

**IMPACT OF ECOLOGICAL FACTORS ON
CROP ENVIRONMENT AND PRODUCTIVITY
OF TEA LANDS IN SRI LANKA**

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ABSTRACT

A detailed study to elucidate relationships between the ecological factors and productivity of tea bushes was carried out in 25 tea estates representing all tea growing agro ecological zones. The objectives of the proposed study were to identify, analyse and evaluate effects of number of agro-ecological factors on the productivity, to estimate the potential productivity, to evaluate the lands for their suitability for tea cultivation and to propose ecological measures for increasing the productivity of tea lands.

At the beginning of the survey, a pre-sampling of estates was done according to the normal randomisation method. However, all information required were not available in some selected estates. Consequently, the stratified sampling procedure was used for the selection of sample estates from different tea growing agro-ecological regions to collect identical information from all estates. To identify and analyse the current status of ecological factors, three fields planted between 1974 and 1978 with varying soil conditions and different yield potentials *i.e.* high, moderate and low were selected from each sample estate.

For the purpose of examining soil profile, soil pits were dug out in the top, middle and bottom of the selected field. Both disturbed and undisturbed soil samples were collected at two depths of each soil profile of the sample tea fields and adjoining forests lands using a post-hole augur and core sampler. Soil samples were analysed to determine the both physical and chemical properties using standard procedures. Details on soil depth, presence of hardpan, subsurface boulders, cabooky and soft rock layers and distribution pattern of gravel within the profiles were also recorded. The time series data on monthly yield and meteorological parameters *i.e.* rainfall, wet days, temperature, evaporation etc. (over 20 years) were also collected from selected estates and adjoining agro-meteorological stations for analysis. The data were statistically analysed and relationships between different variables were established by regression analysis.

Results showed that soil degradation in tea lands was high in the low and mid elevations compared with that of high elevation. The difference in soil properties *i.e.* soil depth, organic carbon content and % gravel of soil, between forests and tea fields widened with decrease in elevation with $r^2 = 0.24, 0.33, \text{ and } 0.14$, respectively ($p < 0.05$). The reduction of soil depth, organic carbon content, and increase in % gravel of soil in the low country tea fields were significantly high.

The productivity of tea plantations is highly sensitive to the bush stand. Majority of the fields in the low country consisted of less than 60% bush stand while those in mid and up country had 80% or more of their original bush stand. While the productivity of up country tea lands was more stable, tea yield in mid and low elevations declined with ageing after 10-13 years from bearing stage. There was a significant positive correlation between bush stand and tea yield in low country and upcountry with $r^2 = 0.60$ ($p < 0.001$) and 0.42 ($p < 0.01$), respectively. Bush stand was also positively correlated to elevation,

soil depth, soil pH, organic carbon content, soil nitrogen and soil moisture content at the field capacity with $r^2 = 0.38, 0.23, 0.23, 0.23, 0.30$ and 0.19 , respectively ($p < 0.05$), while it had a negative correlation with % rock, % gravel, % sand and bulk density with $r^2 = 0.31, 0.06, 0.24$ and 0.08 , respectively ($p < 0.05$).

The productivity of tea plantations was greatly influenced by soil properties. Among the various soil factors, pH, nitrogen content, % sand and the moisture retention ability greatly influenced productivity of tea lands in the up country with $r^2 = 0.46$ ($p < 0.05$), 0.35 ($p < 0.05$), 0.34 ($p < 0.05$) and 0.53 ($p < 0.01$), respectively while soil depth, organic carbon content and moisture retention, were identified as the limiting factors for low grown tea with $r^2 = 0.65$ ($p < 0.01$), 0.48 ($p < 0.001$) and 0.39 ($p < 0.05$), respectively. The findings of the present analysis show the importance in improving the organic matter content of tea soils in the low country is of paramount importance for high productivity. In contrast, more attention should be paid for improving the soil chemical properties (pH and nitrogen content) and moisture retention of up country tea lands to enhance their productivity.

The monthly rainfall of less than 110 mm, 100 mm and 120 mm affects tea production in the low, mid and up country tea growing regions, respectively. Productivity of tea plantations was also greatly affected by rainfall deficit, which is high during the dry period in the low country. A yield reduction of about 30 - 40% can be expected if the dry weather prevails over a period of one month. The estimated minimum monthly rainfall requirement can be used as a measure to plan in advance the drought mitigation measures in tea plantations. With the magnitude of yield losses, the results of this study emphasize the importance of adopting proper drought mitigation measures in tea lands in order to maintain the viability of tea plantations in Sri Lanka.

The base temperature for tea in Sri Lanka was found to be $10.5^\circ\text{C} (\pm 0.5)$ and the optimum ambient mean temperature for tea production was recorded to be $22^\circ\text{C} (\pm 0.5)$. The yield of tea decreases with increase in evaporation above 80 mm month^{-1} . This analysis shows that the increases of temperature and evaporation with global warming would be beneficial for tea cultivation in the upcountry while it could give a negative effect in the low country. The negative response of yield to increasing temperature and evaporation observed in low grown region highly emphasizes the importance of the establishment of shade trees to modify the microclimate around tea bushes in the low country to enhance the productivity.