

Utah State University

DigitalCommons@USU

---

Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San José Llanga

---

2001

## Chapter 02: National, Regional and Local Context

Christian Jetté

*United Nations Development Program, La Paz*

Humberto Alzérreca Angelo

*Small Ruminant Collaborative Research Support Program*

D. Layne Coppock

*Utah State University, layne.coppock@usu.edu*

Follow this and additional works at: [https://digitalcommons.usu.edu/sustaining\\_agropastoralism](https://digitalcommons.usu.edu/sustaining_agropastoralism)

---

### Recommended Citation

Jetté, Christian; Alzérreca Angelo, Humberto; and Coppock, D. Layne, "Chapter 02: National, Regional and Local Context" (2001). *Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San José Llanga*. 9.

[https://digitalcommons.usu.edu/sustaining\\_agropastoralism/9](https://digitalcommons.usu.edu/sustaining_agropastoralism/9)

This Book is brought to you for free and open access by DigitalCommons@USU. It has been accepted for inclusion in Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San José Llanga by an authorized administrator of DigitalCommons@USU. For more information, please contact [digitalcommons@usu.edu](mailto:digitalcommons@usu.edu).



## National, regional and local context

### *Contexto nacional, regional y local*

by Christian Jetté, Humberto Alzérreca and D. Layne Coppock

#### Summary

As a prelude to reviewing site-specific studies undertaken by IBTA and the SR-CRSP, this chapter provides a broad overview of secondary information pertaining to the diverse physical and social geography of Bolivia. Bolivia contains ecosystems ranging from the tropical Amazon Basin to cold, arid Andean mountain ranges, and thus has a great diversity of climatic regimes, natural resources and agroecosystems. Bolivia also has a diverse cultural heritage involving interactions among many indigenous and colonial powers. Today, Bolivia is making strides towards democracy, social equity and economic stability. With a review of environment and social history as cornerstones, this chapter gradually sharpens the focus from a national to a regional (Andean) and local (San José Llanga) scale of resolution. San José Llanga (SJL) is an *Aymara* Indian community which has existed on the semi-arid Altiplano of the Andes for at least 500 years. This chapter therefore helps set the larger environmental, social and political context within which our project operated.

Bolivia is South America's poorest nation with a Gross Domestic Product (GDP) of USD 710 per person per year. About 17% of GDP is provided from use of natural resources. Although during most of Bolivia's history the majority of people have resided in the rural, high-elevation Andean zone (27% of the national land area), the current population of 6.9 million is about evenly divided between urban and rural dwellers. Rural populations in the Andes are now either exhibiting slow rates of growth or are shrinking due to high emigration to urban areas. Urban populations are growing by 4% per annum, with a doubling time of 16 years. This rural/urban dichotomy has materialised in the past 40 years. As one case-in-point, El Alto, a suburb of La Paz, grew from 50 000 residents in 1976 to over 400 000 residents by 1992. The national population is numerically dominated by indigenous Andean peoples such as the *Aymara* and *Quechua*-speaking Indians. Although European

(e.g., Criollo Spanish) and racially mixed (e.g., Mestizo) cultures have been ethnic minorities, they have variously dominated the national economy and political system since colonial times. Recently the Bolivian government has encouraged rural Bolivians to relocate from the Andean zone to the tropical lowlands, but 70% of the national population still resides in urban or rural locales of the Andean highlands.

The ultimate source of much of the ecological diversity in Bolivia is the Cordilleras of the Andes, which is a massive, parallel chain of mountains in the western quarter of the country. The steep slopes of the Cordilleras contain a great diversity of ecosystems including the Yungas and High Valleys, which offer favourable climates for production of a wide variety of agricultural commodities. The Cordilleras also bound a central plateau called the Altiplano. At an average elevation of 3800 m and about 800 km in length and an average of 130 km in width, the Altiplano has climates which vary from sub-humid to hyper-arid. Prior to Spanish contact the *Aymara* Indians and other indigenous peoples commonly used a vertically integrated system of resource use. This system incorporated grazing by camelids [i.e., llama (*Llama glama*), alpaca (*L. pacos*), vicuña (*Vicugna vicugna*) and probably guanaco (*L. guanicoe*)] and production of frost-resistant crops [i.e., potato (*Solanum spp*), quinoa (*Chenopodium quinoa*) and cañawa (*C. palidicaule*)] on the Altiplano along with production of maize (*Zea mays*) and coca leaf (*Erythroxylum coca*) in the High Valleys and Yungas, respectively. Among the *Aymara* such regional agroecological networks of kinship-based communities were referred to as *ayllus*. Camelid pastoralism, with crop cultivation as an ancillary subsistence activity, is thought to have occurred on the Altiplano for about 7000 years BP.

*Aymara* kingdoms dominated what is now the Bolivian Andean region until the second half of the fifteenth century, and comprised a total population of perhaps one to two million people. At this time the *Aymara* were conquered by the *Quechua*-

speaking Inca who expanded south from what is now Peru. A highly developed *Aymara-Quechua* society emerged as a result, but this was short-lived. Spanish conquistadors arrived by the mid-1500s and gradually destroyed the traditional Andean ways of life. The Spanish used indigenous peoples as slave labour in Andean silver mines and broke-up the *ayllus* by establishing the hacienda system in the Yungas, High Valleys and on the best lands of the Altiplano. The Spanish also introduced cattle, sheep, equines and various cultivated crops (i.e., barley, wheat, oats, clovers) and the iron plough to the region, but these were mostly confined to haciendas in the more productive environments. Indigenous populations plummeted during the first century of the Spanish Conquest as a result of exotic diseases, warfare and substandard working conditions. Some free communities of *Aymara*, however, persisted on the less-productive lands on the Altiplano. By 1824 about one-third of lands formerly under indigenous tenure were controlled by the haciendas.

Despite achieving national independence in 1825, and the subsequent social and political upheavals, the hacienda system and other forms of institutionalised discrimination against indigenous Andean peoples by social elites persisted in Bolivia in various forms until the early 1950s when the Movimiento Nacionalista Revolucionario (MNR) seized power. The MNR set a new agenda to empower the indigenous peasantry (or campesinos) in Bolivia. One aspect of change was the Land Reform Act of 1953 in which land ownership in the Andean zone was returned to indigenous peoples and the hacienda system was dismantled. This also served to eliminate the traditional rural elite (Mestiza) class and freed-up and diversified regional marketing channels for agriculture. The new agenda also included expansion of access to primary education in rural areas and increased investment in agricultural research and extension. One outcome of these policies was a gradual increase in the availability of fertilizers, mechanised farm equipment, new varieties of seeds and improved livestock breeds for campesino households.

This diffusion of technology has subsequently led to a mixture of traditional and imported methods for crop and livestock production. Some traditional Andean crops have become marginalised by modernisation. Frost-resistant (bitter) potato, *cañawa* and *quinoa* have all been under threat from purchased products such as rice, wheat and pasta that are often more convenient to cook.

The llama, once relied upon for production of meat, fibre and as a means of portage, has been replaced by sheep, equines and mechanised transport. While the new policies of the MNR increased investment in Bolivian agriculture, this tended to emphasise export crops in the tropical lowlands. Traditional staples of the Andean highlands tended to be ignored. Andean campesinos were also encouraged to migrate to new settlements in the tropical lowlands. Campesinos often settled, however, in the humid Yungas where they began growing coca leaf in response to high international demand by the late 1970s.

Recession and hyperinflation characterised the Bolivian economy of the early 1980s; this was spurred by low prices for key Bolivian exports, fiscal mismanagement and natural disasters like flooding in the lowlands and drought in the highlands. Since the mid-1980s the top priorities of Bolivian governments have been to facilitate economic stability by exerting tighter control on government finance, abolishing public sector interventions, and opening the country to more foreign trade and investment. Large amounts of foreign aid have also played a key role; in 1992 foreign aid was around USD 100 per capita. Despite making substantial strides towards multiparty democracy and economic stability since the mid-1980s, however, the negative decline for agriculture in general, and highland agriculture in particular, has continued. The downward trends are related to a combination of factors including poor performance of tropical agriculture despite increased inputs, inadequate marketing channels and marketing policies, depression of food prices due to large quantities of food aid, importation of cheap food, pervasive technical constraints in Andean agriculture posed by the harsh climate, and depletion of much of the rural Andean labour force due to urban migration. The Bolivian government has taken further steps to try to remedy the decline of agriculture and promote sustainable rural development. It issued a decree in 1990 to modernise the national agricultural research entity called Instituto Boliviano de Tecnología Agropecuaria (IBTA) by promoting a shift in focus to include more efforts for technology generation and technology transfer. In 1994 a Popular Participation Act was passed which provides legal status for campesino communities and redistributes 20% of national tax revenues back to such communities on the basis of population size. Only in the past few years has total government spending on the Altiplano exceeded 10% of total

revenues. Recently, an all-weather road was completed connecting La Paz and Patacamaya with Arica on the Chilean coast. This will have large implications for international trade.

In terms of environment, the Altiplano is a closed hydrological system having high levels of endogenous salinity. The low levels of fresh water inputs from precipitation and glacial run-off are insufficient to allow any salts to effectively leach out of the system. The Altiplano is a lacustro-alluvial plain represented by a series of inter-linked lake basins and tributaries. Ecologically distinct sub-regions have been created by various types of geomorphic barriers. Characteristic features of the Altiplano include Lake Titicaca, Lake Poopó and the extensive salt flats of Coipasa and Uyuni; all are remnants of ancient lakes. The central alluvial plain is often where significant soil deposition has occurred; the slopes of the Cordilleras largely remain covered with unweathered rock. Because the Altiplano is located in the southern hemisphere, a cooler, drier winter occurs from June to August while a warmer, wetter summer occurs from December through February. There is a large daily variation in air temperature. Frost risk is pervasive, especially in winter. Most precipitation occurs as rain from November through March or April. The overall physiognomy of Altiplano vegetation is open with small- and medium-sized plants and little, if any, tree cover. This physiognomy is generally referred to as puna. The shrub-like plants are more common on better-drained soils such as those found on mountain footslopes or terraces. Bunchgrasses occur more at intermediate elevations, while short grasses and halophytes (i.e., salt-tolerant species) occur more at the lowest elevations such as plains or dried lake basins having high water tables.

The Altiplano can be divided into several agroecological regions defined by moisture regimes. The sub-humid region comprises about 6% of the Altiplano and is where the most extensive cultivation occurs. This is largely the environs of Lake Titicaca. The frost risk is very low and annual precipitation varies from 600 to 900 mm. The human population density averages 25 to 37 persons per km<sup>2</sup>. Mixed farming systems prevail in the sub-humid region; it has been recently observed that sheep production has declined, but dairying and production of barley, alfalfa and beef cattle have increased. The semi-arid region comprises about 54% of the Altiplano. Annual precipitation ranges from 400 to 600 mm. The human population density varies from two to 15

persons per km<sup>2</sup>. There is some dairying and beef production in the semi-arid region, but this remains the centre for sheep production and agropastoralism. The arid region comprises about 23% of the Altiplano. Annual precipitation ranges from 200 to 400 mm. There is typically less than one person per km<sup>2</sup>. Cultivation is limited and dominated by hardy indigenous taxa such as *quinoa*; livestock are dominated by camelids and sheep. Salt is harvested for market in some locales. The native vegetation of the arid zone is similar to that of the semi-arid zone, but the former is more patchy and more dominated by shrubby species. The hyper-arid puna comprises about 14% of the Altiplano, with annual precipitation typically <200 mm. There is some rearing of camelids in this zone, but it is largely uninhabited. Finally, about 3% of the Altiplano consists of barren salt flats.

Our study site of San José Llanga (SJL) is located in the semi-arid region on the east-central Altiplano about 120 km southeast of La Paz and El Alto. The main barrio (settlement) of SJL is located about 17 km south of the regionally important town of Patacamaya on the Pan-American highway. The Cantón of SJL is 7200 ha in size and varies from 3725 to 3786 m in elevation. It is located near the middle of the alluvial plain of the Altiplano in the Patacamaya Basin and is thus distant from the foothills of the Cordilleras. The Patacamaya Basin is essentially a flat, extensive fluvio-lacustrine plain largely defined by the environs of the saline, perennial Desaguadero River which runs 15 km to the southeast of SJL. The mean annual precipitation at SJL is about 407 mm. The Cantón of SJL is home to about 100 campesino households distributed among six settlements, loosely organised according to kinship. The people grow food and forage crops on alluvial surfaces and do not have access to hillside cultivation systems common elsewhere. The people also raise sheep, beef cattle, dairy cattle and donkeys. People of SJL are part of a traditional *ayllu* called Llanga, but this (like many *ayllus*) was fragmented and permanently disrupted during the Spanish colonial period. The people of SJL, however, remained relatively free from colonial domination. The ability of the SJL residents to remain free was due in part to their association with a larger indigenous group called *Umala* renowned for its fierce opposition to encroachment by the Spanish. In 1953 SJL received a collective (*pro indiviso*) title to the lands they occupied. Land was then divided among resident

households by action of local committees. Higher value (crop) lands were assigned to households under private tenure except for some restrictions on future sale or transfer; this largely meant that crop lands could only be sold to someone outside of SJL upon approval by a SJL council. Despite that croplands in general were put under private tenure, there was still variation in who could access certain plots and when. For example, although plots which are currently in production are under private control, once they have been harvested or left to fallow they are available for communal grazing. The native grazing lands at SJL tend to be under communal tenure, but higher value parcels may be subject to *de facto* private control, especially if the parcels are located near households which use them regularly.

Like most Andean campesinos this century, the people of SJL have typically been a low priority in the economic development plans of Bolivia. There has been some recent development activity at SJL, however, which is altering the traditional campesino way of life. A dirt road between the main barrio of SJL and the town of Patacamaya was completed in 1988 and has stimulated commerce, including development of smallholder dairying as early as 1989. A 23-km irrigation canal was completed in 1984 linking some potential croplands at SJL with water from the Desaguadero River. The passage of the Popular Participation Act in 1994 will probably also affect SJL through redistribution of tax monies to needy communities and by shifting regional centers of political power.

Overall, it is concluded that recent policy shifts of the Bolivian government offer some chance for people like the *Aymara* to improve their economic status. It is also evident that our study site at SJL has key attributes in terms of landscape position and access to markets and technology that make it an important place to conduct research. The primary exploitation of alluvial plains rather than hillsides makes SJL more of a resource "sink" where nutrients, salts and water collect. The proximity to urban markets and access to new technology via the Patacamaya Research Station make SJL a "living laboratory" in which one can observe effects of market integration and technology diffusion on rural development processes.

## Resumen

Como preludeo a la revisión de los estudios puntuales efectuados por el SR-CRSP y el IBTA,

este capítulo presenta un panorama general de información secundaria referida a la diversidad física y social en la geografía de Bolivia. Bolivia está constituido por diversos ecosistemas que van desde el tropical Amazona hasta las frías y áridas montañas Andinas, debido a ésto existe una gran diversidad de regimenes climáticos, recursos naturales, y sistemas agrícolas. Bolivia tiene una herencia cultural diversa, incluyendo interacciones entre numerosos poderes indígenas y los invasores colonizadores. En la actualidad, Bolivia está haciendo esfuerzos hacia una democracia en un marco de equidad social y estabilidad económica. Con la revisión de características medioambientales e historia social como elementos principales, este capítulo gradualmente enfoca su interés desde una escala nacional, hacia una regional (Andes) y local (San José Llanga, SJL) de resolución. San José Llanga es una comunidad indígena *Aymara* la cual ha existido en el Altiplano semi-árido de los Andes por lo menos por 500 años. Este capítulo, por lo tanto, ayuda a establecer un amplio contexto medioambiental, social y político dentro del cual nuestro proyecto ha operado.

Bolivia es la nación más pobre en Sudamérica con un producto interno bruto (PIB) de USD 710 por persona por año. Aproximadamente el 17% del PIB proviene del uso de los recursos naturales. Aunque en gran parte de la historia de Bolivia la mayoría de la gente residió en las zonas rurales de las tierras altas de los Andes (27% de la superficie total nacional), la población actual de 6.9 millones de habitantes está casi igualmente distribuida entre las zonas rurales y urbanas. Las poblaciones rurales en los Andes actualmente presentan grados lentos de crecimiento o éste está decreciendo debido a la alta emigración a áreas urbanas. Las poblaciones urbanas están creciendo en 4% por año, lo que implica la duplicación de la población en 16 años. Esta dicotomía urbana/rural se ha materializado en los pasados 40 años. Como un caso puntual se tiene a El Alto, un suburbio de La Paz, que ha crecido de 50.000 residentes en 1976 hasta cerca de 400.000 en 1992. La población nacional está numéricamente dominada por gente indígena andina, principalmente de habla *Aymara* y *Quechua*. Aunque la cultura de los europeos (p.e. criollo español) y de gente racialmente mezclada (p.e. mestizo) han sido minorías étnicas, ellas han dominado en varias formas la economía nacional y el sistema político desde tiempos coloniales.

Recientemente el gobierno de Bolivia ha promovido la movilización de la gente desde las áreas rurales de la zona Andina a las zonas bajas tropicales, pero el 70% de la población nacional todavía reside en localidades rurales y urbanas de los Andes.

El origen primario de gran parte de la diversidad ecológica de Bolivia es la cordillera de los Andes, la cual presenta cadenas montañosas masivas y paralelas que ocupan una cuarta parte del país. Las pendientes pronunciadas de estas cordilleras contienen una gran diversidad de ecosistemas incluyendo los Yungas y Valles Altos, los que ofrecen climas favorables para la producción de una gran variedad de productos agrícolas. Las cordilleras también encierran una planicie central llamada Altiplano. El Altiplano con una altura promedio de 3800 m, cerca de 800 km de largo, y 130 km de ancho en promedio, con climas que varían desde sub-húmedo hasta hiper-árido. Antes de la conquista española, los indígenas *Aymaras* y otras poblaciones locales comúnmente usaban un sistema vertical integrado de uso de los recursos. Este sistema incorporaba pastoreo de camélidos [p.e. llama (*Lama glama*), alpaca (*L. pacos*) y utilización dirigida de camélidos silvestres p.e. vicuña, (*Vicugna vicugna*) y probablemente *guanaco* (*L. guanicoe*)] y la producción de cultivos resistentes a heladas [p.e. papa (*Solanum* spp), *quinua* (*Chenopodium quinoa*) y *cañahua* (*C. palidicaule*)] en el Altiplano al igual que maíz (*Zea mays*) y hojas de coca (*Erythroxylon coca*) en los Valles Altos y los Yungas, respectivamente. Entre los *Aymaras*, estas redes agroecológicas regionales, de comunidades relacionadas por parentesco, fueron conocidas como *ayllus*. Se piensa que el pastoralismo de camélidos acompañado por cultivos agrícolas como una actividad complementaria de subsistencia ha ocurrido en el Altiplano desde hace 7000 años AC.

