

Deficient Rainfall in Hassan District and its Effects on Farmers

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Abstract—Agriculture is the primary source of livelihood for the majority of people in Hassan district, Karnataka. The district largely depends on monsoon rainfall for the cultivation of coffee, paddy, maize, arecanut, and other crops. In recent years, deficit rainfall has emerged as a major challenge due to climate change and irregular monsoon patterns. Reduced rainfall has significantly affected agricultural productivity, groundwater availability, and the socio-economic condition of farmers. This study examines the extent of deficit rainfall in Hassan district and its impact on farming communities. It highlights how inadequate rainfall delays sowing, reduces crop yields, increases irrigation costs, and leads to water scarcity. The study also discusses the financial burden on farmers caused by crop losses, declining income, and increasing indebtedness. Special attention is given to the effects of rainfall deficiency on coffee cultivation, which is one of the district's major commercial crops. The research is based on secondary data collected from government reports, research articles, and published literature. It emphasizes the need for sustainable water management, climate-resilient agricultural practices, efficient irrigation systems, and government support to minimize the adverse effects of rainfall deficit. The findings suggest that effective adaptation strategies and improved policy interventions are essential to ensure agricultural sustainability, strengthen farmers' resilience, and safeguard rural livelihoods in Hassan district under changing climatic conditions.

Index Terms—Deficit Rainfall, Climate Change, Hassan District, Farmers' Livelihood, Agricultural Productivity.

I. INTRODUCTION

Hassan district, located in the Malnad and Southern Transition Zone of Karnataka, is one of the state's most important agricultural districts. Agriculture is the primary occupation of the people, with coffee, paddy, maize, ragi, arecanut, pepper, and various horticultural crops forming the backbone of the local economy. The

district largely depends on the southwest monsoon for irrigation and groundwater recharge. When rainfall is below normal, the agricultural sector experiences severe stress. In recent years, changing climatic conditions have resulted in irregular monsoon patterns, prolonged dry spells, and deficit rainfall, creating significant challenges for farmers. Research on Karnataka also shows that rainfall variability has a direct impact on crop production, sowing decisions, and farm income.

Deficit rainfall refers to a situation where a region receives less rainfall than its long-term average during a particular season. In Hassan district, insufficient rainfall delays the onset of agricultural activities and reduces soil moisture, making it difficult for farmers to prepare their fields. Crops such as paddy and maize require adequate water during the sowing stage, and a shortage of rainfall often forces farmers to postpone cultivation or reduce the cultivated area. Even coffee plantations in Sakleshpur, Belur, and Alur taluks depend on timely pre-monsoon showers for flowering and fruit development. When these rains fail, coffee yields decline considerably.

One of the most serious impacts of deficit rainfall is the reduction in crop productivity. Moisture stress affects seed germination, plant growth, flowering, and grain formation. Farmers experience poor yields, which directly reduce their annual income. Coffee plants produce fewer berries, paddy fields remain partially cultivated, and maize and ragi crops suffer from stunted growth. Horticultural crops such as arecanut, pepper, and vegetables also experience reduced production due to insufficient soil moisture. Scientific studies in Karnataka indicate that rainfall deficiency significantly influences crop area and productivity, particularly for rain-fed agriculture.

Deficit rainfall also causes severe water scarcity in rural areas. Tanks, lakes, rivers, and farm ponds

receive less inflow, while groundwater levels decline rapidly. Borewells fail to provide sufficient water for irrigation, forcing farmers to spend additional money on drilling deeper borewells or purchasing water from private suppliers. Small and marginal farmers are the worst affected because they cannot afford expensive irrigation facilities. Livestock also suffer due to the shortage of drinking water and green fodder.

The financial burden on farmers increases significantly during years of rainfall deficit. Farmers invest heavily in seeds, fertilizers, pesticides, labour, and machinery before the cropping season. When rainfall fails, these investments often result in poor returns or complete crop failure. Many farmers are forced to borrow money from banks, cooperative societies, or private lenders to continue cultivation. Failure to repay loans creates indebtedness, financial insecurity, and economic hardship. Rising cultivation costs combined with declining agricultural income have become major concerns for farming households. Coffee cultivation, which is a major source of income in Hassan district, is particularly sensitive to climate variability. Coffee plants require timely blossom showers during March and April, followed by backing showers to ensure proper fruit setting. Deficit rainfall during these periods leads to poor flowering, reduced berry formation, pest infestations, and lower bean quality. Consequently, coffee growers experience significant economic losses, affecting both domestic income and export earnings.

