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Production practices and performance attributes of highland rice cultivars along an altitude gradient, Nepal

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Abstract

Rice is an important cereal crop for Nepalese farmers and is cultivated up to altitudes of 3,050 masl. Highland farmers face significant challenges due to colder temperatures, high UV radiation, and erratic rainfall patterns. Limited research has been done on highland rice cultivation and the performance of resilient genotypes across altitudinal gradients.

We hypothesised that i) altitude environment (especially, temperature and UV radiation) significantly influences rice performance and ii) altitude specific resilient genotypes and management practices are crucial for increasing rice productivity. The study was conducted in Jumla District, a high-altitude region in Karnali Province of Nepal. Field trials were performed along an altitude gradient (2,200–2,800 masl, 4 sites) using six highland rice genotypes: two local (Jumli Marshi and DBB), one improved (CH^{-1}), and three newly developed Jumli Marshi derivatives (JM18, JM20, and JM22). Field trials were established on farmers' fields. Agronomic traits such as phenological and physiological parameters, nitrogen use and stress tolerance indices and yield were measured. Household surveys were conducted to document existing agronomic management practices and production constraints for highland rice.

We observed that altitude had greater influence on key productivity traits than genotype alone. Vegetative growth (e.g. plant height and tillers) was more pronounced at lower altitudes, whereas yield was approximately 40 % higher at higher altitude. The field occupancy was nearly three weeks longer at higher altitudes compared to lower ones. The newly developed Jumli Marshi derivatives displayed adoption traits similar to their parent and showed slightly higher yields, although their performance varied with altitude. Among the genotypes, the locally preserved DBB showed superior adoption and yield performance in most locations, underscoring its potential value in future highland rice breeding programs. Survey results indicated that farmers in higher altitude are shifting to earlier sowing and transplanting times, while overall management practices have remained largely unchanged. Key production constraints for highland rice included seed source and quality, disease pressure, and labour shortages.

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These findings suggest that altitude significantly influences rice performance and highlight the need for altitude-specific research on genotype selection and management practices to optimise highland rice productivity.

Keywords: Agronomic practices, cold tolerance, Jumli Marshi, *Oryza sativa*, phenology, ultraviolet radiation, yield