



# Comprehending farmer's views on climate change and agricultural/livestock adaptation in Halavarthi Village, Koppala District, Karnataka: a case study

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## Summary

This study conducted in Halavarthi village, Karnataka, delves into the intricate impact of climate change on the community's livelihoods. Over two decades, the semi-arid region has witnessed erratic rainfall, rising temperatures and droughts, with profound consequences for agriculture, livestock and overall food security. The farmers in this area have grappled with numerous challenges, including water scarcity, diminishing water quality, crop losses, increased pest and disease outbreaks and the migration of plant species to new locations. These changes have also led to a weakened immunity in humans and a surge in diseases among both people and livestock. While the farmers have initiated some climate change adaptation measures, like crop rotation and intensifying the use of agricultural inputs, there remains a substantial gap in knowledge and awareness regarding climate change mitigation. This research underscores the pressing need to address the extensive repercussions of climate change on agriculture, food security and human health. It highlights the importance of developing comprehensive strategies to enhance the resilience of farming communities such as Halavarthi in the face of an evolving climate.

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## Introduction

Climate change (CC) is the result of alterations in an area's climate, stemming from a combination of anthropogenic and natural disruptions, such as ozone layer depletion and greenhouse effects (Kotir 2011). These changes can be attributed to various factors, including shifts in solar radiation, long-term variations in the earth's orbital elements (eccentricity, obliquity of the ecliptic, and the precession of the equinoxes), natural processes and human-induced influences. While changes in external factors may drive climate change, be they natural or human-induced, future projections primarily focus on the impact of anthropogenic increases in greenhouse gases and other human-related elements (IPCC 2007; Penuelas et al. 2020). Consequently, the twentieth century experienced the most significant warming trend in the past millennium, resulting in an average temperature increase of approximately 0.6 °C (Jones 2005). However, future temperature rises are projected to surpass this, with an estimated increase ranging from 0.1 to 2 °C per decade (Dawson et al. 2016; Haldhar et al. 2023).

Predictions indicate substantial changes in biodiversity, agricultural production and food security in response to the evolving global climate (Morton 2007). One anticipated consequence of climate change is the migration of plant species to higher elevations and

latitudes, away from their current climatic zones (Davis 2001). Species in both terrestrial and marine ecosystems are at risk due to climate changes, leading to extinctions in their current habitats and colonization of new areas (Heller et al. 2008). While sustainable food production is critical for sustainable development, it is currently posing a challenge to the achievements of sustainable development strategies and the 2030 agenda for sustainable development (Kroll et al. 2019). In this context, the agricultural sector must enhance its sustainability performance and adapt to the impacts of climate change without compromising global efforts to ensure food security (Filho et al. 2018; Khadda et al. 2018). Therefore, analyzing the impact of climate change on biodiversity and food security from a global perspective is crucial since climate change is a worldwide phenomenon that demands international attention (Steenwerth et al. 2014; Khadda et al. 2016).

The objectives of this study are as follows: to evaluate the impact of climate change patterns, investigate farmers' experiences with climate change patterns over the past two decades compared to the present situation, identify significant climate change events affecting agriculture and livestock and explore the mitigation measures implemented by farmers in response to climate change challenges in Halavarthi village, situated in the Koppala district of Karnataka.

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## Material and Methods

### 1 Demography, ecology and population dynamics of Halavarthi village, Koppal taluk, Koppal district

Halavarthi village, situated in Karnataka, India, is categorized under village location code 601775 and falls within Koppal taluk of Koppal District. It is located at a distance of 6 km from the district and sub-district headquarters in Koppal. The village covers a total geographical area of 989.04 hectares and is located at coordinates 15.424855°N Latitude and 76.231855°E Longitude (as shown in Figure 1 and detailed in Table 1). Halavarthi has a population of 2,477 individuals, with 1,259 being male and 1,218 being female. The literacy rate in Halavarthi village stands at 45.54 %, with 55.28 % of males and 35.47 % of females being literate. The village consists of approximately 470 houses, and the pin code for the Halavarthi village locality is 583238.



