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Climate change and sericulture sustainability: Impacts on mulberry production, silkworm biology, disease dynamics and silk productivity

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Abstract

Climate change has become a significant challenge to agricultural sustainability, especially in climate-sensitive industries like sericulture, where environmental stability is crucial for both silkworm (*Bombyx mori* L.) rearing and mulberry cultivation. Mulberry growth, silkworm physiology, disease incidence, cocoon productivity, and silk quality are all greatly impacted by variations in temperature, humidity, rainfall patterns, photoperiod and air quality. The current understanding of how climatic variability affects various parts of the sericulture value chain is summarised in this article. Increased vulnerability to diseases like grasserie, flacherie, muscardine and pebrine results from the detrimental effects of high temperatures and humidity variations on silkworm growth, metabolism, feeding efficiency and immunological response. Similarly, mulberry leaf production and nutritional quality are decreased by drought stress and unpredictable rainfall, which has an indirect impact on larval growth and cocoon formation. Important economic characteristics including cocoon weight, shell ratio, filament length and reeling efficiency are also impacted by climate stress, which lowers the quality and market value of raw silk. Beyond biological effects, climate change has an impact on sericulture farmers socioeconomic stability by lowering output, raising the likelihood of crop failure, and endangering jobs in rural areas. The development of thermotolerant silkworm hybrids, climate-resilient mulberry types, better microclimate management, and the implementation of climate-smart sericulture techniques are just a few of the adaptation and mitigation options that are highlighted in the paper. Climate resilience can be further strengthened by technological interventions including weather-based alert systems, precision rearing, and environmental monitoring.

Keywords: Climate change, sericulture, bombyx mori, mulberry, cocoon yield, climate resilience, silk productivity

Introduction

Climate change threatens sustainable agriculture with its rapid and unpredictable consequences, making it more challenging for agricultural researchers and farmers to adjust to biotic and abiotic stress challenges. Climate refers to the long-term patterns of temperature, humidity, rainfall, and wind in a particular region. The role of climate is critical in determining the success of agricultural systems, including sericulture. Climate change is a global phenomenon marked by significant alterations in these natural patterns over time (Porter *et al.*, 2014) [52]. These climatic factors directly influence plant growth, soil health, pest dynamics, and the productivity of livestock and insects (Lesk., *et al.*, 2016) [51]. The rise in temperature is mainly dependent on the concentration of greenhouse gases like carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (NO₂). On the basis of the increase of greenhouse gases, climatic model predicts a 1.4°C to 5.8°C average increase in global warming from 1990 to 2100, probably leading to a more rapid increase in temperature at the surface of terrestrial zones and more extreme local variations (Karl and Trenbeth, 2003) [24]. 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. Silkworms are cold-blooded creatures with body temperatures that are roughly similar to those of their surroundings; changes in air temperature have an impact on their behaviour, growth and reproduction (Neelaboina *et al.*, 2018) [11].

Climate change has emerged as a major challenge for agricultural systems worldwide, and sericulture is no exception. Rising temperatures, shifting precipitation patterns, and increasing frequency of extreme weather events are affecting mulberry cultivation and silkworm rearing, leading to reduced productivity and threatening the sustainability of silk production (Rao *et al.*, 2022). Different weather patterns such as temperature changes impact not only mulberry leaf yield but also nutritional composition hence affecting directly on nutrition and development of the silkworms (Gowda and Reddy, 2007) ^[3] especially temperature plays a critical role. The silk cocoon production is determined by various factors including environment and genotype of the silkworm (Chatterjee and Rao, 1993) ^[46]. Many of the silkworm characters are not only controlled by genes but also influenced by environmental factors such as temperature and relative humidity. High temperature affects nearly all biological processes including the rates of

biochemical and physiological reactions (Hazel, 1995; Willmer *et al.*, 2004) ^[48]. 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. Therefore, this review aims to synthesize the effects of climate change on mulberry cultivation, silkworm biology, disease incidence, cocoon productivity and adaptation strategies in sericulture.