Livestock farming, which supplements agricultural income, is also negatively affected. Reduced rainfall decreases fodder availability, causing nutritional stress among cattle. Milk production declines due to inadequate feed and water. Farmers must purchase fodder at higher prices, increasing the cost of maintaining livestock. This places additional financial pressure on rural households.

The social consequences of deficit rainfall are equally significant. Declining agricultural income forces many rural families to reduce expenditure on education, healthcare, and nutrition. Seasonal migration to nearby towns and cities increases as farmers and agricultural labourers search for alternative employment opportunities. Women and elderly family members often bear greater responsibilities in managing households and farms during difficult periods.

Environmental degradation is another important consequence of prolonged rainfall deficiency.

Reduced vegetation cover increases soil erosion, lowers soil fertility, and decreases groundwater recharge. Forest ecosystems surrounding Hassan district also become more vulnerable to forest fires during extended dry periods. Biodiversity declines as natural water sources dry up, affecting wildlife and ecological balance.

To reduce the adverse effects of deficit rainfall, farmers and government agencies must adopt climate-resilient agricultural practices. Rainwater harvesting, farm ponds, watershed development, drip and sprinkler irrigation, mulching, and groundwater recharge structures can improve water conservation. Farmers should diversify crops by cultivating drought-resistant varieties such as millets and pulses wherever suitable. Scientific weather forecasting, crop insurance, timely financial assistance, and extension services can help farmers manage climate-related risks more effectively. The Government of Karnataka has also identified crop-loss support mechanisms and continues to monitor vulnerable agricultural regions, including Hassan district.

In conclusion, deficit rainfall has become one of the most serious challenges facing agriculture in Hassan district. It reduces crop yields, affects coffee production, lowers groundwater levels, increases financial distress, and weakens the socio-economic condition of farming families. Since agriculture remains the backbone of the district's economy, sustainable water management, climate-resilient farming practices, and effective government support are essential to protect farmers' livelihoods and ensure long-term agricultural sustainability. With proper planning, modern irrigation techniques, and adaptation to climate change, Hassan district can reduce the adverse impacts of deficit rainfall and build a more resilient agricultural system.

II. REVIEW OF LITERATURE ON DEFICIT RAINFALL

Rainfall is the primary determinant of agricultural productivity in Hassan District, Karnataka, where a significant proportion of farming depends on the southwest monsoon. Deficit rainfall has become increasingly frequent due to climate variability, resulting in reduced crop yields, declining groundwater levels, and increased economic hardship for farmers. Several researchers have examined the

relationship between rainfall variability, agricultural production, and farmers' livelihoods. The following review summarizes important studies relevant to deficit rainfall and its impacts on agriculture, with particular emphasis on Karnataka and Hassan District.

1. Thimmegowda (2025)

Thimmegowda and colleagues developed the Deficient Rainfall Impact Parameter (DRIP) to evaluate the effect of rainfall variability on crop production in Karnataka. Their study analysed rainfall and crop data from 2011–2022 and found that rainfall deficits significantly reduced the area, production, and productivity of rainfed crops. The study also identified Hassan as one of the districts exhibiting considerable variability in monsoon rainfall, affecting crops such as maize and finger millet. Farmers were found to shift towards drought-tolerant crops during years of severe rainfall deficiency.

2. Deshpande (2010)

Deshpande examined the agrarian crisis in Karnataka and highlighted that the state's heavy dependence on rainfed agriculture makes farmers highly vulnerable to drought and rainfall deficits. The study emphasized that repeated monsoon failures, inadequate irrigation, rising production costs, indebtedness, and weak agricultural support systems have intensified farmers' distress. The author concluded that rainfall deficiency is one of the major contributors to agrarian vulnerability in Karnataka.

3. Karnataka State Natural Disaster Monitoring Centre (KSNDMC)

Studies and reports from KSNDMC indicate that rainfall monitoring and early weather advisories play an important role in minimizing crop losses. The Varuna Mitra helpline assists farmers by providing weather forecasts, irrigation scheduling, crop management advice, and drought preparedness. Such services have become increasingly important due to frequent rainfall deficits across Karnataka.

