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CLIMATE CHANGE IMPACT ON AGRICULTURE IN KOLAR DISTRICT: A STUDY BASED ON SECONDARY DATA

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ABSTRACT

Agriculture in Kolar District of Karnataka is facing increasing stress from climate-related changes: erratic rainfall, recurrent droughts, declining soil fertility, shifting cropping patterns, increased pests and diseases, and water-scarcity. This article draws on secondary data and published research to assess how climate variability and change are affecting agriculture in Kolar, what the major impacts are, and what adaptation suggestions may help farmers and policy-makers. Key findings show that Kolar is highly vulnerable to climate change, with a rainfed agriculture base, high dependence on groundwater, declining yields and increasing uncertainty. Suggestions include promoting climate-resilient crops, enhancing water management, improving soils, strengthening extension services, and boosting institutional support.

Keywords: Climate change, Agriculture, Kolar district, Karnataka, Temperature variation, Rainfall pattern, Drought,Water scarecity, Crop yield.

OBJECTIVES

1. To examine the agricultural context of Kolar District and its vulnerability to climate change using secondary data.
2. To analyse the impacts of climate change (rainfall variability, droughts, temperature rise) on cropping patterns, yields, water-resources, soils and farmer livelihoods in Kolar.
3. To review farmers' perceptions of climate change in Kolar, drawing on survey-based research.
4. To identify major adaptation strategies and institutional measures being adopted or needed in Kolar in response to climate change.
5. To provide evidence-based suggestions for strengthening climate-resilient agriculture in Kolar District.

INTRODUCTION

Kolar District lies in eastern Karnataka, bordering Andhra Pradesh and Tamil Nadu, and has been historically part of the semi-arid zone of peninsular India. Agriculture remains an important livelihood activity in the district, with many farmers growing crops such as ragi (finger millet), maize, groundnut, pulses, vegetables and horticultural crops like mango. However, the district lacks abundant perennial water-resources, has heavy reliance on rainfall and groundwater, and is therefore particularly sensitive to climate variability and change.

Climate change in India manifests especially in shifts in monsoon timing and intensity, increasing frequency of droughts and extreme rainfall, rising temperatures, and altered pest/disease patterns. Agriculture in rainfed and marginal zones is especially vulnerable. In Kolar, recent research reveals farmers' increasing concerns about erratic rainfall, increased pests, shifts in sowing times and declining yields. Given this backdrop, analysing how climate change is impacting agriculture in Kolar is critical for designing localized adaptation strategies that support farmer resilience and district-level agricultural sustainability.

METHODOLOGY AND DATA SOURCES

This article is a secondary-data review. It draws on published journal articles, district reports, government documents, news reports, and specialised

research focusing on Kolar District and Karnataka's semi-arid agricultural zones. Key data and references include:

- The study "Farmers' Perception towards Climate Change and its Effect on Agriculture in Kolar District of Karnataka, India" (Harish Kumar H.R. et al., 2023) which used survey data from 80 respondents in Kolar.
- District agricultural news and empirical reports on drought, yield decline and groundwater stress in Kolar.
- Soil health and organic carbon data for Karnataka and Kolar district.
- Karnataka State Action Plan showing vulnerability of Kolar to climate change.
- Additional newspaper articles documenting rainfall events, horticulture losses and cropping shifts in Kolar.

Because data is drawn from diverse secondary sources, this article emphasises patterns, themes and qualitative/quantitative findings rather than original statistical modelling.

AGRICULTURAL CONTEXT AND VULNERABILITY OF KOLAR

DISTRICT PROFILE:

Kolar District receives an average annual rainfall of around 650-750 mm. It has substantial rain-fed agriculture about 80%+ of cultivated area is rain-fed. The region lacks major perennial rivers and is heavily reliant on groundwater and rainfall for farming. The cropping system comprises cereals (ragi, maize), pulses, oilseeds, vegetables (tomato, cabbage, bean) and horticulture (mango). Over the years, there has been a shift from multi-cropping traditional systems (intercropping) to more monoculture/vegetable/horticultural crops that may require higher inputs and water.

VULNERABILITY TO CLIMATE CHANGE

According to the Karnataka State Action Plan, Kolar District is identified as highly vulnerable to climate change. Soils in Kolar are noted to have low organic carbon, with over 94% of farmland in the district recording low organic carbon levels, evidencing soil degradation and increased sensitivity to climate stress. The heavy dependence on rainfall and groundwater, combined with high water-stress and shallow soil water holding capacity, further amplify vulnerability.

Collectively, these structural features (rain dependence, groundwater stress, degraded soils, cropping shifts) render Kolar particularly exposed to climate variability and climate change impacts.

IMPACTS OF CLIMATE CHANGE ON AGRICULTURE IN KOLAR

This section summarises major climate-induced impacts in Kolar's agriculture based on secondary data.

