

IKNotes

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No. 99
January 2007



Using traditional knowledge in economic development: The impact of raised field irrigation on agricultural production in Puno, Peru

The Andean region of Puno, known as the *altiplano*, is located at 3,830 meters above sea level. The terrain is prone to flooding, and thus difficult to cultivate. In order to deal with this situation, Andean indigenous populations displaced huge amounts of soil in order to create raised fields that were better adapted to agricultural use.

Raised fields (*camellones* in Spanish, *waru waru* in Quechua, *suka kollus* in Aymara) are elevated platforms of earth, 1 to 20 meters wide, ten to hundreds of meters long, and 0.5 to 1 meter high. Canals that provided the earth for constructing the platforms surround the fields. Erickson estimated that raised fields cover more than 120,000 hectares of the Lake Titicaca basin, but that most are not currently in use¹. Archaeological investigation and agronomic experimentation, carried out by Erickson and his colleagues between 1981 and 1987 with the participation of local farmers, revealed that farmers began constructing raised fields at some point before 1000BC. Raised field agriculture thrived in the Puno region during the Tiahuanaco civilization but fell into disuse around 1100 AD²; most of the fields were later converted into pasture around the colonial haciendas, and then became government cooperatives in 1968.³

Raised fields resolved many of the problems that affect agriculture at high altitude⁴. The technology combines the rehabilitation of marginal soils, drainage improvement, increased water storage, more efficient use of radiant energy, and attenuation of the effects of frosts. The raised platform allows farmers to double the depth of topsoil for crops, and provides dry surfaces in the wet and

often flooded lake and river terrain. The water-filled canals adjacent to the platforms provide moisture during the droughts. Sun heats the water in the canals during the day, which protects the crops against the killing frost that is often present at high altitude. The canals also capture nutrients and produce organic-rich sediments that can be added to the fields to extend the harvest period.⁵ An evaluation of the result of these effects was described as follows in the UNESCO database of Best Practices on Indigenous Knowledge:

Experience shows that the minimum night time temperatures reached in [raised field] areas are two to three degrees centigrade higher than those of the surrounding plains. The moisture provided by the canals lowers the impact of sporadic droughts during the cycle and, in the rainy season, prevents the subsoil from becoming water-logged by ensuring adequate drainage. Crop yields, in particular

IK Notes reports periodically on Indigenous Knowledge (IK) initiatives in Sub-Saharan Africa and occasionally on such initiatives outside the region. It is published by the Africa region's Results and Learning Unit as part of an evolving K partnership between the World Bank, communities, NGOs, development institutions, and multilateral organizations. The views expressed in this article are those of the authors and should not be attributed to the World Bank Group or its partners in this initiative. A webpage on IK is available at: <http://www.worldbank.org/afr/ik>

*yields of potatoes and other Andean tubers, are 50% to 100% higher (...). (...) Studies carried out over the past eight years, covering rotation cycles of five years of cultivation plus three years of fallow, and estimated on the basis of an economic life of 20 years, showed a 7% annual average increase in profits even after maintenance costs were deducted. This result has been achieved in spite of two El Niños.*⁶

Following the apparent success of this experimentation, Erickson and his colleagues began a small-scale development project to rehabilitate pre-Hispanic raised field agriculture in a few indigenous communities of the Lake Titicaca basin, specifically in the Puno region. By the late 1980's nongovernmental organizations (NGOs) and government agencies in Peru and Bolivia began to promote raised field rehabilitation projects by providing funding and assistance for their rehabilitation⁷. Estimates show that farmers from several hundred Quechua and Aymara communities rehabilitated between 500 and 1,500 hectares of raised fields in the years before 1990⁸. A restoration project supported by CARE-Peru began in 1991 to continue using the irrigation in Puno.

To evaluate the effectiveness of raised fields for Puno's agricultural sector, it is useful to determine whether the benefits of implementing the technique outweigh the costs. The interpretation of four data sets helped to determine this⁹. (I) The agricultural yield data (kg/ha) from Puno's Chatuma and Caritamaya communities for 1992-93 provides an assessment of the impact of raised field irrigation compared to that of mountainside and pampas terrain. The figures reveal that in general the yields that were produced with raised fields are higher. (II) A comparison of yields with and without raised fields in the Puno region (1999-2005) shows that in most cases agricultural yield was superior when raised fields were used. (III) Average quinoa yields in the Puno region from 1979 to 1998 show a sustained increase in average yields starting in 1990. (IV) Comparing the costs with the revenue yielded from the harvest of the same year from the fields managed by CARE in 1999-2000 leads to the conclusion that the benefits of using raised field irrigation outweigh the costs incurred by CARE. However, the data also demonstrates that the investment in CARE's staff participation does not result in an impressive cost/benefit outcome.

