3-1994

Raised Fields as a Sustainable Agricultural System from Amazonia

Clark L. Erickson
University of Pennsylvania, cerickso@sas.upenn.edu

Paper presented in the Symposium Recovery of Indigenous Technology and Resources in Bolivia at the 18th International Congress of the Latin American Studies Association, Atlanta, March 10-12.

Raised Fields as a Sustainable Agricultural System from Amazonia

RAISED FIELDS AS A SUSTAINABLE AGRICULTURAL SYSTEM FROM AMAZONIA

by

Clark L. Erickson
Department of Anthropology
University Museum of Archaeology and Anthropology
University of Pennsylvania
33rd and Spruce Streets
Philadelphia, PA 19106-6398

Paper Presented in the Symposium

RECOVERY OF INDIGENOUS TECHNOLOGY AND RESOURCES IN BOLIVIA
Organized by
Dr. Kevin Healy

XVIII International Congress of the
Latin American Studies Association
March 10-12, 1994
Atlanta, GA

Published as:
Erickson, Clark 1999 Agricultura en camellones prehispánicos en las tierras bajas de Bolivia: Posibilidades de desarrollo en el trópico húmedo. IN *Los camellones y chinampas tropicales: Memorias del Simposio-Taller Internacional sobre Camellones y Chinampas Tropicales*, edited by Juan José Jiménez-Orsornio and Véronique M. Rorive, Ediciones de la Universidad Autónomo de Yucatán, Mérida, pp. 39-52.

A Long-Term Perspective on Neotropical Land Use

Landscapes of the Americas have been used, and in many places, continue to be used, intensively for agriculture by indigenous peoples. These peoples utilize systems of agriculture that permit them to make a living from what are sometimes considered to be marginal farming lands, despite pressures from the world economy, urbanism, civil unrest, and top heavy national development. Today these agricultural systems are rapidly disappearing and with them valuable knowledge on sustainable uses of the landscape disappears. A small groups of anthropologists, linguists, geographers, and others are studying these indigenous knowledge systems including topics such as ethnoscience, ethnobotany, ethnopedology, ethnoecology, irrigation engineering, resource management, intensive gardening and swidden, indigenous terminology and classification, agro-forestry, terraces, irrigation, and raised fields. Indigenous knowledge is a localized body of knowledge, beliefs and practices of traditional management of natural and human resources (Brokensha et al. 1980; CIKARD 1993). The scientific studies often promote the preservation and practical application of this knowledge. This information can provide a basis for sustainable agricultural development, in many cases a viable alternative to development schemes that are traditionally promoted by international and national institutions (Netting 1993; Posey and Balée 1989; Denevan and Paddock 1988; Clay 1988, Brokensha et al. 1980; Godoy et al. 1993).

What is often forgotten is that these indigenous knowledge systems have long histories. The deep historical trajectories can not be treated as static phenomena within a synchronic perspective. They result from dynamic, long-term accumulated interaction of humans with their local environments. Much of this indigenous knowledge has been lost over time and that which remains is often fragmentary or transformed. In many cases, indigenous knowledge systems have been completely abandoned, such as in the case of raise field agriculture in the Llanos de Moxos and in the Lake Titicaca Basin. The farming peoples that produced these agricultural remains are not with us anymore to provide direct information regarding these technical knowledge systems.

Archaeology can provide a "window" into the history of indigenous knowledge systems. Many intensive agricultural systems were based on massive transformations of local and regional landscapes, especially throughout much of Latin America. Embedded in these landscapes are the physical structure, patterning, and designs of agricultural engineering and expertise, resulting in a palimpsest of landuse strategies and knowledge systems. For example, in the Andean region of Peru and Bolivia, the remains of prehispanic land use systems, resource management, land modification, engineering works (such as irrigation, terraces, sunken garden, and raised field systems) are present over vast areas. Ironically, much of this agricultural landscape now lies abandoned or underutilized. Archaeology can address these issues by "reading" the remains on the landscape through the interpretation of aerial photography, ground survey, mapping, excavation, and experimentation. Archaeology, combined with a multidisciplinary toolkit, can provide information on crops grown, tools utilized, field morphology and patterning, functions, prehistoric demography, and the technical knowledge used. Also relevant to a long-term perspective is the human social, cultural, political, demographic, and economic context of the ancient farming system and its changes over time. Larger issues include the processes of origin, evolution and

abandonment of past intensive agricultural systems.

