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1.0 What is Dryland agriculture

- The **Dry land farming** refers to growing of crops entirely under rainfed conditions.
- Dryland agriculture is the agriculture which limits the crop **growth to a part of the year due to lack of sufficient moisture**.
- This farming is practiced in the dry parts of India, such as western half of India is characterized by dry climate where arid and semi-arid conditions prevail.
- The **average annual rainfall** in these areas is less than 75cm and the isohyet of 75 cm annual rainfall marks its eastern boundary.

- **65 percent of the cultivated area** in Indian agriculture comes under dryland, which contributes about **40 per cent of the total food production** and plays a critical role in India's food security.
- Dryland Agriculture accounts for 83% of coarse cereals, 80% of pulses, 73% of oilseeds, 70 % of cotton production in India and supports 60% of livestock.
- **Degraded soils with low water holding capacities along with multiple nutrient deficiencies and depleting ground water table** contributes to low crop yields and further leading to land degradation.
- The success of dryland farming depends on the efficient use of the little moisture that is trapped in the soils of crop fields for growing crops, and also the wise selection of crops that will suitably adapt to the farming conditions of dryland farming.



2.0 Salient features of Dry farming

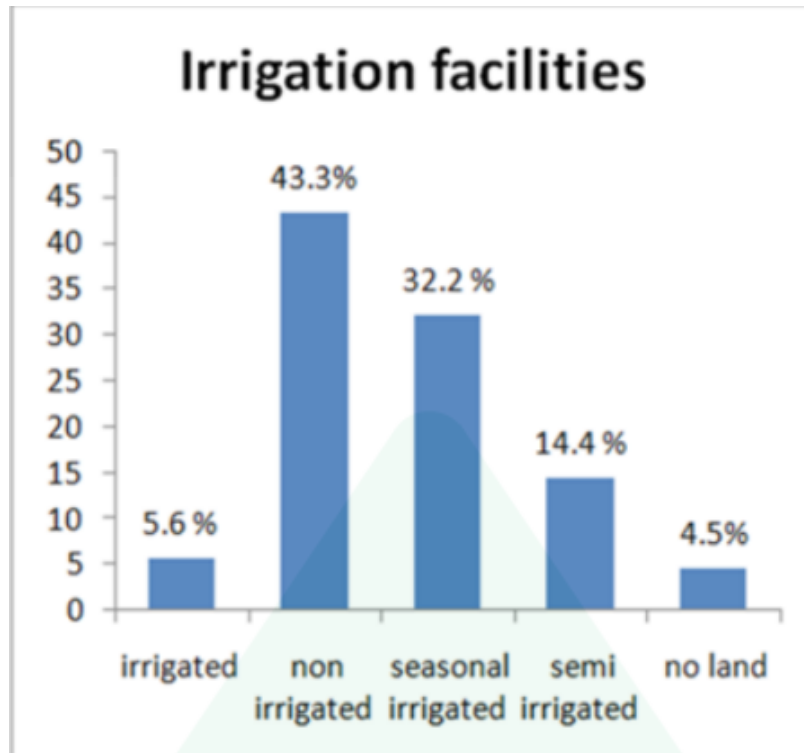
a. Dry Climate

- Areas with 25-50 cm of annual rainfall have semi-arid climate which suffer from deficiency in humidity throughout the year (8 months).
- Rainfall less than 75 cm and it is erratic and unreliable.
- E.g. Jaisalmer and Barmer districts of Rajasthan receives less than 25 cm of annual rainfall and are completely dry areas.
- Problem of water scarcity, scanty rain and shortage of water.
- Variability of rainfall is very high which varies from 20 to 60 percent.
- Seasonal rainfall occurring in 3-4 months leaving 8-9 months dry.
- Late arrival of monsoon and early retreat of monsoons increase unreliability of rainfall. Break in monsoon is also harmful for crops. There is almost complete failure of crops in event of drought.



b. Lack of Irrigation

- Most of areas have dry weather and have to depend on rainfall only. Punjab, Haryana and western parts of U.P. have canal and tube well irrigation facilities.
- However, keeping in the view of the change in the cropping pattern (introduction of rice cultivation) and high level of agricultural intensity, irrigation facilities in these areas are found to be inadequate.
- Rajasthan does not have any major river flowing through its territory and ground water is also brackish. Indira Gandhi Canal taken from confluence of Sutlej and Beas which has provided irrigational facilities to western parts of Rajasthan. This has increased the agricultural productivity and cropping pattern.
- Similarly, most parts of South India are made up of hard rocks and lack in ground water resources. Sinking of tube wells is also difficult in hard rocks. Hence, tanks are major source of irrigation. These tanks dry up during the dry season, and fail to provide water when the crops need it the most.



c. Subsistence Agriculture

- Dry farming is mainly practiced by small and marginal farmers who work in the field along with their family members.
- The agricultural production is just sufficient to feed the family members of the farmer and there is not much surplus for sale in market. These farmers lack financial resources and are not able to buy modern inputs like better seeds, fertilizers and farm machinery.
- They have to face hunger, starvation and unemployment whenever there is any drought.