4. India Meteorological Department (IMD)

IMD reports consistently indicate that irregular monsoon rainfall, delayed onset of rains, prolonged dry spells, and uneven rainfall distribution negatively affect agricultural production. In Hassan District, rainfall variability disrupts sowing operations, reduces

soil moisture availability, and lowers crop productivity, particularly for rainfed crops like coffee, maize, ragi, and pulses.

5. Studies on Climate Change and Coffee Cultivation

Several studies on coffee cultivation in Karnataka have shown that changing rainfall patterns significantly affect flowering, berry development, pest incidence, and overall coffee productivity. Hassan District, being one of Karnataka's coffee-growing regions, experiences reduced yields during years of deficient rainfall due to moisture stress and increased temperatures. These studies recommend climate-resilient farming practices and improved water conservation measures.

6. Research on Farmers' Adaptation Strategies

Various researchers have reported that farmers respond to rainfall deficits by changing cropping patterns, adopting drought-resistant crop varieties, constructing farm ponds, practicing rainwater harvesting, and using micro-irrigation systems. However, adoption remains limited among small and marginal farmers because of financial constraints and inadequate institutional support.

7. Studies on Socio-economic Impacts

Research on rural livelihoods indicates that repeated rainfall deficits lead to declining farm income, increasing indebtedness, seasonal migration, reduced employment opportunities, and psychological stress among farming households. Small and marginal farmers are particularly vulnerable because they possess limited irrigation facilities and fewer financial resources to absorb climatic shocks.

8. Water Resource Studies

Studies on groundwater and water resource management reveal that prolonged rainfall deficits reduce groundwater recharge, lower reservoir storage, and increase dependence on borewells. In Hassan District, excessive groundwater extraction combined with irregular rainfall has intensified water scarcity for irrigation, threatening agricultural sustainability.

9. Government Reports on Drought Management

Government reports emphasize drought relief measures such as crop insurance, compensation for crop losses, irrigation development, watershed

management, and promotion of climate-resilient agriculture. These interventions are considered essential for reducing farmers' vulnerability to recurrent rainfall deficits in districts like Hassan.

10. Research Gap

Although numerous studies have examined rainfall variability and agricultural production in Karnataka, relatively few have specifically focused on Hassan District by integrating meteorological data with farmers' socio-economic conditions. There is a need for district-level research that combines rainfall analysis, crop performance, livelihood impacts, farmers' adaptation strategies, and policy interventions to develop location-specific recommendations for sustainable agriculture.

The reviewed literature clearly establishes that deficit rainfall is a major challenge affecting agricultural productivity and farmers' livelihoods in Hassan District. Rainfall variability influences crop selection, crop yields, groundwater availability, and farm income while increasing farmers' economic vulnerability. Existing studies recommend strengthening irrigation infrastructure, promoting drought-resilient crops, improving weather advisory services, and implementing effective climate adaptation strategies to ensure sustainable agricultural development in the district.

II. OBJECTIVE

To examine the extent and pattern of deficit rainfall in Hassan District and analyse its impact on agricultural production and farmers' livelihoods. The study also aims to assess the socio-economic consequences of rainfall deficiency on farming households.

III. METHODOLOGY

Research paper is based entirely on secondary sources of data to examine the deficit rainfall in Hassan District and its effects on farmers. The study adopts a descriptive and analytical research design. Data were collected from published reports of the India Meteorological Department (IMD), Karnataka State Natural Disaster Monitoring Centre (KSNDMC), the Department of Economics and Statistics, Government of Karnataka, the Department of Agriculture, the Coffee Board of India, and the Census of India.

Information was also gathered from research articles, books, journals, government publications, and reports issued by national and international organizations. Rainfall statistics, crop production data, and agricultural reports for Hassan District were reviewed to identify trends and patterns of rainfall deficiency. The collected data were organized, classified, and analyzed using descriptive methods. Relevant tables, graphs, and comparative analyses were used wherever necessary to interpret the findings. The study also examined the socio-economic impacts of deficit rainfall on farmers, including crop losses, income reduction, indebtedness, and livelihood challenges. The findings were interpreted in the context of climate variability and sustainable agricultural development. The study is limited to available secondary data and published sources relating to Hassan District.

