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## Crop-livestock integration in urban agriculture: Implication for urban food security in Ghana

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### Abstract

Apricot fruits constitute an economically and ecologically important horticultural crop in Gilgit-Baltistan, N-Pakistan. Its high nutritional, medical, and economic value is appreciated by farmers and consumers of the region. An astonishing rich diversity of local landraces is available in the area of which many appear to be rare, are undocumented, and may be thus at risk of extinction, since modern varieties and cash-crop fruits like cherry are alternatively cultivated. To assess the current use, management, and diversity of apricot, 52 households of 15 villages in five valleys and two research centres were visited and a total of 240 landraces collected and morphologically as well as phenotypically characterised. Alpha and beta diversity was calculated to assess landrace richness and diversity measures within and across villages, valleys and the two regions Gilgit and Baltistan. The information derived from 12 microsatellite markers was used to assess genetic variation and structure. The results of two cluster analyses of morphological and genetic parameters were merged into a tanglegram by means of cophenic correlation matrices. A total of 122 vernacular names of apricot landraces were recorded; the most dominant are Halman, Habi, Karfo chuli, and Shikanda. Among five valleys, the mean Simpson index was 0.94 while mean genetic diversity ( $H_e$ ) was moderate (0.729). The overall weighted diversity was 0.737 of which the Gilgit region captured the largest diversity. Negative inbreeding coefficients indicated a moderate excess of heterozygotes in all groups. A moderate correlation ( $r = 0.45$ ,  $p = 0.001$ ) between phenotypic and genetic dendrograms suggested genetically linked apricot stone traits. We were also able to identify true-to-type, synonym, and homonym samples. Considering the high phenotypic and genetic variability, Gilgit-Baltistan appears a promising source of apricot germplasm for future breeding programs. The promotion of local varieties may allow farmers to diversify their production and derived sources of income as well as to maintain a historically important bio-cultural heritage of Gilgit-Baltistan. Comprehensive conservation strategies, combined with further participatory research, will be needed to achieve this goal.

**Keywords:** Dead end valleys, livelihood, microsatellite markers, tree management, varietal richness, and diversity