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Understanding Agricultural Droughts and Effective Management Strategies

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Introduction

Drought is a disaster in slow motion covering large areas. It is characterized by deficient supply of moisture due to sub-normal rainfall or irregular distribution of rainfall or higher water need due to high temperatures or combination of all the three factors. Lack of rains over extended period of time affecting various human activities, results in widespread crop failure, unreplenished ground water resources, depletion in lakes/reservoirs, etc. As drought affects many economic and social sectors, quite good number of definitions has been developed by various disciplines. There are about more than 60 definitions available in later alone. Thornthwaite (1948) characterized four types of drought such as permanent, seasonal, contingent and invisible. He further described that drought as a condition in which the amount of water needed for transpiration and direct evaporation exceeds the amount that is stored in the soil. Broadly droughts are categorized into four types, viz., meteorological, hydrological, agricultural and socio-economic.

- ***Meteorological drought*:** It is a situation when there is significant decrease (> 25%) of normal rainfall over an area.
- ***Hydrological drought*:** Meteorological drought, if prolonged, will result in hydrological drought with marked depletion of surface water and consequent drying up of reservoirs, lakes, streams and rivers, cessation of spring flows and also fall in ground water level.
- ***Agricultural drought*:** It occurs when soil moisture and rainfall are inadequate during growing the growth season to support a healthy crop growth to maturity and resulting in extreme crop stress and wilting.
- Consecutive droughts prevailing over a region result in decline in food reserves, environmental degradation and will lead to famines, which are an extreme on the

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hunger continuum caused, by poverty and lack of food.

Drought Classification:

India Meteorological Department (IMD) classified drought as an occasion when the rainfall for a week is half of the normal or less, when the normal weekly rainfall is above 5 mm or more. If such 4 consecutive weeks occur from middle of May to October, it is considered as agricultural drought. Seasonal drought is considered when the seasonal rainfall is deficient by more than twice the mean deviation. The Drought Research Unit of IMD at Pune have categorized drought on the basis of rainfall departures. A year is considered as drought year whenever rainfall is less than 75 per cent of its normal. If the deficiency is more than 50 per cent of its normal it is considered as severe drought. It further classified the regions as drought areas and chronic drought areas depending upon the frequency of occurrence of deficit rainfall conditions. From the analysis of annual and southwest monsoon rainfall departures for about 500 stations in the country, drought prone areas have been identified and present below:

Drought prone areas: Gujarat, Rajasthan, Punjab, Haryana, West Uttar Pradesh and West Madhya Pradesh, Madhya Maharashtra, Interior Karnataka, Rayalaseema, South Telangana and parts of Tamil Nadu, a small portion of NW Bihar and adjoining east Uttar Pradesh, a small portion of NE Bihar and adjoining portion of West Bengal.

Chronically drought affected: West Rajasthan and Kutch areas

Causes of Droughts:

Drought is a regional manifestation of a general climatic fluctuations associated with the abnormal atmospheric circulation patterns. Following factors may lead to Drought.

1) **Climatic factors:** As drought is the outcome of low rainfall it is mainly dependent on amount of rainfall, and its spatial and temporal distribution. Drought can occur even the amount of precipitation is normal but its distribution is not normal. The other factors, which influence the drought, are temperature and solar radiation. High temperature and solar radiation leads to high evaporation losses, which creates water scarcity and may lead to drought.
2) **Extraterrestrial forces:** There is an 11 year cycle in the variation of annual mean sunspot number. There are some evidences that sunspot activities influence the heat budget at earth and can lead to erratic distribution of rainfall.
3) **Cropping pattern:** Cropping pattern greatly influence the drought conditions. High water demanding crops such as rice and sugarcane require that underground

water to be used for crop growth and development. If underground water is exhausted it may exaggerate the drought conditions.

