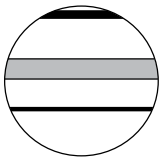

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Evaluating the Indian Summer Monsoon intensity using archeological seeds from early–late historic Vidarbha, Central India

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Abstract

We present an archaeobotanical record representing ~2300 years BP farming practice at Nagardhan an Early Historic—Late Medieval site in the Vidarbha region, Maharashtra, central India. The study assesses the crop harvesting patterns and Indian Summer Monsoon (ISM) intensity using two different approaches (archaeobotany, and canonical correspondence analysis) to understand the variability and impact of ISM on human subsistence systems during periods of dynastic transition. Our results show a gradual transformation from a warm-humid climate during the Early Historic and Historic (300 BCE–1200 CE) with the dominance of large-grained cereals (C_3 plants); to dry climate during the Medieval and Early Modern periods (1200–1900 CE) due to weakening of southwest monsoon (SWM) as evidenced by the dominance of small-grained millets (C_4 plants). The changing crop assemblage and cultural developments in this area of central India provide insights into past human responses to climate change and provide insights for modern societies in exploring sustainable agricultural policies during the ongoing climate deterioration. Moreover, the present study provides insights into the Indian Summer Monsoon (ISM) rainfall variability during the Late-Holocene in global climate change perspectives from one of the poorly understood areas of the tropics in Southeast Asia where the rainfall is essentially controlled by the ISM.

Keywords

C_3 and C_4 plants, central India, climate change, cultural adaptation, ISM, south Asian agriculture, Vidarbha

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Introduction

The Indian Summer Monsoon (ISM) is a synoptic weather system that strongly influences and helps to shape socio-economic and cultural development and transformation across South Asia, and today India's agricultural output, economy and societal well-being are dependent upon the stability of the southwest summer monsoon, its variability and extremes. Deviations in ISM precipitation can severely impact the agricultural productivity and Gross Domestic Product (GDP) of the country (Cook et al., 2010; Gadgil, 2003, 2018; Gadgil and Gadgil, 2006; Quamar, 2019; Quamar et al., 2024; Quamar and Bera, 2020 and references therein). Consequently, understanding the spatio-temporal dynamics of the ISM precipitation throughout the Holocene is important to contextualizing and understanding cultural and economic development and the establishment and abandonment of urban settlements and agricultural intensification (Chauhan and Quamar, 2010; Mayewski et al., 2004; Quamar, 2022; Quamar et al., 2021, 2024). Here we explore the role of ISM variability on long-term agricultural strategies in Central India, through the presentation of carbonized crop remains from the site of Nagardhan, in a region lacking in comprehensive archaeobotanical studies, especially those from the Early Historic and Late Historic periods.

Archaeobotany in India is well established as a valuable scientific tool and has been widely used to investigate continuity and change in past agricultural economies, subsistence strategies, and environments (Goyal et al., 2013; Pokharia et al., 2011, 2014, 2017, 2020, 2024). The social and economic changes in South Asia have been linked to climate variability to provide context for understanding population resilience that has been sustained by agricultural strategies, such as selective seasonal cultivation or crop diversification (Pokharia et al., 2014, 2017, 2020, 2024;

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