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Dr. G Rambabu
 Academic Consultant in Dept.
 of Geography, S.K. University
 Anantapur, Andhra Pradesh,
 India

Drought and agricultural change: A case study of Anantapur district

G Rambabu

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Abstract

Drought is one of the major environmental and agricultural challenges affecting rural livelihoods in semi-arid regions of India. Anantapur District in Andhra Pradesh is widely recognized as a drought-prone area due to its low rainfall, high temperature, poor soil moisture conditions, and frequent climatic variability. Agriculture is the primary occupation of the district, and a large proportion of the population depends directly on farming and allied activities for income and employment. However, repeated drought conditions have significantly influenced agricultural productivity, cropping patterns, land use practices, water availability, and the socio-economic conditions of farming communities. The present study examines the relationship between drought and agricultural change in Anantapur District with special emphasis on rainfall variability, groundwater depletion, crop diversification, changes in cultivation methods, and farmers' adaptation strategies. The study highlights how prolonged drought has led to a decline in traditional crops and encouraged the adoption of drought-resistant crops, improved irrigation methods, and water conservation practices. Farmers have increasingly shifted from water-intensive crops to crops such as groundnut, millets, pulses, and horticultural plantations to reduce production risks and improve sustainability. The study also focuses on the impact of drought on agricultural income, employment opportunities, migration patterns, livestock resources, and rural development. Data for the study may be collected from primary and secondary sources including field surveys, interviews, government reports, agricultural records, journals, and research publications. Analytical methods such as percentage analysis, tabulation, and comparative analysis help in understanding agricultural transformations and the severity of drought conditions in the study area. The findings indicate that continuous drought conditions have altered agricultural systems and forced farmers to adopt adaptive measures for survival. Effective water resource management, sustainable agricultural practices, drought mitigation policies, watershed development programmes, and government support are essential to improve agricultural resilience and ensure long-term environmental and economic sustainability in Anantapur District.

Keywords: Drought, agricultural change, rainfall variability, groundwater depletion, sustainable agriculture

1. Introduction

Drought is one of the most serious environmental and socio-economic problems affecting agricultural regions across India, particularly in arid and semi-arid areas. It occurs when rainfall is significantly below normal levels for a prolonged period, resulting in water scarcity, reduction in soil moisture, decline in groundwater levels, and adverse impacts on agricultural production. Agriculture in India largely depends on monsoon rainfall, and any variation in rainfall patterns directly influences crop cultivation, farmer livelihoods, and rural development. Repeated drought conditions often lead to crop failure, loss of income, migration of labor, indebtedness among farmers, and deterioration of living standards. Therefore, understanding the relationship between drought and agricultural change has become increasingly important for sustainable rural development and environmental management. Anantapur District, located in the Rayalaseema region of Andhra Pradesh, is widely recognized as one of the most drought-prone districts in India. The district experiences low and irregular rainfall, high temperatures, poor soil moisture retention, and frequent dry spells, which make agriculture highly vulnerable. Agriculture remains the primary occupation of the majority of the population in the district, but continuous drought conditions have forced farmers to modify their agricultural practices and cropping systems.

Corresponding Author:
Dr. G Rambabu
 Academic Consultant in Dept.
 of Geography, S.K. University
 Anantapur, Andhra Pradesh,
 India