4) **Social and cultural practices:** There are some region where local societies protect the natural ecosystem and forest covers, on the other hand there are some regions in which people uses natural resources extensively. Forest cover in general is helpful for precipitation.
5) **Volcanic activities:** The injection of large amount of ash and dust into the atmosphere, by violent volcanic activity may alter earth's heat balance and thereby create compensating circulation adjustments, which include climatic fluctuations resulting in drought.
6) **Atmospheric composition:** Changes in the atmospheric composition e.g. water vapor, CO2 and O3 would modify the heat balance of the earth and in turn would produce fluctuations in large-scale circulation pattern resulting in drought.
7) **Interaction in earth-ocean-atmospheric complex:** The enormous heat storage capacity of the ocean and obvious energy exchanges that take place between the atmosphere and the oceans make air-sea interaction a likely cause of climate fluctuations.
8) **Climate change:** It is evident from the historical climatic records that climatic changes are taking place. There is a tendency of global warming. The warming of globe will require lots of water for evaporation and may lead to deficiency of water in soil. Temperature will also increase the water holding capacity of the air.
9) **Human activities:** The recent climate change is the result of human activities specially after the starting of industrial era. There is steep growth of automobile industries, which is responsible for increasing concentration of carbon mono-oxide (CO) and CO2 in the atmosphere. The growth in other sectors is also responsible for altering composition of atmosphere.
10) **Population:** There is great water demand for the domestic uses due to increasing population. When load of population on earth increases it increases water scarcity in two ways:
    i. By using precipitated water which in general is used for crop and ground water recharge.
    ii. By constructing building on land thereby decreasing the are of active infiltration and ground water recharge.

Impacts of Droughts:

One of the sectors where the immediate impact of drought is felt is agriculture. With the increased intensity or extended duration of drought prevalence, a significant fall in food production is often noticed. Drought results in crop losses of different magnitude depending on their geographic incidence, intensity and duration. The droughts not only affect the food production at the farm level but also the national economy and the overall food security as well. Droughts thus have multiplier effect on agricultural production. Their impact is felt during the subsequent years also due to:

1 Deficit in ground water recharge
2 Non-availability of quality seeds,
3 Reduced draught power for agricultural operations due to distress sale of cattle,
4 Land degradation
5 Fall in investment capacity of farmers, rice in prices, reduced grain trade, and power supply

Drought Management Strategies

Five distinct categories of drought effecting crop production in dryland were clearly distinguished in India depending upon the time of occurrence of drought and general climatic conditions of the region. Some of the drought management strategies for these situations are listed below:

1. Early season droughts

The early season droughts occur due to delay in commencement of sowing rains. Sometimes, early rains may occur tempting the farmers to sow the crops followed by a long dry spell leading to withering of seedlings and poor crop establishment. Management of early season droughts in any agro-climatic region requires precise information on:

I. Optimum sowing periods for different crops / varieties grown in the region under rainfed conditions and the cut off dates.
II. Quantum of rainfall adequate to complete the sowings in a given region as per recommended planting schedules.
III. Initial amount of rainfall / soil moisture storage required for safe germination and establishment of crop stand to minimize the effect of dry spells immediately after sowing.

The management options to cope up with early season drought are:

I. Raising a community nursery for cereal crops and transplant the seedlings with the starting of the rainy season.
II. Sowing of alternate crops / varieties depending upon the time of occurrence of sowing rains.
III. If there is poor germination and inadequate plant stand, it is better to resow the crop. If the dry spell after sowing is brief, gap filling is also advocated.

2. Mid-season droughts

Mid-season droughts occur in association with long gaps between two successive rain events if the moisture stored in the soil falls short of water requirement of the crop during the dry period. During certain times, the mid-season droughts may be associated with low and inadequate rainfall in the growing season to meet the crop water needs as per its phenological stage.

Therefore, the strategies to cope up with mid-season droughts aims at increase the total soil water available to the crop either through short term measures like weed control and mulching or through long term measures like land configurations.