Los reinos *Aymaras* dominaron lo que es actualmente la región Andina de Bolivia hasta la segunda mitad del siglo quince. Se estima que en esta época una población total de uno a dos millones de habitantes podrían encontrarse en la región. Hacia esta época los *Aymaras* fueron conquistados por los Inca *Quechua*-parlantes, quienes se expandieron desde el sur, lo que es ahora el Perú. Como resultado se generó una sociedad *Quechua-Aymara* altamente desarrollada, aunque de corta vida. Los conquistadores Españoles arribaron en la mitad de los

1500s y gradualmente destruyeron los sistemas tradicionales de vida de los Andes. Los Españoles usaron a los indígenas como mano de obra esclava para el trabajo en las minas de plata y desintegraron los *Ayllus* con el establecimiento del sistema de hacienda en los Yungas, Valles Altos y en las mejores tierras agrícolas del Altiplano. Los Españoles también introdujeron en la región vacas, ovejas, equinos, varios cultivos (p.e. cebada, trigo, avena, trébol) y el arado de hierro, aunque estas introducciones ocurrieron principalmente en las haciendas y en los medio ambientes más productivos. La difusión gradual de estas nuevas tecnologías ocurrió a lo largo de centenares de años que siguieron a su introducción. La población indígena se redujo drásticamente durante el primer siglo de la conquista española como resultado de enfermedades exóticas, guerras y condiciones de trabajo infrahumanas. Varias comunidades libres *Aymaras*, sin embargo, persistieron en las tierras menos productivas en el Altiplano. En 1824 cerca de un tercio de tierras originalmente controlada por los indígenas pasaron a ser controladas por las haciendas.

A pesar de alcanzar la independencia nacional en 1825, y subsecuentes reformas sociales y políticas, el sistema de hacienda y otras formas de discriminación institucionalizada contra las poblaciones indígenas de los Andes por las élites sociales locales, persistieron en Bolivia en varias formas hasta los primeros años de 1950, cuando el Movimiento Nacionalista Revolucionario (MNR) subió al poder. El MNR estableció una nueva agenda para verdaderamente otorgar poder a los agricultores o campesinos en Bolivia. Un aspecto de este cambio fue el Decreto de Reforma Agraria de 1953, por el cual la propiedad de la tierra en la zona Andina fue devuelta a la población indígena y el sistema de hacienda fue desmantelado. Esto también sirvió para eliminar las clases rurales tradicionales de élite (mestiza), además para abrir y diversificar canales regionales de mercadeo para productos agrícolas. La nueva agenda también incluyó la ampliación del acceso a la educación primaria en el área rural y se incremento la inversión en investigación y extensión agrícola. Un resultado de éstas políticas fue el incremento gradual en la disponibilidad de fertilizantes, maquinaria, equipo agrícola, nuevas variedades de semillas y razas mejoradas de ganado para los productores campesinos.

Esta difusión de tecnología resultó subsecuentemente en el desarrollo de nuevos

métodos mixtos de tecnología con componentes tradicionales e importados para la producción agrícola y ganadera. Algunos cultivos tradicionales andinos resultaron marginalizados por la modernización. La papa amarga resistente a heladas, la *cañahua* y la *quinua* han sido amenazadas por productos de fácil disponibilidad en el comercio local como arroz, trigo y pasta que son por lo general más convenientes. Por otra parte, la llama, de la cual por mucho tiempo se dependió como productora de carne, fibra y como medio de transporte de productos, ha sido remplazada por la oveja, equinos y transporte mecanizado. Mientras que las nuevas políticas del MNR incrementaron la inversión en la agricultura boliviana, estas políticas tendieron a enfatizar la producción de cultivos para exportación en las tierras bajas tropicales y los cultivos tradicionales de las tierras altas andinas tendieron a ser ignorados. Los campesinos de los Andes fueron también concientizados a migrar a nuevas áreas de colonización en las tierras bajas. Los campesinos a menudo terminaron en los Yungas húmedos donde empezaron a cultivar hoja de coca en respuesta a la alta demanda internacional a fines de 1970.

La recesión e hiperinflación caracterizaron la economía de Bolivia en los primeros años de la década de los ochenta; ésto fue favorecido por los bajos precios de los productos claves de exportación de Bolivia, la disminución de los préstamos internacionales, manejo fiscal ineficiente y desastres naturales tales como inundaciones en las tierras bajas y sequía en las tierras altas de los Andes. Desde mediados de 1980, una de las prioridades máximas del gobierno de Bolivia ha sido facilitar la estabilidad económica mediante un severo control de las finanzas del gobierno, eliminar la participación del sector fiscal y abrir el país a las inversiones y mercado extranjero. Los altos montos de ayuda extranjera también jugaron un papel clave. En 1992 la ayuda extranjera fue de alrededor de USD 100 per cápita. A pesar de intentos substanciales para lograr una democracia multipartidaria y estabilidad económica desde mediados de los 80, el crecimiento negativo de la agricultura en general, y la agricultura de la zona andina en particular ha continuado. Estas tendencias decrecientes están relacionadas a una combinación de factores que incluyen el pobre comportamiento de la agricultura tropical a pesar del incremento de insumos, canales y políticas de mercadeo inadecuados, la baja de los precios

de alimentos, los constantes problemas técnicos en la agricultura andina debido a factores climáticos negativos, y la falta de disponibilidad de la mayoría de la fuerza de trabajo rural debido a la migración urbana. El gobierno de Bolivia ha tratado otras medidas para tratar de corregir la disminución en la producción agrícola y promover el desarrollo rural sostenible. En 1990, el gobierno promulgó un Decreto para modernizar la entidad nacional de investigación agrícola llamada Instituto Boliviano de Tecnología Agropecuaria (IBTA) con un cambio de enfoque que incluiría mayores esfuerzos en la generación y transferencia de tecnología. En 1994 se promulgó la Ley de Participación Popular, la que confiere status legal a las municipalidades rurales y redistribuye el 20% de los ingresos de impuestos de regreso a las comunidades en base al tamaño de población. Solo recientemente el gasto total del gobierno en las áreas rurales Andinas ha excedido el 10% del total de los ingresos. Recientemente se terminó de construir una carretera de circulación permanente entre La Paz, Patacamaya, Tambo Quemado y Arica, en la costa chilena, que tendrá amplias implicaciones para el comercio internacional en los Andes.