Major Climatic Factors Affecting Sericulture

Temperature, humidity, rainfall/soil moisture, and light/air movement are the major climatic drivers controlling mulberry growth, silkworm health, disease, and cocoon yield (Rahmathulla, 2012) ^[40].

Table 1: Effect of abiotic factors on sericulture

Climatic factor	Main effects on sericulture	References
Temperature (mean, extremes, heat waves)	Alters the development, survival, fertility, cocoon weight, and shell ratio of silkworms; heat during the fourth and fifth instars significantly increases mortality and deteriorates the quality of silk; it also affects mulberry growth and leaf quality.	(Rahmathulla, 2012; Manzoor and Qayoom, 2024) ^[40, 19]
Relative humidity	The perfect situation rearing period is determined by temperature and RH; high RH combined with temperature promotes bacterial and viral diseases; mismatched RH results in uneven cocoons, poor spinning, and decreased reelability.	(Rabha <i>et al.</i> , 2025) ^[5]
Rainfall & drought / soil moisture	Irregular monsoon, drought, and water stress lower mulberry leaf output and quality, cause leaf drying in rearing sheds, and result in smaller cocoons and crop failures, floods also interfere with mulberry rearing.	(Santhi <i>et al.</i> , 2020) ^[18]
CO ₂ and other gases (O ₃)	Increased CO ₂ and tropospheric O ₂ have an indirect impact on mulberry physiology, pest dynamics, leaf availability, and disease risk.	(Shrestha, 2019) ^[53]
Photoperiod & light	Impacts the behaviour of silkworms, the development of their embryos, and the timing of their rearing seasons; inappropriate light conditions interfere with regular growth and spinning.	(Chanotra and Angotra, 2025) ^[3]
Air movement / wind	In rearing rooms, air current affects the temperature-humidity balance and the spread of disease; strong dry winds enhance mulberry evapotranspiration and leaf desiccation.	(Santhi <i>et al.</i> , 2020) ^[18]

Why these factors matter?

About one-third of cocoon crop success is determined by environmental factors; even little departures from ideal temperature-humidity ranges can significantly reduce yield (Rahmathulla, 2012) ^[40]. Thus, controlling these climate

variables (irrigation, forecasting-based scheduling, microclimate control) is essential to sustainable sericulture in the face of climate change (Chanotra and Angotra, 2025) ^[35].

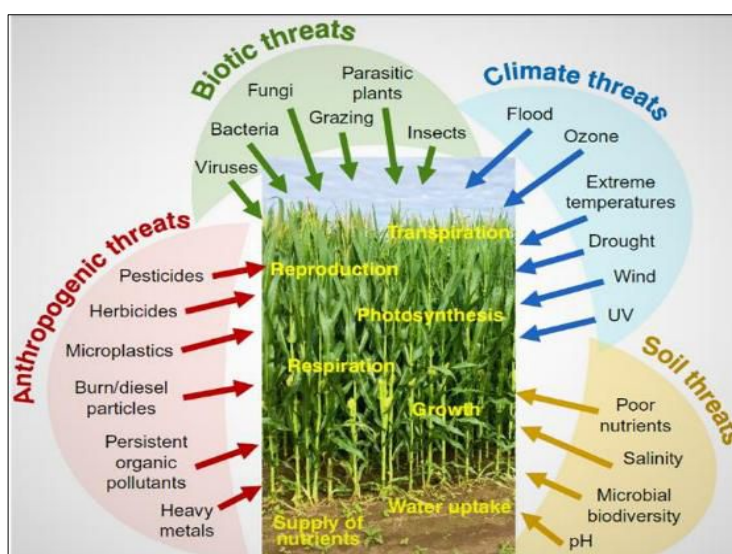


Fig 1: Multifactorial stress combination Source (Zandalinas *et al.*, 2021) ^[45].

Effect on Mulberry cultivation

Being a monophagous insect, the mulberry silkworm exclusively obtains the nutrients from the mulberry leaf needed for its growth and development. plants physiological development and growth are influenced by a variety of climatic and environmental conditions, such as rainfall, temperature, relative humidity and the quality of soil (Mehraj *et al.*, 2020) ^[15]. Climatic change affects the mulberry sprouting behaviour and the unprecedented changes in the weather and climate are giving the segos of early sprouting in mulberry because conditions of some rise in the temperature. The most suitable temperature for mulberry development is approximately 24 -28 °C (Ram *et al.*, 2016) ^[26]. The mulberry (*Morus alba*), a C3 plant, is ineffective at using ambient CO₂, but C4 plant enzymes found in the mesophyll are effective at fixing CO₂. C3 plants stomata stay open for longer, which increases evapotranspiration. Therefore, cooler, moister conditions with higher CO₂ concentrations are favourable for C3 plant growth (Ram *et al.*, 2016) ^[26]. According to (Mehraj *et al.*, 2020) ^[15] climate changes does impact on the physiological processes of mulberry plants like dormancy, bud break and sprouting behaviour. Excessive rainfall can lead to waterlogged soils, root rot, and decreased leaf quality, while drought conditions can stunt plant growth and reduce leaf production. IPCC 2001 ^[58] also reported the direct and indirect effect of climate change as: (1) direct effects from changes in temperature, precipitation, or carbon dioxide concentrations, and (2) indirect effects through changes in soil moisture and the distribution and frequency of infestation by pests and diseases. Poor leaf quality due to drought or excessive rain affects larval nutrition, indirectly lowering silk productivity

Effect on pest and disease of mulberry

Plant-pest populations can be significantly impacted by the combined effects of climate (temperature, precipitation, humidity, etc.) and other factors (soil moisture, atmospheric CO₂, tropospheric ozone, etc.). Mulberry insect pests include Bihar hairy caterpillar (*Diacrisia oblique*), pink mealy bug (*Maconellicoccus hirsutus*), thrips (*Pseudodendrothrips mori*), leaf webber (*Diaphania pulverulentalis*), mites, and diseases like root-knot disease (*Meloidogyne incognita*), powdery mildew (*Phyllactinia corylea*), leaf rust (*Peridiospora mori*), and leaf spot (*Cercospora moricola*). Increased CO₂ levels, more frequent and intense precipitation, and dense canopies (Ravikumar *et al.*, 2010) ^[28].

Increased CO₂ may alter the pathogen's host sensitivity and/or aggressiveness, as well as hinder the pathogen's early establishment on the host, especially fungus. Changes in crop-pest synchronisation of phenology, geographic distribution, overwintering, population growth rate, number of generations, length of their developmental seasons, time of occurrence, and risk of migrating pests can all be brought on by a rise in temperature (Ram *et al.*, 2016) ^[26]. Climate change will have a detrimental effect on the majority of creatures and biodiversity (Parmesan and Yohe, 2003) ^[27]. Throughout their development, the silkworms are guaranteed constant temperature, humidity, and nutritional levels thanks to technologies like climate control units and automated feeding systems (Lalitha *et al.*, 2020) ^[20].

Effect on non-mulberry host plants

Heat waves and droughts have a significant impact on non-mulberry host plants, such as castor for eri, som/sualu for

muga, and other trees for tasar. High temperatures decrease leaf production and quality while increasing evapotranspiration rates and water consumption (Sato *et al.*, 2024) ^[54]. Drought stress damages photosynthesis and interferes with plant metabolism at the physiological and molecular levels (Chaudhry and Sidhu, 2021) ^[55]. Additionally, these stressors increase susceptibility to diseases and pests (Malhi *et al.*, 2021) ^[56].

