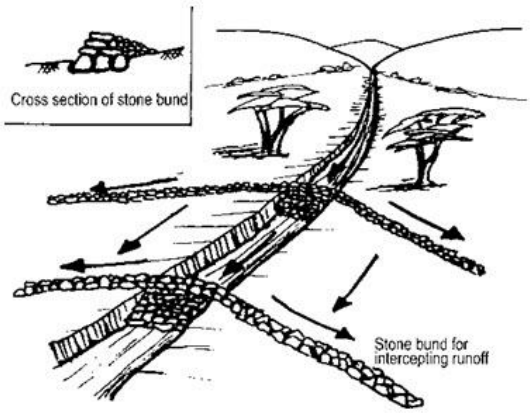
- **Percolation Dam:** These dams are generally constructed at the **valley head, without the provision of checking the percolation loss**. Thus, a **large portion of the runoff is stored in the soil**. The growing crops on downstream side of the dam, receive the percolated water for their growth

Flood Water Harvesting

- To harvest flood water, **wide valleys are reshaped and formed into a series of broad level terraces** and the flood water is allowed to enter into them.
- The **flood water is spread on these terraces where some amount of it is absorbed by the soil** which is used later on by the crops grown in the area. Therefore, **it is often referred to as "Water Spreading" and sometimes "Spate Irrigation**

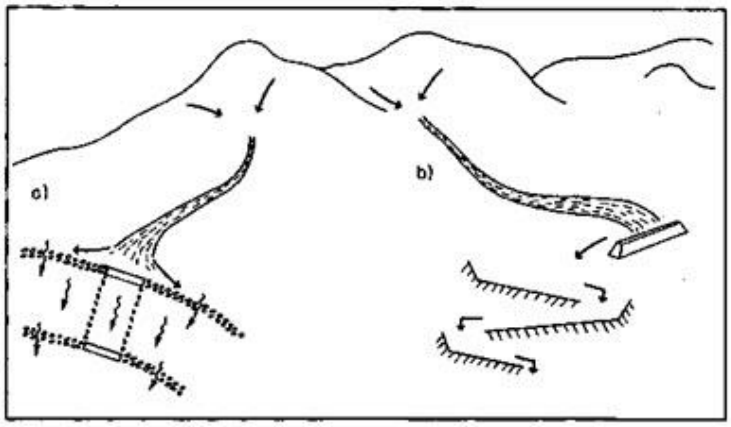
Permeable Rock Dams (for Crops)

- These are long low rock dams across valleys slowing and spreading floodwater as well as healing gullies.
- These are suitable for a situation where gently sloping valleys are likely to transform into gullies and better water spreading is required.



Water Spreading Bunds (for Crops and Rangeland):

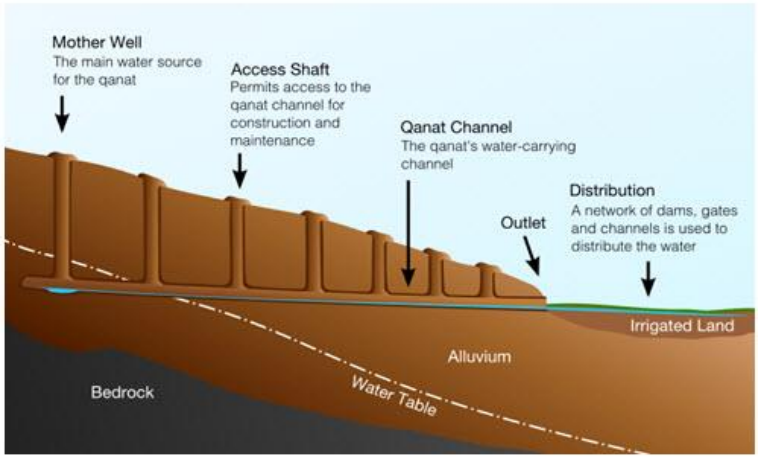
- In this method, runoff water is diverted to the area covered by graded bund by constructing diversion structures such as diversion drains.