**Figure 1.** Google map of Halavarthi village, Koppal

**Table 1.** Demography of Halavarthi village

|                      |             |
|----------------------|-------------|
| <b>Area</b>          | 989.04 ha   |
| <b>Latitude</b>      | 15.424855°N |
| <b>Longitude</b>     | 76.231855°E |
| <b>Altitude</b>      | 526 mt      |
| <b>Population</b>    | 2,477       |
| <b>Literacy rate</b> | 45.54 %     |

**Table 2.** Ecological, soil type and cropping pattern livestock population of Halavarthi village

|                                    |                                                                                  |
|------------------------------------|----------------------------------------------------------------------------------|
| <b>1.Ave. annual Temperature</b>   | 27.5 °C                                                                          |
| <b>2.Ave. annual Rainfall</b>      | 598 mm                                                                           |
| <b>3.Ave. annual Rainfall days</b> | 30-40 days                                                                       |
| <b>4.Ave. annual wind speed</b>    | 5.15mt/sec                                                                       |
| <b>5.Ave. annual pressure</b>      | 1020-1030 mb                                                                     |
| <b>6. Soil type</b>                | Red Loamy soils                                                                  |
| <b>7. Irrigation type</b>          | Both Rainfed and irrigated (Tube wells)                                          |
| <b>8. Major crops</b>              | Maize, sugarcane, sorghum, pigeon pea, black gram, green gram, cowpea, groundnut |
| <b>9. Livestock Population</b>     |                                                                                  |
| a. Cow                             | 55                                                                               |
| b. Buffalo                         | 28                                                                               |
| c. Sheep                           | 19678                                                                            |
| d. Goat                            | 1966                                                                             |
| Total                              | 21644                                                                            |

### 2 Research gap and research questions

To address the adverse effects of climate change, numerous potential agricultural adaptation alternatives have been proposed and some have been put into

The ecology of Halavarthi village in Koppal district is distinguished by several key features, including its semi-arid climate, diverse vegetation, wildlife adapted to arid conditions, agricultural practices and the impact of human activities. The primary source of water for the village and surrounding areas is the Tungabhadra reservoir, located in Munirabad and bordering Halavarthi. In addition to this, tube wells play a significant role in meeting the water requirements for both agricultural and livestock purposes. The region experiences an average annual temperature of 27.50 °C, receiving approximately 598 mm of rainfall each year spread over 30-40 days. Furthermore, it maintains an average annual wind speed of 5.15 meters per second and sustains an average annual atmospheric pressure ranging between 1020-1030 millibars.

The total cultivable land area of the village covers 989.04 hectares. Out of this, 573 hectares are dedicated to rain-fed cultivation, while 416.04 hectares are irrigated, primarily using wells and tube wells as the main sources of irrigation. The predominant soil type in the village is red loamy soil, which supports the growth of various agricultural crops. These crops include maize, sorghum, sugarcane, red gram, black gram, green gram, groundnut and vegetable crops such as tomatoes, gourds and crucifers. The village also hosts a substantial livestock population, totalling 21,644 animals. This livestock population comprises 19,678 sheep, 1966 goats, 55 cows, and 28 buffalo, as detailed in (Table 2).

Households in the village face several significant farming constraints. These include the lower fertility status of the soil, the menace of wild animals in farm fields, low prices for agricultural commodities and a lack of marketing facilities. Other challenges include insufficient irrigation water, inadequate extension services, high costs of fertilizers and plant protection chemicals, high-interest rates on credit, a lack of transportation for the safe transport of agricultural produce to the market, limited rainfall and a shortage of sources for agricultural technology information.

practice. Although a few adaptation strategies for climate change impact analysis have been assumed, the adaptation process itself remains unclear. There is an urgent need to understand the types of adaptation that

are feasible and practical during adverse weather conditions, determine those responsible for implementation and identify the requirements to facilitate or promote their development and acceptance. The objective of this study was to examine farmers' perceptions of agricultural adaptation strategies and the constraints they face concerning climate change. Throughout the research study, we aim to find answers to the following questions in the surveyed area:

1. Gathering general information about the respondent farmers.
2. Assessing their knowledge of climate change.
3. Understanding the impacts of climate change on livelihoods and agriculture.
4. Evaluating the effects of climate change on food security and human health.
5. Identifying the factors that influence climate change adaptation.
6. Examining climate change adaptation and mitigation strategies.

