Case study

ProbingFarmersApprehensions of Climate Change and Adaptation in Karkihalli Village, Koppala District, Karnataka: A Case Study.

Abstract

Study conducted in Karkihalli village, Karnataka, India, aimed to assess the impact of climate change on agriculture and livestock, as well as the adaptation and mitigation strategies employed by farmers. Through interviews with ten farmers, it was found that a majority of farmers were aware of climate change and had observed various climate-related changes over the past two decades. These changes included rising temperatures, decreased rainfall, prolonged droughts and increased occurrences of heat waves, among others.The impact of climate change on agriculture was evident in the form of water scarcity, declining water quality and increased susceptibility of crops and livestock to pest and disease attacks. Farmers noted specific challenges such as new diseases affecting crops, such as fall armyworm and wilt disease, which led to significant crop losses. Erratic monsoon patterns and hailstorms further exacerbated the situation, resulting in reduced agricultural yields and earnings.The deteriorating quality of food due to chemical farming practices was observed to have adverse effects on human health, with changes in food consumption habits contributing to an increase in diseases. Moreover, livestock diseases were more prevalent in recent years, likely linked to climate-related shifts.Farmers identified various drivers for climate change adaptation, including a lack of information and knowledge about climate change, accessibility to credit facilities and the outbreak of new diseases or food scarcity. While many lacked knowledge about climate change mitigation strategies, they had adopted practices like crop rotation, improved seeds and soil conservation technique.

Keywords: Probing, Climate change, Karkihalli, Adaptation

1. Introduction

Climate refers to the long-term variation in the atmospheric conditions of specific regions, and climate change entails a gradual transformation in the climate system driven by both natural and anthropogenic factors. This change results from alterations in various components of

the climate system, including the atmosphere, hydrosphere, biosphere, cryosphere and lithosphere, or from intricate interactions among these elements. The causes of climate change can be broadly categorized into natural and anthropogenic factors. Natural factors encompass variations in solar activity, volcanic eruptions, sea water temperatures, ice cap distributions, westerly and atmospheric waves. Conversely, anthropogenic factors involve emissions of carbon dioxide from industrial and agricultural activities, deforestation, acid rain and the depletion of the ozone layer due to substances like Freon gas. Notably, the increasing concentration of greenhouse gases, primarily carbon dioxide, is recognized as a significant contributor to global warming (Presidential Advisory Council on Education, Science and Technology: PACEST, 2007).

Furthermore, there is a growing awareness among people that global warming is an inevitable consequence of the continuous rise in greenhouse gas emissions and the resulting alterations in the climate system. This awareness was officially brought to the world's attention in the 1972 Club of Rome Report and in 1985, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) officially identified carbon dioxide as the principal driver of global warming. The fourth report of the UN Intergovernmental Panel on Climate Change (IPCC) in 2007 unequivocally asserts that global warming has severe consequences for the planet. It is highly probable that the increased emissions of greenhouse gases from human activities have been the primary cause of global warming since the mid-20th century. This report issues a stark warning that if current levels of fossil fuel consumption, such as oil and coal, persist the earth's average temperature could rise by up to 6.4°C by the end of the 21st century (2001-2100), accompanied by a sea level increase of 59 cm. Notably, over the past century (1906-2005), the earth's average temperature has already risen by 0.74°C (Korea Meteorological Agency, 2008).

Global warming's repercussions extend beyond merely changing average temperatures and precipitation patterns. It also leads to an increased frequency of extreme weather events such as floods, droughts, heat waves and more intense typhoons and hurricanes. These changes are also evident in various other manifestations around the world, including rising sea levels, declining glaciers, the northward migration of plant habitats, shifts in animal habitats, ocean temperature rise, shorter winters and earlier springs(Filho et al., 2018).

