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AI 3019

SUSTAINABLE AGRICULTURE AND FOOD SECURITY

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UNIT - 1

SUSTAINABILITY OF NATURAL RESOURCES

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Land Sparing: This strategy focuses on intensifying production on existing agricultural land to reduce the need to convert more natural habitats into farmland. This approach requires high yields and careful management to avoid ecological damage.

Land Sharing: This approach combines agricultural production with conservation by promoting biodiversity within farmland itself, such as through integrated pest management, organic farming, and habitat restoration alongside crops.

7. Climate Change and Sustainability

Adaptation to Climate Change: With the increasing population and the impacts of climate change, land used for agriculture will face new challenges such as altered weather patterns, droughts, and floods. Sustainable agriculture involves adapting to these changes while maintaining productivity and conserving natural resources.

Carbon Sequestration: Sustainable farming practices like agroforestry, reduced tillage, and organic farming can help capture and store carbon in soils, helping mitigate the impacts of climate change.

8. Social Equity and Land Access

Land Ownership and Access: Sustainable agriculture must also consider social and economic factors. In many parts of the world, unequal land distribution can lead to food insecurity and poverty. Policies promoting equitable access to land and resources are essential for achieving food security in a growing population.

Supporting Small Farmers: Many small-scale farmers, particularly in developing countries, are critical to global food production. Supporting these farmers through sustainable practices, access to education, and fair land policies can help ensure food security for a growing global population.

3. Land utilization

Land utilisation in agriculture refers to the way we use land resources for farming purposes. It's a critical concept that helps us understand how much land is used for agriculture globally and how efficiently we're using these resources. According to the Food and Agriculture Organization (FAO), approximately 38% of the Earth's land surface is used for agriculture. This includes both cropland and pastures for livestock.

Efficient land utilisation is crucial for several reasons:

i. **Food Security:** Proper land use ensures we can produce enough food to feed the world's growing population.
ii. **Environmental Conservation:** Optimizing land use can help reduce deforestation and preserve natural habitats.
iii. **Economic Stability:** Agriculture is a significant economic driver in many countries, making efficient land use vital for economic stability.
iv. **Sustainable Development:** Proper land utilisation contributes to sustainable development goals, balancing human needs with environmental conservation.

4. Net Area Sown

The net sown area is defined as the land area which is used for cropped land once a year and is under consideration is known as the net sown area. The net sown area varies from area to area or state to state.

India, being primarily an agricultural economy, has a large proportion of its land under cultivation. However, the net sown area in India has remained relatively stable over the years, with some fluctuations based on seasonal conditions, cropping patterns, and water availability.

Total Net Sown Area: India's total net sown area as of recent years is around 140 to 145 million hectares, which is approximately 45-50% of the total geographical area of the country.

Net Sown Area in Tamil Nadu:

The net sown area in Tamil Nadu is approximately 5.5 to 6 million hectares, which constitutes around 20-22% of the state's total geographical area. This is a significant portion, as agriculture remains a key sector for employment and livelihood in the state.

5. Cropping pattern

Cropping pattern is the spatial representation of crops rotations, or the list of crops that are being produced in an area and their sequence in time. In India, it has historically been influenced by a range of factors including climate, soil type, and water availability. In recent years, shifts in consumption patterns and marketing conditions have played an increasingly significant role.

Changes in Cropping Pattern in India:

1. **Demand of protein rich food increase:** Led to rise of soyabean cultivation.

2. **Demand for meat and dairy increasing:** Shift towards commercial fodder crop cultivation.
3. **Preference of chemical free food:** Rise in area under organic and natural farming.
4. **Push for more nutritious food:** Increasing area under horticulture crops.
5. **Demand for exotic food:** Growth of hydroponies, and aeroponics crops.

6. Land Degradation:

- Land Degradation

1. Physical
2. Chemical
3. Biological

Physical degradation	Physical degradation is erosion, soil organic carbon loss, change in soil's physical structure-e.g. compaction, waterlogging. Globally soil erosion is the most important land degradation process resulting in removal of topsoil. Soil productivity is depleted through reduced rooting depth, loss of plant nutrients and physical loss of topsoil.
Chemical degradation	Chemical degradation refers to leaching, salinization, fertility depletion, acidification, nutrient imbalances.
Biological degradation	Biological degradation implies the loss of vegetation, rangeland degradation and loss in biodiversity including soil organic matter.

What is Desertification?

According to Article 1 of the United Nations Convention to Combat Desertification (UNCCD, Paris, 1994), desertification means "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities".

Causes of land degradation and desertification in India:

- Overgrazing, Deforestation and Careless Forest Management
- Urban Growth, Industrialisation and Mining –
- Natural causes-Include earthquakes, tsunamis, droughts, avalanches, landslides, volcanic eruptions, floods, tornadoes, and wildfires.
- Land Shortage, Land Fragmentation and Poor Economy
- Population Increase
- Agricultural activities and practices
- Poor Irrigation and Water Management

7. Rainfall forecasting

Rainfall forecasting is important for agriculture because it helps farmers make decisions about irrigation, crop selection, and planting schedules. Accurate rainfall forecasts can help farmers:

Optimize water usage: Farmers can use rainfall data to reduce waste and improve crop yields.

Avoid adverse weather conditions: Predictive models can help farmers plan agricultural activities to avoid adverse weather conditions.

Forecast flood risks: Rainfall data can help forecast flood risks and manage water allocation.

Improve resource management: Farmers can use rainfall forecasts to make data-driven decisions about irrigation, pest control, and field operations.

Rainfall forecasting can be done using a variety of technologies, including:

Rain gauges: Measure the amount of precipitation over a specific period

Radar and satellite imagery: Provide insights into rainfall patterns across larger geographical areas

AI and IoT: Can be used to create real-time rain forecasting models

GPS, sensors, and drones: Can be used to provide real-time data to map and monitor conditions.