## Results and Discussions

### 1 Climate Change, Impact and Mitigation Strategies Adopted in Halavarthi (V)

In a survey conducted in Halavarthi village regarding climate change patterns, the impact of climate change on agriculture and livestock and the mitigation measures

adopted by farmers, a total of sixteen individuals were interviewed. These participants fell within the age group of 37 to 80, with varying levels of education ranging from illiteracy to high school education. The primary questions posed during the survey encompassed topics such as the respondents' knowledge of climate change, the causes of climate change, personal experiences with climate change, cropping patterns, livestock management, the effects of climate change on pests and diseases, the adoption of mitigation strategies, and government-initiated schemes aimed at addressing climate change. The major climate change vulnerabilities identified in the village included erratic rainfall, drought, heat waves, loss of biodiversity and pollution.

A semi-structured questionnaire survey was utilized to gather information regarding farmers' perceptions of climate change and variability. The survey involved 16 farmers, and a significant majority (85.50 per cent) of them possessed over 30 years of farming experience. Among the respondents, 50 % fell within the age group of 30-50 years, while another 50 % belonged to the age group of over 50 years. In terms of educational background, the survey included 43.75 % of illiterate farmers, 50.00 % with primary education, and 6.25 % with high school education, as indicated in Table 3.

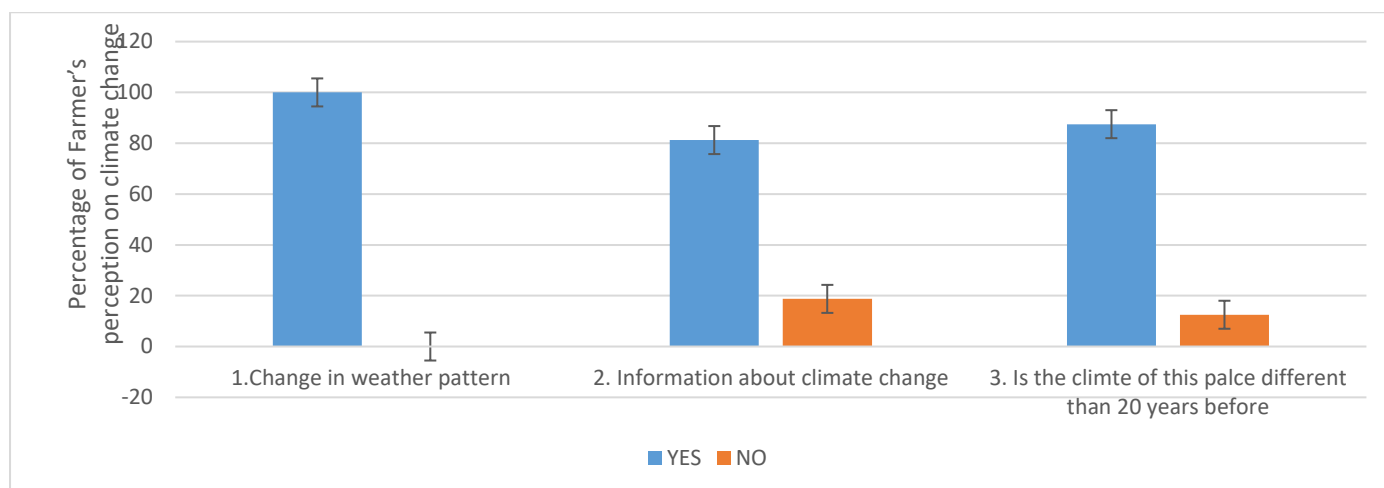
**Table 3.** Socioeconomic background of the respondent's farmers in Halavarthi village