Groundwater Harvesting

Qanat System:

- A qanat consists of a long tunnel or conduit leading from a well dug at a reliable source of groundwater (the mother well).
- Often, the mother well is dug at the base of a hill or in the foothills of a mountain range.
- The tunnel leading from the mother well slopes gradually downward to communities in the valley below.



Watershed Development and Management

- The **term 'watershed' refers** to **a topographically distinctive area, which is drained by a stream,** generally implies a small catchment or a basin,
- The 'watershed approach enables a holistic development of an area **involving conservation, regeneration and judicious use of natural resources of the area.**
- **Bali (1980)** suggested an upper area limit of **2,000 km2 for a watershed.**
- According to Bali's classification, watersheds are further classified into 5 categories based on their areas as
    - **macro-watersheds** - with area between 500 and 2,000 km^2,
    - **sub-watersheds'** –with area between 100 and 500 km^2,
    - **milli-watersheds'** –with area between 10 and 100 km^2,
    - '**mini-watersheds' –**with area between 1 and 10 km^2 as well as
    - '**micro-watersheds'** –with area less than 1 km^2.

Scope of Watershed Management

- By delineating the ridgelines in a medium or a large river basin, the **entire basin can be subdivided into a number of watersheds,** each with an area within 2,000 km2.
- Because **of their compact size, it is always easier to manage** watersheds rather than a river basin.
- In a well-managed watershed, all the natural resources such as soil, water, vegetation, etc. are conserved

Nature of Terrain	Improvement Techniques
• Hill tops and upper reaches of watershed	Afforestation
• Steep hill slopes a little lower down	Development of grass lands
• Lower parts of watershed	(i) Contour bunding and terracing of agricultural fields (ii) Contour trenching (iii) Contour cultivation (iv) Strip cropping (v) Gully plugging (vi) Stream bank protection against erosion (vii) Farm ponds (viii) Control & regulation of grazing

Methods used:

- **Contour Trenching :** This consists of excavating shallow/ intermittent trenches across the land slope and forming a small earthen bund on the downstream side.
    - Plantation is done on the bund to stabilize the bund.
- **Controlled Grazing**
- **Bench Terraces:** These consist of **series of platform excavated on the slope**. Depending upon the rainfall conditions and crops to be grown, terraces are constructed flat, sloping inwards and sloping outwards
- **Contour Cultivation :** This consists in **carrying out different agricultural operations like ploughing, planting and inter-culture in horizontal lines across the sloping land.**
    - Such practices help in retaining rainwater and retarding erosion. These measures are effective when land slope is about 2% and less.
- **Strip Cropping**
- **Gully Plugging :** Gullies are a symptom of functional disorder of the land, improper land use and are the most visible result of severe soil erosion.
    - **The gully plugging measures include vegetative plantings and brushwood check dams, boulder bunds**, brick masonry and earthen bunds or a combination of both, sand bag plugs etc.
- **Contour Bunding :** This measure i**nvolves construction of horizontal lines of small earthen or boulder bunds across the sloping land surface**.
    - The bunds act as barriers to the flow of water and at the same time impound water to build up soil moisture storage.
- **Stream Bank Protection :** Eroding stream banks not only damage adjoining agricultural lands but also contribute large quantities of sediment load to the river systems. Under the watershed management programme, bank protection of only small/ minor streams are included.
    - However, works of this nature should only be taken up if the benefits justify the cost of construction.
    - The works usually involved are in the nature of **boulder pitching on banks of about 20-30 cm thickness after dressing the bank to a stable slope**.

Agro Processing

- Agroprocessing industry refers to the subset of manufacturing that processes raw materials and intermediate products derived from the agricultural sector
- the scope of the agro-processing industry encompasses all operations from the stage of harvest till the material reaches the end users in the desired form, packaging, quantity, quality and price.

Organisations dealing with Agro Processing in India

- **APEDA (Agricultural and Processed Food Products Export Development Authority)**
  - It is under Ministry of Commerce and Industry
  - The APEDA **was established by the Government of India under the APEDA Act passed by the Parliament in December,1985**.
  - APEDA is mandated with the responsibility of export promotion and development of the following scheduled products:
    - Fruits, Vegetables and their Products.
    - Meat and Meat Products.
    - Poultry and Poultry Products.
    - Dairy Products.
    - Confectionery, Biscuits and Bakery Products.
    - Honey, Jaggery and Sugar Products.
    - Cocoa and its products, chocolates of all kinds.
    - Alcoholic and Non-Alcoholic Beverages.
    - Cereal and Cereal Products.
    - Groundnuts, Peanuts and Walnuts.
    - Pickles, Papads and Chutneys.
    - Guar Gum.
    - Floriculture and Floriculture Products.