Abiotic factors on Silkworm Biology

Temperature

Temperature and humidity are the most important environmental factors influencing the growth, physiology and productivity of silkworms. These abiotic factors directly affect feeding behaviour, metabolism, development, cocoon formation and silk quality (Benchamin and Jolly, 1986; Hussain *et al.*, 2011; Manisankar *et al.*, 2008) ^[33, 36, 43]. Silkworm growth is highly dependent on stable environmental conditions. The optimum temperature for successful silkworm rearing ranges between 25–26 °C, and deviations below 20–21 °C or above 28–29 °C can negatively affect larval development and survival ((Rahmathulla, 2012)) ^[40]. Environmental requirements also vary with the developmental stage. Young larvae require relatively higher temperatures (26–28 °C) and humidity (80–85% RH) to support active feeding and growth, whereas late instar larvae perform best at slightly lower temperatures (23–24 °C) and 70–75% relative humidity (Zhang, 2018) ^[41].

Exposure to high temperatures during cocoon spinning can adversely affect reelability, resulting in lower raw silk recovery and variation in filament denier (Vage and Ashoka, 2000) ^[34]. Similarly, fluctuations in climatic conditions may disturb the synchronization between silkworm developmental stages and the availability of nutritious mulberry leaves, which serve as their exclusive food source. Climate variability also increases the vulnerability of silkworms to major diseases such as grasserie, flacherie, and muscardine. Thermal stress weakens the immune response of silkworms, increasing their susceptibility to infections and ultimately reducing cocoon quality (Bora and Saika, 2022) ^[42]. High temperature stress may also induce hyperthermia characterized by increased respiration, dehydration, and a higher incidence of bacterial diseases such as flacherie, which can cause severe crop losses (Gupta and Dubey, 2021) ^[47]. At the cellular level, temperature stress disrupts normal protein synthesis and damages important biological molecules such as DNA, RNA, and lipids, thereby affecting normal physiological functions (Sureshkumar *et al.*, 2002; Denlinger and Yocum, 1998) ^[38, 44].

Silkworm races differ in their tolerance to environmental stress. Bivoltine breeds, which are preferred for superior silk quality, are generally more sensitive to temperature fluctuations and disease incidence. This has led to the development of thermotolerant and disease-resistant hybrids to sustain productivity under changing climatic conditions (Rahmathulla, 2012) ^[40]. Hybrids such as CSR4 × CSR2, PM × CSR2, and APS45 × APS12 have demonstrated better adaptability to fluctuating environmental conditions while maintaining desirable cocoon and silk filament characteristics. Overall, maintaining optimal environmental conditions remains essential for ensuring healthy silkworm

growth, disease resistance, and superior silk production, especially under the challenges posed by climate change.

Humidity

Another important element that has a direct impact on silkworm physiological functions is humidity. It affects their general health, respiration and ability to retain moisture (Manisankar *et al.*, 2008) ^[43]. High humidity levels (over 80%) may increase the growth of harmful bacteria and fungus, which can lead to infections like bacterial sepsis and muscardine. On the other hand, dehydration, decreased feeding efficiency, and stunted growth might result from low humidity levels (below 60%) (Oripovich and Ramazonovich, 2020) ^[30]. Young silkworms, also known as chawki worms, flourish in high humidity conditions (75–85%) (Devamani and Beevi, 2019) ^[29], because their delicate bodies are more vulnerable to desiccation. As the silkworms mature, their tolerance depends with humidity changes. A slightly less humidity level (70–75%) is necessary for older

larvae, especially those in their final instars, to avoid problems like overhydration and the proliferation of infections.

Rainfall

Rainy season patterns: Prolonged rainy seasons increase ambient and rearing-room humidity, which increases the prevalence of bacterial and viral infections as well as total disease incidence. Humidity has been found to have strong negative relationships with cocoon yield and positive correlations with grasserie, flacherie, and muscardine (Sharma *et al.*, 2020) ^[1]. Temperature fluctuations: Abrupt heat waves, particularly in the fourth and fifth instars, stress larvae and make them more vulnerable to infections, increasing disease losses under climate change (Bhat *et al.*, 2024) ^[57]. Interaction with outdoor rearing: Variations in temperature, relative humidity, and precipitation significantly raise disease and pest-related larval mortality in tasar and other outdoor systems.

