ARCHAEOLOGY

Agricultural renaissance in the high Andes

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ONE of the saddest sights in Peru and Bolivia is the vast extent of farmland that was intensively cultivated in prehispanic times and is now all but abandoned. Between 50 per cent and 75 per cent of Inca terraces are no longer in use, and in some of the coastal valleys there was up to 40 per cent more irrigated land in pre-Conquest times than there is today (Clark Erickson, manuscript in preparation). Moreover, entire technologies have been forgotten: the *qochas* (circular field basins) of the high Andes, the sunken gardens in areas of high ground-water along the coast, and the systems of raised fields in waterlogged areas at all altitudes. The remains of these indigenous technologies are now being rediscovered by archaeologists and geographers, and the implications have forced government agronomists and foreign-aid agencies to take notice.

The most sophisticated of the current projects are located in the basin of Lake Titicaca, on the Peru–Bolivia border at about 3,800 m above sea level. Aerial photographs revealed more than 83,000 hectares of eroded and abandoned fields on the lakeshore plain in terrain nowadays used only as low-grade pasture. The zone adjacent to the lake is perennially marshy and is subject to flooding in the wet season. These problems are compounded by efflorescence of salts as a result of evapotranspiration, and by the risk of sudden frosts that can wipe out an entire harvest.

Investigations began in 1981–86 when Erickson excavated a group of raised fields near Huatta, on the Peruvian side of the lake^{1,2}. He showed that between 1000 BC and AD 400 the inhabitants of the region dug a series of parallel canals, and piled the earth between them to form long, low mounds about 1 m high, 4–10 m wide and 10–100 m long. Pollen from the field soils indicates that potatoes and quinoa (a high-altitude grain rich in protein) were the main crops. The canals provided moisture during periods of drought, and were also a source of green mulch and organic muds to fertilize the fields, thus eliminating the need for fallowing. The raised planting surface helped to prevent waterlogging of roots, and the canals served as traps for sediment (which could be scooped out and recycled) and also as heat sinks, warming up during the days and slowly releasing heat at night. Measurements show that the night temperature on raised fields in conditions of light frost was about 2 °C higher than that of control plots, and that the frost was

several hours shorter in duration. The effect was not merely to reduce frost damage, but also to extend the growing season.

In the Huatta region, construction of raised fields ceased by about AD 400, a date that coincides with the growth of the city of Tiwanaku in the southern (Bolivian) part of the basin. In the rural hinterland around Tiwanaku, Kolata and

destroyed harvests on conventional plots, losses of potatoes, barley, quinoa and vegetables on the raised fields were minimal.

Above all, as Erickson and his colleagues emphasize^{1,2}, raised-field technology requires no imported seed, chemical fertilizers or expensive machinery, is based on traditional crops and tools, and does not disrupt existing work patterns and social norms. In contrast, other competing schemes have been capital-intensive or designed to produce cash crops from which most small farmers have not benefited. By starting at the bottom, with the villagers themselves (rather than imposing from the top), by setting a

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The shores of Lake Titicaca, in prehispanic times a site of intensive agriculture.

Ortloff are studying the agricultural landscape that provided food for one of the main prehistoric civilizations of the Andes. They show that the landscape of the Tiwanaku period (about AD 400–1100) was almost entirely man-made, with terraces on the hill slopes and systems of raised fields, interspersed with farms and townships, on the lakeshore plain^{3,4}. Using mathematical models to study water flow and the effects of fluctuating water levels on drainage, salinization and heat-storage capacity, they demonstrate that the landscape functioned as an integrated system. Wet-season rainfall in the hills was collected in modified natural gullies and transferred by means of aqueducts across the plain and into the lake. Canalizing runoff prevented deposition of unwanted sediment and, more importantly, controlled the water table by reducing infiltration of surface water into the groundwater reservoir.

But could this kind of system work today? The answer is 'yes'. On experimental raised fields, sustainable potato yields are twice those of the control plots, and often much more. In years when frost

practical example, and by initiating a training programme with simple manuals in Spanish and Quechua, the Huatta team has persuaded several local communities to build raised fields for themselves. Similar experiments have begun on a small scale in the very different conditions of coastal Ecuador⁵, and Colombia (with more than 500,000 hectares of abandoned raised fields in the Caribbean lowlands⁶) is also showing interest. □

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