- Herbal and Medicinal Plants.

- **CSIR – CFTRI (Central Food Technological Research Institute)**
    - It is one of **the 42 national research laboratories in India**, **set up under the aegis of the Council of Scientific and Industrial Research (CSIR).**
    - It was opened on 21 October 1950 in **Mysore, Karnataka.**
    - Area of research includes **food engineering, food biotechnology, microbiology**, grain sciences, sensory science, Biochemistry, Molecular Nutrition and food safety.[2]
    - CSIR-CFTRI has developed over 3000 products, processes and equipment designs.

- **Central Institute of Fisheries Technology (CIFT)**
    - It was set **up in 1957 is the only national center in the country where research in all disciplines relating to fishing and fish processing is undertaken**.
    - The institute started functioning at Cochin in 1957

Controlled And Modified Atmosphere Storage

- Controlled atmosphere (CA) and modified atmosphere (MA) storage are technologies for extending the shelf life of foods, especially fruits and vegetables; and for eliminating pests in stored grains and oilseeds.
- The most important application of CA and MA is for long-term storage of apples, but the shelf life of certain other fruits (pears, sweet cherries) and vegetables (cabbage) can also be extended by these methods.
- **The principle** behind controlled and modified atmosphere technologies is **to reduce the rate of respiration, reduce microbial growth, and retard enzymatic spoilage by changing the gaseous environment surrounding the food product.**
    - This is achieved by **reducing the concentration of oxygen (O2),** which is required in respiration, or by **adding an inhibitory gas such as carbon dioxide (CO2) or carbon monoxide (CO).**
- The CA implies a higher degree of control than MA in maintaining specific levels of O2, CO2, and other gases

Advantages include:

- Reduction in chlorophyll breakdown, with resulting higher color stability.
- Reduction in enzymatic browning in cut produce, whenever low levels of O2 are used.
- Improvement in texture caused by the action of CO2 on enzymes acting on cellular membranes.
- Reduction in some physiological disorders induced by C2H4, such as scald of apples and pears and chilling injury of citrus fruits, avocado, chili pepper, and okra.
- Reduction in microbial activity especially molds.

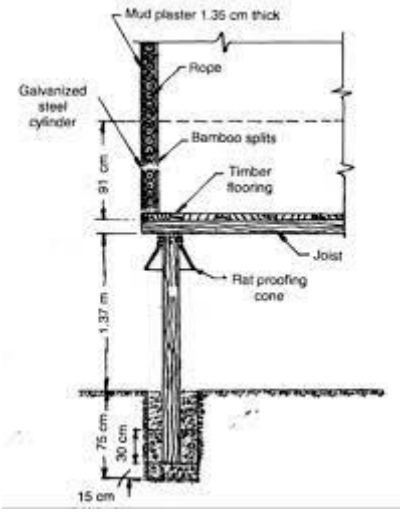
Storage Structures

1. Traditional Storage structures
2. Improved Storage structures
3. Modern Storage Structures

Traditional Storage Structures:

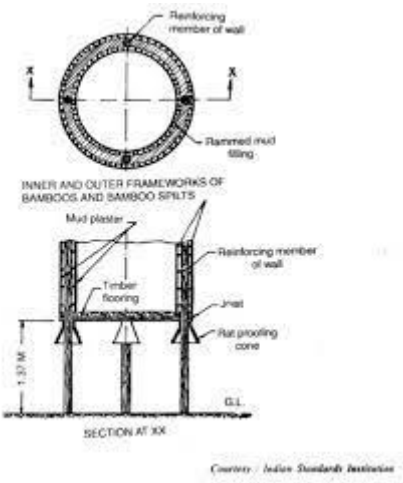
Morai type:

- Morai type storage structures is used for the storage of paddy, maize and sorghum (jowar) in the rural areas of eastern and southern regions of India.