Agricultural production is inherently linked to the selection of crops suited to the climate of a specific region and the application of appropriate farming practices. Agriculture is, thus a climate-dependent bio-industry characterized by distinct regional features. Regional characteristics pertain to the ecosystem attributes determined by the local climate. Climate change disrupts the agricultural ecosystem, leading to modifications in vital climatic elements such as temperature, precipitation and sunlight(Morton, 2007).This disruption further influences agricultural aspects like crop cultivation, livestock rearing and hydrology.The impact of climate change extends to livestock diseases such as foot and mouth disease (FMD), lumpy skin disease (LSD), and anthrax in animals. These diseases contribute to substantial economic losses and high mortality rates among livestock in the farming community in Karnataka(Lalasangi et al., 2023 and Sushma et al., 2021).El Niño and La Niña seem to influence Indian monsoon rainfall, with other weather parameters by incidence, spread and prediction of Anthrax diseases in Karnataka (Suresh et al., 2022).While the intricate relationship between climate change and livestock diseases is complex, it is evident that the changing climate has repercussions on the epidemiology of Anthrax, Foot and Mouth Disease (FMD) and Lumpy Skin Disease (LSD), with both exacerbating and ameliorating effects depending on the specific disease dynamics and environmental conditions (Bylaiah et al., 2002, Sushma et al., 2022and Indrabalan et al., 2022).

Climate change's impact on hydrology encompasses alterations in underground water levels, water temperature, river flow and the quality of lakes and marshes. These changes are a consequence of shifts in precipitation, evaporation and soil moisture content. Increased precipitation due to climate change results in higher outflows, while rising temperatures intensify evaporation, leading to decreased outflows. To quantitatively evaluate the effects of climate change on water resources, deterministic hydrological models based on general circulation models are employed(Kroll et al., 2019). As illustrated, climate change has a wide-ranging impact on rural economies, affecting agricultural productivity, farm household income, asset values and agricultural infrastructure due to changes in water resources available for agriculture. Farmers of Hyatimundaragii village of Koppala district, Karnataka have faced climate variability and noticed increasing temperature, delayed onset of rainfall, intermittent rainfall, prolonged drought conditions, depletion of the water table, untimely filling of water bodies, increased incidence of pests and diseases, livestock diseases, and decreasing soil moisture as the critical factors affecting their cultivation, decrease yield and quality of crop

produce. Some of them have started to adapt to these changes by soil conservation measures like the construction of graded bunds, mulching, green manuring and sorghum+pigeonpea intercropping, crop rotation, cultivating drought, pest and disease resistance short duration varieties, providing lifesaving irrigation to crops (Naveesh et al., 2023).

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

2. Study Methodology

2.1. Demography, ecology and population dynamics of Karkihalli village, Koppal Taluk, Koppal District

Karkihalli village, located in Karnataka, India, is assigned the village location code 601786. It is situated in the Koppal taluk of Koppal District, approximately 19 kilometers to the north of the district headquarters, Koppal. The village covers a total geographical area of 4636.13 hectares, positioned at coordinates 15.251872°N Latitude and 76.247060°E Longitude (as depicted in Figure 1.0 and Table 1).Karkihalli village is home to a population of 2,428 individuals, with 1,221 being male and 1,207 being female. The literacy rate in Karkihalli village stands at 49.59%, with 59.54% of males and 39.52% of females being literate. The village comprises approximately 407 households, and its postal code is 583238.

Table 1. Demography of Karkihallivillage

Area	4636.13 ha
Latitude	15.251872°N

Longitude	76.247060°E
Altitude	526 mt
Families	407
Population	2,428
Literacy rate	49.59 %

Fig. 1. Google map of Karkihallivillage, Koppal

The ecology of Karkihalli village in Koppal district is characterized by a semi-arid climate, which is associated with a range of features including diverse vegetation, wildlife adapted to arid conditions, agricultural practices and the influence of human activities.The primary water source for this area is the Tungabhadra reservoir, located in Munirabad and adjacent to Hatti village. This reservoir plays a crucial role in meeting the water needs of nearby villages. In addition to the reservoir, tube wells are a significant source of water for both agricultural and livestock purposes.The region experiences an average annual temperature of 27.0°C. It receives an annual average of approximately 580 mm of rainfall, typically distributed over a period of 20-30 days. Furthermore, the area sustains an average annual wind speed of 5.18 meters per second and maintains an average annual atmospheric pressure within the range of 1008-1010 millibars.