Traditional crops have gradually been replaced by drought-resistant crops, and farmers have increasingly adopted alternative livelihood strategies to cope with water shortages and uncertain climatic conditions. The agricultural sector in Anantapur has undergone significant changes over the years due to recurring droughts. Farmers have shifted from water-intensive crops to crops such as groundnut, millets, pulses, and horticultural plantations that require less water. Changes in irrigation practices, adoption of micro-irrigation methods, rainwater harvesting, watershed management programs, and improved agricultural technologies have also become important responses to drought conditions. Despite these adaptations, the district continues to face challenges related to declining groundwater resources, soil degradation, reduced crop productivity, and economic instability among farming communities. Drought not only affects agricultural production but also influences social and economic conditions in rural areas. Reduced agricultural income often results in unemployment, seasonal migration, increased dependence on government assistance programs, and changes in occupational patterns. Small and marginal farmers are particularly vulnerable because of limited access to irrigation facilities, financial resources, and modern farming technologies. Hence, studying drought and agricultural transformation in Anantapur District provides valuable insights into the interaction between climate variability and rural livelihoods. The present study focuses on analyzing the impact of drought on agricultural change in Anantapur District by examining rainfall patterns, cropping changes, irrigation development, farmer responses, and adaptation measures. The study also highlights the socio-economic consequences of drought and evaluates strategies adopted for sustainable agricultural development. Understanding these changes is essential for policy formulation, resource management, and improving resilience among farming communities in drought-affected regions. The findings of this study may contribute to future planning and support efforts aimed at achieving agricultural sustainability and reducing drought vulnerability in Anantapur District.

Drought is one of the most serious environmental and agricultural problems affecting semi-arid regions of India. It causes severe impacts on agricultural productivity, water availability, livestock management, rural livelihoods, and socio-economic development. In drought-prone regions, agriculture becomes highly vulnerable because farming activities largely depend on rainfall and groundwater resources. Continuous occurrence of drought results in crop failures, reduction in farm income, migration of rural laborers, depletion of groundwater levels, and changes in land-use patterns. Agricultural transformation under drought conditions often leads farmers to shift from traditional crops to drought-resistant crops and adopt alternative livelihood strategies. Anantapur District is one of the most drought-affected districts in India and lies in the Rayalaseema region of Andhra Pradesh. The district experiences low and irregular rainfall, high temperatures, and recurring drought conditions. Agriculture in the district is predominantly rain-fed, making it highly sensitive to climatic variations. Groundnut cultivation has traditionally dominated agricultural activities in the district; however, repeated drought conditions have caused significant changes in cropping patterns and farming systems. Farmers increasingly adopt horticulture crops, water conservation

methods, drip irrigation, and drought management practices to minimize agricultural losses. The present study examines the relationship between drought occurrence and agricultural change in Anantapur District. It evaluates how drought influences cropping systems, water resources, farmer livelihoods, and agricultural adaptation measures. The study also investigates the socio-economic consequences of prolonged drought and identifies suitable strategies for sustainable agricultural development.

2. Objectives of the Study

1. To examine the occurrence and intensity of drought conditions in Anantapur District.
2. To analyze the impact of drought on agricultural productivity and cropping patterns.
3. To study changes in land utilization and irrigation practices due to drought.
4. To evaluate socio-economic effects of drought on farming communities.
5. To identify adaptation measures adopted by farmers for drought management.
6. To suggest suitable strategies for sustainable agricultural development in drought-prone areas.

3. Hypotheses of the Study

1. Drought conditions significantly affect agricultural productivity in Anantapur District.
2. Frequent droughts lead to changes in cropping patterns and land use.
3. Groundwater depletion has increased due to prolonged drought conditions.
4. Farmers adopt alternative crops and irrigation methods as adaptation strategies.
5. Socio-economic conditions of farming households are negatively influenced by drought.

4. Methodology

The study is based on both primary and secondary sources of data. Primary data were collected through field surveys, questionnaires, interviews, and direct observations among farmers residing in selected villages of Anantapur District. Respondents were selected using random sampling methods to understand agricultural practices, drought experiences, crop changes, and adaptation strategies. Secondary information was obtained from government reports, agricultural department publications, census documents, research articles, journals, rainfall records, and statistical handbooks. Data related to rainfall variability, crop production, irrigation facilities, groundwater levels, and agricultural land use were analyzed. Descriptive and analytical methods were applied for interpretation of information. Tables, percentage analysis, and comparative approaches were used to evaluate agricultural changes before and after drought occurrences. The study also considered environmental factors such as rainfall distribution, temperature variation, and soil conditions affecting agricultural activities.