1. **Rainfall Variability, Droughts and Water Stress**

One of the most consistent findings: Kolar has experienced recurrent drought years, erratic rainfall, delayed monsoons, and declining groundwater. For instance, a 2019 article reported a decade of drought in Kolar, stating that in a year "90 per cent of the crops sown in Kolar failed" due to insufficient rain and dry bore wells. The district is among the six permanently drought-prone districts in Karnataka.

Rainfall variability doesn't just mean shortage there have been episodes of heavier-than-usual rain, but often poorly timed. For example, in October one year, Kolar recorded 113 % excess rainfall compared to normal. Such excess rainfall may help in one sense but if not aligned with cropping cycles or if causes water logging, may be detrimental.

- **Groundwater extraction is extreme:** Kolar has "zero net groundwater for future use" and very high extraction rates.
- These conditions affect sowing windows, crop germination, crop growth and overall yields. A farmer quoted: "The seeds did not even germinate" due to dry conditions; sowing window disturbed because of missing pre-monsoon showers.
- Thus climate change (in terms of altered rainfall timing/amounts and water stress) is clearly impacting Kolar's agriculture.

2. **Crop Yields, Cropping Patterns and Livelihoods**

Yield declines and cropping shifts are evident in Kolar. The decade-long drought led to many farmers abandoning earlier cropping patterns. The 2019 article cites ragi yield dropping from ~30 quintals per hectare

to ~18 quintals; groundnut yield from ~10 quintals to ~4 quintals per hectare in some pockets.

Horticulture (mango) used to be a strong suit of Kolar the district once produced about 7 lakh tons of mango alone; this dropped drastically in drought years. Vegetable cultivation has also been hit: for example, tomato production is affected by water scarcity and erratic rainfall. A news piece records: "The APMC in Kolar received a mere 50 % of its usual supply in November" due to disrupted supply chains and climate stress.

Crop diversification appears to be declining: farmers switching to higher-risk cash crops or water-intensive horticulture, though these may be less resilient under drought/variability. For example, the trend toward monocropping of vegetables such as tomato and flowers is rising in Kolar, even as traditional intercropping ("akkadi saalu") is giving way.

Thus the combined effect of drought, erratic rain, water-stress and cropping pattern shifts is altering yields, farmer incomes and cropping viability in Kolar.

3. Soil Degradation and Fertility Decline

Soil health is another channel where climate change interacts with agriculture. Degraded soils have lower resilience to climate stress (rainfall, drought, heat). In Kolar District, it was noted that "over 94 per cent of its farmland recording low organic carbon levels." Declining organic matter means reduced water-holding capacity, lower nutrient retention, higher vulnerability to erosion and moisture stress.

In the context of Kolar's semi-arid zone, low organic carbon means soils cannot buffer variability in rainfall and moisture. Combine that with climate-related stress and yields can suffer further.

4. Pest, Disease, Weeds & Other Risks

Farmers in Kolar have reported increasing pests and disease pressures consistent with climate change. The survey of 80 farmers in Kolar found that farmers identify increasing pests and diseases, altered sowing periods, increased weed competition as effects of climate change. Unfavourable climate also caused "unknown viral disease in tomatoes" in Kolar's Mulbagal area.

These biotic stressors are emerging channels by which climate change affects productivity elevated temperatures, shifted rainfall, humidity changes all influence pest and disease cycles, which reduce yields and increase input cost.

5. Livelihoods, Migration and Social Impacts

Agriculture being a major livelihood in Kolar, climate-induced stress is leading to social consequences. The drought-report noted that many farmers are moving to cities (Bengaluru) to work as daily-wage labourers. Water-stress, crop failure and declining returns reduce incentives for farming.

Vegetable supply disruptions lead to price crashes (for farmer) or shortages (for consumer). For example, in Kolar tomato prices crashed to Rs 2-3/kg while production cost could not be recovered.

These livelihood, economic and social consequences underline that climate change impact in Kolar's agriculture is more than agronomic it is a broader rural-livelihoods challenge.

From the above evidence we can summarise key patterns for Kolar District:

- The agriculture in Kolar is highly vulnerable because of its rain-dependence, high groundwater stress, degraded soils and semi-arid climate.
- Climate change in the form of rainfall variability (both deficit and excess), droughts, erratic seasonal timing, and temperature rise is contributing to reduced crop yields, shifting cropping patterns, increased risk of crop failure and increased costs (inputs, irrigation).
- Cropping systems are shifting from traditional multi-crop, intercropping approaches toward high-input, cash crops and horticulture which may increase risk if climate stress intensifies.
- Soil health has declined (very low organic carbon) which reduces resilience of soils to moisture stress and temperature extremes.
- Farmers perceive the changes, indicating that adaptation is possible but likely limited by institutional/technical constraints.
- The livelihood consequences are significant: lower incomes, crop failures, migration, market failures, risk of indebtedness.
- Institutional vulnerability is also evident: inadequate irrigation, weak water-resource management, limited support in extension/advisory services, lack of tailored

climate-smart agriculture for semi-arid zones like Kolar.

