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Climate change and its impact on sericulture: A brief review

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Abstract
Sericulture, a vital agro-based industry intricately linked to climatic factors, particularly temperature and humidity. Climate change has emerged as a critical threat to sericulture, an agro-based industry highly sensitive to environmental variables such as temperature and humidity. Rising global temperature, erratic rainfall and increased frequency of extreme weather events have adversely impacted mulberry (*Morus* spp.) cultivation and silkworm (*Bombyx mori*) rearing. Elevated temperatures can reduce leaf yield and nutritional quality in mulberry, while also causing physiological stress in silkworms, leading to decreased cocoon quality and survival rates. Additionally, seasonal shifts due to climate change are altering the voltinism patterns of silkworms, resulting in mismatched breeding cycles and reduced synchronization with mulberry availability. To ensure sustainable silk production, there is an urgent need to develop drought and heat tolerant mulberry varieties and climate-resilient silkworm breeds This review paper presents a concise synthesis of the influence of climate change on sericulture, focusing on the physiological and developmental impacts of temperature and humidity on mulberry and silkworms, shifts in voltinism patterns due to seasonal variations, and the development of drought and heat-tolerant mulberry genotypes.

Keywords: Temperature, humidity, voltinism, breeds, silkworm health

Introduction

Agriculture forms the backbone of many economies, especially in developing countries where it provides livelihood to a large portion of the population. It encompasses a range of activities including crop cultivation, livestock farming, and allied sectors like horticulture, fisheries and sericulture (Popkin *et al.*, 2012) [17]. Among all, sericulture the cultivation of silkworms for silk production holds a special place due to its potential for rural employment, ecological sustainability and economic value.

The role of climate is critical in determining the success of agricultural systems, including sericulture. Climate refers to the long-term patterns of temperature, humidity, rainfall, and seasonal variations in a given region. These climatic factors directly influence plant growth, soil health, pest dynamics, and the productivity of livestock and insects (Lesk C., *et al.*, 2016) [13]. In the context of sericulture, both the mulberry plant, which is the exclusive food of the silkworm (*Bombyx mori*), and the silkworm itself are highly sensitive to climatic variations.

With the onset of climate change, marked by rising global temperatures, erratic rainfall patterns, prolonged droughts and increased frequency of extreme weather events, the traditional practices of agriculture and sericulture are facing new challenges. Changes in temperature and humidity can disrupt the sprouting and leaf quality of mulberry plants, affect the metabolic and developmental processes of silkworms, and reduce the yield and quality of cocoons and silk. These disruptions not only threaten silk production but also impact the socio-economic stability of farmers dependent on sericulture.

Therefore, understanding the interaction between climate and agriculture-particularly sericulture-is essential for developing sustainable practices. This includes breeding climate-resilient mulberry varieties, improving silkworm strains, optimizing rearing conditions and adopting adaptive farming strategies that can withstand changing environmental conditions.

Climate

Climate refers to the long-term patterns of temperature, humidity, rainfall, and wind in a particular region. Climate change is a global phenomenon marked by significant alterations in these natural patterns over time. Driven largely by anthropogenic activities such as the combustion of fossil fuels, deforestation and industrial emissions, it results in rising global temperatures, frequent wildfires, unpredictable rainfall and food insecurity (Porter *et al.*, 2014) [18]. According to climatic models, the average global temperature is expected to rise between 1.0 °C to 5.8 °C by the end of the 21st century (Hansen *et al.*, 2010). To mitigate such changes, strategies like afforestation and carbon sequestration must be aggressively implemented.

Causes of climate change

Climate change refers to the long-term alteration of temperature and typical weather patterns in a place. It is primarily driven by both natural processes and human activities. One of the main causes is the burning of fossil fuels like coal, oil, and natural gas for energy, transportation, and industry. This releases large amounts of carbon dioxide (CO_2) and other greenhouse gases into the atmosphere. These gases trap heat from the sun, leading to the greenhouse effect, which warms the planet.