En términos medioambientales, el Altiplano es un sistema hidrológico cerrado con altos niveles endógenos de salinidad. Los bajos niveles de agua fresca incorporados por la precipitación y provenientes de los glaciales son insuficientes para eliminar esta salinidad fuera del sistema. El Altiplano es una planicie lacustre-aluvial caracterizada por la presencia de una serie de tributarios y cuencas con lagos intercomunicados. Ecológicamente, varios tipos de barreras geomorfológicas han influido para la formación de distintas sub-regiones. La característica más relevante del Altiplano incluye el Lago Titicaca, el Lago Poopo y los extensos salares de Coipasa y Uyuni; ambos salares son residuos de lagos antiguos. La planicie central aluvial es frecuentemente la zona más importante donde han ocurrido depósitos significativos de suelos, las laderas de las cordilleras permanecen cubiertas por rocas que resistieron el desgaste por factores climáticos. Debido a que el Altiplano está localizado en el hemisferio sur, el invierno, de Junio a Agosto, es frío y seco, mientras que el verano, de Diciembre a Marzo, es caliente y húmedo. La temperatura del aire presenta una amplia variación térmica diaria, y el riesgo de helada es constante, especialmente

en invierno. La mayoría de la precipitación ocurre como lluvia desde Noviembre hasta Marzo o Abril. En general, la fisionomía de la vegetación del Altiplano por lo general es abierta, con plantas de tamaño pequeño y mediano, con muy poco o ausencia de arboles. Esta fisionomía es generalmente conocida como puna. Las plantas arbustivas son más comunes sobre suelos de mejor drenaje tales como en los pies de laderas y terrazas. Los pastos amacollados ocurren con mayor frecuencia en elevaciones intermedias del paisaje, mientras que los pastos cortos y halófilas (p.e. especies tolerantes a sal) ocurren por lo general en zonas bajas, tales como planicies o cuencas secas de lagos con aguas subterráneas superficiales.

El Altiplano puede ser dividido en varias regiones agroecológicas definidas de acuerdo al régimen húmedo. La región sub-húmeda abarca cerca del 6% del Altiplano y es allí donde la mayoría de los cultivos ocurren. Esta zona ocupa mayormente los medio ambientes influenciados por el Lago Titicaca. El riesgo de heladas es bajo y la precipitación anual varía desde 600 hasta 900 mm. La densidad de la población humana varía en promedio de 25 a 37 personas por km<sup>2</sup>. Recientemente se ha observado que en los sistemas agrícolas mixtos de la zona sub-húmeda la producción de ovejas está declinando, pero la producción de leche, cebada, alfalfa y ganadería de carne se está incrementando. La puna semi-árida abarca cerca del 54% del Altiplano. La precipitación anual en la zona varía entre 400 y 600 mm. La densidad de la población humana varía entre 2 a 15 personas por km<sup>2</sup>. En ésta zona existe algo de producción lechera y de carne de vacuno, sin embargo, esta región se destaca como el centro de la producción ovina y agropastoralismo. La región árida abarca casi un 23% del Altiplano. El rango de la precipitación anual en la zona árida varía entre 200 y 400 mm. Típicamente, para esta zona se registra menos de 1 persona por km<sup>2</sup>. El cultivo es limitado y restringido a cultivos indígenas rústicos tales como la *quinua*, en tanto que la ganadería está dominada por los camélidos y ovinos. También se extrae sal para mercadeo en algunos mercados locales. La vegetación nativa de la puna árida es similar a la de la puna semi-árida, pero en la zona árida la vegetación es más fragmentada y dominada por especies arbustivas. La puna hiper-árida abarca cerca del 14% de el altiplano, con una precipitación anual de <200 mm. En la zona se crían algunos camélidos, pero

en su mayor parte está deshabitada. Por último, cerca de un 3% del Altiplano está cubierto por áreas planas desnudas saladas.

Nuestro sitio de estudio de San José Llanga (SJL) está localizado en la puna semi-árida del Altiplano central-este, a una distancia de cerca de 120 km al sudeste de La Paz y El Alto. El barrio mayor de SJL está localizado aproximadamente a 17 km al sur del regionalmente importante pueblo de Patacamaya sobre la carretera panamericana. El cantón SJL tiene 7200 ha en tamaño y su elevación varía desde 3725 hasta 3786 m. San José Llanga está localizada en el centro de una planicie aluvial del Altiplano en la cuenca de Patacamaya y está por lo tanto lejos de las pendientes de la cordilleras. La cuenca de Patacamaya es esencialmente una extensa planicie fluvio-lacustre largamente definida por el medio ambiente salino del permanente río Desaguadero. Este río se encuentra a 15 km al sudeste de SJL. La precipitación anual media de SJL es alrededor de 407 mm. El Cantón de SJL se encuentran aproximadamente 100 familias campesinas distribuidas entre seis localidades, libremente organizadas de acuerdo a lazos familiares. La gente cultiva alimentos y forrajes en superficies aluviales y no tiene acceso a sistemas de cultivo en laderas comunes en otras partes de los Andes. Los habitantes de SJL también crían ovejas, vacunos para carne, vacunos para leche y burros. La gente de SJL fueron parte del tradicional *ayllu* llamado Llanga, pero este (al igual que muchos *ayllus*) fue fragmentado y constantemente alterado durante el período colonial español. La gente de SJL, sin embargo, permaneció relativamente libre de la dominación colonial. La habilidad de los residentes de SJL para permanecer libres se debió en parte a su asociación con un grupo indígena más grande de la región de *Umala* y conocido por su tenaz oposición a la dominación local por los españoles. Gracias a la Reforma Agraria de 1953, SJL recibió una título colectivo (*pro-indiviso*) de las tierras que ocupaban. La tierra fue entonces dividida entre las familias residentes a través de la acción de los comites locales. Tierras de alto valor (agrícolas) fueron entregadas a familias bajo la condición de tenencia privada, excepto por algunas restricciones sobre la venta futura o transferencia; esto significaba que las tierras agrícolas podrían ser vendidas solamente a personas ajenas a la comunidad solo después de la aprobación de un consejo de SJL. En general, a