The Americas provide evidence of sophisticated technology and engineering make landscapes productive during precolumbian times. What can we learn from these ancient indigenous knowledge systems? Throughout Latin America there are underutilized landscapes, abandoned, exhausted lands, grinding poverty, with farmers moving to cities, low carrying capacity, and low population densities. This is in sharp contrast to the precolumbian situation on the same landscapes. Evidence of long-term use of these ancient technologies demonstrates that they were time-tested and potentially sustainable forms of agriculture. Many were associated with large and well-organized societies. My colleagues and I practice what is referred to as an "applied archaeology," believing that much of this ancient indigenous knowledge has a potential practical contribution to rural development in the contemporary situation.

In this short presentation, I would like to discuss how an "applied archaeology" can contribute to the study of long-term prehispanic landuse in the neotropics and provide alternative strategies for development. The Agro-Archaeological Project of the Beni is a collaboration between the Instituto Nacional de Arqueología de Bolivia (INAR), the Universidad Técnica del Beni (UTB), the Promoción de Moxos (PRODEMO), and the University of Pennsylvania. This multidisciplinary project combines archaeology, historical ecology, agronomy, hydrology, remote sensing, and agricultural experimentation in the study of ancient agricultural earthworks and associated hydraulic infrastructure in the Llanos de Moxos of the Department of the Beni, Bolivia. Much of the methodology is based on our previous applied research on raised fields in the Andean highlands of the Lake Titicaca Basin of Peru during the 1980s (Erickson 1989, 1992).

The Archaeology of Raised Field Agriculture

The traditional perspective on Amazonian prehistory is that the region could not have sustained large populations due to the limitations of a tropical environment; and therefore, cultures would not develop beyond the level of hunting and gathering bands and swidden agricultural villages (Meggers 1971). Many conservationists and environmentalists (scholars and the public) have romanticized this perspective to argue for a stereotype of the indigenous "noble savage," "at one" with their environments and having minimal impact on the natural environment (Denevan 1992; Redford 1992).

Archaeological research indicates that the traditional perspective of the Amazonian environment as static is incorrect. The savanna and forest landscape of the Bolivian Amazon was heavily modified by precolumbian farmers. In the early 1960s, William Denevan and George Plafker (Denevan 1966) discovered that large expanses of the savannas of the Llanos de Moxos were covered with massive earthworks including raised fields, canals, causeways, reservoirs, dikes and mound settlements constructed by the prehispanic inhabitants of the zone. Denevan and his colleagues have found raised fields throughout the Americas in the flooded savannas of Colombia, Ecuador, Venezuela, and Surinam, in addition to the Andean region of Peru, Bolivia, Colombia, and Ecuador.

The Llanos de Moxos is located in the southwestern headwaters of the Amazonian drainage basin. The region corresponds roughly to the modern political boundaries of the Department of the Beni of Bolivia. The area is a flat landscape of forested zones along rivers and higher ground (20%) and savanna grasslands and scrub and palm forest (pampa) (80%). Much of the lowlying lands are covered with shallow flood waters during parts of the rainy season. The rest of the year, dry conditions prevail and water becomes a scarce commodity. The seasonal flooding alternating with dry conditions, combined with poor soil conditions and lack of high ground, make farming these areas difficult. The ancient inhabitants of the zone created an anthropogenic landscape to resolve these problems and make the area highly productive. A major part of this transformation of the environment was the construction of raised fields. Raised fields are large planting surfaces of earth elevated above the seasonally flooded savannas and wetlands. Experiments and ethnographic analogy indicate that raised fields serve a wide variety of functions including localized drainage, improved soil conditions (such as aeration, mixing of soil horizons, and doubling the organic topsoil), with water management (for drainage and irrigation), nutrient production and recycling in the adjacent canals (such as sediment sinks, organic muck production, and management of economic faunal and floral resources).

Until recently, the prehispanic raised fields of Moxos remained unstudied. Denevan (1966) has provided an estimate of 12,000 ha. of raised fields and canals distributed over an area of 77,000 km^2 based on his interpretation of aerial photographs. Analysis of recent aerial photographic coverage indicates that these figures underestimate the extent of raised fields. Our ground survey has determined that many raised fields are under dense tree canopy. Many are only faint traces on the savanna due to massive erosion but these can be studied using digital enhancement of aerial and satellite imagery. Field patterning is highly structured in some areas; in others the fields are more informally organized. Discrete blocks of fields may reflect prehispanic land tenure systems and the social organization of farmers who constructed and maintained these fields.

While previous projects focused on excavations of archaeological mounds (Nordenskiöld, Rydén, Bustos, Dougherty and Calandra), our archaeological team investigates the agricultural earthworks and the associated hydraulic infrastructure. This includes archaeological survey, mapping and excavation of the ancient agricultural system. Trenches excavated in prehispanic raised fields and causeways provided valuable information on the internal structure of the earthworks, construction techniques, rebuilding phases, sedimentation rates, original functions, crops cultivated, soil fertility, and the chronology of field construction, use and abandonment. Preliminary analysis of pollen from field canals has identified the presence of gualusa (Xanthosoma, a New World taro), guayusa (Ilex, mate, used for a caffeine-rich drink), and urucú (Bixa, used for red body paint) which may have been cultivated. Maize and manioc have not yet been identified in the limited number of samples processed, but we believe these were the major raised field crops. Radiocarbon dates from one agricultural site indicate that the raised fields were used between 2000 and 800 years ago. These data indicate that the fields have a considerable time depth and use period (Erickson 1980, i.p.; Erickson et al. 1990; 1993a; 1993b).

Raised fields are often associated with large, long causeways and canals. These may have served for transportation and communication between village sites. We believe that these earthworks were also part of an integrated system of water management. Analysis of detailed topographic mapping a several agricultural sites have begun to address this hypothesis. Causeways appear to have been used to block the flow of water, impounding large bodies of shallow water within raised field blocks. By opening and closing sections of causeways, optimal water levels could have been maintained for field cultivation. It appears that the ancient farmers of Moxos were also involved in relatively sophisticated hydraulic engineering projects.

We have found that these field systems sustained large populations organized in large villages and towns dispersed within the savannas and forests. Several thousand "islands" (islas) or low mounds of several hectares of surface area are found in the savannas. These locations, often surrounded by raised fields and causeway/canal networks, were the habitation sites of prehispanic farming communities. We have investigated several of the sites where they have been disturbed by road construction and one was excavated in 1993. They commonly contain refuse debris from long term occupations and some are still considered today to be ideal settlement locations.

Experiments in Raised Field Agriculture

Experimental raised field design (form, dimensions, and patterning) is based on a model established through mapping and excavation of ancient raised fields of the zone. We believe that the raised field farmers had developed ideal earthwork designs and a appropriate crop inventory during the long period of evolution of field use. In 1990, a small block of raised fields (0.5 ha) was constructed in the pampa at the Biological Station of the Beni. Labor was provided by members of the community of Totaisal, located 3 km from the station. Field form was based on archaeological fields at El Villar located 17km to the west. The fields were constructed over three periods under very difficult climatic conditions. A total of 900 person-days were needed to construct a single hectare of fields and canals. The fields were expanded another 0.25 ha for student thesis projects in 1992-3. The fields were constructed under better conditions and only 400 person-days were necessary to construct a single hectare of platforms and canals.

Manioc and sweet potatoes produced bumper crops on experimental raised fields. The maize and plantains also did well. Production figures are not complete for these years but maize was estimated to have produced 2 metric tons per hectare (including field platforms and canals). During the last season, Julio Arce calculated a manioc harvest of 25 metric tons per hectare, a substantial figure compared to local production figures (Arce 1993). This is surprising because soils samples analyzed from this experimental site were found extremely poor for agriculture. A student thesis project undertaken by Carlos Roman compared raised field agriculture to traditional slash and burn agriculture (chaco) in the area during 1992-3 and found that the raised fields produced the only manioc in the region that year because of heavy rains which caused rotting of roots.

Applied Archaeology and the Indigenous Community

The experimental raised fields at the Biological Station of the Beni provided an excellent context for acquiring controlled data on labor, production, and field functions, but didn't tell us if this technology would work within a social context. Would local farmers be interested in raised fields? Would they adopt the system? What are the potential problems facing the reintroduction of ancient knowledge systems?

There are a large number of linguistic and ethnic groups of native peoples in the Bolivian Amazon (estimates of 150,000-190,000 people). The native population makes up one quarter of the population of the Department of the Beni and as much as 85% of the population of the Province of Moxos (Jones 1990). These peoples have been generally marginalized by ranching interests into the forested zones of Mojos, often neglected, impoverished, and exploited. They practice swidden agriculture in the better drained areas; hunt, fish and collect in the forests, rivers, and wetlands; and occasionally work on ranches, logging concessions, or in the few urban centers of the region. Communities tend to be dispersed and highly fluid. Many communities are relatively recently established (such is the case of Bermeo and Esperanza where the raised field experiments are located).

The Promotion of Moxos (PRODEMO), a small grassroots development group with a 2 person staff associated with the Parish of San Ignacio, recently received a small grant from the Interamerican Foundation for promoting and diffusing raised field agriculture in indigenous communities in Central Moxos. The Agro-Archaeological Project of the Beni (PAAB) provided a series of technical designs for raised field construction based on the archaeological field remains.

We approached several communities that had previously worked with PRODEMO on small scale development projects (wells, health, vegetable gardening). Our approach was to set up a public meetings or cabildo with local community leaders to discuss raised field agriculture with the community. Most families sent an adult representative to the meeting, with participation ranging from 25-50 people. We presented a short discussion of our archaeological research on raised fields and the experimental research at the Biological Station of the Beni. Black and white photographs of archaeological and experimental raised fields were passed around as illustrations. Much of the discussion revolved around explaining the concept of experimentation and specifics on how the community would collaborate with us on this study. We wanted to make sure that they understood that this project was experimental and that there could be positive and/or negative results.

As an incentive to participate, we could offer a small daily wage (approximately $2/day), crop seed, and food for lunch breaks during workdays. The participants receive all the crops produced on the fields. We also provided a loan of tools that are used in the construction. In return, they would provide the land, labor, and help us with monitoring the fields and the collection of data during the agricultural season.

This was followed by intense discussion, questioning, and debate between the community members and our team. Many were worried about the amount of labor they would have to provide;

others argued that the work would be too difficult. From their personal experience, others didn't think that raised fields would work in inundated zones. Participants would intensely debate the pros and cons of working with us among themselves. This was followed by a visit to potential raised field construction sites which often included visits to local sites with archaeological earthworks (raised fields, causeways, and occupation mounds) which often surround these communities. Sometime after the initial meeting, a vote was taken by the community regarding their participation. In all cases, only part of the community participated in the actual construction, maintenance, and harvest of the fields.

I had wanted to construct raised fields in the same environment (seasonally flooded grassland savannas) as the archaeological fields, or ideally, rehabilitate ancient fields in situ. A major problem encountered was the lack of seasonally flooded savanna land within the boundaries of these small communities and absence of prehistoric fields. Most communities had been established along old levees in the gallery forests along permanent bodies of water. Often the locations shown to us were unsuitable for raised field construction and would have actually required cutting down forest to construct the fields. In two communities, we decided to construct raised fields within large slash and burn fields that had been abandoned because of heavy flooding two consecutive years (resulting in total crop loss). Soils here were friable and better drained than most savanna locations. Many of these areas are secondary forest and may have originally been pampa in the past. The Community of Bermeo controlled a small section of flooded savanna and swamp, in which we located an additional field site.

The two communities collaborating with us were established relatively recently (in the past 20 years) and have not developed a strong internal political structure. Bermeo was made up of families that were driven out of lands near the Rio Mamoré during serious flooding during the 1970s. Esperanza was established in the site of a temporary road construction camp. In our applied archaeology project in Peru, we collaborated with indigenous farmers is well-established communities based on a strong tradition of formal labor reciprocity and communal labor projects. I had expected to encounter a very difficult labor situation in the Beni. Local ranchers and timber cutting operations have difficulties getting local labor. Communities and ranches are dispersed and there are few urban centers in the Beni. Most ranchers and even anthropologists consider the indigenous peoples to be lazy, unmotivated, and uncooperative. We did not find this the case. Farmers use informal reciprocal labor practices with neighbors or work alone with extended families on small-scattered gardens and swidden plots. Communal labor organization is not well developed, but is used for the construction and maintenance of roads, school buildings, wells, church, community meeting house, and the village plaza. We found that although the communities did not appear to have had much experience working together on labor projects, the work organization for raised fields was adequate.

Because secondary growth had taken over some of the abandoned field sites, the first day of construction was spent clearing the debris, which was later burned. A detailed topographic map was produced for each field location. Metric tapes, wooden stakes and string were used to mark off the areas of canals and field platforms. These measurements were based on ideal models of raised

fields based on the archaeological research. Several different sizes of canals and platforms were constructed for comparative purposes. When possible, control plots were established in slash and burn fields adjacent to the raised field sites.

The communities established the schedule for construction. Groups participating in the field construction ranged from 10 to 40 people. Participants included men, women, and children of all ages. Field construction was done using hand tools available to local farmers: shovels, large hoes, and metal tipped digging sticks. Soil was removed from the areas demarcated as canals to a depth of 30 - 50cm and placed on adjacent field surfaces. The original surface vegetation was buried and organic matter worked into the platforms. Work days lasted 5-8 hours with most of the work concentrated in the morning before the hottest part of the day. Most workers tended to cluster in groups of 3-6 excavating canals and piling the earth on the adjacent platforms. Because the work was delayed long into the dry season, soil conditions were not ideal. During the wet season, soils are heavy, wet and muddy; during the dry season, the clayey soils harden into a concrete-like texture. We have found that there are two short "windows" of time then field construction is optimal--just after the first rains and at the beginning of the dry season.

Only small blocks of fields (0.25 - 0.5 ha) were constructed the first years. Our labor calculations indicate that 576--680 person-days are required to construct a hectare of raised fields and canals which compared favorably with the figures for raised field construction from the Biological Station of the Beni and from the Altiplano. We are currently calculating labor necessary for the maintenance of the fields during the growing seasons (weeding, harvesting, and repair,) and between years (rebuilding fields, and removing organic sediments from canals).

The community fields were planted in local crops including maize, manioc (yuca), beans, peanuts, bananas, sweet potatoes and wet rice. Fields are being currently being harvested and we do not have precise figures of production at this moment. An early harvest of beans greatly exceeded local production rates in traditional fields. The manioc will be the first harvest in over two years for these communities because flooding destroyed the past two years' crops. An innovation suggested by the community was to plant wet rice in the canals between the fields for an additional harvest.

Failures did occur in the experiments. The raised fields in the pampa were planted too early (before the rainy season) and much of the seed did not sprout. Some plants died due to lack of water at critical stages. This problem could have been resolved by planting after the initial rains of the rainy season.

We are promoting a "bottom up," grassroots approach. In contrast to other development projects, we assume that local farmers are capable of constructing and maintaining large-scale agricultural earthworks and engineering through indigenous knowledge systems and local technology, even if this technical knowledge comes from the precolumbian past. Our goal has been to minimize institutional infrastructure and bureaucracy, using the established infrastructure of local communities and PRODEMO.

Agronomic research of raised field agriculture has provided an excellent opportunity for Bolivian student participation in the project. Boarding students at a Catholic high school in San Ignacio constructed raised fields as a class project, which produce food for their meals. Four agronomy students at the Technical University of the Beni are currently doing research on raised field experiments. Raised fields provide a chance for them to do original research on their own history, providing a practical solution to local rural development and an opportunity to collaborate with rural communities. There are a number of potential thesis projects, and potential employment related to raised field development.

Political Implications of Raised Field Agriculture

A conference on raised field agriculture in the Department of the Beni was organized in honor of Dr. William Denevan, one of the discoverers of raised fields, in Trinidad in August of 1993. The conference was attended by a number of indigenous leaders of the Central de Pueblos Indígenas del Beni, non-governmental institutions and political activists who heard talks on the archaeology of raised fields, agricultural experiments and applied work in indigenous communities. There was great interest in the potential application of raised field technology in newly established Indigenous Territory concessions. Much of the land reform debate had addressed the issue of obtaining more forested regions where indigenous peoples could expand hunting, collecting and swidden agriculture activities (Jones 1990). The realization that raised fields could make savanna grasslands productive encouraged discussion of new strategies to increase native communities control over savannas. Savanna lands in the Department of the Beni have traditionally been under the control of large ranching landowners with indigenous peoples marginalized in the continuously forested zones and gallery forests along rivers. This increased awareness of the potential economic benefits of farming savanna may have widespread political implications, possibly involving claims by indigenous peoples against white ranchers for grasslands.

The recent discovery of extensive tracts of raised fields under forested cover within the Indigenous Territories indicates that many over these zones may have once been savanna when prehispanically farmed. Because of the intensive nature of raised field farming, small plots within the savanna and forest could produce sufficient crops to sustain local indigenous populations and produce surplus without the need for large areas of savanna.

The Future of Raised Fields in Development

Development institutions and planning agencies are oblivious to the long term history and evolution of agricultural landscapes. Contemporary indigenous knowledge systems are often viewed as "backwards" and "primitive." Lip service is given to anthropological input in these projects and an archaeological perspective would never be considered. The capital-based western technology and the "appropriate" or "adequate" technology introduced by these groups generally have a low success rate in Latin America. It is ironic that archaeology can demonstrate that many landscapes such as the Llanos de Moxos sustained large populations in the past that today are

underdeveloped, underutilized, and underpopulated. The potential carrying during the prehispanic period based on raised field agriculture was staggering. This indicates that raised fields provided a stable and presumably sustainable production base for ancient inhabitants of the region. We need to incorporate a long term, anthropologically informed, historical ecology to our schemes of rural development (and landscape conservation, preservation, environmental protection).

Can raised field agriculture be reintroduced as a form of sustainable development? Sustainability has become a buzzword in the development literature and has become closely associated with traditional agricultural systems. I use the World Commission on Environment and Development's definition of sustainable agriculture as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (in CIKARD 1993:3). Although relatively imprecise, sustainability connotes the maintenance of high productivity over the long run while managing and protecting local environmental resources from degradation. Sustainable development also promotes an "acceptable livelihood," with connotations of justice and equitability.

We don't have enough data on long term experimentation of raised field agriculture within farming in the context of communities to know whether it is truly sustainable. We believe that some farmers will adopt raised field agriculture because of specific needs and requirements. Other farmers will not adopt it because of the labor involved. The social, political, economic, demographic, and environmental context of present farming in the Beni is very different from that when the fields were originally constructed and use by prehispanic farmers. An sustainable adequate technology alone is not enough reason for the system to be adopted. The initial interest by farmers in Bermeo and Esperanza and local indigenous leaders indicates that it has potential.

As an answer to environmental and technical problems posed to agricultural production, raised field technology could be applied to numerous zones of the humid tropical lowlands of South America. These include the seasonally inundated savannas, river floodplains, and permanent wetlands in the lower Llanos de Orinoco (Venezuela), Pantanal (western Mato Grosso, Brazil), eastern Marajó Island (Brazil), Bolivar savannas (northern Columbia), along the Amazon floodplain, Rio Casquiare region (Brazil and Venezuela), on the SW side of Lake Maricaibo (Venezuela), the Orinoco Delta (Venezuela), and the Rio Heath (SE Peru), interior and coastal savannas (Guyana), Gran Chaco (Paraguay and Bolivia), upper Orinoco Llanos (Venezuela), and parts of the Planalto Central (Brazil) (Denevan 1966:4-5). Prehispanic field systems found in many of these area are evidence of past intensive use.

Certain popular and scientific literature promoting indigenous technologies and practices as sustainable development has come into criticism recently as a return to the idea of the "noble savage" (Redford 1990). Conservationists, ecologists, and anthropologists often romanticize indigenous knowledge systems as a "Return to Eden." As Denevan notes, "the Indian impact was neither benign nor localized and ephemeral, nor were resources always used in a sound ecological way. The concern here is with the form and magnitude of environmental modification rather than with whether or not Indians lived in harmony with nature with sustainable systems of resource

management. Sometimes they did, sometimes they didn't" (1992:10). I am not stressing a naive "return to the past" by promoting ancient agriculture. We are beginning a long-term scientific study of raised field potential through experimentation. These systems desperately need scientific study to accumulate detailed comparative data from which adequate interpretation can be based.