8. Adequacy of Rainfall for crop growth:

How Rainfall Affects Crop Health

Rainfall is essential to crop health, as it provides the water and nutrients needed for the growth and development of plants. When rain is plentiful, crops can absorb the water and nutrients they need, and the soil around them remains moist and fertile. This allows the plants to grow and produce large, healthy yields.

However, too much rain can be detrimental to crop health. Excessive rainfall can lead to flooding, which can wash away soil nutrients and damage crops. Additionally, too much water can cause crops to become waterlogged, leading to root rot and disease.

Inadequate rainfall can also be harmful to crop health. Without enough water, crops may suffer from drought-related stress, which can reduce yields and lead to poor crop health. To ensure optimal crop health, farmers should monitor rainfall levels and adjust their irrigation systems accordingly.

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In addition, farmers should practice crop rotation and use good soil management techniques to help retain moisture, reduce erosion, and improve soil fertility. Adequate rainfall can lead to a good harvest, while too much or too little rain can harm crop yields.

Effects of Less Rainfall on Farming

Insufficient rainfall can lead to drought conditions and negatively impact crop growth and yields. Therefore, an optimal amount of rainfall is necessary for optimal crop growth and yields. Drought conditions can lead to moisture stress, causing plants to wilt, and reducing crop yields. Thus, the right amount of rainfall at appropriate times is crucial for optimal crop growth and production.

Effects of Excessive Rainfall on Agriculture

Rainfall is important for the growth and development of crops as it provides the necessary water for plant growth and reproduction. Too much rainfall, however, can be harmful and lead to waterlogging and soil erosion, reducing crop yields.

Rainfall has a significant impact on crops as it provides the necessary moisture for plant growth and development. Excessive rainfall can cause soil erosion, and waterlogging, and increase the risk of plant diseases. The areas with lack of rainfall have a great importance of the methods such as drip irrigation in agriculture.

9. Rainfall, Drought and production instability

Rainfall is an important factor in agricultural production. Without adequate rainfall, crops cannot grow, and yields can be limited. Farmers need to understand how much rainfall their crops need to produce a good yield. Organic farming has also a great importance of rainfall as it mostly depends on the natural climatic conditions.

In general, most crops need between 20-40 inches of rain per year. This amount can vary based on the type of crop, the soil type, and the climate of the region. The amount of rainfall also needs to be distributed evenly throughout the growing season for the crops to benefit from it.

Farmers can use rain gauges to monitor the amount of rainfall their crops receive. This data can then be used to adjust and optimize their irrigation systems to ensure the crops are getting

the right amount of water. Additionally, farmers can use meteorological data to plan for drought conditions so that they can take measures to minimize losses.

Drought

a) Early workers defined drought as prolonged period without rainfall;

b) According to Ramdas (1960) drought is a situation when the actual seasonal rainfall is deficient by more than twice the mean deviation.

c) According to American Meteorological Society defined drought as a period of abnormally dry weather sufficiently prolonged for lack of water i.e. due to absence of rain.

d) To agriculturalist drought means deficiency of soil moisture in crop root zone.

Types of Drought:

(i) Hydrological drought

Hydrological droughts are caused by a decrease in rainfall and an increase in temperature.They can be influenced by human water management.Hydrological droughts can lag behind meteorological droughts.

(ii) Agricultural drought

Agricultural droughts are caused by a lack of moisture in the soil. They can be caused by rainfall deficits, reduced groundwater, or low reservoir levels. Agricultural droughts can lead to poor harvests.

(iii) Socioeconomic drought

Socioeconomic droughts occur when the demand for water exceeds the supply. They can be caused by meteorological, agricultural, or hydrological droughts. Socioeconomic droughts can impact power generation, industrial operations, and food availability.

Effects of drought on crop production

Photosynthesis:

Photosynthesis is reduced by moisture stress due to reduction in Photosynthetic rate, chlorophyll content, leaf area and increase in assimilates saturation in leaves (due to lack of translocation). Due to water deficit leaf and canopy temperatures of plant increases. To reduce

the temperature in plant, stomata starts closing during day time. As a consequence, the entry of CO2 into plant reduces.

Growth and Development:

The expansion of cells and cell division are reduced due to moisture stress resulting in decrease in growth of leaves, stems and fruits. Moisture stress affects germination. leaf area leaf expansion and root development. Maturity is delayed it drought occurs before flowering while it advances drought occurs after flowering.

Development: In general, moisture stress delays maturity. If stress occurs before flowering. The duration of crop increases and when it occurs after flowering, the duration decreases.

Reproduction and grain growth:

Drought at flowering and grain development determines the number of fruits and individual grain weight, respectively. Panicle initiation in cereals is critical while drought at anthesis may lead to drying of pollen: Drought at grain development reduces yield while vegetative and grain filling stages are less sensitive to moisture stress.Pod abortion takes place due to drought in several legumes including in soybean. Drought decreases photosynthetic rate and water potential in leaves, flowers and pods. Drought decreases leaf sucrose and starch concentrations but increased hexose (Glucose + Fructose) concentrations.

Yield:

The effect on yield depends hugely on what proportion of the total dry matter considered as useful material to be harvested. If it is aerial and underground parts effect of drought is as sensitive as total growth. When the yield consists of seeds as in cereals moisture stress at flowering is detrimental. When the yield is fibre or chemicals where economics product is a small fraction of total dry matter modrate stress on growth does not have adverse effect on yields.

Crop Adaptations

The ability of crop to grow satisfactorily under water stress is called drought adaptation.

Adaptation is structural or functional modification in plants to survive and reproduce in a particular

* Crops survive and grow under moisture stress conditions mainly by two ways: