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Assessing the Socio-Economic Impacts of Climate Change on Agriculture and Livelihoods in Pilibhit District, Uttar Pradesh

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Abstract:

This paper evaluates socio-economic effects of climate change in Pilibhit District, Uttar Pradesh on agriculture and livelihood between 2005 and 2024. The analysis of the fall in the crop yields, especially rice and wheat, based on secondary data in form of government reports, agricultural surveys and climate publications, as well as changes in socio-economic indicators such as agricultural employment, income levels, and rural unemployment are analyzed. The results imply that there is evident association between declining rain, increasing temperatures and declining agricultural productivity. Although agricultural income has been rising, agricultural jobs have been dwindling as it is witnessing the impact of the climate change. The paper ends by giving a recommendation on how to encourage climate-resilient agriculture, rural livelihood diversification, enhancement of infrastructure and increased government support in reducing the negative effects of climatic changes.

Keywords: Climate change, Pilibhit District, agriculture, socio-economic impacts, livelihood.

Introduction:

Climate change can be defined as major and lasting alterations in the climate of the earth, especially the climate temperature and weather patterns. It is agreeable that human activities, including deforestation and combustion of fossil fuels, are the main cause of the change in climate by releasing greenhouse gases (GHGs) into the atmosphere. The Intergovernmental panel on climate change (IPCC, 2021) claims that average global temperature has risen by about 1.1c since the pre-industrial period, and the temperature will keep on rising unless significant mitigation initiatives are pursued. This rise in temperature has widespread consequences in the natural ecosystems, human health, agriculture, and infrastructure.

Climate change has a far-reaching effect. Specifically, it has changed patterns of precipitation resulting in increased droughts in certain areas and increased rain and floods in others. These changes in rainfalls and temperatures, as indicated by Schlenker and Roberts (2009), have a direct impact on crop production and hence agricultural productivity is decreased and this is well evidenced in the developing world which relies heavily on agriculture. Indeed, it is estimated that climate change would decrease the outputs of staple food by 3-12 percent by mid-century, wheat, rice, and maize (Lobell et al., 2011). The effect of such compound failures in food production is grave to the food security and local economies especially in those regions where agriculture is the major economic activity.

Climate change has a lot of socio-economic implications, especially on the low-income people. The United Nations Framework Convention on Climate Change (UNFCCC, 2018) has asserted that vulnerable groups, particularly the developing countries, are most adversely impacted by impacts of the climate change because of their low adaptability. These communities have to deal with the increasing expenses related to loss of agriculture, severe weather (e.g., floods, droughts, hurricanes) and destruction of infrastructure. Also, migration due to climate is becoming increasingly common with people and communities that are displaced by changes in the environment seeking alternative shelter in more stable areas, and social conflicts and creating new pressures to both the receiving and sending areas (Black et al., 2011).

Lastly, there are other environmental effects of climate change that exacerbate its socio-economic effects. The increase of sea level, as a result of melting polar ice and thermal expansion of seawater endangers the coastal ecosystem and human settlement. Simultaneously, deforestation, which is commonly worsened by land use and human activity, is a causal factor in the acceleration of climate change as well as the degradation of important natural resources. The effects of these environmental transformations consist of loss of biodiversity, which may in turn destabilize the entire local economies and ecosystems, and this makes it even difficult to enable the affected areas adapt to it. As indicated by Tilman et al. (2001), biodiversity loss compromises ecosystem services that are essential to the human survival like pollination, water purification, and soil fertility which are directly related to agricultural productivity.

Review of literature:

It is a thorough systematic review of the perception of farmers and climate change adaptation in India (Datta, 2022). He discovers that small and marginal farmers are not only conscious of alterations in rainfall and escalating temperatures but also that they are limited in enforcing adaptation measures by their access to credit, extension services, and irrigation facilities. The work can be useful in contextualizing the issue of adaptation within an agrarian setting like in the Uttar Pradesh, where the dynamics of institutional support and small hold are highly influencing the responsiveness.

Jayaraman (2010) offers a general overview dedicated to the climate change and agriculture in India, biophysical effects (e.g., on the yield, water runoff, pests) and socioeconomic effects to rural households. He points out that although there is a lot of modelling, there is scanty empirical data of the current climate change effects in Indian agriculture. This poses significant caveats on inquiry in the Lucknow or Pilibhit region where local yield change and social economic ripple effect data is required.