3. Late season or terminal droughts

If the crop encounters moisture stress during the reproductive stage due to early cessation of rainy season, there may be rise in temperature hastening the process of crop maturity. The grain yield of crops is highly correlated with the water availability conditions during the reproductive stage of growing (Ramana Rao et al. 1983, 1984). Short duration high yielding varieties may escape late season droughts. Another possibility is to provide supplementary irrigation through rainwater harvesting and recycling. Organic mulches were found to be useful. When crops are grown late under rainfed conditions, terminal drought can be anticipated with greater certainty. Therefore, varieties which respond better under terminal droughts have to be referred.

4. Apparent droughts

While rainfall in a region may be adequate for one crop, it may not be so for others. One very good example is that of paddy grown in uplands of the sub-humid regions of India. If there is failure of rainfall in these areas, the water received through rainfall may not be adequate for paddy. Instead of paddy, some other crops like maize, sorghum, fingermillet, etc. can be grown with success in uplands. Therefore, apparent droughts are encountered due to mismatching of the crops in relation to water availability patterns in some of the area.

5. Permanent droughts

Permanent droughts are associated with inadequacy of rainfall /soil moisture to meet the water requirement of the crops during most of the years. In the arid and even in some of the semi-arid dry tropical regions, the rainfall is assured for a very a short period of 6-8 weeks or less. In these regions, crops are grown for subsistence, although the rainfall is not adequate to grow even a short duration crop of 60 to 80 days. Thus, droughts are most common and frequent in some of the regions, thus qualifying themselves to be called s drought prone areas. In the areas with light textured soils, alternate land use systems have been introduced for sustainability of

production and stability of income. In the regions with better soils where post-rainy season cropping is practiced, assessment of soil moisture will guide the choice of crops. Drought proofing through judicious and integrated management of natural resources is necessary in highly drought prone areas.

The crop based strategies that will help to mitigate drought:

1. **Land planning systems:**

- ⊡ Some lands can only sustain limited cultivation because they are prone to drought. These are best used for alternate uses rather than normal food grain crops.

Some examples of alternate crops you can grow are:

- Growing of short duration legume crops, like mungbean (green gram), cowpea etc.
- Establishing perennial grasses for livestock farming
- Alley-cropping, Agroforestry or Silvipasture practices.

2. **Soil management techniques:**

- Tillage during the off-season or in pre-rainy season, helps with rain water intake.
- This allows water to seep to the deeper soil layers and keeps the soil wet for longer time.
- Tillage also controls weeds which depletes the soil moisture.
- Off-season tillage also destroys the eggs, cocoons and larvae of some pests by exposing them to the sun.

3. **Crop management techniques:**

Selection of crops

- Avoid growing of drought prone crops like maize, cotton etc.
- Growing drought resistant grain crops like sorghum, pearl millet, finger millet etc.
- Growing drought resistant legume crops like pigeonpea, green gram, horse gram etc.
- Growing of oil seed crops like castor, sunflower, niger, sesame, safflower etc.

Intercropping practices

A few examples of suitable intercropping systems under drought are

- ➢ Sorghum and Pigeon pea
- ➢ Pearl millet and Pigeon pea
- ➢ Pearl millet and Cowpea
- ➢ Sunflower and Horse gram

Plant Density

It is important to keep optimum plant population and row spacing. Generally wider plant spacing is preferred in drought prone areas.

Weed management

- Weeds compete with crops for soil moisture and nutrients.
- Weeds also hosts some pests and diseases.

Surface mulching

- Reduce water evaporation from soil.
- Reduces water runoffs from the cropped fields.
- Help to control weeds.

4. **Integrated Nutrient management (INM)**
   - Increases water holding capacity of the soil.
   - Increases the amount of nutrients in the soil.
   - The soil will be free from disease causing organisms.
5. **Integrated watershed management (IWM):**

These approaches are:

- Soil and water conservation
- Rain water harvesting
- Efficient land and crop management

6. **Other water management techniques**
   - Building masonry storage tanks and reservoirs.
   - Building earth percolation ponds to store rain water.
   - Building check dams
   - Rooftop rain water harvesting.

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