NOTE: 2/23/98: The raised field rehabilitation project with the communities has been "on hold" since 1994 due to administrative problems of PRODEMO. We hope to re-institute the project soon.

References Cited

Arce Z., Julio
1993 Evaluación y comparacion de rendimientos de cuatro cultivos en tres anchuras de camellones (campos elevados) en la Estacion Biologica del Beni (Prov. Ballivián, Dpto. Beni). Tesis de grado presentado para obtener el título de Ingeniero Agrónomo. Universidad Técnica del Beni, Trinidad.

Brokensha, David, D. M. Warren, and Oswald Werner eds.
1980 Indigenous Knowledge Systems and Development. University Press of America, Washington, DC.

CIKARD
1993 Background to the International Symposium on Indigenous Knowledge and Sustainable Development. Indigenous Knowledge and Development Monitor 1(2):2-5.

Clay, Jason W.
1988 Indigenous Peoples and the Tropical Forests: Models of Land Use and Management from Latin America. Cultural Survival Report 27, Cultural Survival, Cambridge, Massachusetts.

Denevan, William
1966 The Aboriginal Cultural Geography of the Llanos de Mojos of Bolivia. University of California Press, Berkeley.

Denevan, William
1992 The Pristine Myth: The Landscape of the Americas in 1492. Annals of the Association of American Geographers 42(3):369-385.

Denevan, William and Christine Padoch eds.
1988 Swidden Fallow Agroforesty in the Peruvian Amazon. Advances in Economic Botany, vol. 5, New York Botanical Gardens, New York

Erickson, Clark L.

1980 Sistemas agrícolas prehispánicos en los Llanos de Mojos. América Indígena 40(4):731-755.

1992 Prehistoric Landscape Management in the Andean Highlands: Raised Field Agriculture and its Environmental Impact. Population and Environment (special issue "Social Science Perspectives on Environmental Management" edited by Timothy Kohler), 13(4):285-300.

1995 Archaeological Methods for the Study of Ancient Landscapes of the Llanos de Mojos of Bolivia. En Archaeology in the American Tropics: Current Analytical Methods and Applications. edited by Peter Stahl, Cambridge University Press, Cambridge.

Erickson, Clark L. and Kay L. Candler
1989 Raised Fields and Sustainable Agriculture in the Lake Titicaca Basin. in Fragile Lands of Latin America: Strategies for Sustainable Development, edited by John Browder, pp. 230-248, Westview Press, Boulder [18 pages]

Erickson, Clark L., José Esteves, Wilma Winkler, Marcos Michel
1991 Estudio preliminar de los sistemas agrícolas precolombinos en el departamento del Beni, Bolivia. unpublished manuscript, University of Pennsylvania and the Instituto Nacional de Arqueología.

Erickson, Clark L., Kay L. Candler, Wilma Winkler, Marcos Michel, John Walker
1993a Informe sobre las investigaciones arqueológicas del Proyecto Agro-Arqueológico del Beni en el 1992. unpublished manuscript, University of Pennsylvania and the Instituto Nacional de Arqueología.

Erickson, Clark L., Kay L. Candler, John Walker, Wilma Winkler, Marcos Michel, Dante Angelo.
1993b Informe sobre las investigaciones arqueológicas del Proyecto Agro-Arqueológico del Beni en el 1993. unpublished report, University of Pennsylvania and the Instituto Nacional de Arqueología.

Godoy, Ricardo et al.
1993 Sustainable resource management. Economic Botany

Jones, James
1990 A Native Movement and March in Eastern Bolivia: Rationale and Response. Development Anthropology Network 8(2):1-8.

Meggers, Betty J.
1971 Amazonia: Man and Culture in a Counterfeit Paradise. Aldine, Chicago.

Netting, Robert
1993 Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable

Agriculture. Stanford University Press, Sanford.

Posey, Darrell and William Balée eds.
1989 Resource Management in Amazonia: Indigenous and Folk Strategies. Advances in Economic Botany, vol. 7, New York Botanical Gardens, New York.

Redman, Kent H.
1992 The Ecologically Noble Savage. Cultural Survival Quarterly 15(1):46-48.