3. Methods of Dry Farming

- Field is ploughed repeatedly in order to conserve moisture in the soil. This process is necessary especially during the raining season so that rainwater can be utilized properly.
- Fallowing of land for recuperation of soil fertility: Soil fertility is reduced when cultivation is continued for number of years. This problem becomes serious particularly in the background of farmer's inability to make use of fertilizers and manures.
- Pulverization of soil is done before sowing. This process converts soil into small particles which permits easy flow of water in the soil and plant roots find ample opportunity to grow in strength and support the plants.
- Hoeing, weeding and pruning are done at regular intervals. Functions of these practices are-
 1. **Hoeing** allows air to enter the soil space and helps in plant growth. It is generally done before sun-rise so that night dew can enter soil and provide moisture to plants.
 2. Through **weeding**, unwanted plants in the fields are removed and pressure on the soil to feed the plants is reduced.
 3. **Pruning** removes unwanted plants and find ample opportunity to grow.
 - Land is usually covered with straw to reduce evaporation of the soil moisture and to control soil erosion by the wind.
 - In the order to improve their income level, the farmers keep themselves engaged in allied agricultural activities such as livestock keeping and dairying.

4. Important characteristics of dryland farming

Characteristics of dryland farming includes-

- a. Low agricultural productivity,
- b. High degree of vulnerability to vagaries of nature,
- c. Instability in output,
- d. Complete dependence on rains,
- e. Application of traditional agricultural methods.

5. Significance of Dryland Farming

- Dryland is agriculturally dominant region wherein more than two-thirds of total population (against national average of 54.6%) depends on the agriculture.
- Here, agriculture occupies 65% of total area while 2.9% of the total geographical area is

occupied by permanent pastures.

- Although this region is plagued with large number of problems like scanty rainfall, inadequate irrigation, lack of basic inputs like better seeds, fertilizers and farming machinery, etc. as well as widespread poverty among the farmers, yet this region accounts 85% of pulses production of the country.
- This region also produces 75% oilseeds, 80% maize and 95% jowar and bajra in India. About 40% food grains of India, are also produced by this type of agriculture.
- There has been change in the cropping pattern of this region. Farmers have started to give priority to main food grains like wheat and rice which has adversely affected the production of pulses and oilseeds. India has to spend huge amounts of foreign exchange on the imports of oilseeds.

6. Types of Dryland Agriculture

Depending on the amount of rainfall received, dryland agriculture has been grouped into three categories:

A. Dry Farming

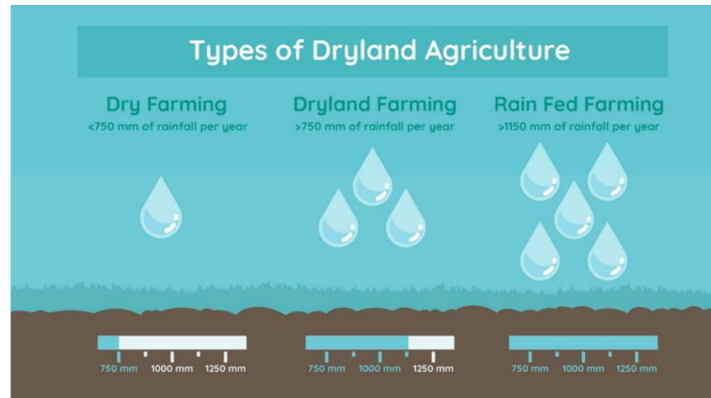
- i. Annual rainfall is less than 750 mm.
- ii. It is generally practiced in arid regions of the country
- iii. Crop failures are more frequent under dry farming condition owing to prolonged dry spells during crop period.
- iv. Moisture conservation
- v. Alternate land use system
- vi. The growing season is less than 75 days.

B. Dryland farming

- i. Annual rainfall above 750 mm to 1150mm.
- ii. The growing season is less than 200 days.
- iii. Semi-arid regions are included under this category.
- iv. Dry spell during crop duration occurs, but crop failures are less frequent.