Another major contributor is deforestation, especially in tropical regions. Trees absorb CO_2 during photosynthesis, and when forests are cut down or burned, this stored carbon is released back into the atmosphere. Industrial processes, such as cement production and chemical manufacturing, also release significant amounts of greenhouse gases. Additionally, agricultural activities, including rice cultivation and livestock farming, emit methane (CH_4) and nitrous oxide (N_2O) — two potent greenhouse gases. Urbanization and rapid land-use changes increase heat absorption by the Earth's surface, causing what is known as the urban heat island effect. The use of synthetic fertilizers and improper waste management also contribute to emissions. Another overlooked factor is aerosols-tiny particles from industrial pollution and vehicle exhaust-which can affect cloud formation and atmospheric temperatures.

Natural causes like volcanic eruptions and solar variations have influenced climate in the past but cannot fully explain the current rapid warming trend (Bindoff *et al.*, 2013) [1]. Scientific evidence overwhelmingly supports that the recent climate change is largely anthropogenic or human-induced. The concentration of CO_2 has raised from pre-industrial levels of 280 ppm to over 420 ppm today. Melting glaciers, rising sea levels, extreme weather events, and shifting ecosystems are clear signs of this ongoing change. If emissions continue unchecked, the planet will face more severe consequences in the coming decades. Addressing climate change requires international cooperation, sustainable development practices, and a shift to clean energy sources (IPCC, 2013) [10]. Public awareness and policy changes are critical to mitigate the causes and protect future generations.

Global scenario of climate change

Climate change has emerged as a defining global crisis of the 21st century, affecting every continent and ecosystem. Worldwide, the average global temperature has increased by approximately 1.1 °C since the pre-industrial era (1850-1900), largely due to the surge in greenhouse gas emissions from human activities. This warming is not uniform-polar regions, especially the Arctic, are warming nearly four times faster than the global average, leading to rapid ice melt and rising sea levels. Extreme weather events are becoming more frequent and intense across the globe. Countries in Europe and North America are experiencing record-breaking heatwaves, while regions in Asia and Africa face severe droughts and erratic rainfall. Floods in countries like Pakistan and Bangladesh, wildfires in Australia and the U.S., and cyclones in the Indian Ocean highlight the rising toll of climate-related disasters. These events are displacing millions, damaging infrastructure, and threatening food and water security.

Small island nations, such as the Maldives and Tuvalu, face the risk of submersion due to rising sea levels. Glacier retreat in the Himalayas and Andes is disrupting freshwater supply for billions of people. Climate change also threatens biodiversity, with rising temperatures and habitat destruction pushing many species toward extinction. The global ocean is warming, becoming more acidic, and losing oxygen, which endangers marine ecosystems and fisheries. The Intergovernmental Panel on Climate Change (IPCC) warns that global warming must be limited to 1.5 °C to avoid irreversible damage. However, current global pledges under the Paris Agreement are insufficient to meet this target. While some progress is being made in renewable energy adoption and emissions reduction, developing countries still struggle due to lack of resources and technology.

Effect on agriculture

Climate change has a profound and multifaceted impact on agriculture, threatening food security and rural livelihoods worldwide. Rising global temperatures alter growing seasons, disrupt crop cycles, and reduce overall yields. Many staple crops like wheat, rice, and maize are sensitive to heat stress; even a small temperature increase can lead to flowering failure and reduced grain quality Kumar K and Parikh J. (1998) [12]. In tropical and subtropical regions, where agriculture is already climate-sensitive, these impacts are more severe. Change in rainfall patterns-including droughts, floods and unpredictable monsoons-affect water availability for irrigation and dryland farming. Decline in soil fertility and structure due to increased erosion, salinization and nutrient leaching caused by extreme weather events. Pest and disease outbreaks are also becoming more common, as warmer temperatures create favorable conditions for their survival and spread. For instance, fall armyworm and other invasive pests have expanded into new regions, threatening food crops.

Livestock production is equally affected by heat stress, water scarcity and declining fodder availability, which reduce animal productivity and increase mortality. In many developing countries, smallholder farmers lack the resources to adapt to these changes, making them highly vulnerable. Irrigation demands are increasing, putting pressure on already stressed water sources like rivers and aquifers. Climate change is also reducing the nutritional quality of crops, with declines in protein, iron, and zinc concentrations being reported. Cash crops such as tea, coffee, and cocoa, which rely on specific climatic conditions, are facing reduced yields and lower quality, affecting both local economies and international markets. In coastal regions, sea level rise and saltwater intrusion are making fertile lands unusable. Furthermore, shifts in pollinator populationscrucial for fruit and vegetable production-are disrupting crop productivity.

Effect on sericulture

Sericulture is the art and science of silk production through the rearing of silkworm and cultivation of mulberry plays a significant role in the rural economy of many Asian countries, particularly India, China, and Uzbekistan. It is a climate-sensitive agro-based industry that depends heavily on stable environmental conditions for optimal productivity. Climatic variables such as temperature, relative humidity, photoperiod, and rainfall directly influence the growth and quality of mulberry leaves, which is exclusive diet of silkworms, and consequently affect silkworm health, growth, and silk yield. In recent years, global climate change has introduced significant challenges to sericulture. Rising temperatures, altered rainfall patterns, and increasing frequency of extreme weather events such as droughts and floods are disrupting both mulberry cultivation and silkworm rearing. For instance, elevated temperatures can cause leaf scorching and reduce photosynthetic efficiency in mulberry, while silkworms exposed to thermal stress show increased susceptibility to diseases and reduced cocoon quality (Nanita *et al.*, 2022) [15].

Moreover, climate change is altering the voltinism pattern in silkworms, shifting the number of broods per year, particularly in tropical and subtropical regions. This can disturb synchronization between silkworm life cycles and mulberry leaf availability, impacting the economic viability of sericulture Given these complex challenges, there is a growing need to develop climate-resilient sericulture practices, including the breeding of drought and heat-tolerant mulberry varieties and robust silkworm hybrids (Neelaboina *et al.*, 2018) [16]. This review explores the multifaceted impacts of climate change on sericulture with a focus on temperature and humidity effects, voltinism shifts, and the development of resilient genotypes for future sustainability.

Effect of climate change on soil

Climate change has significant and far-reaching impacts on soil health, which is a foundational element of agriculture and ecosystem stability. Rising temperatures and altered precipitation patterns accelerate soil degradation processes such as erosion, desertification, and nutrient depletion. Increased rainfall intensity can lead to surface runoff, washing away topsoil that contains essential nutrients and organic matter. Conversely, prolonged droughts reduce soil moisture, making it harder for plants to grow and microbes to function properly. One of the major effects of climate change is the loss of soil organic carbon (SOC). As temperatures rise, microbial activity increases, leading to faster decomposition of organic matter and the release of carbon dioxide, reducing the soil's carbon storage ability. This not only contributes to further global warming but also diminishes soil fertility. Soil compaction and crusting, worsened by frequent heavy rains, restrict root growth and water infiltration.

Salinization of soil is another growing concern, especially in arid and semi-arid regions. As water evaporates more quickly due to heat, salts accumulate in the upper layers of the soil, reducing its productivity. Soil acidification may also increase in certain areas due to changes in rainfall chemistry and atmospheric nitrogen deposition. These chemical changes disrupt the soil's nutrient balance and affect plant growth. Climate change also impacts soil biodiversity, including beneficial organisms like earthworms, fungi, and bacteria, which play vital roles in nutrient cycling and disease suppression. Disruption of these communities weakens the soil ecosystem. Additionally, thawing permafrost in polar regions is releasing large amounts of greenhouse gases and destabilizing vast tracts of previously frozen, carbon-rich soils.

To mitigate these effects, it is essential to adopt sustainable land management practices such as conservation tillage, organic amendments, crop rotation, cover cropping, and agroforestry. Protecting soil health under a changing climate is crucial for ensuring long-term agricultural productivity, food security, and environmental resilience.