pesar que las tierras agrícolas fueron puestas bajo la propiedad privada, el acceso, uso y quién puede usar tales tierras es variable. Por ejemplo, aunque algunas parcelas están siendo usadas para el cultivo bajo el control privado, una vez que han sido cosechadas o puestas en descanso, éstas tierras pasan al uso de pastoreo comunal. En tanto que los campos de pastoreo nativos en SJL tienden a estar bajo la tutela común, ciertas parcelas, de mayor valor, pudieran estar sujetas al control privado *de facto*, especialmente si éstas se ubican cerca de casas de familias que usan éstas tierras a menudo.

Al igual que la mayoría de los campesinos andinos en este siglo, la gente de SJL típicamente ha tenido baja prioridad para el desarrollo económico de Bolivia. Planes recientes de desarrollo en SJL están alterando la forma tradicional de vida del campesino. Podemos citar algunos ejemplos; un camino ripiado se terminó en 1988 ha estimulado el comercio local incluyendo el desarrollo de pequeños productores de leche desde 1989. Por otro lado, en 1984 se terminó de construir un canal de irrigación de 23 km que une mediante riego con agua del río Desaguadero algunas áreas agrícolas potenciales de SJL. La promulgación de la ley de participación popular en 1994 incluye la redistribución de dinero de los impuestos a comunidades necesitadas y dado el cambio de los centros regionales de poder político probablemente también afectarán a SJL.

Por lo general se ha concluido que los recientes cambios en el gobierno Boliviano ofrecerá oportunidades a la gente, como los *Aymara*, para mejorar su calidad económica. Por otro lado es indudable que nuestro estudio en la comuna de SJL tiene sus características en cuanto a términos de ubicación de las tierras y su acceso a los mercados y disponibilidad de tecnología, que la convierten en un lugar importante para la investigación. La explotación primaria de las planicies aluviales en vez de las laderas hacen de SJL un “pozo” de recursos en donde tanto los nutrientes, sales y agua se acumulan. La proximidad a los mercados urbanos y el acceso a nueva tecnología a través de la Estación Experimental de Patacamaya hacen de SJL un “laboratorio vivo” en el cual se pueden observar los efectos de la integración del mercado y la difusión de las tecnologías en los procesos de desarrollo rural.

## 2.1 Introduction

To better understand today's constraints and opportunities for improving small ruminant production systems on the Bolivian Altiplano, it is important to first consider the broader contexts of environment and social history. This chapter provides an introductory overview of secondary information concerning major ecological regions of Bolivia, constituent agroecosystems and how ecological regions are interrelated in terms of climate, geography, macro-economics and agricultural policy. Key aspects of cultural change and political history are also reviewed. These are important because present-day values and behaviours of Andean campesinos, as well as their use of agricultural technologies, have been profoundly shaped by forces including the indigenous *Aymara* culture, Incan occupation, Spanish colonialism, the initial Republican Period and contemporary policies of the Bolivian government.

## 2.2 National overview of Bolivia

Bolivia encompasses a total area of 1 098 591 km<sup>2</sup> (or 424 164 square miles), located in the geographic centre of the South American continent bordered by Argentina, Brazil, Chile, Paraguay and Peru. The country is governed as a democratic republic and administered as nine departments with the legal capital (judicial branch) at Sucre and seat of government (legislative and executive branches) in La Paz (Figure 2.1). As the largest city in Bolivia with over a million inhabitants, La Paz is nestled at 3650 masl near the Altiplano (Plate 2.1).

In 1995 Bolivia had a population of about 6.9 million with a population growth rate of 2.1%; roughly 50% of the people live in rural areas with the remainder urban dwellers (GDRU 1994). Thirty-nine percent of the population is under 14 years of age. The ethnic composition of the population is approximately 30% *Quechua* Indian, 25% *Aymara* Indian, 5% other native groups and 40% Mestizo (mixed European and Indian ancestry) and European. Ninety-five percent of the population are Roman Catholics (SR-CRSP 1994). About 80% of citizens over the age of 15 years can read and write. Agriculture (including forestry and fisheries) accounts for about 17% of Gross Domestic Product (GDP); principal agricultural commodities include soybeans, coffee, cotton, corn, sugarcane, rice, potatoes, coca leaf (*Erythroxylum*