| Variables                 | Respondents (%) |
|---------------------------|-----------------|
| <b>1. Age Group</b>       |                 |
| 20-30                     | 0.00            |
| 30-50                     | 50.00           |
| 50 and above.             | 50.00           |
| <b>2. Education Level</b> |                 |
| Illiterate                | 43.75           |
| Primary                   | 50.00           |
| High school               | 6.25            |
| PUC                       | 0.00            |
| Graduation                | 0.00            |
| <b>3. Family size</b>     |                 |
| 1-5                       | 25              |
| 5-10                      | 43.75           |
| 10-15                     | 31.25           |
| 15-20                     | 0.00            |
| >20                       | 0.00            |
| <b>4.Type of Land</b>     |                 |
| Dryland                   | 12.5            |
| Irrigated land            | 12.5            |
| Both (Irrigated+ Dryland) | 62.5            |
| Fallow land               | 12.5            |

### 2 Farmers' general perception of knowledge of climate change

The findings regarding the general perception of knowledge about climate change patterns revealed that 100 % of the farmers had some level of awareness. Furthermore, 81.25 % of the farmers agreed on the

existence of climate change patterns. A significant portion, 87.50 %, acquired their climate change information from mass media and the input of people in their surroundings. Additionally, they acknowledged that the climate in their village has been undergoing mitigation for the past 20 years, as depicted in Figure 2.



**Figure 2.** General perception knowledge of climate change

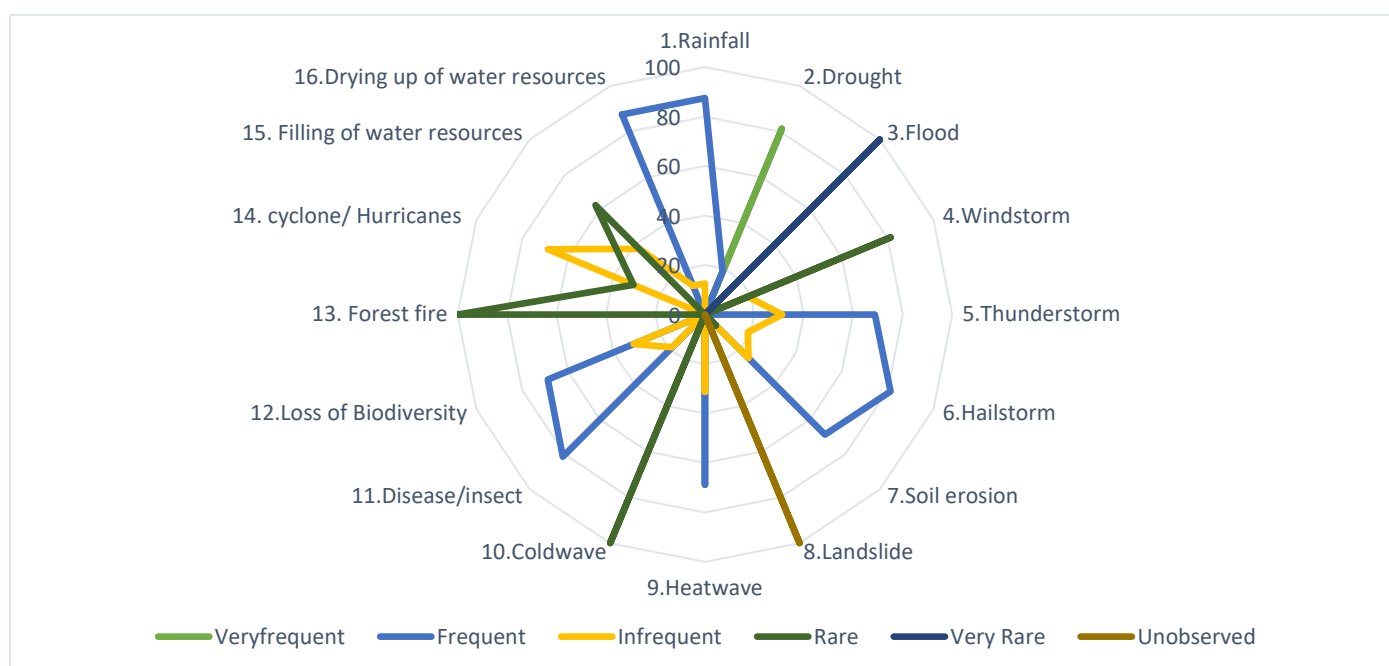
### 3 Evaluating the Awareness and Perceptions of Farmers Regarding Climate Change