Table 2: Relationship between climate variability and silkworm disease outbreaks

Disease type (agent)	Favoured by	Mechanism & evidence
Viral grasserie (NPV)	Rainy and summer crops with high humidity and warmer nights	In more general evaluations of climate sericulture, high temp–RH combinations were also associated with an increased risk of viral infections. (Qayoom <i>et al.</i> , 2023) ^[19] .
Bacterial flacherie	warm, humid rainy and late-summer crops	Also exhibits a strong positive association with maximum relative humidity and minimum temperature; peaks in rainy/summer crops (Sharma <i>et al.</i> , 2020) ^[1] . Larvae are predisposed by heat stress and moisture, which increases bacterial epizootics. (Qayoom <i>et al.</i> , 2023) ^[19] .
Fungal muscardine (Beauveria)	Cooler, humid seasons; sometimes post-rain cool spells	Promotes the growth of the g=fungal pathogens (Sharma <i>et al.</i> , 2020) ^[1] .
Microsporidiosis (pebrine, others)	Often linked to humid, warm weather and poor hygiene	Reviews of climate change indicate that warmer and more humid weather will increase the incidence of protozoan and fungal infections. (Qayoom <i>et al.</i> , 2023) ^[19] .

Photoperiod

In *B. mori*, moderate day-night cycles (about 12L:12D) often lead to rapid larval growth, shorter cocooning times, and higher shell ratios when compared to 8L:16D or 16L:8D (Renthlei *et al.*, 2017) ^[32]. Traditional research demonstrates that photoperiod can shorten or prolong larval duration depending on egg-incubation temperature, without a straightforward relationship to cocoon weight; some regimes with 24L:0D or 16L:8D produce the heaviest cocoons and shell weight (Sumimoto, 1974) ^[21]. When compared to feeding in the dark, feeding in light (>18 h/day) typically speeds up early larval growth and increases body weight, with effective wavelengths close to green–yellow (Shikata *et al.*, 1977) ^[4].

Long light regimes (20–24L) can increase certain commercial features (larval weight, cocoon properties) when compared to shorter day (Salim *et al.*, 2025) ^[7], according to recent field-oriented research. 24L:0D increases the amount of DNA, RNA, and protein in the silk

glands of the Tasar silkworm *Antheraea mylitta*, increasing sericogenic activity (Ghonmode, 2024) ^[37].

Effect on diapause, hatching and voltinism

Photoperiod during egg and larval stages controls embryonic diapause; short days induce diapause eggs, long days non-diapause, via brain–endocrine pathways (Shimizu, 2024) ^[14]. Clock genes that function in photoperiodic time measurement, such as period and cryptochrome 1, are crucial for the development of short-day diapause (Tobita and Kiuchi, 2024) ^[25].

Under short days, very dim night lighting (≥ 0.1 lux) virtually eliminates diapause in the following generation, lowering its incidence from 100% to <2% (Iwamoto, *et al.*, 2024) ^[2]. Hatching and eclosion rhythms are altered by circadian clock disruption (e.g., Clock, Cry1 mutants), which can be utilised to concentrate hatching but may impact seasonality and egg storage (Tobita & Kiuchi, 2024) ^[25].