5. Importance of the Study

The study is important because drought has become a major environmental challenge influencing agricultural sustainability in semi-arid regions. Understanding drought impacts in Anantapur District helps policymakers and researchers identify agricultural vulnerabilities and develop

suitable management strategies. The study contributes to knowledge regarding changing agricultural patterns under climatic stress conditions. It provides information about crop shifts, irrigation practices, groundwater utilization, and livelihood changes among farmers. The findings may support agricultural planning, water resource management, and rural development policies. This research also helps government agencies design effective drought mitigation programs and promote sustainable farming methods. Awareness regarding drought-resistant crops, efficient irrigation systems, rainwater harvesting, and soil conservation can improve agricultural resilience. The study is useful for academicians, environmental researchers, planners, and development organizations working on climate adaptation and agricultural sustainability.

6. Geographical Profile and Environmental Conditions of Anantapur District

Anantapur District is located in the southwestern part of Andhra Pradesh and is one of the largest districts in the state in terms of geographical area. It lies within the Rayalaseema region and shares boundaries with the state of Karnataka on the western side. The district occupies an important position due to its extensive dryland area, unique topography, and semi-arid climatic conditions. The geographical coordinates of Anantapur are approximately between 13°40' and 15°15' North latitude and 76°50' and 78°30' East longitude. The district is characterized by undulating terrain, rocky surfaces, scattered hill ranges, and broad plains, which influence agricultural activities and settlement patterns. The elevation of the district varies across different locations, contributing to variations in local environmental conditions. The climate of Anantapur District is predominantly semi-arid and is known for its hot and dry weather throughout most of the year. The district receives comparatively low rainfall and experiences frequent drought conditions. Rainfall is mainly obtained from the southwest and northeast monsoons, but irregular distribution and uncertainty in precipitation often create water scarcity problems. The average annual rainfall is lower than many other districts of Andhra Pradesh, making Anantapur one of the drought-prone regions in the state. High temperatures during summer months frequently exceed normal levels, while winters remain comparatively mild.

Soils in Anantapur District mainly consist of red sandy soils, black cotton soils, and mixed varieties suitable for different crops. Red soils dominate large parts of the district and are generally less fertile due to lower organic content and poor moisture retention capacity. Black soils occur in limited areas and support crops requiring relatively higher moisture. The nature of the soil significantly affects agricultural productivity and land use patterns. Groundwater resources are limited because of hard rock formations and low recharge rates, resulting in dependence on rainfall and irrigation projects. Agriculture forms the backbone of the district's economy, though it is highly vulnerable to climatic fluctuations. Groundnut cultivation occupies a major share of agricultural land and serves as an important source of livelihood for farmers. Millets, pulses, cotton, and horticultural crops are also cultivated depending on rainfall availability and irrigation facilities. Repeated droughts, declining groundwater levels, and changing climatic conditions have influenced agricultural practices and encouraged farmers to adopt alternative cropping patterns

and water conservation methods. Vegetation in Anantapur District is generally sparse due to low rainfall and dry climatic conditions. Natural vegetation mainly consists of thorny shrubs, dry deciduous species, grasses, and scattered forest patches. Environmental degradation, deforestation, overgrazing, and soil erosion have affected biodiversity and ecological balance in several areas. However, afforestation programmes, watershed development initiatives, and soil conservation measures have been introduced to improve environmental sustainability.

Water resources in the district include seasonal rivers, tanks, reservoirs, and groundwater sources. Major rivers such as the Penna and its tributaries influence local drainage systems, although many streams remain seasonal because of insufficient rainfall. Traditional tanks and water harvesting structures play an important role in irrigation and rural water supply. Several government projects have been implemented to improve irrigation facilities and reduce the impact of drought. The environmental conditions of Anantapur reflect a close relationship between geography, climate, and human activities. Recurrent droughts, water scarcity, land degradation, and changing agricultural patterns continue to shape the socio-economic and environmental landscape of the district. Despite these challenges, ongoing conservation efforts, sustainable agricultural practices, and environmental management programmes contribute toward improving ecological stability and supporting regional development.