Bukhari type:

- Bukhari type storage structures are cylindrical in shape and are used for storage of sorghum, wheat, paddy, Bengalgram, maize etc.



Kothar type:

- These are used to store paddy, maize, sorghum, wheat etc. Their capacity varies between 9 to 35 tonnes.
- The storage structure is box like made of wood and raised on pillars.

Mud Kothi (Mud bin):

- These storage structures are quite common in rural areas for storage of grains and other seeds.

Muda type

- These are in use for storing grains in the rural areas of Bihar. The capacity of muda varies between 1 to 3 tonnes. It is being made of "Narai" ropes.

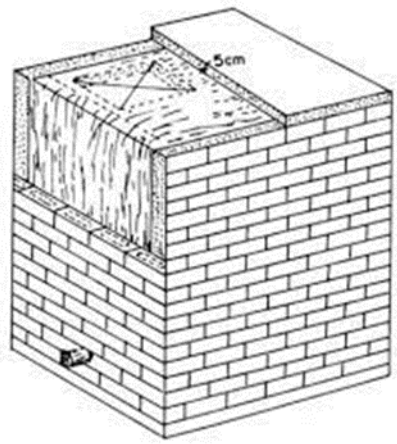
Kanaj type:

- These storage structures are very common in the rural areas of Karnataka and Maharashtra for storage of grains.

<u>Improved Storage Structures:</u>

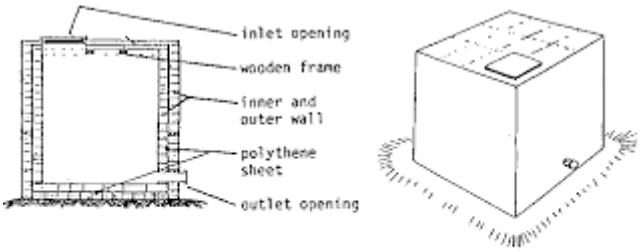
Pusa bin

- It is just like other traditional storage structure and is made of mud. To make this storage structure moisture proof, a plastic film is used on inner side of the bin. A platform of mud bricks is made, first.
- On this platform, a sheet of 700 gauge plastic is spread in such a way that it overlaps the platform on all sides by atleast 6 cm.



Brick and cement bins –

- These storage structures are very strong and therefore, the effect of season on them is negligible. The bin is made on a platform raised at 60 cm above the ground.
- A ladder isprovided on one side of the bin for loading of the grains. A hole of about 60 cm diameter is provided on the roof for the purpose of loading the material i.e. grains.



Source: Bodholt and Diop (1987)

Bunker storage

- The structure is used for long term storage of a larger volume of grains. The structure is successful as a means of storing grains safely, securely and economically.

CAP' Storage structures –

- The 'CAP' is used for cover and plinth storage. The word plinth is means plinth from the bottom and cover means cover from the top. This type of open storage is considered as intermediate storage and serves the purpose of storage of food grains in bags for short period.
- This type of storage facility is cheaper as compared to conventional bag storage godowns.

Modern Storage Structures:

Silo type of storage structures

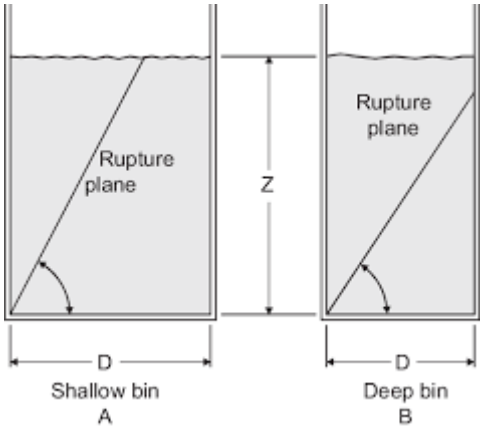
- The modern facilities for **storing grains in bulk are 'silo'**. Silos are constructed from steel or reinforced concrete.There are a cluster of adjoining silos in any modern large capacity processing plant
- The **advantages of modem storage bins are**,
    - less expensive and easier handling and quality control,
    - lesser space requirement,
    - savings of cost of bags,
    - provision of automation and mechanization for quicker handling and maintaining quality of stored product,
    - protection from losses due to birds and rodents.
- These silos are generally circular with conical bottom. Bulk storage bins for storing grains can be made from reinforced concrete, plain or corrugated galvanised sheet, mild steel black sheet, aluminium sheet, fibre glass, brick, ferro cement, asbestos sheet etc.
- But in India mild steel bins and R.C.C. bins are quite common.