The total cultivable land area of the village is 805 hectares, with 473 hectares dedicated to rain-fed cultivation and 332 hectares designated for irrigated farming, primarily relying on wells and tube wells as the main sources of irrigation. The predominant soil type in the village is red loamy soil.The primary agricultural crops grown in the area include maize, sorghum, sugarcane, red gram, black gram, green gram, groundnut and various vegetable crops such as tomatoes, gourds and crucifers. The village also boasts a total livestock population of 3,576 animals, comprising 1,569 sheep, 643 goats, 1,070 cows and 294 buffalo, as detailed in Table 2.Households in the village face several farming constraints, including the low fertility status of the soil, the presence of wild animals causing damage to farm fields, low prices for agricultural commodities, and a lack of marketing facilities. Other challenges include insufficient irrigation water, a scarcity of extension services, high costs of fertilizers and plant protection chemicals, elevated interest rates on creditand a shortage of transportation for the safe transport of

agricultural produce to the market, limited rainfall, and difficulties in accessing agricultural technology information.

1.Ave. annual Temperature	27.0 °C
2.Ave. annual Rainfall	587 mm
3.Ave. annual Rainfall days	30-40 days
4.Ave. annual wind speed	5.67 mt/sec
5.Ave. annual pressure	1008-1010 mb
6. Cultivable area (Rainfed + Irrigated)	805 ha
6. Soil type	Red Loamy soils
7. Irrigation type	Both rainfed and irrigated(Tube wells)
8. Major crops	Maize, sugarcane, sorghum, pigeon pea, black gram, green gram, cowpea, groundnut
9. Livestock Population a. Cow b. Buffalo c. Sheep d. Goat **Total**	 1070 294 1569 643 **3576**

Table 2. Ecological, Soil type, cropping pattern and livestock population of Karkihallivillage.

2.2 Research gap and research questions

In response to the adverse effects of climate change, a multitude of potential agricultural adaptation alternatives have been proposed, with some already in practice. While a few adaptation strategies for analyzing the impact of climate change have been assumed, the adaptation process itself remains somewhat opaque. An urgent need exists to comprehend the types of adaptations that are both feasible and practical during adverse weather conditions. It is imperative to identify those responsible for implementing these strategies and to pinpoint the requirements necessary to facilitate and promote their development and acceptance.The objective of this study is to investigate farmers' perceptions of agricultural adaptation strategies and the constraints they encounter when dealing with climate change. Throughout our research study, we aim to find answers to the following questions within the surveyed area:

1. What are the farmers' perceptions of agricultural adaptation strategies in the context of climate change?
2. What specific challenges do farmers confront in addressing climate change?

3. How can these adaptation strategies be effectively implemented and promoted?
4. What are the requirements essential to support the development and acceptance of these adaptation strategies?
5. Examining climate change adaptation and mitigation strategies

3. Results and Discussions

3.1 Climate Change, Impact and Mitigation Strategies Adopted in Karkihalli(V)

In a survey conducted in Karkihalli village to investigate climate change patterns, the impact of climate change on agriculture and livestock and the mitigation measures adopted by farmers, a total of ten individual farmers were interviewed. These participants were in the age group of 36 to 60 and had varying levels of education, ranging from illiteracy to primary school education. The primary questions posed during the survey covered topics such as the respondents' knowledge of climate change, the causes of climate change, their 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 used to collect information on farmers' perceptions of climate change and variability. The survey involved 10 farmers, with a significant majority (70.50 percent) having over 30 years of farming experience. Among the respondents, 60 percent were in the age group of 30-50 years, while the remaining 40 percent were over 50 years old. Regarding educational background, the survey included 40.00 percent of illiterate farmers, 60 percent with primary education and no one had received education beyond the primary level, as indicated in Table 3.

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

Variables	Respondents (%)
1.Age Group	
20-30	0.00
30-50	60.00
50 and above**.**	40.00
2.Education Level	
Illiterate	40.00
Primary	60.00
High school	0.00
PUC	0.00
Graduation	0.00
3. Family size	
1-5	50.00
5-10	20.00
10-15	10.00
15-20	30.00
>20	0.00
4.Type of Land	
Dry land	12.5
Irrigated land	12.5
Both (Irrigated+ Dry land)	62.5
Fallow land	12.5

3.2 Farmers' general perception of knowledge of climate change

The findings related to the general perception of knowledge about climate change patterns indicated that 90 per cent of the farmers had some degree of awareness. Moreover, 70 per cent of the farmers confirmed the existence of climate change patterns. A substantial majority, accounting for 90 per cent, obtained their information on climate change from mass media and individuals in their immediate vicinity. Additionally, they acknowledged that the climate in their village has been undergoing changes for the past 20 years, as illustrated in Figure 2.