C. Rainfed farming

- i. Areas receiving more than 1150 mm rainfall,
- ii. Sub-humid and humid areas are included under this category.
- iii. Here chances of crop failure and water stress are very less.
- iv. Emphasis on Water harvesting and Drainage.
- v. The growing season is more than 200 days.



7. Geographical Distribution of Dryland Agriculture in India

- i. Rajasthan plateau region
- ii. Saurashtra Region of Gujarat
- iii. Marathawada, and Vidharbha Region of Maharashtra,
- iv. Bundelkhand
- v. Most Part of Northern and Central India
- vi. Deccan Plateau
- vii. Rainshadow Zone of Western Ghats
- viii. Tamil Nadu Highlands

8. Comparison Study of Dry farming, Dryland Farming and rainfed farming

Particular	Dry Farming	Dryland farming	Rainfed Farming
1. Rainfall/annum(mm)	<750	750-1150	>1150
2. Moisture availability	Acute shortage	Shortage	Enough
3. Crop growing Seasons	<75 days	75-120 days	>120 days
4. Growing regions	Arid	Semi-arid	Humid
5. Cropping Systems	Single crop/Inter crop	Single crop/Inter crop	Inter/multi cropping
6. Dry spells	Most common	Less frequent	No occurrence
7. Crop failure	More frequent	Less frequent	Rare
8. Constraints	Wind erosion	Wind/water erosion	Water erosion
9. Measures required	Moisture conservation practices	Moisture conservation practices and drainage of vertisols	Proper drainage

9. Problems of Dryland Agriculture

a. Rainfall

- Low rainfall which are **unevenly distributed, highly erratic and uncertain**.
- The crop production in drylands is mainly dependent on the **frequency and intensity of rainfall** making it a less productive.
- Sometimes due to late onset of monsoon, the sowing of crop is delayed resulting in poor yields.

b. Soil

- Low moisture holding capacity, coarse soil texture.
- Large areas are covered by sandy soil which lacks in nutrient materials for soil fertility.
- Deficient in macronutrients like nitrogen and phosphorous, low fertility.
- Excessive runoff due to further deteriorates soil nutrient status and prone to soil erosion.
- Yields are low and crops are susceptible to pests and diseases.

c. Infrastructure

- Large areas of dry farming lack basic infrastructural facilities like market, transport, storage, refrigeration etc.
- The farmers are forced to opt for distress sale in the absence of these facilities and fail to get remunerative prices for their products.

d. Extensive agriculture

- Prevalence of monocropping extensively makes farm lands lack of nutrients and result in reduction of yield.

e. Occurrence of drought

- The extensive climatic hazards are seen in drylands as the soils are weak and can be subjected to environmental stress to a higher level, leading to further land degradation.
- Drought is a common scenario in drylands as water availability is less further leading to low productivity.

- Lack of moisture and inadequate irrigation facilities.

f. Quality of Crop Produce

- Grain is of inferior quality due to underdevelopment.
- Plant growth is also affected, often termed as stunted. This results in less fodder production and farmers get less return on their produce from the market.

g. Marketing Problems

- The crops grown in a particular region are usually similar. When similar crops are grown, all mature at the same time and a large quantity of produce reaches the market leading to glut in the markets.
- This situation is severely exploited by the traders and the middlemen in the markets.
- The issue of marketing turns out to be a big problem in dryland agriculture.

h. Poor economy of farmers

- Economic status of farmers is low in drylands, due to the less choice of the crops that are grown in these areas.
- Few crops have the adaptability to grow in arid or dryland conditions.
- Majority of the farmers are poor and cannot afford costly inputs like better seeds, fertilizer, farm mechanics etc.

10. Solutions for problems related to Dryland farming

A. Contingent Crop Plans

1. Inadequate and Uneven Distribution of rainfall

- Rainfall is low and highly variable which results in uncertain crop yield.
 - Distribution of rainfall during the crop period is uneven, receiving high amount of rain when it is not needed and lack of it when crop needs it.
- a. Cultivation of low water required crops.
 - b. Short duration crops grown.

- c. Providing life-saving irrigation.

2. Long Gap in Rainfall

- Increase in seed rate to obtain more population.
- Spraying of urea solution.
- Providing life-saving irrigation at critical growth stages.
- Weeding and intercultural operations.

3. Early Onset of Monsoon

- Cultivate pearl millet, Sesamum etc.