Examining the current climate change necessitates a historical perspective, as much as possible and framing a baseline climate data is important for establishing a reference point to assess climate change (Khan *et al.* 2014). The findings from the farmers' perceptions regarding changes in the climate are presented in Table 4. The results revealed that the majority of the farmers in the village are experiencing aberrations in climate change as they have been farming there for many years. Hundred per cent of the farmers revealed that the temperature is increasing and has become unbearable, especially in the summer months. There was uniformity in their opinion (75.00 %) decrease in rainfall and prolonged dry spells during the cropping season which

resulted in dry spells. Because of the decrease in rainfall no flood conditions in that village, almost all farmers have the same opinion of continued drought conditions in one or the other years. Apart from this, educated farmers' perceptions of the frequency of climate change events, farmers noticed continuous drought conditions of very frequently with 81.25 % perception, 87.0 % of the farmers noticed frequent changes in rainfall and thunderstorms (68.75 %), followed by heat waves (68.75 %), loss of biodiversity (68.75 %) and hailstorms equally constituted 81.25%, Soil erosion & dry spells with 68.75% only. Farmers rarely observed the changes in climate events like forest fires, floods, cold waves & cyclones and never knew the landslide-like events in their village (Table 4 and Fig. 3).

**Table 4.** Farmer's general perception of climate change events over 20 years

| Climate Variables | Increased (%) | Decreased (%) | No change (%) |
|-------------------|---------------|---------------|---------------|
| 1. Temperature    | 100           | 0             | 0             |
| 2. Rainfall       | 0             | 75            | 25            |
| 3. Flood          | 0             | 0             | 100           |
| 4. Drought        | 75            | 0             | 25            |



**Figure 3.** Farmer's awareness and perception about climate change

#### 4 Perception of farmers on climate change impacts on livelihood and agriculture

In terms of farmers' perceptions regarding the impact of climate change on livelihood and agriculture, several key findings emerged. A significant majority, 87.50 % of the farmers, reported that they have been grappling with water scarcity in their village for the past 20 years. This was closely followed by concerns about the deterioration of water quality. Additionally, 93.75 % of farmers acknowledged the drying of water resources over time, with 68.75 % identifying a lack of water as a hindrance to their agricultural activities. Furthermore, 81.25 % of the farmers expressed their concern about water scarcity, while 75 % revealed that excessive crop loss due to moisture and an increase in fungal infections had been detrimental. Consequently, these changes have led to an increased incidence of pests and diseases affecting both crops and livestock populations. Farmers noted that all these consequences are the result of significant shifts in climatic events over time. They have also encountered a new pest called the fall armyworm in maize, which has severely impacted maize production, and wilt disease in pigeon pea, leading to substantial crop losses. Farmers primarily attributed the incidence of pests and diseases to the use of pesticides, hybrid varieties, and extensive farming practices, which they believe have contributed to the emergence of new pest and disease incidents compared to two decades ago. Additionally, farmers have been contending with erratic monsoon patterns during the sowing season and hailstorms during the harvest season, resulting in substantial yield losses. As a result, 87.50 % of farmers reported experiencing losses in farm earnings, as outlined in Table 5.