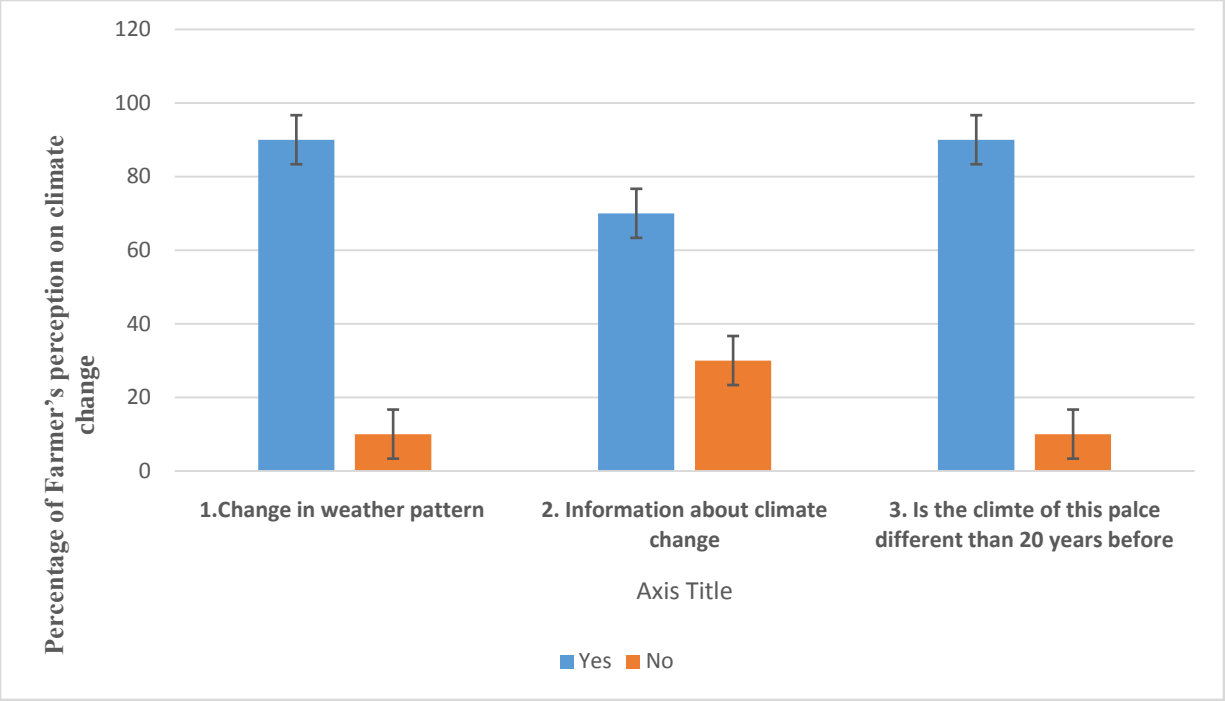

Fig. 2: General perception knowledge of climate change

3.3 Evaluating the Awareness and Perceptions of Farmers Regarding Climate Change

Examining the current climate change situation requires a historical perspective and establishing a baseline climate data is essential to provide a reference point for assessing climate change, as noted by Khan et al. in 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 have been farming there for many years and are experiencing noticeable shifts in climate conditions. Specifically, 90 percent of the farmers reported an increase in temperature, which they found unbearable, particularly during the summer months. There was a consensus (90.00%) among them about a decrease in rainfall and prolonged dry spells during the cropping season, leading to drought conditions. Due to reduced rainfall, flooding was not a concern in the village, and almost all farmers shared the opinion of experiencing continued drought conditions in some years.Furthermore, educated farmers' perceptions of the frequency of climate change events included a frequent occurrence of drought conditions (80%), frequent changes in rainfall and thunderstorms (90.0%), heat waves (100%), loss of biodiversity (80.00%), and hailstorms, all equally reported at 80 per cent. Soil erosion and dry spells were

observed by 90 per cent of the farmers. In contrast, farmers rarely observed changes in climate events such as forest fires, floods, cold waves, cyclones, and were unaware of landslide-like events in their village, as indicated in Table 4 and Figure 3.