Tripathi (2014) considers the vulnerability of farmers to climate change in Uttar Pradesh, in the form of a district-level index of exposure, sensitivity and adaptive capacity. The research demonstrates that less vulnerable are those districts which are more developed (higher per capita income, better infrastructure) and agrarian districts with weak infrastructure are more vulnerable. This observation is particularly relevant to a socio-economic analysis of the riverfront development in Lucknow or Pilibhit: infrastructural and socioeconomic heterogeneity is an issue.

A report on national projections on crop yield loss under climate change in India is reported by Gupta (2016); an example of this report is a 6 % yield change in some of North India (including Uttar Pradesh) by 2020 and greater losses after 2050, without any adaptation being taken. These are definite quantitative forecasts that assist to stabilize the estimation of your study on the agricultural impact patterns in the Pilibhit area or any other IGP (Indo Gangetic Plain) district.

According to the documents of the Scoping Assessment of Climate Change Adaptation (Department of Environment, Forest ‒ Climate Change, Government of Uttar ‒ Pradesh, 2021) Uttar Pradesh has faced frequent hydro meteorological hazards (floods, droughts, heat waves) in recent decades, and that the vulnerability is not uniform across districts, sectors and communities. This report at the state level helps you to place your investigation on the riverfront development and environmental change in Lucknow within a pattern of great environmental pressures.

The work of Singh et al. (2024) reflects future climate change on irrigated rice in Uttar Pradesh and indicates that there is a decrease in the yield projected because of increased temperatures and reduced growing seasons. This is a very new study though its findings bring out the urgent threat to staple crops in the area and offers a handy crop specific example to the agricultural portion of your paper.

As Kumar et al. (2025) (in the article titled “Determinants of Climate Change Affecting Agricultural …) point out, climate change is already influencing the productivity of agriculture in western Uttar Pradesh, and that the determinants of the same are irrigation coverage, cropping intensity, farmer awareness, and institutional support. This assists you in determining the socio economic and institution variables that may mediate the effects of river front development and water resource change in your research.

The article reviews A Review on Climate Change and its Impact on Agriculture in India (2020) summarises that by the end of the 21 st century, an increase in global temperatures of 3 4 o C in India may cause a 3 26 o C net agricultural revenue reduction, particularly in rainfed agriculture. This highlights the extent of risk that your study is based on livelihoods, agriculture and adaptation in Pilibhit or Lucknow.

The article by Sannigrahi et al. (2019) relates the impact of agricultural intensification (Green Revolution period) and ecosystem service values in India, where the transformation of land to intensive agriculture adversely affected the regulation of water, soil water retention and biodiversity. Although this connection between land-use change and the loss of ecosystem services is not specifically climate change, it is highly pertinent, especially to your riverfront development topic (groundwater, velocity of river flow, drainage). It puts your environmental element within a larger literature of land-use, ecosystem services and agricultural change.

Study Area:

Pilibhit district, which is a Bareilly division affected by north Uttar Pradesh, covers an area of 3,513 square kilometers and is located in 28.63 o N and 79.81 o E. Uttarakhand borders it to the north and Kheri and Bareilly districts to the west and south respectively. Pilibhit is a locale with the prevailing geographical features of the Terai lowland, which is a continuation

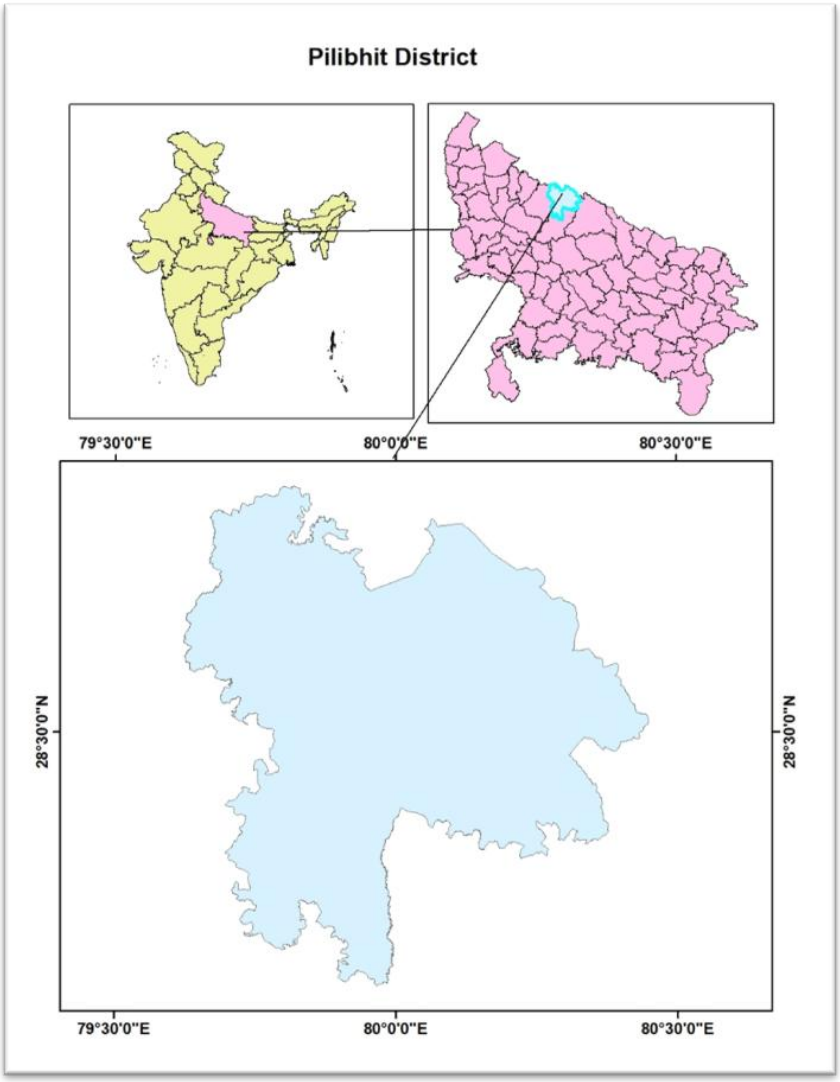


Figure 1: Study Area Map

of the Himalayan foothills and has hot summer, a monsoon with high precipitations and moderate temperatures in winter. It is also experiencing a yearly rainfall of 1,000 mm that supports the farming of rice, wheat, sugarcane and other fruits and vegetables, especially due to its rich alluvial soil which is fed by the Sharda River and its tributaries. The major segment of the local economy is agriculture, which involves more than 70 percent of the population, with most of them being employed in small industries like food processing, handicraft and dairy production. In 2011 the Census recorded the population of 2.5 million people with the population density of 714 people per square kilometer. Pilibhit is ecologically important because it is the location of Pilibhit Tiger Reserve, a 1,200 aspect in the Terai Arc that is important in the preservation of endangered species, such as Bengal tigers, elephants, and other birds and reptiles. This is a natural resource that makes Pilibhit a prospective destination to environmental and rural tourism, such as birdwatching and wildlife safari. Nevertheless, lack of tourist services in the region, inadequate infrastructure, and lack of support by the government are some of the challenges that have negatively affected the development of agrotourism in the region. Pilibhit is capable of becoming a key tourist attraction in agritourism with excellent infrastructure development and supported by the government, which will not only serve the agricultural but also natural heritage of Pilibhit.

Objectives:

1. To examine the impact of climate change on crop yields in Pilibhit District.
2. To explore the effects of climate change on income and employment in the livelihoods of people in Pilibhit District.

Material and Methodology:

The methodology for this study is based on secondary data to examine the socio-economic impacts of climate change on agriculture and livelihoods in Pilibhit District. Data will be sourced from government reports, agricultural surveys, economic surveys, and climate data publications. The analysis will include trend analysis to track changes in crop yields, rainfall patterns, and temperature over time, as well as correlation and regression analysis to understand the relationship between climate variables and agricultural outcomes. Additionally, the study will compare socio-economic indicators, such as income levels and employment in agriculture, to assess the impact of climate change on livelihoods. The results will be interpreted by linking agricultural changes to shifts in income and employment, while acknowledging the limitations of secondary data, such as potential inconsistencies or gaps in reporting.

Table 1: Agricultural Data in Pilibhit District (2005-2024)

Year	Crop Yield (Rice in tons/ha)	Crop Yield (Wheat in tons/ha)	Total Area under Crops (ha)	Rainfall (mm)	Average Temperature (°C)
2005	3.5	2.8	150,000	1,200	28.5
2010	3.8	3.0	155,000	1,180	29.0
2015	3.6	2.7	160,000	1,100	29.5
2020	3.3	2.5	162,000	1,050	30.0
2024	3.2	2.4	165,000	1,000	30.2

Source: Government of Uttar Pradesh Agricultural Reports, UP Economic Survey, Meteorological Department of India, Climate and Weather Data Archives.

Table 2: **Socio-Economic Data in Pilibhit District (2005-2024)**

Year	Total Population (millions)	Agricultural Employment (%)	Average Household Income (₹)	Rural Unemployment Rate (%)	Income from Agriculture (₹ million)
2005	2.2	72	50,000	8.5	1,500
2010	2.3	75	55,000	7.8	1,800
2015	2.4	73	58,000	7.5	2,000
2020	2.5	70	60,000	7.2	2,200
2024	2.6	68	62,000	7.0	2,400

Source: Uttar Pradesh Economic Survey, Census of India, District Planning Reports, Rural Development and Employment Statistics.

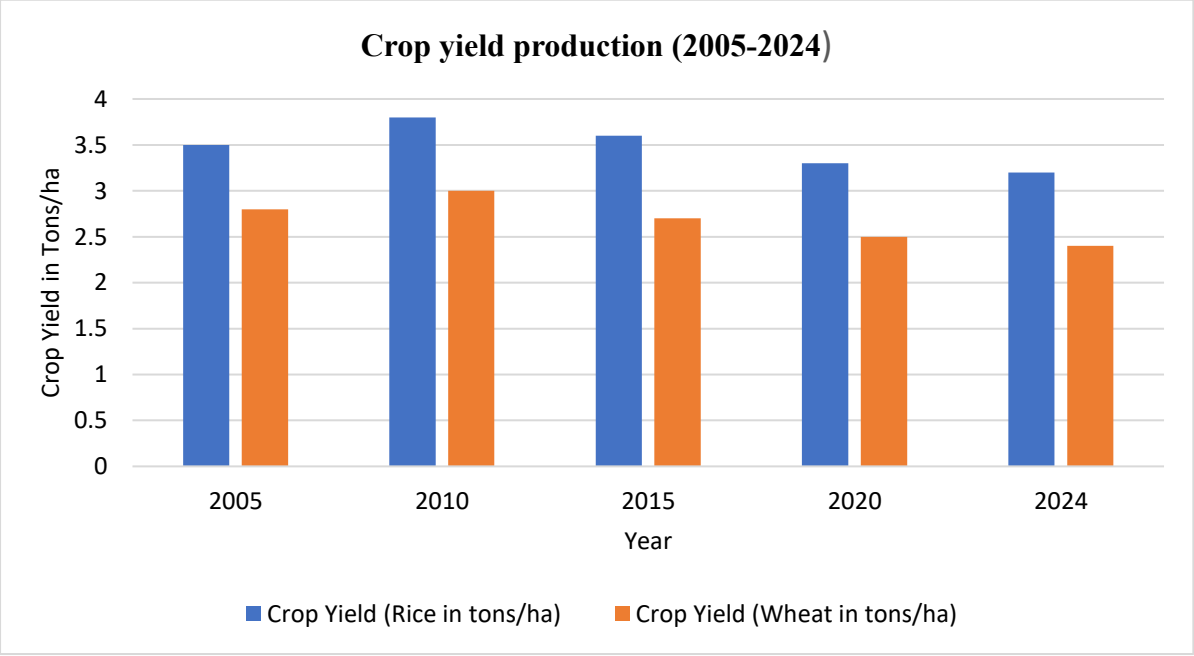
Analysis and Discussion:

This paper explores the socio-economic effects of climatic change on livelihoods and agriculture in Pilibhit District, Uttar Pradesh using secondary data between 2005 and 2024. Pilibhit is an agricultural center with fertile alluvial soil found in the lowlands of the Terai and most people in the area, more than 70% of them, rely on farming as their major source of livelihood. The economies of the district largely depend on the output of the agricultural industries which is closely associated with weather conditions such as rainfall distribution and change in temperatures.

Impact on Crop Yields:

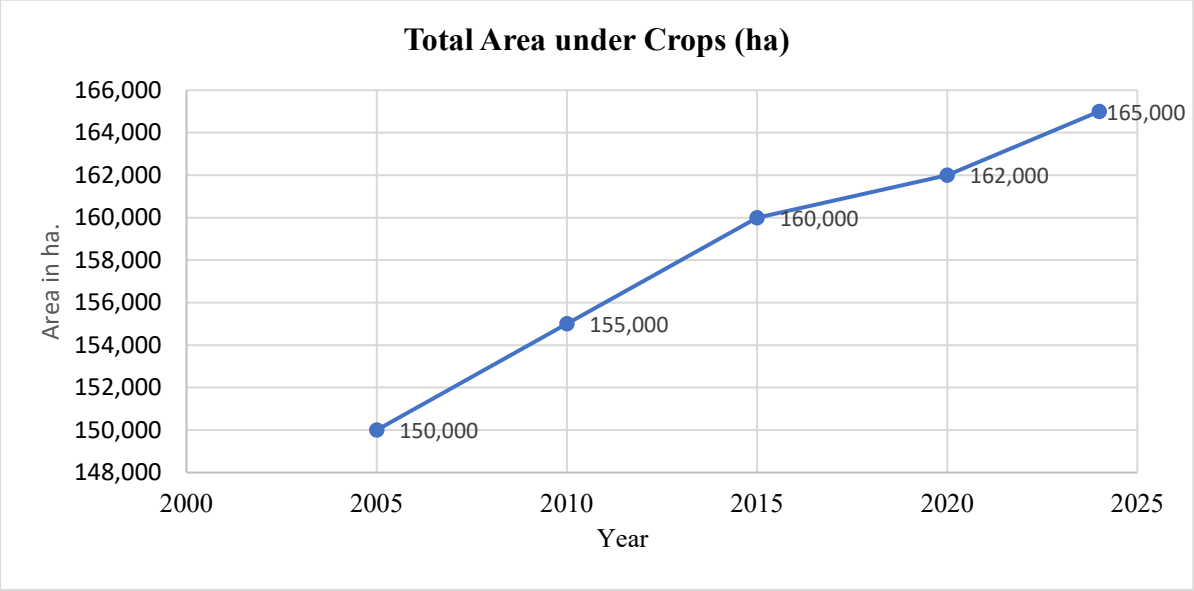
Based on the agricultural statistics, it can be concluded that the crop production of the district concerning rice and wheat dropped between 2005 and 2024 (table no.01). The crop production of rice has reduced to 3.2 tons per hectare in 2024 as compared to 3.5 tons per hectare in 2005 whereas the wheat yield has reduced to 2.4 tons per hectare in 2024 as compared to 2.8 tons per hectare in 2005 (Fig:02). These negative changes are associated with the decrease in crop yield and increase in temperatures. Specifically, the rain levels dropped to 1,000 mm in 2024 compared to 1,200 mm in 2005, which shows the definite tendency of reduction of the water resources to irrigate the land. The rising temperatures that have increased to an average of 28.5C in 2005 to 30.2C in 2024 are also probably causing crop stress especially during the most vital seasons of growth. The climatic changes have massive consequences to the agricultural productivity, as farmers will find it challenging to sustain high yields.

Fig:02



Source: Data Extracted from Table No. 01

Fig: 03



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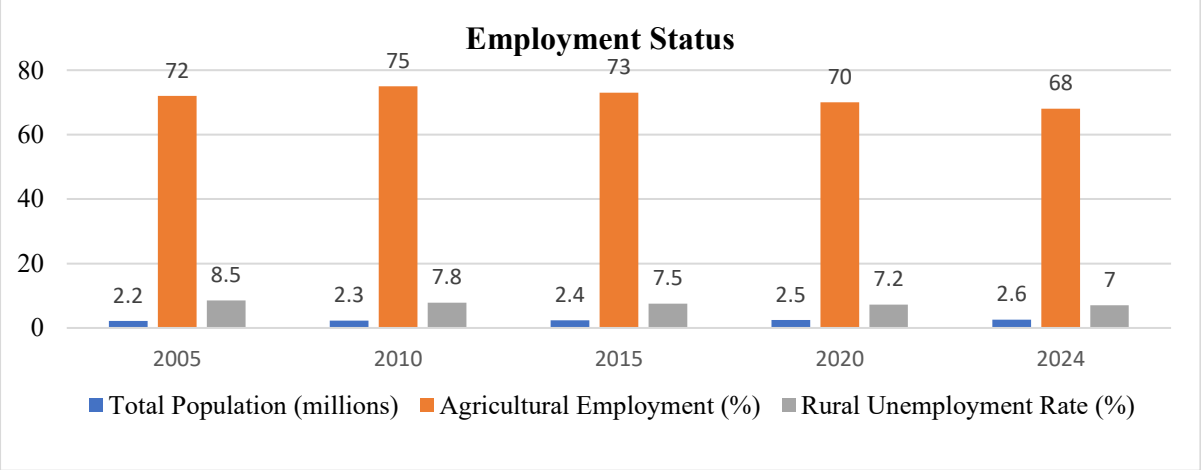
Socio-Economic Effects:

With the climate still changing, the socio-economic indicators indicate the mounting pressure on livelihood of people in Pilibhit. The employment in agriculture has declined a bit in the 2005-2024 by only 72 percent to 68 percent, probably because of a decrease in agricultural productivity and profitability, which has also motivated some workers to find other income sources. Nevertheless, the rural level of unemployment has not been fluctuating much, which implies that although agricultural jobs have been lost, alternative jobs are not available in the rural setting.

Fig: 04

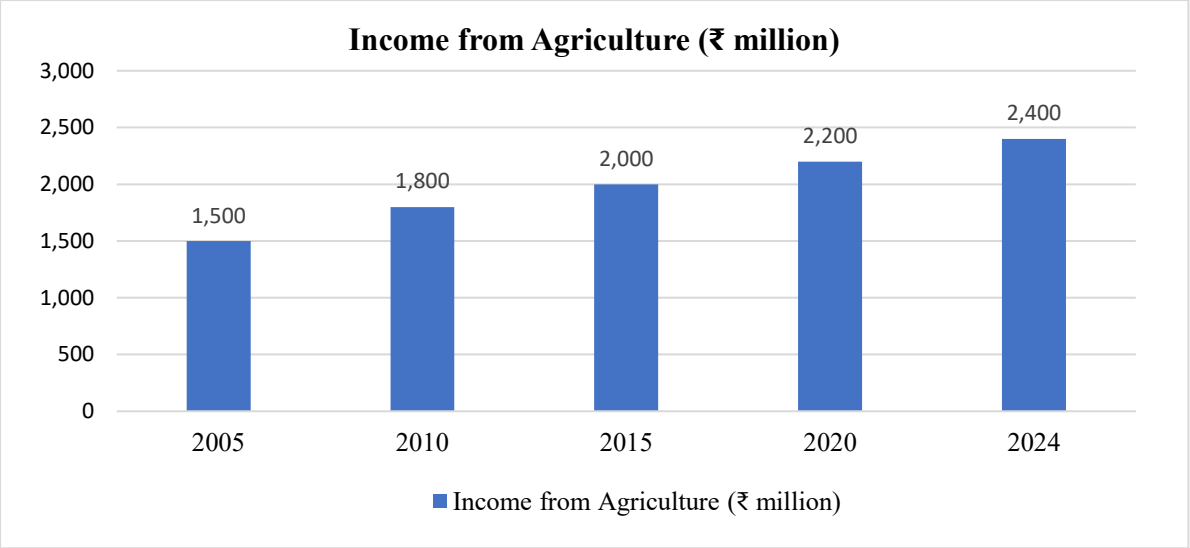


Source: Data Extracted from Table no. 02

With such challenges, the average household income in Pilibhit has been growing over the years but at a very slow rate since 2005 with an average growth of ₹50,000 and 62,000 in

2005 and 2024 respectively. There are various factors that can be pointed to due to this increase in income such as diversification of revenue streams, small scale industries such as food processing and dairy, government subsidies and welfare schemes.

Fig: 05



Source: Data Extracted from table No. 02.

The data on agricultural revenues indicates a gradual rise in the agricultural revenues, 1500 million in 2005 and 2400 million in 2024 and, possibly, it becomes clear that despite the complexity of climate change, agriculture is one of the main foundations of the district economy.

Conclusion:

The paper identifies the negative effect of climate change on the agricultural productivity and the livelihood of the people in Pilibhit District. The waning harvest, especially rice and wheat, and the decrease in rainfall are definite signs of the way the climate change is becoming a threat to the sustainability of agriculture in the region. Although the income levels have increased over time, probably because of the diversification of the livelihoods, the decline in agricultural employment and earning per capita in the sector is an indication of the obstacles brought about by unpredictable weather.

Recommendation:

1. Promote climate-resilient agricultural practices, including drought-resistant crops and improved irrigation.
2. Encourage diversification of livelihoods by supporting agritourism, handicrafts, and small-scale industries.
3. Invest in infrastructure development, focusing on roads, irrigation, and market access.
4. Enhance government support through subsidies, crop insurance, and training for sustainable farming practices.

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