FINDINGS

1. **Rainfall and water-resource stress dominate the climate-impact story in Kolar.** The district's lack of perennial water, dependence on rainfall and high groundwater extraction means that variability in rainfall (timing, amount) and droughts have major impact. The decade-long droughts and drying borewells illustrate this.
2. **Yields and cropping patterns are declining/shifting because of climate stress.** Ragi yields, groundnut yields have significantly reduced in drought years. Vegetables and horticulture, while water-intensive and high-value, face higher climate risk and variable returns. The move away from resilience-oriented crops toward risky cash crops is observed.
3. **Soil health is an underlying vulnerability that worsens climate impact.** Low organic carbon, degraded soils reduce buffering against climate stress and reduce soil water holding capacity. This means that even small variations in rainfall or temperature may translate into yield losses.
4. **Pests, diseases, sowing period shifts are already affecting farmers.** Farmers in Kolar report increasing pest/disease loads, altered sowing times, and weed competition all consistent with climate change effects. This adds to the cost and risk of agriculture.
5. **Farmer awareness exists but adaptation capacity is limited.** The survey in Kolar shows farmers are aware of the problem, but translation into large-scale adaptation strategies (climate-resilient crops, improved irrigation, crop calendar shifts) is still restricted. Institutional support, technical assistance and enabling conditions are crucial.
6. **Livelihoods and social vulnerability are increasing.** With crop failures, low returns, and increasing risk, farming in Kolar is becoming more precarious. Migration, diversification away from farming, and distress shifts (debt, daily wage labour) are rising concerns.
7. **Institutional and systemic adaptation gaps persist.** Kolar's agricultural system lacks robust irrigation infrastructure, climate-based advisory services tailored to local semi-arid conditions, resilient crop systems, and soil-health restoration. The policy documents mark the district as highly climate-vulnerable but operational response appears insufficient.

DISCUSSION

The evidence from Kolar District underscores how climate change amplifies existing structural vulnerabilities in agriculture: water scarcity, rain-dependence, degraded soils, monoculture risk and limited adaptive capacity. While climate change is a global phenomenon, local context matters for Kolar, the semi-arid setting, high groundwater stress, high percentage of rain-fed agriculture, and cropping system shifts make it particularly exposed.

One key insight: adaptation in such contexts needs to address both the drivers (rainfall variability, drought, temperature rise) and the structural vulnerabilities (soil health, water access, cropping system, farmer capacity). It is not enough to promote climate-resilient crops alone; water-management, soil restoration, cropping system diversification, institutional advisory services and market security all matter.

For example, Kolar's move toward monocropping of vegetables and horticulture (risky under water-stress) suggests that in a climate-stress scenario, resilience may be diminished rather than enhanced. The older intercropping "akkadi saalu" system (rotating 18-20 types of crops) appears more resilient and is being revived by some farmers in Kolar.

Another key point: Farmers' perception of climate change is positive, which is a good starting point. But perception alone doesn't equal adaptation. The enabling environment (credit, extension, technology, water infrastructure) is essential. The survey found education, access to weather-information, social media usage improved perception — which means communication interventions matter. So, for Kolar, adaptation must be multi-pronged —

technological (irrigation, soil improvement, climate-resilient seeds), agronomic (crop diversification, intercropping, adjusted sowing calendars), institutional (extension services, weather alerts, credit), and market-linked (ensuring value, lowering risk). Policy must recognise the district as high-vulnerability and allocate resources accordingly (which the state plan does).

Finally, there is a need for near-term and long-term interventions. Immediate actions might address water-harvesting, drip/micro-irrigation, improved soil organic carbon; long-term actions include changing cropping systems, better risk-transfer (insurance), market linkages and institutional strengthening.

SUGGESTIONS FOR ADAPTATION AND RESILIENCE IN KOLAR

Based on the findings, the following suggestions are proposed for strengthening climate-resilient agriculture in Kolar District:

1. Enhance water-management and irrigation infrastructure.

- Promote micro-irrigation (drip, sprinkler) for water-efficient crop watering, especially for vegetables/horticulture.
- Strengthen water-harvesting infrastructure: farm ponds, small check-dams, recharge structures, to capture pre-monsoon rainfall and run-off.
- Encourage groundwater recharge via treated wastewater use (as has been piloted in Kolar).
- Improve drainage and water-logging management in cases of heavy rainfall, since erratic rainfall may include intense events.
- Promote scheduling of irrigation based on soil-moisture monitoring and weather forecasts.