IV. EFFECTS OF DEFICIT RAINFALL ON FARMERS

Deficit rainfall has emerged as one of the most serious challenges affecting agriculture in Hassan District. Since agriculture in the district is predominantly dependent on monsoon rainfall, any significant reduction in rainfall directly influences crop production, water availability, and the socio-economic well-being of farmers. Recurrent rainfall deficits have resulted in declining agricultural productivity, increasing financial stress, and greater vulnerability among farming communities. The following are the major effects of deficit rainfall on farmers in Hassan District:

1. Decline in Agricultural Production

Deficit rainfall significantly reduces agricultural production in Hassan District, where farming is largely dependent on the southwest monsoon. Insufficient rainfall delays sowing operations and reduces soil moisture, resulting in poor crop germination and stunted plant growth. Major crops such as paddy, maize, ragi, coffee, and pulses experience lower yields during drought years. Farmers are often forced to reduce the cultivated area or abandon cultivation altogether due to inadequate water availability. Consequently, agricultural productivity declines, affecting both food security and the local economy.

2. Reduction in Farmers' Income

Crop failure caused by deficient rainfall directly reduces farmers' income. As yields decline, farmers are unable to recover the cost of seeds, fertilizers, pesticides, labour, and irrigation. Coffee growers in Hassan also suffer financial losses because irregular rainfall affects flowering and berry development, reducing both the quantity and quality of production. Reduced income lowers the purchasing power of farming households and affects their ability to invest in the next cropping season, leading to long-term economic instability.

3. Water Scarcity and Irrigation Problems

Deficit rainfall decreases the recharge of rivers, tanks, lakes, and groundwater sources across Hassan District. Water levels in wells and borewells decline considerably, making irrigation difficult, especially during the critical crop growth stages. Farmers who depend on groundwater incur additional expenses for drilling deeper borewells or pumping water. Small and marginal farmers, who cannot afford such investments, are the worst affected. Water scarcity also impacts livestock and domestic water supply in rural areas.

4. Increase in Farmers' Indebtedness

Repeated rainfall deficits compel farmers to borrow money from banks, cooperatives, and private moneylenders to meet cultivation expenses and household needs. When crops fail, farmers struggle to repay these loans, resulting in mounting debts. High interest rates from informal credit sources further increase their financial burden. Continuous indebtedness affects the economic stability of farming families and discourages future agricultural investments.

5. Changes in Cropping Pattern

Due to uncertain rainfall, farmers in Hassan District increasingly shift from water-intensive crops to drought-resistant crops such as millets and pulses. Some farmers reduce the area under paddy and sugarcane cultivation and diversify into horticulture or mixed farming. While these adaptations help minimize losses, they may also reduce farm income because alternative crops often have lower market value. Such changes indicate farmers' efforts to cope with changing climatic conditions.

6. Migration and Employment Loss

Deficit rainfall reduces agricultural activities and labour demand in rural areas. As employment opportunities decline, many agricultural labourers and small farmers migrate temporarily to nearby towns and cities in search of work in construction, factories, or service sectors. Seasonal migration disrupts family life, children's education, and the social fabric of rural communities. Women and elderly family members are often left behind to manage farms with limited resources.

7. Environmental Degradation

Persistent rainfall deficiency leads to soil moisture depletion, increased soil erosion, and degradation of agricultural land. Dry conditions reduce vegetation cover, increase the risk of forest fires, and decrease groundwater recharge. Reduced water availability also affects biodiversity and livestock. Environmental degradation lowers the long-term productivity of agricultural land and makes farming more vulnerable to future climate variability.

8. Psychological and Social Stress

Continuous crop failures and financial losses create significant psychological stress among farmers. Anxiety about loan repayment, uncertain income, and family responsibilities adversely affects their mental well-being. Economic hardship also leads to social problems such as reduced spending on education and healthcare, family conflicts, and declining living standards. These socio-economic challenges highlight the broader human impact of deficit rainfall beyond agricultural production alone.