4. Late Onset of Monsoon

- Sowing of crops is delayed resulting in poor yields.
- Alternate crop and varieties: Castor (Aruna), green-gram, cowpea, sunflower.
- Dry sowing/Kurra sowing
- Pre-Sowing
- Seed soaking/treatment
- Transplanting of one month old bajra seedlings
- Complete weed control
- Grow legumes/oilseed crops in the place of cereals
- Most suitable crop for this condition is sunflower

5. Early Cessation of rains

- Sometimes the rain may cease very early in the season exposing the crop to drought during flowering and maturity stages which reduces the crop yields considerably.
- a. Select short duration varieties
- b. Using mulching/ mulches
- c. Life-saving irrigation applied
- d. Decrease in plant population

6. Prolonged Dry Spells

- Long breaks in the rainy season is an important feature of Indian Monsoon. These intervening dry spells when prolonged during crop period reduces crop growth and yield and when unduly prolonged crops fail.
- If dry spells in 10 days of sowing, resowing.
- If mild moisture stress at 30-35 days after sowing, thinning of alternate rows of Sorghum and pearl millet.
- If severe moisture stress at 30-35 days after sowing, cutting of sorghum and pearl millet & rationing.
- If moisture stress at booming stage, cutting of sorghum and pearl millet & rationing.
- Breaking of monsoon for short, while shallow inter cultivation for eradicating weeds/soil mulch.
- Wider spacing for moisture conservation.
- Spray of 2 percent urea after drought period is useful for indeterminate crops like castor, pigeon-pea, and groundnut.

B. Developing Strategies

Following development strategies may be undertaken for developing dry farming.

1. Conservation and Optimum use of Water Resources

- The greatest problem faced by dry farming is scarcity of water resources.
- Water present in soil can be saved by deep and surface ploughing.
- In kharif crops, deep ploughing breaks deeper layers of soil where rainwater can easily percolate. Besides, it is useful for sowing and weeding.
- Surface ploughing is useful for rabi crops because it plays an important role in conservation of soil moisture.
- Wastage of water through runoff can be avoided by contour bunding, embankment and dams. Efforts should also be made to arrange for rainwater harvesting for which government and non-government organizations can be of greater help.

2. Reducing Evaporation Losses

- Soil moisture is the most limiting factor in dryland agriculture. It is lost as evaporation from the soil surface and as transpiration from the plant surfaces.

Use of Mulches:

1. About 60 to 75 percent of the rainfall is lost through evaporation. These evaporation losses can be reduced by applying mulches.
2. Mulch is any material applied on the soil surface to check evaporation and improve soil water.
3. Application of mulches results in additional benefits like soil conservation, moderation of temperature, reduction in soil salinity, weed control and improvement of soil structure.



3. Checking Soil Erosion

- Soil erosion by strong winds is serious problem in areas of dry farming because loose particles of soil are easily blown away by wind.
- Important strategies that can be adopted to solve this problem are planting trees in rows so that they can act as obstruction to blowing wind, making sand dunes stable by plantation and ploughing along the contours.

4. Drought resistant crops

- Drought resistant crops can be encouraged so that effect of drought conditions is minimized.
- Early maturity crops can also be helpful in this regard.
- Better quality seeds like mustard, maize, barley, wheat and some pulses have responded very well to arid and semi-arid conditions in these areas.

5. Use of weedicides and Pesticides

- Proper arrangement should be made to use the weedicides and pesticides to save the crops from weeds, pests and diseases.

- However, care should be taken to replace these chemicals by eco-friendly bio-technical materials.

6. Proper areal Distribution of crops

- It can go a long way in increasing the farm productivity and safeguard against vagaries of climate.
- For e.g., crops requiring more moisture such as rice should be grown in lower parts of catchment areas of tanks and reservoirs.
- Cotton should be confined to areas more dependable on rainfall and areas where sprinkle irrigation is available.
- Crops like sunflower, mustard should be popularized in areas of scarce rainfall.

7. Diversification of crops

- It is better to go for crop diversification rather than choosing a few selected crops.
- This can solve the twin problem of uncertainty of weather and soil degradation.
- If one crop is destroyed due to unsuitable weather conditions, the other crop may compensate for the loss.
- For e.g., Legumes can be grown along with food grains.

8. Use of manures

- Majority of the farmers in dry farming areas are poor and cannot afford to purchase costly chemical fertilizers.
- Under such conditions, the farmers should be encouraged to use cow dung and other biological manures.
- This will economize agricultural inputs and also save environment from pollution.

C. Alternative land planning use

Following two alternative land planning strategies are suggested to avoid crop failure and to increase income of farmers.

- Encourage agro-forestry and devote large areas to legumes.
- Develop grazing lands and social forestry in marginal lands and in cultivable wastes.