Shallow bins:

- A grain bin referred to as a shallow bin when the depth of grain is less or equal to the equivalent diameter.
- The equivalent diameter is taken as four times the hydraulic radius of the bin. Hd < 4R .

Deep bins

- A grain bin referred to as a deep bin when the depth of grain is greater than the equivalent diameter.
- The equivalent diameter is taken as four times the hydraulic radius of the bin. Hd >= 4R , Where Hd is depth of grain.



Farm Silos

- Farm silos is a farm structure used to store and protect the animal fodder so that it is preserved in an ideal condition for farm animals.
- Animal fodder is cut and packed in the air tight silo to allow a partial fermentation to occur. The storage fodder is known as silage.

Tower silos

- Cylindrical Shape and made of masonary, wood or metal
- Cost of construction is comparatively much higher than that of horizontal type.

Shed (Warehouses) or Go downs

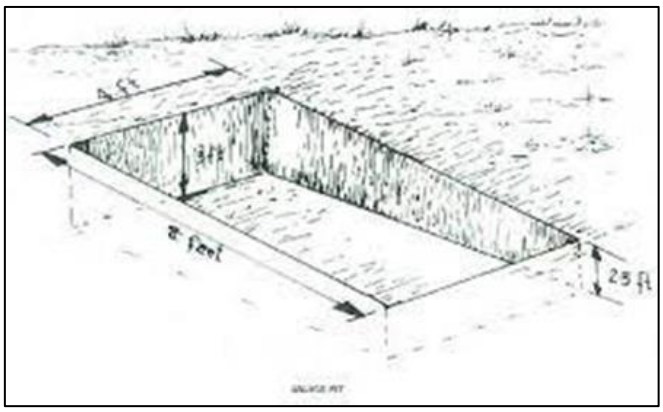
- A **horizontal shed has been used to provide low- cost, large volume storage.**
- Very large volume sheds have also been constructed by **Food Corporation of India (FCI) for** storing grains and other products. **Sheds are usually made of steel or corrugated sheet construction with flat concrete floors.**
- Roofs have to be supported on a network of purlins and rafters.
- Belt conveyors are often used in bulk sheds for loading and unloading grains.

Horizontal silos

- In horizontal silos pit type, bunker type and trench or stake type of storage structures used for storage of animal fodder.