These interpretations provide evidence that although the benefits of applying traditional knowledge to an economic sector can potentially outweigh the costs, there are nonetheless inefficiencies in the way that the raised field technique was applied to agriculture in Puno. Two of these challenges are a tendency for farmers to abandon management of the raised fields (which explains the high standard

deviation and coefficient of variation observed in data set II for the raised fields), and the shortcomings of a costly NGO staff participation in carrying out raised field rehabilitation.

According to Erickson¹⁰, many farms abandoned raised fields in spite of the increase in crop yield. However, reasons for abandonment of the raised fields are independent of the technique's effectiveness for production. Among the reasons Erickson found are:

- Competing labor demands: Constructing large blocks of raised fields requires a significant amount of labor at the start, even though this need diminishes when spread out over successive years of cultivation. However, many farmers migrate for temporary work to cities and mines during a part of the year, which reduces the availability of labor for raised field implementation.

- Traditional fallow cycles: Traditionally, farmers plant crops for three years and then leave fields in fallow for up to twenty years. This rotation pattern allows for an optimization of the potential of exhausted and eroded mountain soils, at a relatively low cost. Farmers today apply this traditional rotation technique to raised field agriculture, even though it is not necessary for fields that are well managed. Thus, many raised fields that appear to be abandoned might actually be in fallow.

- Competition with livestock: Livestock is a significant income source for Quechua farmers. Those who manage raised field areas must choose between rehabilitating the fields and grazing livestock. Because livestock has relatively higher market value, farmers often choose livestock over raised fields. Experiments are currently being carried out by individual farmers for integrating raised field agriculture with livestock grazing, but this integration of methods presents challenges and has not yet been widely implemented.

- Political instability: The instability caused by Shining Path activities in the late 1980's and early 1990's resulted in most international aid agencies leaving Peru, including those who were promoting raised fields in Puno. NGO funding for raised field rehabilitation thus became increasingly irregular, and some fields were therefore abandoned.

These reasons for abandonment of the raised fields highlight the fact that raised fields were not a structural part of agricultural life in Puno before their rehabilitation by NGOs at the end of the 1980's. The Puno case study is particular in this regard, since knowledge of the traditional irrigation technique was re-introduced into farmer communities after centuries of disuse and was not an inherent part

of community life. This characteristic is exceptional: in the majority of cases in which traditional knowledge is used in development, the knowledge is held by community members and passed on between generations instead of being reintroduced by exterior research or development organizations such as Erickson's archaeological team. This exceptional status of the Puno case study may account for a large part of why raised fields were often abandoned.

Based on these facts and the results of data set IV concerning CARE's financial contributions toward rehabilitating raised fields, it becomes apparent that NGO participation in applying traditional knowledge to development implies certain challenges that need to be accounted for. For example, NGOs failed to provide farmers with individual incentives for rehabilitating the raised fields. A USAID program provided surplus food, which was given to farmers in exchange for participating in raised field development projects¹¹. In the mid-1980s the government of Peru encouraged rehabilitating raised fields using a system by which farmers contributed their labor to building the fields for a low daily wage. To supplement this low income, the payment of additional incentives (food, tools and seed) ensured the farmers' participation in projects, thereby creating competition between development agencies¹². However, as a result of this system, farmers ended up in a position where they were working for a development agency or NGO rather than for their own farming enterprise. It is therefore not surprising that most of the rehabilitated raised fields that were abandoned in the 1990's had been constructed by communities or by large groups of farmers working together and not individually¹³. In the community projects, "poor organization and leadership, internal tensions, and land tenure problems within communities worked against long-term sustained commitment to communal farming of large raised field plots"¹⁴. This happened because individual farmers were not educated on the potential value that the raised fields had for their crops, so they lacked individual incentive to implement them.

These facts led to adverse results in managing the raised field projects, in spite of the irrigation's potential to increase yields substantially. In response to these difficulties, the "Project for the Rehabilitation of the Andean Waru Waru Region" (PIWA, by its Spanish acronym¹⁵) initiated its activities in August 1989: through a community outreach system, PIWA provided technical and scientific knowledge to sustain the operation and dynamic of raised field systems.¹⁶ PIWA incorporated various local organizations such as rural communities, mothers clubs, families and schools, to spread knowledge of raised field technology throughout the communities.¹⁷ A few Peruvian governmental organizations also provided subsidies to PIWA, as a result of the

observation that raised fields were improving crop yield¹⁸. These organizations enabled the reconstruction of 500 hectares of raised fields in 72 rural communities in the Puno region. After they were constructed, operating and maintaining the systems became the sole responsibility of the farmers who benefited from using the technology.¹⁹

However, in the case of both CARE's and PIWA's involvement, projects were subsidized by a combination of governmental and international funds²⁰, which led to farmers remaining dependent on development organizations to finance their raised field agriculture²¹. Provided with the expectation that the funding institutions would continue to fund these projects, there was limited motivation from the farmers themselves to consolidate their knowledge of how raised fields must be built and managed. The predominance of institutional investment over individual sacrifices to make the construction of raised fields possible, meant that when the outside funds were suspended there was not a sufficiently solid foundation in the community for the raised fields to be maintained.