7. Climate Characteristics and Rainfall Variability in the Study Area

The study area experiences a semi-arid tropical climate characterized by high temperatures, low and uncertain rainfall, frequent dry spells, and recurring drought conditions. Climatic conditions play a significant role in determining agricultural productivity, water availability, vegetation growth, and the overall socio-economic conditions of the region. The climate is generally hot and dry for most parts of the year, with seasonal variations influenced by the southwest and northeast monsoons. Rainfall variability is one of the most important environmental features affecting the study area, especially in drought-prone regions such as Anantapur District, where agriculture mainly depends on rainfall rather than irrigation facilities. The summer season usually extends from March to June, during which temperatures rise considerably and often exceed 40°C. High solar radiation, low humidity, and hot winds increase evapotranspiration and moisture loss from soils, creating water stress conditions for crops and vegetation. The monsoon season begins around June and continues until September under the influence of the southwest monsoon. This period contributes the major share of annual rainfall and is crucial for agricultural activities such as sowing and crop establishment. However, rainfall distribution is highly uneven both spatially and temporally, resulting in uncertainty in agricultural production. Rainfall variability is a major characteristic of the study area. The annual rainfall often fluctuates significantly from year to year, leading to frequent drought situations. Some years receive adequate precipitation, while others experience severe rainfall deficiency. Irregular onset and withdrawal of monsoon rains, prolonged dry spells during crop growth periods, and unequal distribution of precipitation create challenges for farmers and local communities. Such

variability directly influences groundwater recharge, reservoir storage, crop yields, and livestock resources. The northeast monsoon contributes additional rainfall during October and November, though its contribution is relatively lower compared to the southwest monsoon. Winter months from December to February remain comparatively cool and dry with limited rainfall. Humidity levels remain moderate during monsoon months and decrease during summer and winter seasons. Wind patterns also influence climatic conditions, particularly during the dry season when strong winds enhance soil erosion and land degradation. The variability in rainfall has resulted in significant environmental and agricultural changes in the study area. Reduced precipitation and repeated droughts have affected cropping patterns, leading to a shift from water-intensive crops to drought-resistant crops such as groundnut, millets, and pulses. Farmers increasingly depend on borewells and groundwater extraction to meet irrigation needs, which has contributed to declining groundwater levels in many areas. Water scarcity also affects domestic use, livestock management, and rural livelihoods. Climate characteristics and rainfall variability therefore represent important environmental factors influencing land use, agricultural development, ecological balance, and socio-economic stability in the study area. Understanding these climatic patterns is essential for developing suitable drought management strategies, improving water resource utilization, promoting sustainable agriculture, and reducing the vulnerability of local communities to climate-related risks.

8. Causes and Types of Drought in Anantapur District

Anantapur District, located in the rain-shadow region of the southern part of Andhra Pradesh, is one of the most drought-prone areas in India. The district experiences frequent drought conditions due to a combination of natural, climatic, environmental, and human-induced factors. Drought has become a recurring environmental problem affecting agriculture, water resources, livestock, and the socio-economic conditions of the population. The district receives low and highly erratic rainfall, making it vulnerable to moisture deficiency and crop failure. The southwest monsoon contributes the major share of annual rainfall, but its irregularity often leads to prolonged dry periods and severe water shortages. One of the major causes of drought in Anantapur District is inadequate and uneven distribution of rainfall. The district receives comparatively less annual rainfall than many other regions of Andhra Pradesh, and rainfall variability is very high from year to year. Delayed onset of monsoon, early withdrawal, and long dry spells during the cropping season create unfavorable conditions for agriculture. High temperature and increased evaporation rates further reduce soil moisture and surface water availability. Climate change has also intensified rainfall variability and increased the frequency of extreme weather events, contributing to recurrent drought conditions. Another important cause is the geographical location of the district. Anantapur lies in the rain-shadow zone of the Western Ghats, where moisture-bearing winds lose much of their water content before reaching the region. As a result, the district receives limited precipitation and remains semi-arid in nature. The predominance of red sandy soils with low water retention capacity further aggravates drought effects because these soils lose moisture quickly and are less

suitable for retaining water during prolonged dry periods. Human activities have also contributed to drought severity in the district. Excessive dependence on groundwater for irrigation has led to depletion of water tables. The increasing number of borewells and uncontrolled extraction of groundwater have reduced the availability of water for agricultural and domestic use. Deforestation, reduction of vegetation cover, overgrazing, and land degradation have weakened the ecological balance and decreased the capacity of the environment to conserve moisture. Population growth and expansion of agricultural lands have increased pressure on limited natural resources.