Effects of climate change on mulberry and silkworm growth

Mulberry

Mulberry plants require moderate temperature of 24 °C to 30 °C and relative humidity between 65% and 80% for optimal growth. Climate-induced temperature extremes and erratic rainfall affect photosynthesis, nutrient uptake, and leaf yield. High temperatures result in stunted growth, leaf scorching, and reduced chlorophyll content. Additionally, low humidity increases evapotranspiration, reducing soil moisture and leaf succulence. Climate change poses a significant threat to mulberry primary host plant for silkworms by affecting its sprouting, vegetative growth, and overall development (Mehraj *et al.*, 2020) [20].** Mulberry is highly sensitive to changes in temperature and moisture. Rising temperatures can lead to early or irregular sprouting, which disrupts the synchronization between leaf availability and silkworm rearing cycles, ultimately affecting cocoon production.

Unpredictable weather patterns, such as unseasonal rains or sudden temperature drops, can damage newly sprouted buds and delay growth. Drought stress caused by reduced rainfall lowers soil moisture, impairs root growth, and reduces nutrient absorption. On the other hand, heavy and prolonged rainfall can result in waterlogging and root diseases, weakening the plants. These changes significantly alter leaf yield and quality-key factors for successful sericulture. Heat stress reduces photosynthetic efficiency and leaf protein content while increasing moisture and lignin levels, making the leaves less suitable for silkworm feeding. In addition, high temperatures and humidity create favorable conditions for the spread of pests and diseases, such as leaf spot, powdery mildew, and nematodes.

Furthermore, altered climatic conditions affect the timing and success of flowering and seed production in mulberry plants. Soil salinity and nutrient loss, exacerbated by climate extremes, further limit plant development and field productivity. In response, researchers are focusing on breeding climate-resilient mulberry varieties and promoting sustainable practices like mulching, organic fertilization, and efficient irrigation.

Silkworm

Silkworm is poikilothermic organisms, meaning their metabolic processes and developments were highly temperature-dependent. The optimal range for silkworm rearing is between 25 °C to 28 °C and relative humidity of 70% to 85%. Any deviation from this range adversely affects larval development, silk gland function, and cocoon quality. High temperatures can accelerate larval metabolism, causing reduced feeding efficiency, shortened larval duration, and decreased cocoon weight. Moreover, low humidity makes larvae susceptible to desiccation, while excessive humidity increases the prevalence of microbial diseases such as grasserie, muscardine and flacherie. Temperature stress also affects hormonal regulation in silkworms, disrupting ecdysis and silk secretion processes. Severe heat stress (>32 °C) can impair the development of the posterior silk gland, responsible for fibroin production, leading to inferior silk filament quality and weak cocoons.

Impact on silkworm health and productivity

Climate change, particularly the rise in global temperature, irregular rainfall patterns and increased frequency of extreme weather events has had a profound impact on the health and productivity of the silkworm. Silkworm is poikilothermic organisms, meaning their physiological processes are heavily influenced by environmental temperature and humidity. Even minor fluctuations in temperature beyond the optimal range (22-28 °C) can significantly reduce larval growth, feed efficiency and cocoon production (Manzoor, 2024) [14].

One of the most sensitive stages of the silkworm lifecycle is the fifth instar, during which high metabolic activity supports cocoon formation. Exposure to heat stress (above 30 °C), along with combined with low humidity, leads to oxidative stress, cellular damage and increased mortality. This stress disrupts hormonal balance and impairs silk gland development, resulting in poor filament quality and reduced cocoon yield. Climate-induced shifts in temperature and humidity also predispose silkworms to diseases such as grasserie, flacherie and muscardine. These infections are often aggravated during extreme climatic conditions such as sudden pre-monsoon showers followed by high humidity, which create a conducive environment for pathogen proliferation.

Furthermore, rising temperatures may lead to phenological mismatches between the silkworm's developmental stages and the availability of high-quality mulberry leaves, its sole food source. Poor leaf quality due to drought or excessive rain affects larval nutrition, indirectly lowering silk productivity (Deka. M. *et al.*, 2020) [3]. In response to these threats, researchers are exploring the development of thermotolerant silkworm breeds and climate-resilient sericulture practices. However, continued research and regional adaptation strategies remain critical to mitigating climate impacts on sericulture.