Government Schemes

The Government has initiated the following schemes to develop dry farming:

- It forms an important part of the 20-point programme.
- Identification of 4,609 micro-watersheds has been done for comprehensive and systematic development covering an area of about 35,45,000 hectares.
- Each micro-watershed covers an area of about 1000 hectares.
- The programme includes scientific management of rain water, land development, use of drought resistant seeds, plantation of trees, and development of animal husbandry and allied activities.
- As many as 46 model watersheds have been identified for development as focal points.
- A pilot project, taken up with assistance of World Bank, envisages the development of identified watersheds about 25 to 30 thousand hectares in Madhya Pradesh, Maharashtra, Andhra Pradesh, Telangana and Karnataka.
- Crops requiring less moisture such as maize, sunflower, soyabean, mustard, and coarse grains are being promoted in rain shadow areas of Karnataka.
- A national waterlogging area development plan was initiated during the Seventh Five-year Plan in 99 selected districts of 16 states.
- Agro-forestry, agro-horticulture and silvi-pasture, etc. have been initiated by the government for alternative land use systems.

Some other practices

1. Reducing Transpiration Losses

About 99 per cent of the water absorbed by the plants is lost in transpiration. If transpiration is controlled, it may help in maintenance of favorable water balance.

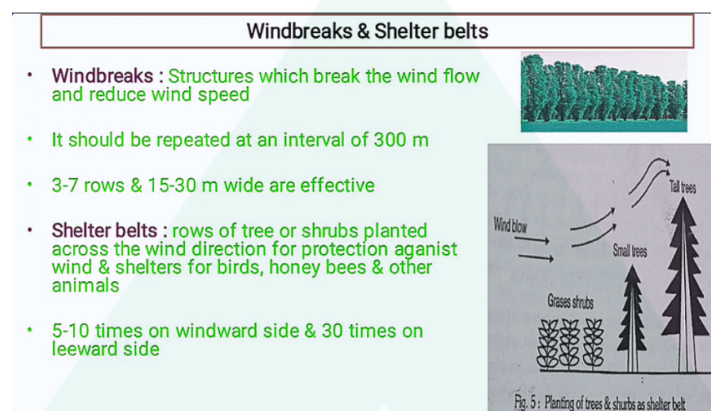
Anti-transpirants: Anti-transpirants is any material applied to transpiring plant surfaces for reducing water loss from the plant. These are of four types:

- **Stomatal Closing:** Fungicides like phenyl mercuric acetate (PMA) and **herbicides** like atrazine in low concentrations serve as anti-transpirants by inducing stomatal closing.
- **Film forming:** Plastic and waxy materials which form a thin film on the leaf surface retard the escape of water due to formation of **physical barrier**.
- **Reflective:** These are **white materials** which form a coating on the leaves and **increase the leaf reflectance (albedo)**.
- By reflecting the radiation, they **reduce leaf temperatures** and **vapor pressure gradient** from leaf to atmosphere and thus reduce transpiration.

- **Growth retardant** : These chemicals **reduce shoot growth and increase root growth** and thus enable the plants to resist drought.

2. Windbreaks and Shelterbelts

- **Windbreaks** are any structures that obstruct wind flow and reduce wind speed while **shelterbelts** are rows of trees planted for protection of crops against wind.
- Due to reduction in wind speed, evaporation losses are reduced and more water is available for plants. The beneficial effect of shelterbelts is seen more clearly in drought years.



3. Weed Control

- Prompt weed control eliminates the competition of weeds with crops for limited soil moisture.

4. Others

- **Improved crop varieties** should be used , which can withstand stress.
- Soil conservation by **contour bunding, terracing, land levelling** and also by practicing **conservational tillage** (zero tillage and minimum tillage).
- Practice of **drip irrigation** to save water.
- Agronomic practices like **mixed cropping and crop rotation** which increase the yield of crops need to be practiced.
- **Integrated nutrient management** need to be practiced with special emphasis on use of **bio-fertilizers to maintain the soil fertility**
- **Alley cropping, pasture management, tree farming, silvi-pastoral management systems and agro-horticultural system** which are more relevant to dryland situations

have to be adopted for successful dryland farming system.