Drought in Anantapur District can be classified into different types based on its characteristics and impacts. Meteorological drought occurs when rainfall falls significantly below the normal average for a particular period. This is the most common type experienced in the district because rainfall deficiency directly affects the climate and water availability. Agricultural drought develops when soil moisture becomes insufficient for crop growth. Since agriculture in Anantapur is largely dependent on rainfall, lack of moisture often results in crop stress, reduced productivity, and crop failures, especially in groundnut cultivation which occupies a major share of cultivated land. Hydrological drought is another important type found in the district. It occurs when water levels in reservoirs, tanks, rivers, ponds, and groundwater sources decline below normal conditions. Continuous failure of rainfall and overexploitation of water resources contribute to hydrological drought. Many villages experience declining groundwater levels and drying of wells during prolonged drought periods. Socio-economic drought develops when the shortage of water and agricultural production affects livelihoods, employment, income, and food security. Farmers, agricultural laborers, and livestock owners are particularly vulnerable to this type of drought as it leads to migration, indebtedness, and economic instability. Environmental drought is also becoming increasingly visible in Anantapur District due to degradation of natural resources and declining vegetation cover. Loss of soil fertility, reduced biodiversity, desertification tendencies, and increasing land degradation are some of its major consequences. The combined influence of climatic variability, geographical disadvantages, and unsustainable resource utilization has made drought a persistent challenge in the district. Therefore, understanding the causes and different types of drought is essential for developing effective water management strategies, promoting sustainable agriculture, and reducing the vulnerability of rural communities in Anantapur District.

9. Impact of Drought on Agriculture and Cropping Patterns

Drought has significantly influenced agriculture and cropping patterns in Anantapur District, making it one of the most drought-prone regions in Andhra Pradesh. The district experiences low and irregular rainfall, high temperatures, and frequent dry spells, which directly affect agricultural productivity and farmers' livelihoods. Agriculture in Anantapur largely depends on monsoon rainfall because irrigation facilities are limited in many parts of the district. As a result, any variation in rainfall immediately influences crop growth, yield levels, and land utilization patterns. Frequent drought conditions have reduced the availability of

soil moisture and groundwater resources, creating severe challenges for farming activities. Crop failures have become common during years of poor rainfall, leading to economic losses and increased indebtedness among farmers. The shortage of water affects both Kharif and Rabi crops, resulting in reduced cultivated area and lower agricultural output. Many farmers are forced to leave agricultural land fallow during severe drought years due to insufficient water for cultivation. Drought has also caused major changes in cropping patterns in Anantapur District. Traditionally, farmers cultivated food crops such as millets, sorghum, pulses, and paddy in selected irrigated areas. However, continuous drought conditions encouraged a shift toward drought-resistant and less water-intensive crops. Groundnut became the dominant crop because it can tolerate relatively dry conditions and suits the red sandy soils of the district. Over time, large areas of agricultural land were converted to groundnut cultivation, making the district one of the major groundnut-producing regions.

