Potential impact of the climate parameters on the yield and climate suitability for tea (*Camellia sinensis* (L.) O. Kuntze) in North-East India

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India, particularly the northeastern region, plays a crucial role in the global tea industry, significantly contributing to its production and supply. Maintaining a high yield of quality tea in tea gardens necessitates careful regulation of various supporting factors. To predict the potential effects of climate change on crop production, it is essential to develop models that assess how crops respond to varying weather conditions. One common approach involves employing different modelling techniques trained on historical yield data and standardised meteorological variables, such as minimum temperatures (T_{min}) and maximum temperatures (T_{max}), rainfall, sunshine hours, average wind speed and mean evaporation. Additionally, climatic parameters like ozone, sulphur dioxide, carbon dioxide and nitrogen dioxide are often included in these models. The present study collected and analysed data from 2010 to 2021 across four tea-growing regions of Assam: Borsillah, Borkatonee, Tezpur and Koomber, using statistical and schematic modelling methods. The analysis revealed that climatic conditions had a significant influence on tea production. Meteorological parameters and atmospheric components were found to strongly affect tea yields in these regions. Among the statistical approaches applied, time-series analysis and multiple linear regression models demonstrated the best fit for predicting monthly tea yields. These findings suggest that multivariate time-series models may be more effective in capturing both long-term trends and short-term fluctuations in the yield data. Statistical evaluations indicated that crop and climatic parameters had the most substantial impact compared to other initially considered variables, which were progressively excluded based on their *P*-values. This highlights the pivotal role of environmental and atmospheric factors in influencing tea production and emphasises the need for tailored predictive models to ensure sustainable yields amidst changing climatic conditions.

Keywords: Climate model predictions, climate variables, crop variables, MLR models, regression analysis, tea yield, time-series analysis

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TEA is the second most consumed beverage worldwide, playing a significant role in the economies of over 58 countries situated between the latitudes of 45° N and 34° S. The Assamese tradition of tea consumption was documented in the 1830s by Robert and Charles Bruce among the Shingpho Tribe. Commercial tea production in Assam began in 1940 under the Assam Tea Corporation, Guwahati, which has since become the largest tea producer globally. However, according to the Tea Board of India, Kolkata, India's tea production dropped by 1.3% in 2010, amounting to 966.4 million kilograms, primarily due to decreased output in Assam. This marked a historic decline in both the robust flavour and quantity of Assam tea. Several factors have contributed to this decline in recent years. Tea, requiring adequate rainfall and warm temperatures, is predominantly cultivated in tropical and subtropical regions[1–3]. In Assam, annual tea production fell from 564,000 tonnes in 2007 to 460,000 tonnes in 2010. Despite global tea production increasing by an average of 3.5% annually to 6.29 million tonnes by 2020 (ref. 4–6), Assam's output has continued to face challenges. One of the primary reasons for the decline is soil waterlogging, which is linked to several climate-related issues, including prolonged monsoon seasons. Waterlogging in tea gardens occurs due to various factors such as human interference, damaged drainage systems, rising river water levels, seepage and extended monsoon periods. This condition often leads to pest infestations and fungal infections, significantly impacting both the quality and quantity of tea production. Global warming, driven by climate change, has increasingly disrupted agricultural systems[7]. Over the next two decades, temperatures are projected to rise by more than 1.5°C. Recent studies indicate that key tea-producing countries, including India, have experienced significant changes in rainfall distribution patterns and average maximum temperatures[8–10]. In India, average temperatures have risen by 0.1°C–0.3°C per decade during the pre-monsoon season and 0.2°C–0.4°C per decade during the post-monsoon season over the last 40 years. By 2100, these increases are projected to reach 1.1°C–2.1°C. These climatic shifts are expected to severely impact tea production, affecting both its quality and yield[11–13].