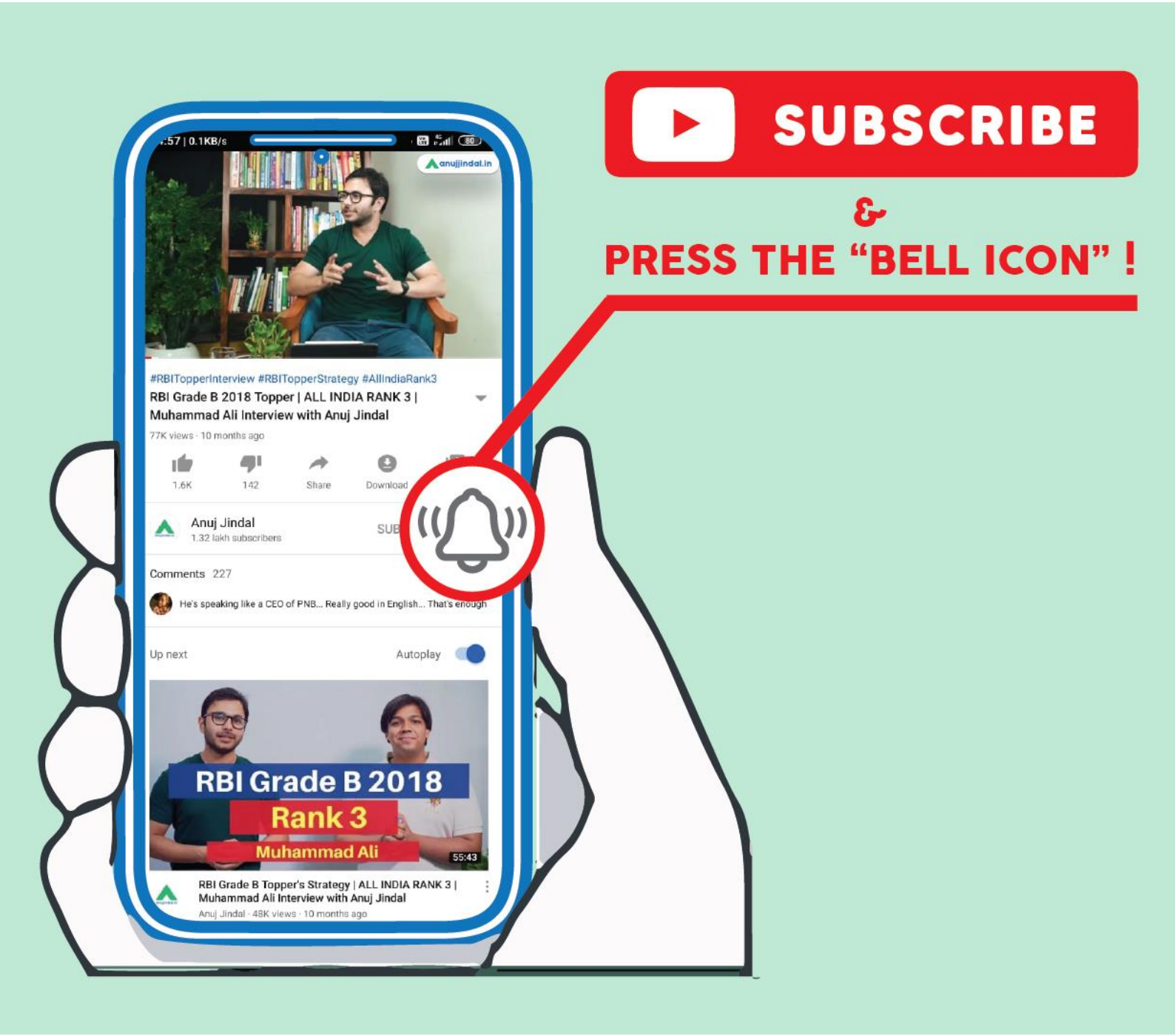
Pit Silos

- Permanent pit silo is a circular deep well which is lined all around the side, and sealed from bottom, so that water may not rise in to it.
- Made in areas where the soil is deep and the water table is very low