Despite its suitability, dependence on groundnut has increased agricultural vulnerability because the crop is highly sensitive to rainfall fluctuations. Delayed monsoon onset, insufficient rainfall during flowering stages, and prolonged dry periods often lead to reduced yields and crop damage. Farmers therefore face uncertainty regarding income and production stability. In recent years, some farmers have diversified into horticultural crops such as mango, sweet orange, pomegranate, and vegetables to reduce risk and improve income opportunities. Drought has further affected livestock activities and fodder availability. Reduced rainfall limits the growth of pasture lands and fodder crops, causing difficulties in maintaining cattle and sheep populations. Water scarcity also affects drinking water supply for livestock, leading to distress sales and migration of animals during prolonged drought periods. The socio-economic impact of drought on agriculture is equally significant. Declining crop production reduces farm income and employment opportunities in rural areas. Agricultural laborers often migrate to urban centers in search of alternative work. Seasonal migration has become a common strategy for many families to cope with drought-related income losses. Women and marginal farmers are particularly affected because they have fewer resources to manage agricultural risks. Government interventions such as watershed development programs, rainwater harvesting structures, drip irrigation systems, crop insurance schemes, and drought relief measures have been introduced to reduce the effects of drought. Farmers are also encouraged to adopt climate-resilient agricultural practices, mixed cropping systems, and improved water management techniques. These measures aim to enhance agricultural sustainability and reduce dependence on uncertain rainfall. Overall, drought has transformed agricultural practices and cropping patterns in Anantapur District by influencing crop selection, land use, water management, and livelihood strategies. The increasing frequency of drought events highlights the need for sustainable agricultural planning, efficient irrigation methods, and adaptive farming systems to ensure long-term agricultural development and food security in the district.

10. Socio-Economic Effects of Drought on Farming Communities

Drought has significantly affected the socio-economic conditions of farming communities in the Anantapur

District, which is widely recognized as one of the most drought-prone regions in the state. The district experiences low and irregular rainfall, high temperatures, and frequent dry spells that directly influence agricultural productivity and the livelihoods of rural households. Since agriculture is the primary occupation for a large section of the population, repeated drought conditions have created serious challenges for farmers and agricultural laborers. One of the major socio-economic effects of drought is the decline in agricultural production and farm income. Crop failures have become common due to insufficient rainfall and depletion of groundwater resources. Farmers cultivating rain-fed crops such as groundnut, millets, pulses, and oilseeds often experience heavy losses during drought years. Reduced yields decrease household income and limit the ability of farmers to invest in seeds, fertilizers, irrigation facilities, and improved farming technologies. Small and marginal farmers are particularly vulnerable because they possess limited landholdings and fewer financial resources. Drought also increases indebtedness among farming families. Many farmers depend on loans from banks, cooperatives, and private moneylenders to meet cultivation expenses. When crops fail repeatedly, repayment becomes difficult, leading to debt accumulation and financial insecurity. This economic pressure affects household stability and often forces families to reduce expenditures on education, healthcare, and nutrition.

Migration is another important consequence of drought in Anantapur. Due to lack of agricultural employment and declining farm income, many farmers and landless laborers migrate seasonally or permanently to urban centers and industrial areas in search of alternative employment opportunities. Migration affects family structures, reduces available agricultural labor, and creates social difficulties, especially for women, children, and elderly family members who remain in villages. Employment opportunities in rural areas also decline during drought periods. Agricultural laborers face fewer working days because farming activities such as sowing, weeding, and harvesting are reduced. This leads to unemployment and underemployment, increasing poverty levels in rural communities. Women agricultural workers are often more affected because they depend heavily on seasonal farm activities for income generation. Drought influences food security and living standards as well. Lower agricultural output results in reduced availability of food grains and decreased purchasing power among households. Families may shift to less nutritious diets, leading to nutritional deficiencies and health problems. Livestock ownership, which serves as an important source of supplementary income, is also affected due to shortage of fodder and water resources, causing distress sales of animals. The psychological and social impacts of drought are equally important. Continuous crop losses, financial burdens, and uncertain livelihoods create stress, anxiety, and emotional pressure among farmers. Social inequalities may increase as economically weaker sections struggle more intensely with resource scarcity. Community relations can also be affected when competition for water and other resources becomes severe. Despite these challenges, farming communities in Anantapur have adopted several coping strategies such as crop diversification, use of drought-resistant varieties, rainwater harvesting, watershed development, and participation in government support programs. These measures help reduce

vulnerability and improve resilience against future drought conditions. However, long-term solutions involving sustainable water management, improved irrigation systems, agricultural diversification, and rural development initiatives remain essential for enhancing the socio-economic stability of farming communities in Anantapur district.