Shifts in voltinism due to seasonal change

Voltinism in silkworms defined as the number of generations completed in a year, is largely governed by genetic makeup and environmental cues, particularly photoperiod and temperature. Traditionally, silkworms are categorized as univoltine (one generation per year), bivoltine (two generations) or polyvoltine (multiple generations), each adapted to specific agro-climatic zones. However, climate change is increasingly altering the voltinism patterns, leading to unpredictable and often maladaptive shifts.

Rising ambient temperatures and shorter or irregular winters are triggering premature breaking of diapause in univoltine eggs, thus converting them into bivoltine or even polyvoltine types in some regions. This shift disrupts the synchrony between silkworm development and optimal mulberry leaf availability, reducing larval performance and silk productivity. For example, in temperate zones like parts of North India or China, univoltine races are emerging earlier due to warmer winters, potentially resulting in poor cocoon harvests due to immature or poor-quality leaf during early spring.

Moreover, polyvoltine races, which typically thrive in tropical regions, may exhibit increased generational turnover under warming conditions, leading to a higher cumulative disease burden and nutritional stress due to repeated mulberry leaf harvesting cycles. These unsynchronized voltinism shifts may also reduce the economic viability of sericulture in regions where traditional voltinism was crucial to success. To adapt, breeding programs are focusing on developing silkworm hybrids that can tolerate changing climates while maintaining desirable voltinism traits. However, continuous monitoring of local climate patterns and dynamic voltinism modeling are essential for future sericulture sustainability.

Development of climate-resilient mulberry genotypes

To ensure year-round leaf availability under extreme climates, scientists have breed new mulberry varieties with better adaptability. Varieties such as S1635, G2 and DD have shown promise under water-deficient and high-temperature conditions by maintaining higher leaf moisture, better root systems, and disease resistance. These genotypes also exhibit better photosynthetic efficiency and withstand leaf blight and powdery mildew more effectively than traditional varieties. Biotechnological tools like marker-assisted selection (MAS) and genomic mapping are now being employed to identify genes responsible for drought and heat tolerance. Tissue culture techniques and induced mutagenesis are further accelerating the development of elite, climate-resilient mulberry clones.

Heat and disease tolerant silkworm breed

Silkworm breeds traditionally used in sericulture-especially bivoltine races preferred for high-quality silk-are vulnerable to stress from temperature spikes and pathogen attacks. This has prompted the breeding of thermo-tolerant and disease-resistant silkworm hybrids (Rahmathulla, V.K., 2012) [19]. For example, hybrids such as CSR4 × CSR2, PM × CSR2 and APS45 × APS12 have shown greater tolerance to fluctuating environmental conditions without compromising cocoon and filament quality. These races exhibit higher feed conversion efficiency, lower larval mortality and resistance to common diseases like grasserie and muscardine. Additionally, heat shock protein (HSP) gene studies have enabled molecular screening of silkworm breeds with innate thermal tolerance, opening new frontiers for genetic improvement (Chen L. *et al.*, 2023) [2]

Effect of climate change on post-cocoon processing

Climate change not only impacts mulberry cultivation and silkworm rearing but also has notable effects on the post-cocoon sector of sericulture, which includes cocoon drying, storage, reeling, and raw silk production. These processes are sensitive to ambient temperature, humidity and water availability**,** all of which are being increasingly altered due to global climate variability. One of the primary concerns is the fluctuation in cocoon moisture content**.** High humidity