11.0 Institutes related to Dryland farming

Important Institutes	About
CRIDA – Hyderabad	Central Research Institute for Dryland Agriculture (CRIDA) is a National Research Institute under the Indian Council of Agricultural Research (ICAR) established in 1985 with a mandate to carry out basic and applied research in rainfed farming. This is the lead Institute and the National Nodal point for the National Innovations in Climate Resilient Agriculture (NICRA) which is being implemented at large number of Research Institutes of ICAR, State Agricultural Universities and 100 KVVKs.
NRRA – Delhi	NRRA was established IN November 2006 as an expert body of Ministry of Agriculture to provide the much-needed knowledge inputs regarding systematic up-gradation and management of country's dry land and rainfed agriculture
ICRISAT – Hyderabad	The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is an international non-profit organization that undertakes scientific research for development. The vision is to have a prosperous, food secure and resilient dryland tropics.
IRI- Roorkee	Irrigation Research Institute (IRI) was established to carry out Research and Development work under the aegis of the U. P. Irrigation Department in the year 1928 as a small research unit in Lucknow. The success of this small unit was duly acknowledged and in 1945 activities were expanded. The expanded unit was shifted to <u>Bahadurabad</u> (Roorkee) in 1946.

12.0 Length of Growing Period

- A period in which the available soil moisture is enough to meet the evapotranspiration requirement of Dryland crops and hence dry land productivity is assured.
- The length of growing period is given as 'G' with starting and ending of length of growing period in terms of Meteorological standard weeks.

Length of Growing Period (LGP)	Crop Status
< 5 weeks	Crop failures will occur
Minimum of 14 weeks	Permit the dry land crop to attain its potential productivity
14 weeks	A single Dry land crop can be cultivated
14 to 20 weeks Suitable inter cropping system can be cultivated	Suitable intercropping systems can be cultivated
>20 weeks	Long duration crop/double crop can be cultivated

Characteristics of Dry farming Ecozones

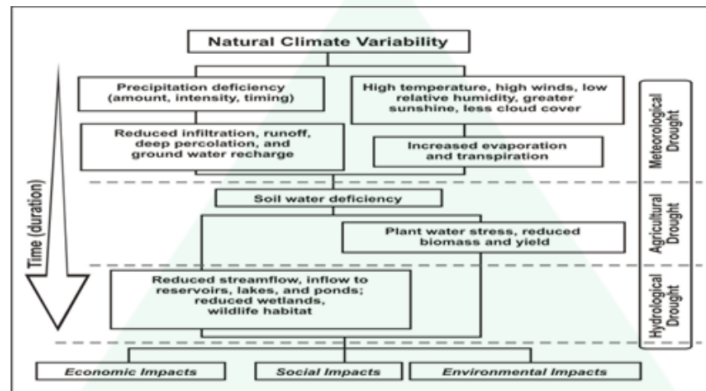
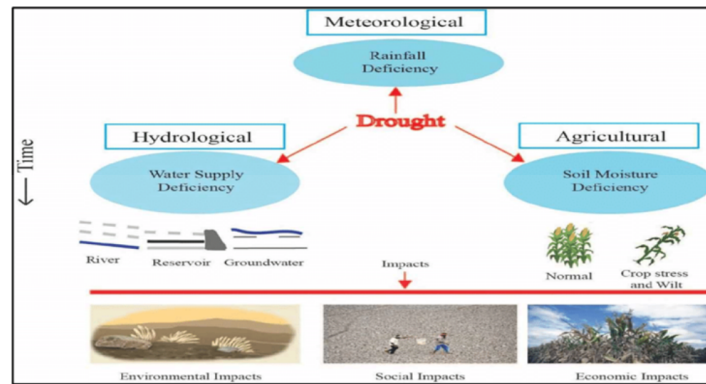
Dry Farming Ecozones	Their characteristics			
	Rainfall	LGP	Soil	Cropping Pattern
1. <u>Arid-subtropics</u>	350	0-90	<u>Aridisols</u>	Single short duration crop
2. <u>Semi-arid tropics</u>	500-700	90-180	<u>Alfisols, vertisols</u>	Inter/mono cropping
3. <u>Semi-arid sub tropics</u>	900	120-180	<u>Alfisols, vertisols and Entisols</u>	Intercropping
4. <u>Semi-humid tropics</u>	1200	210-300	<u>Alfi, verti, Enti and Inceptisols</u>	Inter/Double cropping
5. <u>Bi-model rainfall area both season</u>	>700	-----	<u>Alfi and Vertisols</u>	Double cropping

13.0 Drought

- The moisture deficit which results when the amount of water vapor available in the soil is not sufficient to meet the demand of potential evapo-transpiration.
- Drought is a situation occurring in any areas in a year when annual rainfall is less than 75% of the normal.
- Severe Drought: > 50% rainfall deficiency than normal.