2. Improve soil health and fertility.

- Restore organic carbon levels in soils via integrated nutrient management: use of organic manures, composting, green-manure crops, crop residues. Given Kolar's low organic carbon, this is urgent.
- Promote conservation agriculture (reduced tillage, mulching) to improve moisture-retention and resilience to heat and drought.
- Encourage intercropping and crop rotation systems which enhance soil structure and fertility, rather than shifting exclusively to high-input monocultures.
- Soil health cards and soil testing should be institutionalised to guide precise nutrient management.

3. Promote climate-resilient crops and cropping systems.

- Encourage cultivation of drought-tolerant crops such as ragi, millets, pulses and oilseeds which are better adapted to marginal rainfall conditions. Noting that ragi area has declined in Kolar, this needs reversal.
- Revive traditional multi-crop intercropping systems (e.g., "akkadi saalu") that diversify risk and maintain yields in variable conditions.
- Adjust cropping calendars based on shifts in rainfall patterns: early-sowing or alternate sowing windows depending on local forecasts.
- Develop and disseminate improved seed varieties that are heat/drought/pest-resilient suited for Kolar's agro-ecology.
- Promote agro-forestry systems on farm boundaries, combining trees, crops and livestock to diversify incomes and improve micro-climate.

4. Strengthen extension and climate advisory services.

- Provide timely weather alerts, sowing advisories, pest/disease warnings specific to Kolar's agro-ecology. The survey showed that weather information sources helped perception of climate change.
- Train extension workers and farmers in climate-smart agriculture practices, pest/disease management under shifting climate.
- Facilitate farmer-field schools, peer-learning networks, demonstration plots of resilient practices.
- Use mobile-based advisory services (SMS, apps) for disseminating real-time data, sowing alerts, cropping advice.

5. Market and livelihood support.

- Build value-chains and markets for millets, pulses and other less water-intensive crops to make them profitable alternatives.
- Provide crop-insurance schemes tailored to climate risk (drought, unseasonal rainfall) for Kolar farmers.
- Support farmer producer organisations (FPOs) to aggregate production, negotiate better prices, reduce individual risk.
- Infrastructure development – cold-chains, storage, processing units for vegetables/horticulture to reduce post-harvest losses in climate-disturbed conditions.

6. Institutional and policy measures.

- Prioritise Kolar District in state climate-resilience funding given its high vulnerability index.
- Integrate climate risk assessment into district agricultural planning — mapping vulnerable zones, cropping shifts, water-resource mapping, soil-health mapping.
- Invest in monitoring systems: rainfall, soil-moisture, groundwater levels, crop health — to provide evidence for adaptive management.
- Encourage participatory approaches: involve farmers in decision-making, climate-planning at gram/mandal level, local adaptation committees.

7. Research and data-generation.

1. Conduct long-term monitoring of climate variables (rainfall, temperature, soil moisture) at farm/ village level in Kolar to detect changes and guide planning.
2. Study local agro-ecological responses: how specific crops/varieties in Kolar respond to heat, drought, pest/disease shifts.
3. Evaluate adaptation practices (intercropping, micro-irrigation, organic soil amendments) in Kolar's conditions for cost-effectiveness and scalability.
4. Integrate socio-economic research: how farmers in Kolar perceive, adopt, and benefit from adaptation practices; what constraints remain.

CONCLUSION

The case of Kolar District in Karnataka provides a clear example of how climate change intersects with agriculture, livelihoods and rural resilience in semi-arid regions. The district's structural vulnerabilities rain-dependence, groundwater stress, degraded soils, cropping shifts have been amplified by climate variability and change: droughts, erratic rainfall, heat, increased pest/disease pressure. The secondary data reviewed here show that agriculture in Kolar is under stress: yields are down, cropping patterns are shifting, farmers are aware of change, but adaptation capacity remains limited.

However, the situation is not hopeless. There is both awareness among farmers and emerging alternatives (e.g., intercropping revival, water-harvesting, micro-irrigation pilots). What is required is an integrated, locally-tailored adaptation strategy combining water management, soil health, resilient crops, effective extension services, market support and institutional strengthening. Given Kolar's vulnerability ranking, more concerted policy attention is warranted.

In the face of continuing climate change, the urgency is high: adaptation cannot be an after-thought. For Kolar, building resilient agricultural systems is not only about productivity but about sustaining livelihoods, maintaining food security and preventing rural distress. The suggestions above offer a roadmap — but implementation will depend on collaborative efforts between farmers, extension services, local government and research institutions. Strengthening such combinations of agro-ecological and institutional resilience offers hope for Kolar's agriculture in a changing climate.

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