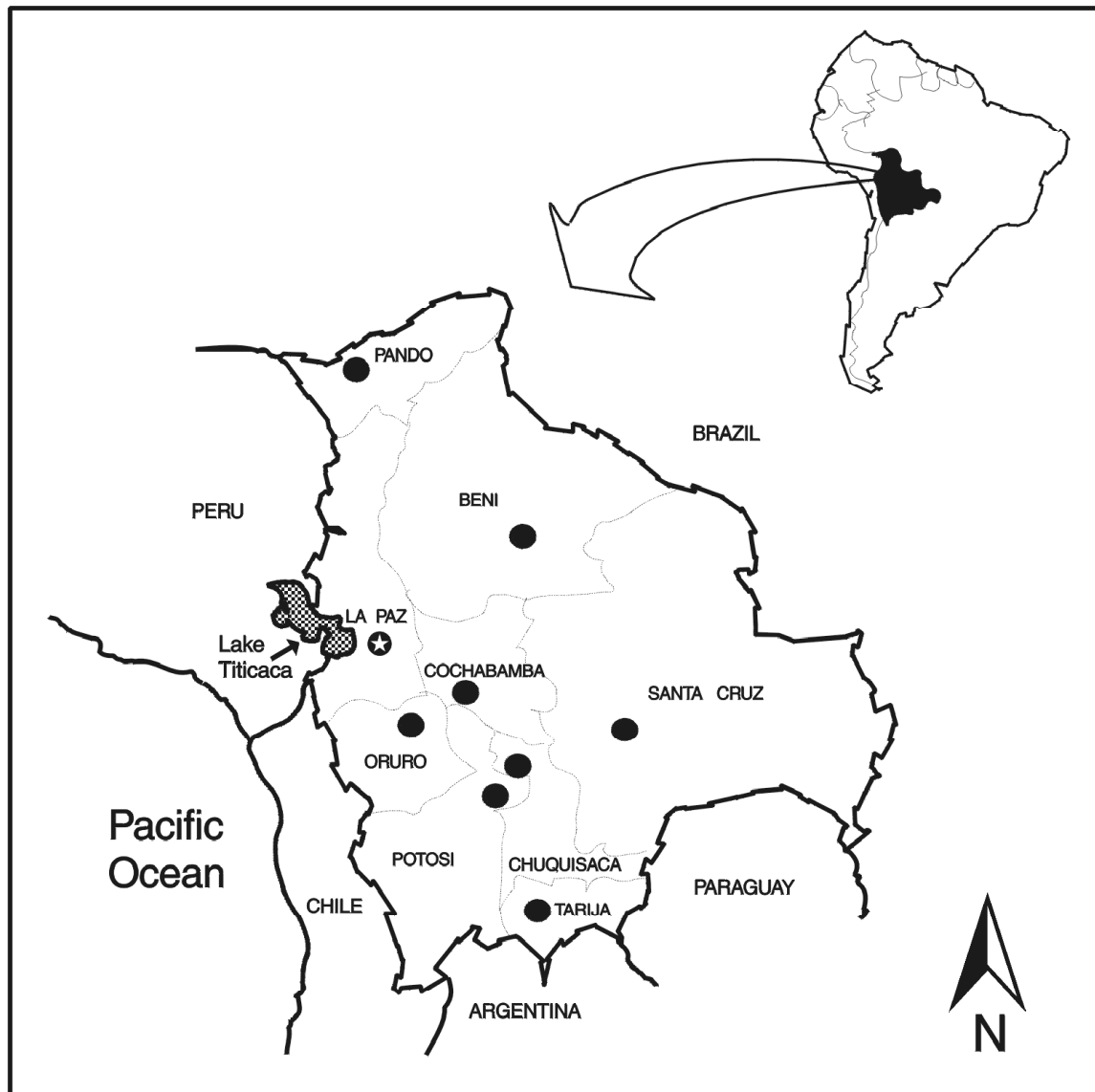


Figure 2.1. Location of Bolivia in South America and depiction of Bolivian regional administrative departments and placement of major cities. Source: C. Jetté (IBTA/SR-CRSP, unpublished)

coca) and timber. The remainder of GDP is largely provided from commerce, transport, finance, administration and services (45%), manufacturing and construction (20%), metals, petroleum, and natural gas (10%), and indirect taxes (8%). Exports include mainly metals, natural gas, jewelry, soybeans and timber (GDRU 1994). In 1993, per capita GDP was USD 710 per annum (GASO 1995, 35), placing Bolivia near the bottom for Latin America. According to a Human Development Index from PNUD (1994), Bolivia is also regarded as the least developed country in South America.

### 2.2.1 National highlights of physical geography and environment

Bolivia is a country of great physiographic and ecological diversity with ecosystems ranging from hot, tropical lowlands to cold, arid highlands. The most pervasive influences on climate are exerted by two mountain chains that run north to south and occupy the western portion of the country. These mountain chains are called the Cordilleras (Figure 2.2; Plate 2.2). The Cordilleras are part of the Andean mountain complex; some peaks in the



Plate 2.1. *Vista of the city of La Paz. La Paz is nestled at the edge of the Altiplano at an elevation of 3650 masl. Photograph: Lita Buttolph*

Cordilleras exceed 6000-m elevation (Muñoz-Reyes 1982). The western Cordillera comprises a physically continuous chain of mountains, while the eastern Cordillera is a more fragmented sequence of parallel ranges, oriented along a north-west to southeast direction, that yield a diverse series of inter-mountain locales. The two chains of the Cordilleras are combined into one unit in much of Peru, but throughout southern Peru and western Bolivia they are separated and enclose a central highland plateau called the Altiplano. The eastern and western Cordilleras are rejoined into one unit to the south in Argentina and consequently the Altiplano ends. The Altiplano averages an elevation of 3800 m and is a region of dry, temperate ecosystems (see Section 2.3.1.2: *Regional environment*). Together the Cordilleras and Altiplano above 2000-m elevation comprise 27% of the total land area of Bolivia. The Bolivian lowlands oc-