Types of Droughts

- **Agricultural Drought:** When soil moisture is not sufficient to meet the PET demand of the crop. This drought occurs when water shortage significantly damages or destroys agricultural crops.
- **Hydrological Drought:** Drought refers to low water supply in our rivers, lakes, acquies and other reservoirs that often follows meteorological drought.
- **Meteorological Drought:** Refers to extended period of dry weather patterns.
- **Agricultural Drought:** Drought occurs when water shortage or scarcity significantly destroys the agricultural crops.
- **Environmental Drought:** Widespread ecological damage caused due to loss of soil moisture.
- **Socio-Economic Drought:** Water shortage affecting supply and demand of drought commodities such as water, food grains and fish.
- Drought area: 20% of the year drought occur.
- Chronic Drought area: > 40% of the year.



Drought condition initiate:

1. Accumulation of proline
2. Synthesis of ABA
3. K and Mg deficiency occurs

Remedies:

1. Spraying of 2 percent DAP
2. Foliar spray of 0.5-1 percent KCl
3. Use of Anti-transpirants
4. Foliar spray of 500 ppm CCC

Anti-transpirants

- Any material applied to transpiring plant surfaces for reducing water loss.

1. Stomatal closure type	2,4-D, Atrazine, PMA, Phosphon D, Potassium meta-bisulphate, methanol 10%
2. Film Farming type	Thin- Hexadecanol, Cetyl alcohol, Paclobutrazole Thick- Mobileaf, Waxol, S-800, Hico-1100R, Follicot, Silicon
3. Reflectant type	Kaoline (5%), China Clay, Calcium bicarbonate, Lime Water
4. Growth retardant type	Cycocel (CCC), Phosphor

Different Index's:

Different Index	
1. Moisture Availability Index (MAI) =	$\frac{\text{Rainfall at 50\% probability}}{\text{PET}}$
2. Aridity Index =	$\frac{\text{Water Deficit}}{\text{PET}} \times 100$
3. Moisture Deficit Index =	$\frac{\text{Precipitation} - \text{PET}}{\text{PET}} \times 100$
4. Thronthwaite Moisture Index =	$\frac{\text{Percent probability of Actual evaporation}}{\text{PET}}$

14.0 Crop adaptations in Dry conditions

A. Escaping Drought

1. Ephemeral crop

- Growing such crops completes their cropping cycle in a short duration.
- They grow normally in favorable conditions, but under abnormal conditions, they go dormant.
- Seed inhibitors – e.g. Sorghum CO16
- Seed tolerance

2. Early maturing variety

- Pigeon pea variety- UPAS 120

B. Drought resistance

1. Drought Avoidance

- Plant physiology is less affected.
- Conserve water (Water saver)
 - a) Stomatal mechanism
 - b) Increased Photosynthetic efficiency-c4/c3 plants- Co2 affinity
 - c) Low rate of cuticular transpiration-aloe vera
 - d) Lipid deposit on leaves- sorghum
 - e) Reduced leaf area
 - f) Leaf morphology-eg,- thorns, cuticle and spines
 - g) Effects of Awns-wheat
 - h) Water storage in plants-pineapple
- Improve water uptake (Water spender)
 - a. Root development- pulses: deep-root system
 - b. Root shoot ratio- root length/shoot length
 - c. Increased plant osmotic potential- xylem

2. Drought Tolerance

- Plant physiology is changed or affected
- Mitigation of stress
- High degree of tolerance

Drought tolerance- Tolerance of plant to level of stress at which 50% cells die or 50 % cell reduce.

1. Mitigating stress-

- Resistance to dehydration
- Prevention of cell collapse
- Osmotic Adjustment

2. High degree of Tolerance-

- Metabolic Strain (Co2 and N2 metabolism)
- Plastic strain (tissue loss)

15.0 Watershed Management

Watershed	Catchment area
•Natural unit of land whose runoff collects & flows out of the area through common outlet into a river other water body	•It comprises of all the areas from which water flows out into a common river or waterpool
•Smaller area	•Larger area
•Same unit for both land and water	•Separate units

•It is rational utilization of land & water resources for optimum production with minimum hazards to the environment

•Integrated approach to natural resource management

- Launched in 7th FYP
- Collaboration of Dept of agriculture and ICAR
- 1983 programme accelerated
- World Bank developed 4 watersheds

Watershed types

1. Sub-watershed
2. Micro-watershed

Features

1. **Soil and Water Conservation measures-** This includes Soil survey, land reclamation, repairing old bunds and dams, contour, and bunding.
2. **Scientific dry farming-** This includes Deep ploughing, integrated pest and nutrient management, mulching, etc.
3. **Forest and Pasture development-** This includes timber, teak, grasses and legumes, etc.
4. **Animal Husbandry and dairy development**