V. SOCIO-ECONOMIC CONSEQUENCES OF RAINFALL DEFICIENCY

Rainfall deficiency has become a major concern for farming households in Hassan District due to the district's heavy dependence on rainfed agriculture. Irregular and inadequate rainfall affects agricultural production, household income, employment, and overall living conditions. The socio-economic consequences extend beyond crop losses, influencing education, health, migration, indebtedness, and the quality of life of farming families. The following are the major socio-economic consequences of rainfall deficiency on farming households in Hassan District.

1. Decline in Household Income

Rainfall deficiency leads to reduced agricultural production, resulting in a significant decline in the income of farming households. Crop failures and lower yields reduce earnings from the sale of agricultural produce, making it difficult for farmers to recover cultivation costs. Coffee, paddy, maize, and ragi growers in Hassan District experience considerable financial losses during drought years. As household income declines, farmers struggle to meet daily expenses, invest in agriculture, and maintain a stable standard of living. The reduction in income also limits savings and increases financial insecurity among rural families.

2. Increased Indebtedness

One of the most serious consequences of rainfall deficiency is the increasing burden of debt on farming households. Farmers often borrow money to purchase seeds, fertilizers, pesticides, and irrigation equipment. When crops fail due to inadequate rainfall, they are unable to repay loans on time. Consequently, many farmers depend on private moneylenders who charge high interest rates, worsening their financial condition. Continuous indebtedness reduces their ability to invest in future agricultural activities and creates long-term economic vulnerability.

3. Employment Loss and Seasonal Migration

Rainfall deficiency reduces agricultural activities such as sowing, transplanting, weeding, and harvesting, thereby decreasing employment opportunities for agricultural labourers. As farm income declines, many farmers and labourers migrate seasonally to nearby towns and cities in search of alternative employment in construction, industries, and service sectors. Migration often separates families, disrupts children's education, and weakens traditional rural social structures. Women and elderly family members are frequently left behind to manage agricultural activities under difficult circumstances.

4. Food and Nutritional Insecurity

Reduced crop production caused by rainfall deficiency affects the availability of food within farming households. Families often consume less nutritious food due to declining income and higher food prices. Limited availability of cereals, pulses, vegetables, and milk affects the nutritional status of children, women,

and elderly people. Poor nutrition increases the risk of health problems and reduces the overall well-being of rural households. Thus, rainfall deficiency contributes to both food insecurity and malnutrition.

5. Decline in Education and Health Expenditure

Financial stress resulting from crop losses forces farming households to reduce expenditure on education and healthcare. Parents may delay school fee payments, discontinue higher education for their children, or require children to assist with agricultural work or wage labour. Similarly, medical treatment is often postponed due to lack of financial resources. Reduced investment in education and health adversely affects human development and limits future opportunities for rural families.

6. Psychological and Social Stress

Continuous rainfall deficiency and repeated crop failures create severe psychological stress among farmers and their family members. Uncertainty regarding income, loan repayment, and agricultural productivity causes anxiety, depression, and emotional distress. Financial difficulties also contribute to family conflicts and social insecurity within rural communities. The cumulative impact of economic hardship and uncertainty significantly affects the mental well-being and social stability of farming households in Hassan District.

VI. RESULTS AND DISCUSSION

The present study examined the pattern of deficit rainfall in Hassan District and its effects on farmers using secondary data obtained from government reports, meteorological records, research articles, and published literature. The analysis indicates that rainfall deficiency has significantly influenced agricultural production, water availability, and the socio-economic conditions of farming households. The findings further reveal that repeated monsoon deficits have increased farmers' vulnerability and necessitated the adoption of climate-resilient agricultural practices. The following are the major results and discussions of the study.

1. Deficit Rainfall Has Reduced Agricultural Productivity

The analysis shows that irregular and deficient monsoon rainfall has considerably reduced

agricultural productivity in Hassan District. Rainfed crops such as paddy, maize, ragi, and pulses recorded lower yields during years of rainfall deficit due to inadequate soil moisture and delayed sowing. Coffee plantations also experienced lower productivity because irregular rainfall affected flowering and berry development. These findings indicate that agriculture in Hassan District remains highly dependent on monsoon rainfall, making crop production vulnerable to climatic variability.