Table 4. Farmers General Perception on climate change events over 20 years.

Climate Variables	Increased (%)	Decreased (%)	No change (%)
1.Temperature	90.00	0.00	10.00
2.Rainfall	0.00	90.00	10.00
3.Flood	0.00	0.00	100
4.Drought	70.00	0.00	30.00

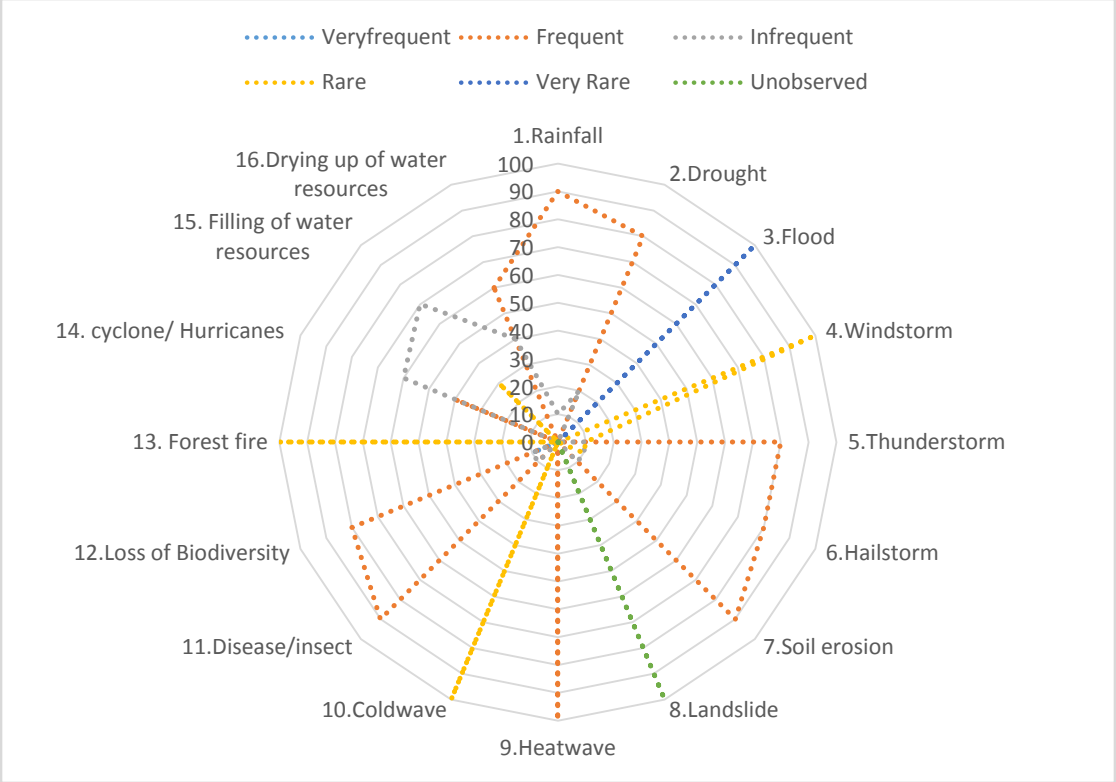

Fig. 3: Farmer's awareness and perception about climate change.

3.4 Perception of farmers on climate change impacts on livelihood and agriculture

Regarding farmers' perceptions of the impact of climate change on their livelihoods and agriculture, several significant findings emerged. A substantial majority, comprising 90 per cent of the farmers, reported that they have been dealing with water scarcity in their village for the past 20 years. This concern was closely followed by worries about the deterioration of water quality. Additionally, 100 per cent of the farmers acknowledged the drying up of water resources

over time, with 68.75 per cent identifying a lack of water as a hindrance to their agricultural activities.