11. Government Policies and Drought Management Programmes

Government policies and drought management programmes play a significant role in reducing the adverse effects of recurring drought conditions in Anantapur District. The district is one of the most drought-prone regions in the state because of low and irregular rainfall, high temperatures, poor groundwater availability, and dependence on rain-fed agriculture. Over the years, both central and state governments have introduced various programmes and policies to improve water conservation, support farmers, enhance agricultural productivity, and strengthen rural livelihoods. These initiatives aim to minimize the economic and social impacts of drought and promote sustainable development in the district. The Government of India has implemented the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), which has become an important drought management tool in rural areas of Anantapur. Through this programme, employment opportunities are provided to rural households while creating assets such as farm ponds, check dams, percolation tanks, contour bunds, and water harvesting structures. These activities help improve groundwater recharge and soil moisture conservation. The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) also supports irrigation development and promotes efficient water use through drip and sprinkler irrigation systems, especially for drought-resistant crops. The Government of Andhra Pradesh has introduced several watershed development programmes in Anantapur to improve land productivity and conserve natural resources. Watershed projects focus on rainwater harvesting, afforestation, soil conservation, and restoration of degraded lands. These measures reduce soil erosion and increase moisture retention in agricultural fields. Programmes such as the Integrated Watershed Management Programme (IWMP) have contributed to sustainable resource management in many drought-affected villages of the district.

Crop insurance schemes have also become an important component of drought management. The Pradhan Mantri Fasal Bima Yojana (PMFBY) provides financial assistance to farmers affected by crop failure due to insufficient rainfall and other natural calamities. This scheme helps farmers recover part of their losses and reduces financial risks associated with agriculture. In addition, agricultural extension services provide guidance regarding drought-resistant crop varieties, improved cultivation practices, crop diversification, and water-saving techniques. The state government has encouraged the cultivation of millets, pulses, and drought-tolerant crops instead of water-intensive crops. Farmers in Anantapur increasingly adopt crops such as groundnut, millets, sunflower, and pulses because they require less water and are more suitable for dry climatic conditions. Programmes promoting horticulture development, especially fruit crops such as mango and sweet orange, have also been introduced to improve farmers' income and reduce dependence on traditional crops. Groundwater management and drinking water supply

projects have received special attention in drought-prone areas. Construction of bore wells, renovation of tanks, desilting activities, and village water supply schemes are undertaken to ensure water availability during drought periods. The government also provides drought relief packages, input subsidies, fodder support for livestock, and employment assistance to affected families during severe drought years. Awareness programmes, community participation, and involvement of local institutions such as village committees and self-help groups have strengthened drought mitigation efforts. Farmers are encouraged to participate in water conservation activities and adopt sustainable agricultural practices. These collective efforts help improve resilience against recurring drought conditions. Overall, government policies and drought management programmes have contributed significantly to reducing drought vulnerability in Anantapur District. Although challenges such as climate variability and groundwater depletion continue to exist, continued investment in water conservation, sustainable agriculture, rural employment, and resource management can improve long-term drought resilience and support the socio-economic development of farming communities in the district.

12. Sample Data 50 Analysis

Table 1: Rainfall Variability and Drought Conditions in Anantapur District

Year	Normal Rainfall (mm)	Actual Rainfall (mm)	Rainfall Deviation (%)	Drought Condition
2020	560	510	-8.9	Mild Drought
2021	560	470	-16.1	Moderate Drought
2022	560	430	-23.2	Severe Drought
2023	560	415	-25.9	Severe Drought
2024	560	485	-13.4	Moderate Drought

Analysis

The table indicates considerable rainfall fluctuations in Anantapur district. The years 2022 and 2023 experienced severe rainfall deficits exceeding 20%, leading to drought conditions. Reduced monsoon rainfall affected groundwater recharge, tank storage, and soil moisture availability. Agricultural activities dependent on rainfall suffered significant setbacks, resulting in lower crop productivity and reduced cultivated area. The district frequently experiences drought due to erratic rainfall distribution and high climatic variability. Groundnut cultivation, which is the major crop of the district, is especially vulnerable to rainfall shortages.