2. Rainfall Deficiency Has Increased Water Scarcity

The study found that deficit rainfall has reduced groundwater recharge and lowered the water levels in tanks, lakes, wells, and borewells. Farmers faced severe irrigation constraints during critical crop growth stages, resulting in moisture stress and poor crop performance. The increasing dependence on groundwater has raised irrigation costs and accelerated groundwater depletion. This highlights the urgent need for rainwater harvesting, watershed development, and efficient irrigation systems to ensure sustainable water management.

3. Significant Decline in Farmers' Income

The results indicate that reduced agricultural production has directly lowered the income of farming households. Crop failures and reduced coffee yields limited farmers' earnings and affected their ability to recover cultivation costs. Many households experienced financial instability due to declining agricultural returns. The findings suggest that rainfall deficiency not only affects crop production but also weakens the overall economic condition of farming families.

4. Increase in Indebtedness Among Farmers

The study reveals that repeated rainfall deficits have increased farmers' dependence on institutional and non-institutional credit. Many farmers borrowed money to meet cultivation expenses, but poor harvests made loan repayment difficult. Consequently, indebtedness increased, especially among small and marginal farmers. This finding supports previous studies that identify rainfall variability as a major contributor to rural financial distress.

5. Changes in Cropping Pattern and Farming Practices

The analysis shows that many farmers have shifted from water-intensive crops to relatively drought-tolerant crops such as millets and pulses. Some farmers also adopted micro-irrigation, rainwater harvesting, and crop diversification to reduce climate-related risks. Although these adaptation strategies helped minimize losses, limited financial resources and inadequate technical support restricted their widespread adoption.

6. Socio-economic Challenges Faced by Farming Households

The study found that rainfall deficiency has adversely affected the socio-economic well-being of farming households. Reduced income resulted in lower expenditure on education, healthcare, and household welfare. Seasonal migration increased due to the shortage of agricultural employment, while financial insecurity created psychological stress among farmers. These findings demonstrate that the impacts of rainfall deficiency extend beyond agriculture and affect the overall quality of rural life.

7. Need for Climate-Resilient Agricultural Policies

The findings emphasize the importance of strengthening climate adaptation measures in Hassan District. Expansion of irrigation facilities, promotion of drought-resistant crop varieties, watershed development, timely weather advisories, crop insurance, and financial assistance can reduce farmers' vulnerability. Strengthening extension services and encouraging sustainable farming practices will improve agricultural resilience and enhance farmers' livelihoods under changing climatic conditions.

VII. DISCUSSION

The findings of this study are consistent with previous research on rainfall variability and agriculture in Karnataka. Earlier studies have shown that deficient rainfall significantly reduces crop productivity, lowers groundwater availability, and increases farmers' economic vulnerability. The present study confirms that Hassan District faces similar challenges because of its dependence on monsoon rainfall. The analysis also demonstrates that climate variability has intensified socio-economic problems such as indebtedness, migration, and reduced household

welfare. Therefore, effective drought management, improved water conservation, climate-resilient agricultural practices, and stronger institutional support are essential to ensure sustainable agricultural development and improve the resilience of farmers in Hassan District.

VIII. CONCLUSION

The study concludes that deficit rainfall has become a major challenge to agricultural sustainability and farmers' livelihoods in Hassan District. The analysis of secondary data reveals that irregular and inadequate monsoon rainfall has significantly reduced crop productivity, groundwater availability, and farm income. Rainfall deficiency has also increased indebtedness, unemployment, seasonal migration, and socio-economic vulnerability among farming households. Coffee growers and farmers cultivating rainfed crops have been particularly affected due to prolonged dry spells and moisture stress. The findings highlight the urgent need for climate-resilient agricultural practices, efficient water resource management, and the promotion of drought-tolerant crop varieties. Strengthening irrigation infrastructure, rainwater harvesting, watershed development, and crop insurance schemes can reduce the adverse effects of rainfall deficiency. Timely weather advisories, improved agricultural extension services, and financial support from government agencies are also essential to enhance farmers' resilience. Sustainable policy interventions and community participation will play a vital role in minimizing the impact of future rainfall deficits. Therefore, a coordinated approach involving government institutions, researchers, and farmers is essential to ensure sustainable agricultural development and improve the socio-economic well-being of farming communities in Hassan District.

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