**Table 5.** Farmers' perception on climate change impacts on livelihood and agriculture

| Events                                                                                             | Respondents (%) |
|----------------------------------------------------------------------------------------------------|-----------------|
| 1. Quality of water deterioration over the years                                                   | 87.50           |
| 2. Drying of water resources over the years                                                        | 93.75           |
| 3. Faced water scarcity for crop production                                                        | 68.75           |
| 4. Due to climate change susceptibility of crops/ livestock to pest/ disease attacks has increased | 81.25           |
| 5. Have you noticed new disease incidence in the crops                                             | 75.00           |
| 6. Have you noticed new insects in crops                                                           | 81.25           |
| 7. Have you noticed new diseases or parasites in livestock                                         | 68.75           |
| 8. Have you noticed any shifts in the flowering and harvesting period of crops                     | 68.75           |
| 9. Have you noticed any quality deterioration observed in farm products                            | 75.00           |
| 10. Have you noticed any losses in farm earnings                                                   | 87.50           |
| 11. Incidence of illness due to any disease increased in your family                               | 75.00           |

#### 5 Farmers' perceptions regarding the impact of climate change on food security and human health

The public distribution system holds significant importance and has played a pivotal role in distributing food grains to the public for their consumption over the past 20 years. However, the quality of food has gradually deteriorated due to the adoption of chemical farming practices during this period. Changes in food consumption habits, shifting from roti to rice, dosa and idli have contributed to a decline in immunity over time. This has led to the increased incidence of diseases such as dengue, malaria, typhoid, viral fever, and others. Furthermore, livestock diseases, including Foot and Mouth Disease (FMD), Lumpy Skin Disease (LSD) in cattle and Anthrax in sheep, have become more prevalent in recent years. These diseases were less frequently observed two decades ago.

#### 6 Drivers of Climate Change Adaptation

The majority of farmers lack both information and knowledge about climate change. Additionally, they face challenges related to the timely availability of credit facilities for purchasing inputs, and there's a general absence of effective climate change mitigation strategies. These three factors collectively account for 75 % of the concerns raised by farmers. Furthermore, 93.75 % of farmers concurred that the accessibility of credit is a significant factor influencing climate change adaptation. About 62.50 % of farmers cited the scarcity of water during the dry season as a key driver prompting them to undertake adaptation measures. Additionally, 87.50% of farmers emphasized that the outbreak of new diseases or food scarcity plays a pivotal role in motivating them to adopt climate change adaptation measures, as detailed in Table 6.

**Table 6.** Factors influencing climate change adaptation

| Events                                                                                              | Respondents (%) |
|-----------------------------------------------------------------------------------------------------|-----------------|
| 1. Lack of information and knowledge on climate change acts as a barrier to climate change adoption | 75.00           |
| 2. Credit accessibility influences take adaption measures                                           | 93.75           |
| 3. Using technology (like mobile, TV, radio, etc.) to influence adopt adaptation measures           | 81.25           |
| 4. Government/NGO/others' support influences adopting adaptation strategies                         | 68.75           |
| 5. Scarcity of water during the dry season influences to take adaptation measures                   | 62.50           |
| 6. Outbreak of new diseases or food scarcity influence to take adaptation measures                  | 87.50           |

#### 7 Farmers' views on strategies for adapting to and mitigating climate change

In the village, the majority of farmers (81.25 %) lack knowledge about climate change mitigation strategies. Nonetheless, 87.50 % have adopted practices such as intercropping and crop rotation. Water conservation methods, particularly those involving farm ponds, are less prevalent at 12.50 %. Regarding their livestock, most farmers (81.25 %) prefer desi cows over crossbreeds.

However, only 25.00 % make use of weather forewarning systems to monitor weather conditions, as indicated in Table 7. The strategies they have implemented include providing crucial irrigation during prolonged dry spells, typically by administering one or two rounds of irrigation to their crops. They rely on resources such as borewells and lift irrigation facilities provided by the government. Additionally, they employ soil conservation techniques such as mulching, the construction of graded bunds, and the application of green manure, the adoption of a maize+ cowpea intercrop system, and the utilization of a cereal-pulse cropping system to preserve soil fertility. Nevertheless, farmers often lack access to crop and livestock insurance to safeguard against climate change-related disasters. Furthermore, they are not actively engaged in community-based land and soil conservation initiatives.