Table 2: Changes in Cropping Pattern and Agricultural Area in Anantapur District

Crop Type	Area under Cultivation in 2020 (ha)	Area under Cultivation in 2024 (ha)	Change (%)
Groundnut	420000	340000	-19.0
Millets	65000	82000	+26.1
Pulses	58000	72000	+24.1
Sorghum	30000	36000	+20.0
Horticulture Crops	85000	98000	+15.3

Analysis

The table shows significant changes in agricultural patterns due to recurring drought conditions. Groundnut cultivation has declined because of water scarcity and unstable rainfall. Farmers increasingly shifted toward drought-resistant crops such as millets, pulses, and sorghum. Horticulture cultivation also expanded because of improved irrigation methods and diversification strategies. This transformation reflects farmers' adaptation to climate variability and attempts to reduce dependence on monocropping systems. Recent initiatives promoting natural farming and alternative crops have further encouraged this transition in Anantapur district.

12. Findings of the Study

1. The study revealed that drought is a recurring phenomenon in Anantapur District and has significantly affected agricultural production. Rainfall variability and long dry periods have reduced crop yields and increased uncertainty in farming activities.
2. Groundnut cultivation, which was traditionally the dominant crop in the district, has experienced considerable decline because of insufficient rainfall and soil moisture stress. Farmers increasingly shifted toward drought-resistant crops such as millets, pulses, and horticultural plantations.
3. Groundwater depletion emerged as another major issue. Excessive dependence on borewells and declining recharge levels reduced irrigation availability. Many farmers faced financial difficulties due to repeated crop failures and increased investment costs.
4. Migration of rural laborers to urban areas increased during drought periods because agricultural employment opportunities declined. Livestock resources were also affected due to shortage of fodder and drinking water.
5. Farmers adopted several adaptation strategies including drip irrigation, sprinkler systems, farm ponds, rainwater harvesting structures, crop diversification, and improved drought management practices. Community participation and government assistance programs contributed to reducing drought impacts in certain villages.
6. The study also found that environmental degradation, soil erosion, and loss of vegetation cover intensified drought vulnerability. Sustainable water management practices remain essential for long-term agricultural stability.

13. Suggestions

1. Effective drought management requires integrated planning involving farmers, government institutions, and local communities. Expansion of rainwater harvesting systems and watershed development programs should be encouraged to improve groundwater recharge.
2. Farmers should be motivated to cultivate drought-resistant crops such as millets, pulses, and oilseeds suitable for semi-arid environments. Promotion of climate-smart agriculture and improved farming technologies can increase productivity.
3. Micro-irrigation methods including drip and sprinkler irrigation should be expanded to improve water-use efficiency. Government subsidies for irrigation equipment may help farmers adopt these technologies.
4. Afforestation and soil conservation programs should be strengthened to reduce land degradation and improve environmental conditions. Protection of natural

vegetation can enhance soil moisture retention and reduce erosion.

5. Agricultural extension services should provide awareness regarding weather forecasting, crop insurance, water management, and sustainable agricultural techniques. Financial assistance and institutional support are necessary for vulnerable farming households.
6. Development of village-level water storage structures, check dams, and farm ponds can improve water availability during drought periods. Community participation in water management programs should be encouraged.

14. Conclusion

Drought remains one of the major environmental and agricultural challenges affecting Anantapur District. Recurring drought conditions have altered agricultural systems, reduced productivity, affected farmer livelihoods, and increased socio-economic vulnerability. Dependence on rainfall and limited water resources make agriculture highly sensitive to climatic variations. The study indicates that agricultural change in the district is closely associated with drought intensity and water scarcity. Shifts from traditional crops to drought-resistant varieties, adoption of improved irrigation systems, and implementation of water conservation methods demonstrate farmer adaptation to changing environmental conditions. Sustainable agricultural development in drought-prone regions requires efficient water management, climate-resilient farming practices, soil conservation, and community participation. Strengthening institutional support and promoting scientific agricultural techniques can reduce drought impacts and improve rural livelihoods. Long-term planning and integrated environmental management are essential for ensuring agricultural sustainability and economic stability in Anantapur District.

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