CARE and PIWA have now ceased managing raised field rehabilitation in Puno, largely due to lack of continued funding from their respective international and governmental sources²². Both the abandonment of raised fields and the inefficiencies of NGO participation in Puno demonstrate that traditional knowledge is more likely to be beneficial to local economic growth if it is maintained within the community itself rather than promoted by detached organizations. Ultimately, educating each new generation in the community on its traditional knowledge can optimize the potential for this knowledge to contribute to development solutions.

Endnotes

¹ Erickson, Clark, "Agricultural Landscapes as World Heritage: Raised Field Agriculture in Bolivia and Peru", in *Managing Change: Sustainable Approaches to the Conservation of the Built Environment*, Ed. Jeanne-Marie Teutonico and Frank Matero, Getty Conservation Institute, Los Angeles, 2003, pp. 181-204.

² <http://www.unesco.org/most/bpik19-2.htm>

³ Ibid.

⁴ Erickson, Clark and D. Brinkmeier, "Raised field rehabilitation projects in the northern Lake Titicaca basin", unpublished report to the Interamerican Foundation, Washington, D.C., 1991.

⁵ Informe Final del Seminario-Taller sobre Tecnologías Alternativas para Aumentar la Disponibilidad de Agua en América Latina, Lima, Peru, 19-22 Sept. 1995, OAS/

UNEP. See also Tapia, Mario E. and Mairano Banegas, “Human Adaptation to a High-Risk Environment: Camellones or Waru Waru: Traditional Agricultural Technology of the Peruvian Andes”, *Journal of Farming Systems Research-Extension 1* (1): 93-98.

⁶ Kolata, A.L., O. Rivera, J.C. Ramirez, and E. Gemio, “Rehabilitating raised-field agriculture in the southern Lake Titicaca basin of Bolivia”, in *Tiwanaku and Its Hinterland: Archaeology and Paleoecology of an Andean Civilization*, Vol. 1, Agroecology, ed. A.L. Kolata 203-30, Washington, D.C.: Smithsonian Institution Press.

⁷ PIWA, Priorización de las Áreas Potenciales para la reconstrucción de waru waru en el Altiplano de Puno, Programa Interinstitucional de Waru Waru, INADE/PELT-COTESU, Puno, Peru, 1994.

⁸ A more complete analysis can be found in the author’s master’s thesis, “Using traditional knowledge in economic development: The impact of raised field irrigation on agricultural production in Puno, Peru”, dir. Dr. Patrick Messerlin, Institut d’Études Politiques de Paris (GEM), June 2006.

⁹ Erickson, Clark, “Agricultural Landscapes as World Heritage: Raised Field Agriculture in Bolivia and Peru”, in *Managing Change: Sustainable Approaches to the Conservation of the Built Environment*, Ed. Jeanne-Marie Teutonico and Frank Matero, Getty Conservation Institute, Los Angeles, 2003, pp. 181-204.

¹⁰ Erickson, Clark and D. Brinkmeier, “Raised field rehabilitation projects in the northern Lake Titicaca basin”, unpublished report to the Interamerican Foundation, Washington, D.C., 1991.

¹¹ Garaycochea, I., “Community-based organizations and rural development with a particular reference to Andean peasant communities”, Master’s thesis, Reading University, Reading, England.

¹² Erickson, Clark and D. Brinkmeier, “Raised field rehabilitation projects in the northern Lake Titicaca basin”, unpublished report to the Interamerican Foundation, Washington, D.C., 1991.

¹³ Erickson, Clark, “Agricultural Landscapes as World Heritage: Raised Field Agriculture in Bolivia and Peru”, in *Managing Change: Sustainable Approaches to the Conservation of the Built Environment*, Ed. Jeanne-Marie Teutonico and Frank Matero, Getty Conservation Institute, Los Angeles, 2003, pp. 181-204.

¹⁴ PIWA or PIWANDES: Proyecto Interinstitucional de Rehabilitación Waru Waru (de los Andes)

¹⁵ This was done with the financial support of the Swiss Agency for the Development and Cooperation (COSUDE).

¹⁶ Ibid.

¹⁷ Among these were the Instituto Nacional de Investigación Agropecuaria y Agroindustrial (INIAA), the Centro de Investigación Agropecuaria Salcedo (CIAS) and the Centro de Proyectos Integrales Andinos (CEPIA).

¹⁸ *Source Book*, IETC Technical Publication Series, UNEP International Environmental Technology Centre, Osaka/Shiga, Japan, 1997.

¹⁹ in large part the Netherlands, with the support of the NUFFIC or Netherlands Organization for International Cooperation in Higher Education. See www.unesco.org/most/bpik19-2.htm

²⁰ Middleton, M., interview with Jaime Villena, Executive Director for PIWANDES, Feb. 2006.

²¹ Ibid.