Table 3: Photoperiod management strategies for achieving different sericulture production goals

Goal in sericulture	Helpful photoperiod strategy	Citations
Maximize silk yield per crop	Longer or continuous light (16–24L) with good temperature–RH control	(Shikata <i>et al.</i> , 1977) ^[4]
Faster crop turnover	Moderate LD (12L:12D) to shorten development with good shell ratio	(Renthlei <i>et al.</i> , 2017) ^[32]
Produce storable diapause eggs	Strict short days and true dark nights	(Tobita and Kiuchi, 2024) ^[25]

Air quality

The health of silkworms and cocoon output are

significantly influenced by the quality of the air in their rearing environment. The air that silkworms breathe through

the spiracles on their sides has a direct impact on their physiological processes. Silkworm health and silk quality can both suffer from poor air quality, which is defined by low oxygen levels or the presence of hazardous gases (Kumar *et al.*, 2024) ^[10]. The respiration of silkworms and their general metabolic activities depend on oxygen. Hypoxia, which is brought on by low oxygen levels, can result in lethargy, decreased eating, and stunted growth. Furthermore, silkworm health may be negatively impacted by the presence of dangerous gases as formaldehyde (HCHO), sulphur dioxide (SO₂), carbon dioxide (CO₂), and ammonia (NH₃) (Subhan *et al.*, 2013) ^[31]. Elevated CO₂ levels can cause lethargy and decreased feeding efficiency in silkworms, resulting in slower growth and smaller cocoons (Lee, 1999) ^[39]. As a consequence of burning fossil fuels, SO₂ can contribute to respiratory problems and poor cocoon quality, which is characterised by weaker strands. Ammonia, which is frequently created when organic matter breaks down, can make sericin insoluble during reeling, making the process of extracting silk more difficult.

Effects on cocoon yield (number and weight)

Temperature stress (especially heat)

Higher temperatures speed up larval growth but decrease larval weight, cocoon weight, and shell weight and increase mortality (Rahmathulla, 2012) ^[40]. The ideal rearing temperature is approximately 22–28°C. Mean larval body weight and cocoon weight decrease dramatically at 34°C compared to 26°C, reducing the rate of silk conversion (Lopes *et al.*, 2023) ^[16] field studies under subtropical conditions demonstrate a rise in disease incidence and

cocoon crop loss in autumn rearing vs. cooler spring (Sharma *et al.*, 2020) ^[11].

Humidity and combined stresses

Nutritional efficiency indices (ECI for cocoon and shell) deteriorate and pupation percentage, cocoon weight, shell weight, and shell ratio are all decreased by non-optimal combinations (e.g., high temperature with high or very low RH) (Rahmathulla, 2012; Ibragimov and Tokhirjonova, 2023) ^[40, 23] found that high temperature and high relative humidity specifically harm cocoon yield attributes in hybrids.

Seasonal / climatic variability

Seasonal rearing experiments reveal that whereas cooler, more stable winter/post monsoon temperatures produce the best seed cocoon production, summer (high temperature, low relative humidity) yields the lowest pupation, cocoon yield per 100 dfls, single cocoon weight, and shell weight. (Rahmathulla, 2012) ^[40]. Due to recent climate variability, Tasar and Muga farmers report decreasing cocoon yield and more frequent total crop loss (Gedam *et al.*, 2023) ^[22].

Effects on cocoon quality and reeling performance

High temperatures and/or unfavourable humidity degrade cocoon morphology, shell structure, filament length, nonbroken filament length, and reeling efficiency, particularly during hot and humid seasons (Kumar *et al.*, 2024) ^[10]. Higher temperatures tend to decrease stiffness and breaking energy, which affects downstream silk qualities. Temperature during spinning changes cocoon structure and mechanical strength (Offord *et al.*, 2016) ^[8].

Table 4: Impact of climate variability on cocoon yield and quality parameters

Climate factor change	Main cocoon impact	Sources
High temperature	↓ cocoon & shell weight, ↑ disease/loss	(Sharma <i>et al.</i> , 2020) ^[11] .
Non-optimal humidity	↓ pupation, more loose/double cocoons	(Rahmathulla, 2012) ^[40]
Seasonal warming/variability	↓ yield, poorer reeling quality	(Sharma <i>et al.</i> , 2020) ^[11] .