during storage delay cocoon drying and promotes microbial growth, particularly fungi and bacteria. This leads to cocoon rotting and degradation of the sericin layer, which protects the silk filament. Improper drying due to climatic irregularities can result in poor reeling performance**,** with increased thread breaks and waste generation during reeling.
Elevated temperatures also accelerate cocoon aging**,** leading to hardening of the pupal case and damage to silk filament quality. Overaged cocoons are difficult to reel and produce uneven or coarse filaments. In reeling units, water quality and temperature play a vital role in softening cocoons and enabling smooth reeling. However, water scarcity during dry spells and increased water temperature due to climate warming reduce reeling efficiency and filament recovery rate (FAO). Additionally, higher environmental temperatures and humidity affect the mechanical properties of silk, including its tenacity, elasticity and luster. Raw silk reeled under improper environmental conditions shows lower tensile strength and poor dye absorption, making it less desirable in the textile market. Climate-induced changes in mulberry leaf quality also affect cocoon quality, which in turn affects shell ratio, filament length, and reelability. The impact extends to silk reeling infrastructure as well. Traditional reeling units without proper environmental controls are more vulnerable to climatic extremes, affecting labor productivity and increasing the risk of post-cocoon losses.

Mitigating the effects of climate change in sericulture
Mitigating the effects of climate change in sericulture requires a comprehensive and scientific approach involving crop improvement, environmental management, and technological innovation. One important strategy is the development of climate-resilient mulberry and silkworm varieties**.** Drought-and heat-tolerant mulberry genotypes, as well as thermotolerant and disease-resistant silkworm breeds, can help maintain productivity under stressful environmental conditions. Advanced molecular breeding techniques, including marker-assisted selection and CRISPR-Cas9 gene editing, offer promising tools to develop climate-adapted genetic resources (Chen. L., *et al.*, 2023) [2]
Climate monitoring and early warning systems can play a key role in adaptation. Automated weather stations and remote sensing technologies enable real-time tracking of environmental changes. GIS-based forecasting tools can help predict pest outbreaks, droughts, and heatwaves, allowing farmers to take preventive measures. Improving the microclimate in rearing houses is essential. This can be achieved by constructing climate-controlled rearing environments with proper ventilation, insulation, and humidity regulation. Incorporating sensors and automated control systems based on IoT technology ensures optimal conditions for silkworm growth and minimizes the risk of disease.
Efficient water and soil management techniques are critical under changing rainfall patterns. Using drip or sprinkler irrigation systems, applying mulch, and enriching soil with organic matter or biochar can enhance moisture retention, reduce erosion, and support plant health. Watershed-level approaches also help in conserving and recharging groundwater resources. Adopting sustainable nutrient and pest management practices ensures better resilience. Site-specific nutrient applications, slow-release fertilizers, and the use of microbial biofertilizers promote healthy growth while minimizing environmental impacts. Integrated Pest and Disease Management (IPDM) strategies, supported by biocontrol agents and botanical pesticides, reduce chemical input and maintain ecological balance (Sharma S., *et al.*, 2021) [21]. In the post-cocoon sector**,** adapting reeling infrastructure to changing climates is vital. Use of energy-efficient cocoon drying units, temperature-regulated reeling machines, and humidity-controlled storage rooms helps preserve cocoon quality and improve silk yield, even under variable climatic conditions.
Capacity building and policy support are essential for long-term success. Training farmers in climate-smart sericulture, promoting access to insurance schemes, and supporting the adoption of resilient technologies through subsidies and extension services can enhance adaptive capacity. Finally, promoting carbon sequestration and low-emission technologies within sericulture systems-such as agroforestry, organic farming, and solar-powered units-can contribute to climate mitigation efforts while supporting sustainable livelihoods.

Conclusion
Climate change presents multifaceted and intensifying challenges to sericulture, impacting both mulberry cultivation and silkworm rearing. Elevated temperatures, erratic rainfall, and increased disease incidence directly affect silk yield and quality. To counter these effects, adaptive strategies such as modified agro-techniques, stress-tolerant mulberry varieties, and climate-resilient silkworm breeds are essential. Innovations in silkworm rearing practices, including controlled environments and season-specific hybrids, also hold promise. Future research must prioritize genetic engineering approaches to introduce traits for heat and disease tolerance. The integration of remote-sensing and climate modeling can improve forecasting and risk assessment for sericulture regions. Additionally, sustainable pest and disease management practices need to be aligned with evolving climatic threats. Strengthening institutional support and farmer training will also enhance climate resilience at the grassroots level.