**Table 7.** Climate change adaptation/ mitigation strategies

| Events                                                                                        | Respondents (%) |
|-----------------------------------------------------------------------------------------------|-----------------|
| 1. Received any skill development training program to cope with the impact of climate change  | 18.75           |
| 2. Changed in cropping pattern (crop rotation/intercropping/ new crop) over the past 20 years | 87.50           |
| 3. Invested in farm ponds for irrigation purposes                                             | 12.50           |
| 4. Adopted improved seeds for cultivation                                                     | 81.25           |
| 5. intensified the application of farm inputs                                                 | 87.50           |
| 6. Reared livestock of a different breed than the earlier one over the past 20 years          | 18.75           |
| 7. Measures have you taken to improve soil properties                                         | 81.25           |
| 8. Using any forewarning systems to know about weather conditions                             | 87.50           |
| 9. Using any forewarning systems to know about weather conditions                             | 25.00           |

#### 8 Major climate change mitigation strategies adopted by the farmers in the village

Adaptation measures: Blend of traditional and improved practices

1. Soil conservation practices
2. Graded bunds, mulching, and green manuring with sun hemp, daincha.
3. Intercropping system (sorghum+ pigeon pea), (Maize + cowpea).
4. Crop rotation: Maize- chickpea (Cereal- pulse cropping pattern).
5. Drought-Disease-resistant varieties.

#### Conclusion

The study conducted in Halavarthi village in the Koppal district of Karnataka sheds light on the multifaceted impact of climate change on the lives and livelihoods of its residents. The findings indicate that the village's semi-arid ecological conditions, characterized by erratic

rainfall, droughts, and increased temperature, have significantly affected agriculture, livestock, and overall food security. The farmers, who have been experiencing these changes over the past two decades, have witnessed challenges such as water scarcity, deteriorating water quality, crop losses, increased incidence of pests and diseases and the migration of plant species. These effects have led to a decline in immunity and an increase in diseases in both humans and livestock. While farmers have adopted some climate change adaptation strategies, such as crop rotation and intensified use of farm inputs, there remains a lack of knowledge and information on climate change mitigation. The study underscores the urgency of addressing climate change's far-reaching implications on agriculture, food security, and human health, and the need for comprehensive strategies to enhance the resilience of farming communities like Halavarthi to the changing climate.

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#### Authors contribution

Comprehending farmer's views on climate change and agricultural/livestock adaptation in Halavarthi Village, Koppala District, Karnataka: a case study was a collaborative effort led by Suresh K P, who served as the corresponding author and played a pivotal role in designing and executing the research. Naveesh Y B., Sagar N., Jayashree A., and Sushma R., contributed significantly to data collection and analysis, particularly in gathering vital demographic and ecological information about the village. Ragga. R. and Ashwini. M also assisted in the analysis of collected data while providing support in manuscript editing. Suresh K. P., Krishnamoorthy P., Siju S. J. and Patil S S provided brief information regarding the preparation of the questionnaire, addition final correction and editing of the manuscript.

#### Conflict of interest

Authors declare that they have no competing interests

#### Consent from Farmer's

We have recorded videos of each farmer with their clear and transparent consent, signifying their willingness to participate in activities involving their land and data, all in adherence to agreements ensuring transparency and respecting their rights and interests.

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All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors, and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher. To the best of our knowledge, this study helps reduce challenges that remain, encompassing limited access to climate change information and credit requirements of the farmers for inputs. The study highlights there is a need for initiatives by the government and NGOs to encounter the challenges faced by the farmers regarding climate change. Thereby, farmers might have utilized novel technologies or strategies through comprehensive policy implementations, ensuring food security and human health of the farmers.

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