Aims and Objectives

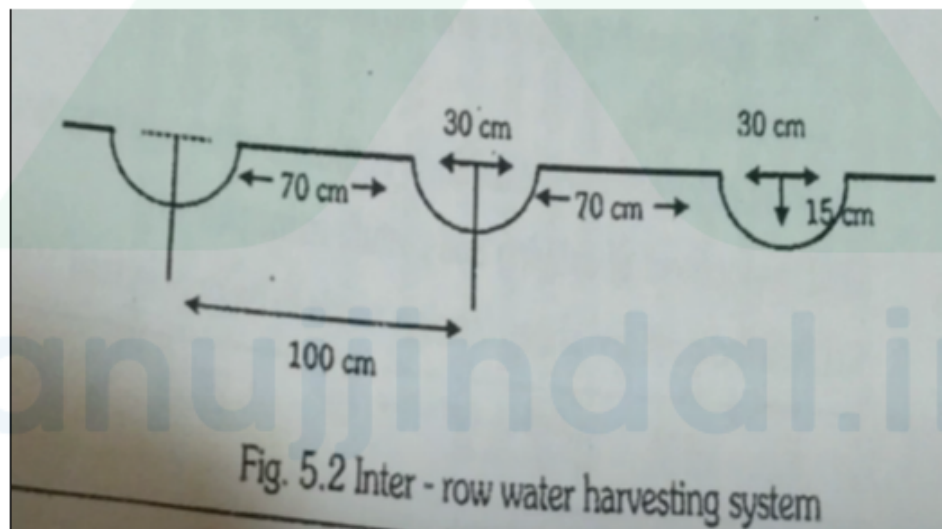
1. Land resources
2. Water resources
3. Natural resources

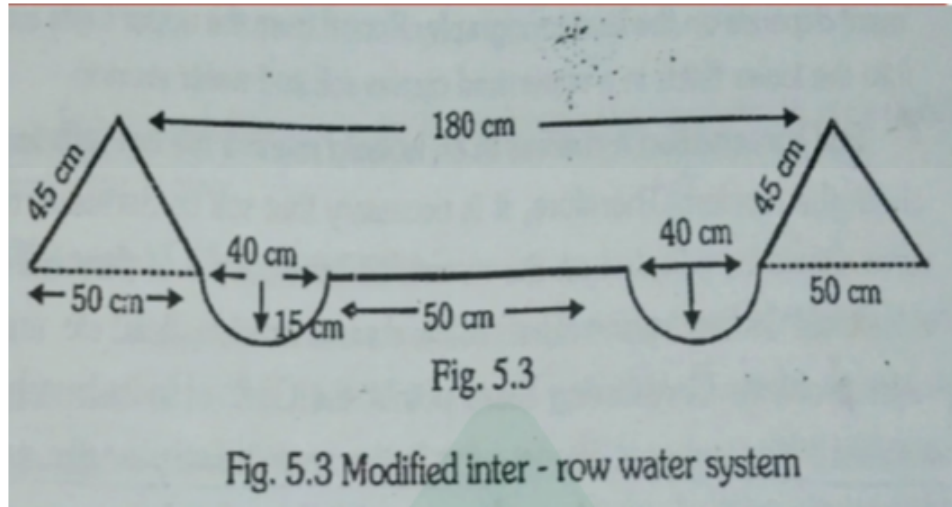
Measures

1. Water harvesting
2. Crop production technology

3. Afforestation
4. Horticulture practices
5. Use of groundwater and irrigation
6. Dairy and pasture management
7. Sericulture
8. Processing units
9. Extension and training programs

Water Harvesting	
- Defined as collection and storing water on the surface of soil for subsequent use - Term water harvesting was used by Myers - Hilly areas or bare soil with small portion of cultivation	
TYPES	
Water Harvesting Techniques	Features
Inter-row Water harvesting	- Arid region (rainfall less than 400-450 mm) - Artificial miniature watershed
Inter-plot or microplot Water harvesting	- High rainfall areas - Furrows prepared
Water harvesting in farm ponds & reservoirs	- Surface runoff from small watershed stored - Life saving or supplemental irrigation





Other methods to control runoffs

1. Asphalt: A chemical and water-repellent material with a lightweight structure that does not dissolve in water and controls seepage
2. Bentonite: It is an absorbent swelling clay consisting mostly of montmorillonite which has good sealing properties.
3. Plastic films or metal sheets
4. Broad Bed and Furrow systems: Excess water collected in furrows and passed to farm ponds or reservoirs.

anujjindal.in