Disclaimer (Artificial intelligence)
Author(s) hereby declare that NO generative AI technologies such as Large Language Mode (Chat GPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

Competing interests
Authors have declared that no competing interests exist.

Reference
1. Bindoff NL, Stott PA, Achuta Rao KM, Allen MR, Gillett N, Gutzler D, *et al.* Detection and attribution of climate change: From global to regional. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, *et al.*, editors. Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2013. p. 867-952.
2. Chen L, Zhao Y, Wang J, Li X. Biotechnological interventions for enhancing silkworm adaptation to

climate change. Biotechnology Advances. 2023;35(4):789-802.
3. Deka M, Saikia S, Goswami R. Climate change and its impacts on sericulture. International Journal of Current Microbiology and Applied Sciences. 2020;9(7):3306-3315.
4. Food and Agriculture Organization of the United Nations (FAO). Silk production and processing. Rome: FAO; 2017. p. 1-45.
5. FAOSTAT. Silk production statistics. Rome: Food and Agriculture Organization of the United Nations; 2023. Available from: https://www.fao.org/faostat
6. Ghosh S, Banerjee M. Adaptation strategies for sustainable sericulture: A review. Journal of Entomology and Zoology Studies. 2019;7(1):267-274.
7. Hansen J, Ruedy R, Sato M, Lo K. Global surface temperature change. Reviews of Geophysics. 2010;48:RG4004. doi:10.1029/2010RG000345.
8. Intergovernmental Panel on Climate Change (IPCC). The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, *et al.*, editors. Cambridge: Cambridge University Press; 2007. p. 1-996.
9. Intergovernmental Panel on Climate Change (IPCC). The scientific basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2001. p. 1-881.
10. Intergovernmental Panel on Climate Change (IPCC). Summary for policymakers. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, *et al.*, editors. Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2013. p. 1-30.
11. Intergovernmental Panel on Climate Change (IPCC). Summary for policymakers. In: Edenhofer O, Pichs-Madruga R, Sokona Y, Farahani E, Kadner S, Seyboth K, Adler A, *et al.*, editors. Climate change 2014: Mitigation of climate change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2014. p. 1-30.
12. Kumar K, Parikh J. Climate change impacts on Indian agriculture: The Ricardian approach. In: Dinar A, Mendelsohn R, Evenson R, Parikh J, Sanghi A, Kumar K, McKinsey J, Lonergan S, editors. Measuring the impact of climate change on Indian agriculture. World Bank Technical Paper No. 402. Washington DC: World Bank; 1998. p. 133-148.
13. Lesk C, Rowhani P, Ramankutty N. Influence of extreme weather disasters on global crop production. Nature. 2016;529(7584):84-87.
14. Manzoor S, Qayoom K. Impact of climate change on sericulture. Asian Research Journal of Agriculture. 2024;17(3):107-113.
15. Bora N, Saikia S. Climate change and its impact on sericulture industry. Just Agriculture. 2022;2(5):1-7.
16. Neelaboina B, Khan G, Gani M, Ahmad M. Impact of climate change on agriculture and sericulture. Journal of Entomology and Zoology Studies. 2018;6(5):426-429.
17. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutrition Reviews. 2012;70(1):3-21.
18. Porter JR, Xie L, Challinor AJ, Cochrane K, Howden SM, Iqbal MM, *et al.* Food security and food production systems. In: Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, *et al.*, editors. Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2014. p. 485-533.
19. Rahmathulla VK. Management of climatic factors for successful silkworm (*Bombyx mori* L.) crop and higher silk production: A review. Psyche: A Journal of Entomology. 2012;2012:1-12.
20. Mehraj S, Kamili AS, Ganie NA, Mir SA, Khan FA, Mir MR, Sharma RK. Climate change triggers early sprouting in mulberry (*Morus* sp.). International Journal of Advanced Biological Research. 2020;10(4):197-201.
21. Sharma S, Mehta R, Joshi N. Emerging technologies for climate-resilient sericulture: A review. International Journal of Agriculture, Environment and Biotechnology. 2021;14(1):121-129.