Socio-economic channels of impact

Reduced production and income loss

Higher temperatures, erratic rainfall, drought, and floods reduce the yield of mulberry leaves and raw silk, which increases crop failures and thread breaking. Projected warming of 2–4 °C could reduce sericulture income at the farm level by roughly 9–25% (Hazarika *et al.*, 2024) ^[6]. Lower yields and poorer quality cocoons directly reduce household income and profitability (Makne, 2025) ^[12].

Rural employment, poverty and migration

In India and other Asian nations, sericulture is a significant source of on-farm and cottage-level employment, particularly for women; climate-driven output shocks jeopardise this role by raising livelihood instability and perhaps leading to out-migration. Climate-sensitive eri, and particularly muga, farming in Assam exhibits yield decreases that result in lower rural income and fewer workdays for reelers and rearers (Das *et al.*, 2023) ^[17].

Regional and macro-economic effects

When broader agriculture is taken into account, climate-induced reductions in mulberry leaf and silk output are predicted to lower net farm revenues nationally and diminish total net profits by around 12% under a +2 °C scenario. Sericulture contributes to India's agricultural GDP (Hazarika *et al.*, 2024) ^[6].

Adaptation and equity dimensions

Improved mulberry varieties, climate-controlled rearing facilities, climate-resilient silkworm lines, and technologically advanced sericulture can stabilise yields and generate higher-value jobs, especially empowering rural women (Hazarika *et al.*, 2024) ^[6]. However, high costs, limited credit, and skills gaps restrict adoption for smallholders, leaving poorer farmers more vulnerable (Bora *et al.*, 2025) ^[13].

Table 5: Major climate change factors affecting sericulture production and sustainability

Climate factor change	Main sericulture impact	Citations
High temp + humidity	Higher silkworm disease, cocoon crop failure risk	(Bora <i>et al.</i> , 2025) ^[13] .
Drought / soil degradation	Reduced mulberry biomass and leaf nutrition	(Qayoom <i>et al.</i> , 2023) ^[19] .

Adaptation and mitigation strategies

Climate-resilient biology: breeding mulberry genotypes and silkworm races that can withstand heat and stress; choosing races that are climate-adapted (Makne, 2025) ^[12]. Environmental control and forecasting: IoT-based monitoring to stabilise microclimate and anticipate dangerous times, temperature/humidity-controlled rearing houses, and weather advisories (Kumar *et al.*, 2025) ^[9]. Climate-smart mulberry farming: mulching, effective irrigation, nutrient enrichment, drought-tolerant cultivars, and soil health management to preserve leaf output and quality under stress (Qayoom *et al.*, 2023) ^[19].

Research gaps

Future research should prioritize the integration of molecular breeding, climate modelling, and precision sericulture technologies to develop location-specific adaptation strategies. Strengthening extension services and improving access to climate information will also be essential to support smallholder farmers. A holistic approach integrating biological, environmental, and socioeconomic strategies will be necessary to safeguard the future of sericulture under climate change. Ensuring climate resilience in sericulture will not only protect silk productivity but also sustain rural livelihoods and the economic stability of sericulture-dependent communities.

Conclusion

The long-term viability of sericulture is seriously threatened by climate change, which has an impact on mulberry yield, silkworm health, cocoon quality, and total silk production. Temperature and humidity continue to be the most important climatic elements influencing silkworm growth, survival, and susceptibility to disease. If suitable adaptive measures are not put in place, increasing climate variability such as heat stress, erratic rainfall, and drought is likely to increase production risks, lower cocoon output, and impact silk quality.

Sericulture has a great deal of potential for climate adaptation through scientific and technological interventions, notwithstanding these obstacles. The creation of thermotolerant silkworm breeds and stress-tolerant mulberry cultivars, along with enhanced rearing techniques and environmental management systems, can significantly lessen losses brought on by climate change. Resilience will be further increased by climate-smart techniques such better irrigation management, soil health maintenance, microclimate modulation, and disease forecasting systems.

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