Trench Silos

- A trench often dug into a bank or slope, sometimes lined with concrete, and used mostly in regions of low rainfall for making and storing silage.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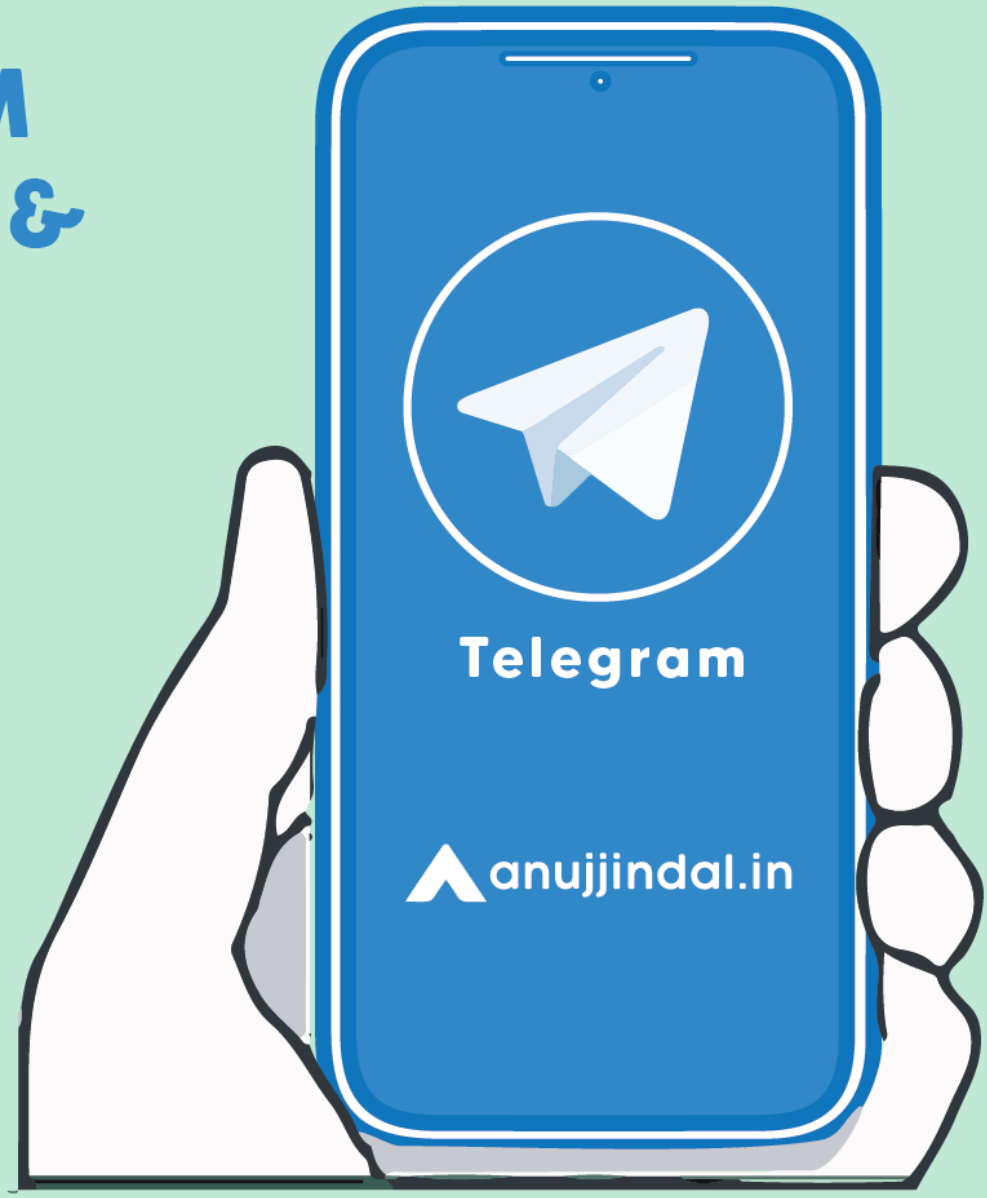

HALL OF FAME

All Indian Rank 01
Rajendran S
SEBI

All India Rank 03
Ali
RBI

All India Rank 06
Aditya Sood
RBI

All India Rank 10
Sameer
RBI

All India Rank 11
Abhishek
RBI

Cleared RBI Grade B
Sanskar Vijay

Cleared RBI Grade B
Sanjay Meena

Cleared RBI Grade B
Yash Gupta

Cleared RBI Grade B
Ila Sahu

Cleared RBI Grade B
Argha Banerjee

Cleared RBI Grade B
Suchana Ghosh

Cleared NABARD
Vinay Verma

Cleared NABARD
Lal Chand Kumar

Cleared NABARD
Krishna Kumar Singh

Cleared NABARD
Anshu Goel

Cleared NABARD
Jatin Kumar

Cleared NABARD
Atul Yadav

Cleared SEBI
Abhishek Kumar

Cleared SEBI
Vishwanidh Singh

Cleared SEBI
Gopika Jayan

Cleared SEBI
Vasant Kesari

Cleared SEBI
Swetha Bodagala

NET with 98 Percentile
Anushka Keshri

JRF with 96.92 Percentile
Vaishali Jadon

NET with 89.27 Percentile
Srishti Gupta

JRF with 72 Percentage
Abhishek Mohanty

NET with 68 Percentage
Dinesh Mohan

JRF with 64.66 Percentage
Adhwaresh Pandey

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