Furthermore, 70 per cent of the farmers expressed their concerns about water scarcity, while 90 per cent revealed that excessive crop losses due to moisture and an increase in fungal infections had been detrimental to their agriculture. Consequently, these changes have led to an increased incidence of pests and diseases affecting both crop 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, hybrids 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. Consequently, 90 per cent of farmers reported experiencing losses in farm earnings, as detailed 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	90.00
2. Drying of water resources over the years	100.00
3. Faced water scarcity for crop production	70.00
4.Due to climate change susceptibility of crops/ livestock to pest/ disease attacks has increased	90.00
5.Have you noticed new disease incidence in the crops	90.00
6.Have you noticed new insects in crops	90.00
7. Have you noticed new diseases or parasites in livestock	80.00
8. Have you noticed any shifts in the flowering and harvesting period of crops	80.00
9.Have you noticed any quality deterioration observed in farm products	70.00
10. Have you noticed any losses in farm earnings	90.00
11. Incidence of illness due to any disease increased in your family	60.00

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

The public distribution system has held significant importance and 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, including a shift from roti to rice, dosa and idli, have contributed to a decline in immunity over time. This shift has led to an increased incidence of diseases such as dengue, malaria, typhoid, viral fever and others.Furthermore, livestock diseases, such as 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.

3.6 Drivers of climate change adaptation

The majority of farmers lack information and knowledge about climate change. Additionally, they face challenges related to the timely availability of credit facilities for purchasing inputs, and there is a general absence of effective climate change mitigation strategies. These three factors collectively account for 80 percent of the concerns raised by farmers. Furthermore, 100 percent of farmers agreed that the accessibility of credit significantly influences climate change adaptation. About 80 percent of farmers cited the scarcity of water during the dry season as a key driver prompting them to undertake adaptation measures. Additionally, 90 percent 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	80.00
2.credit accessibility influence take adaption measures	100.00
3.Using technology (like mobile, TV, radio, etc.) influence adopt adaptation measures	70.00
4.Government/NGO/others' support influences adopting adaptation strategies	80.00
5.Scarcity of water during the dry season influences to take adaptation measures	80.00
6.Outbreak of new diseases or food scarcity influence to take adaptation measures	90.00

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

In the village, the majority of farmers (80 percent) lack knowledge about climate change mitigation strategies. Nevertheless, 80 percent have adopted practices such as intercropping and crop rotation. Water conservation methods, particularly those involving farm ponds, are less prevalent, with only 10 percent of farmers adopting them. On the other hand, 80 percent of farmers have embraced improved seeds for cultivation, and 90 percent have adopted soil conservation technologies such as green manuring, construction of graded bunds and contour bunding for soil conservation practices.Regarding their livestock, most farmers (81.25 percent) prefer desi cows over crossbreeds. However, only 30 percent utilize 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. They have adopted an intercropping system with maize and cowpea, as well as a cereal-pulse cropping system to preserve soil fertility.However, 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	20.00
2.Changed in cropping pattern (crop rotation/intercropping/ new crop) over the past 20 years	80.00
3.Invested in farm ponds for irrigation purposes	10.00
4.Adopted improved seeds for cultivation	80.00
5.intensified the application of farm inputs	70.00
6.Reared livestock of a different breed than the earlier one over the past 20 years	10.00
7.Measures have you taken to improve soil properties	90.00
8.Change in planting time to overcome pest and disease attacks	80.00
9. Using any forewarning systems to know about weather conditions	30.00

3.8 Major climate change mitigation strategies adopted by the farmers in the village

Adaptation measures: Blend of traditional and improved practices

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

4. Conclusion

The study conducted in, Karkihalli village in Koppal district, Karnataka, faces the challenges of climate change, impacting agriculture, livestock and the overall well-being of its residents. Farmers in the village have shown awareness of climate change patterns and have witnessed changes over the past two decades, including increased temperatures, decreased rainfall and more frequent climate-related events. These changes have had adverse effects on water resources, agriculture stand the incidence of pests and diseases. Farmers have adopted various adaptation strategies, such as intercropping, crop rotation, and soil conservation practices, but many lack access to essential resources like credit facilities and climate change knowledge. The study underscores the importance of addressing these challenges and promoting effective climate change adaptation to safeguard the livelihoods and agriculture of the village's residents.

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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