

developed over 200 improved cultivars, contributing significantly to the global tea industry (Chen et al., 2007). The genetic diversity of tea plants is not only confined to China but extends to other regions such as Sandu County in Guizhou Province, where ancient tea plant germplasm exhibits high genetic and phenotypic diversity (Zhao et al., 2021). This diversity is crucial for breeding programs aimed at improving tea plant varieties to meet various environmental and market demands.

In addition to China, tea plants are cultivated in over 50 countries worldwide, including regions like the Lankaran-Astara region of Azerbaijan, where significant morphological diversity among tea accessions has been documented. This global distribution underscores the importance of preserving genetic resources to ensure the sustainability and adaptability of tea plants in diverse climatic conditions.

## 2.2 Key genetic traits of interest in tea breeding

Tea breeding programs focus on several key genetic traits to enhance yield, quality, and resistance to environmental stresses. Genomic selection strategies have been proposed to increase genetic gain in tea breeding by improving selection accuracy and reducing the breeding cycle duration. Traits such as catechin and caffeine content are of particular interest due to their impact on tea quality. Genomic predictions and genome-wide association studies have identified candidate genes associated with these metabolites, facilitating genomics-assisted breeding (Yamashita et al., 2020).

Moreover, the genetic diversity within tea plant populations, such as those in Guizhou Plateau, provides a rich resource for marker development and breeding. The identification of single nucleotide polymorphisms (SNPs) and the analysis of linkage disequilibrium patterns are crucial for understanding genetic diversity and facilitating marker-assisted selection. These efforts aim to enhance desirable traits in tea plants, ensuring their competitiveness in the global market.

## 2.3 Challenges in global preservation efforts

Preserving the genetic resources of tea plants poses several challenges, primarily due to the need for large areas for planting mother plants or their clones, which is labor-intensive and costly. The rapid disappearance of spontaneous and native varieties, such as those in Japan, due to afforestation and replanting with new varieties, highlights the urgency of developing efficient long-term storage methods for seeds and pollen.

Additionally, the genetic improvement and breeding of tea plants face challenges related to limited resources and the need for accurate selection methods in low- to middle-income countries where tea is predominantly grown (Xia et al., 2020; Lubanga et al., 2022). The integration of advanced genomic tools and technologies, such as genome assembly and transcriptome analysis, offers potential solutions by providing insights into the genetic makeup and evolutionary history of tea plants (Zhang et al., 2020). However, the implementation of these technologies requires significant investment and expertise, which may not be readily available in all tea-producing regions.

## 3 Factors Threatening Tea Plant Genetic Diversity

### 3.1 Climate change and environmental stressors

Climate change poses a significant threat to tea plant genetic diversity by altering environmental conditions that are crucial for tea cultivation. The impacts of climate change include increased frequency of extreme weather events such as droughts, heavy rains, and frosts, which adversely affect tea production (Muoki et al., 2020; Jayasinghe and Kumar, 2021). These climatic changes can lead to shifts in the geographical suitability for tea cultivation, potentially resulting in the loss of traditional tea-growing areas. Additionally, climate change influences the prevalence of pests and diseases, further threatening tea plant health and genetic diversity (Tibpromma et al., 2021). The variability in environmental factors such as temperature, rainfall, and soil conditions can also impact the quality of tea by affecting the concentration of secondary metabolites, which are crucial for the plant's resilience and flavor profile (Ahmed et al., 2018; Ahmed et al., 2019).

To mitigate these impacts, adaptive strategies such as breeding climate-resilient tea cultivars and implementing sustainable agricultural practices are essential. These strategies involve understanding the complex interactions