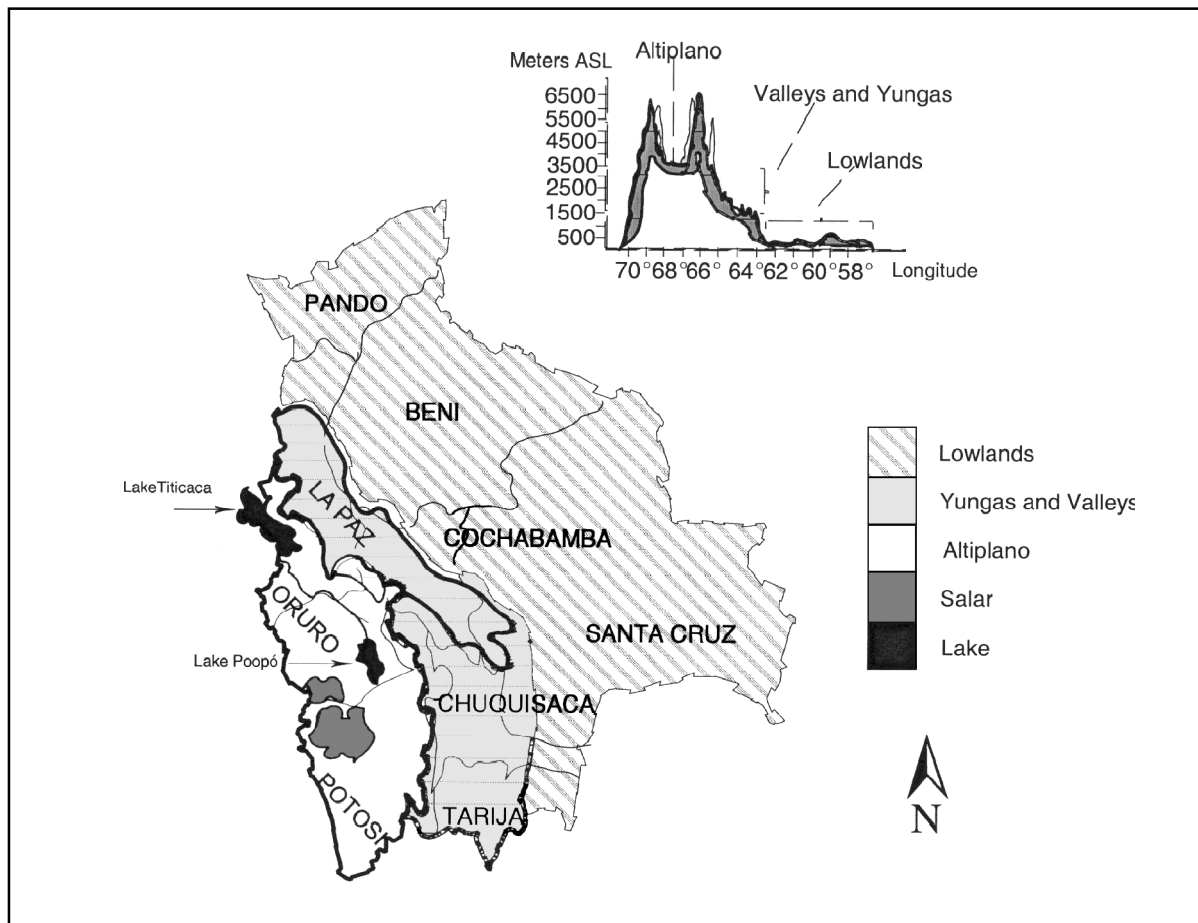


Figure 2.2. *Elevational cross-section (in masl or meters above sea level) of Bolivia and location of generalised agroecological zones with respect to regional administrative departments in Bolivia. Sources: Adapted from Freeman et al (1980) and Ellenberg (1981)*



Plate 2.2. *Vista of the Altiplano situated between the two chains of the Cordilleras.* Photograph: D. Layne Coppock

cur outside of the Andean zone and primarily consist of tropical rainforest and tropical savanna to the north and northeast. Lowlands to the east and southeast include the subtropical Gran Chaco savanna plains and forests. To the north, as one descends the slopes of the eastern Cordilleras, there is a steep gradient of increasing precipitation and ambient temperature. This transitional region occurs between 500- to 2500-m elevation and is referred to as the Yungas (Figure 2.2). The Yungas are humid, narrow valleys with steep slopes suitable for growing tropical crops like coffee and coca leaf. Similarly, to the south as one descends the eastern Cordilleras there is a gradient of increasing ambient temperature with variable precipitation; this transitional region occurs between 1000- to 3000- m elevation and is referred to as the Valleys (Figure 2.2). The Valleys consist of more semi-arid and sub-humid locations suitable for growing crops such as corn and wheat. Both the Yungas and Valleys have been very important to Bolivian agriculture. The Valleys located at higher elevations near the Altiplano (i.e., the High Valleys) and the Yungas were also traditionally exploited by highland peoples as part of a vertically integrated pattern of herding and farming (see Section 2.3.2: *Regional historical highlights*). At the base of the east-facing slopes of the eastern Cordilleras emerges Bolivia's largest hydrological system, the Amazon Basin, which fans out and extends into Brazil (Figure 2.2). The second largest hydrological system is the Rio de la Plata Basin to the south and southeast. The third hydrological system is the closed (e.g., endorheic) basin of the Altiplano where water inputs occur as precipitation and glacial runoff, and water losses

occur via evaporation. By virtue of their distinct ecosystem features the Andean, transitional and lowland zones have equally varied histories of human occupation and resource use, some of which will be referred to later in this chapter. Readers interested in a detailed treatment of physical geography and environment at a national scale for Bolivia are referred to Muñoz-Reyes (1982), Brockmann (1986) and Montes de Oca (1989).

## 2.2.2 National highlights of social history

### 2.2.2.1 1400 to 1824

In the early 1400s the region of what is now western Bolivia was populated by the indigenous *Aymara* and other minority ethnic groups such as the *Pukinas* and the *Uru-Chipaya* speaking peoples. These groups were dominated by the *Aymara* who occupied the Altiplano and transitional Andean zones (Klein 1984). Despite the well-organised socio-political and economic structures of the *Aymara* kingdoms, they were conquered by the Incas, a *Quechua*-speaking people originating near Lima in what is now Peru, in the second half of the fifteenth century. The Incan occupation, however, fundamentally changed few aspects of *Aymara* society. By the early 1500s a highly developed *Aymara-Quechua* society had emerged in what is today the Bolivian Andean zone; this society was administered as one of four divisions of the Incan Empire called *Kollasuyo* [Moseley (1992) cited by Kolata (1993)]. One attribute of the *Aymara-Quechua* society was the integrated utilization of different agroecosystems along spatial and altitudinal gradients. The economy was based on agropastoral production systems with extensive grazing occurring more at higher elevations or in semi-arid and arid areas (the semi-arid Altiplano) and intensive farming in areas more favourable for agricultural production in the Altiplano (the Lake Titicaca Basin) and at lower elevations (Yungas and High Valleys). Important changes in *Aymara* agriculture that resulted from Incan influence included, for example, construction of complex terracing systems on Andean mountainsides and development of warehouses to store foodstuffs (Klein 1984).

In contrast to the Andean highlands and transitional zones, the remaining two-thirds of what is now Bolivia was inhabited by less-sophisticated cultures including hunter-gatherers and village-based agriculturalists. Some small, well-organised "states" for these peoples occurred in the lowlands.

These included the Chiriguano in the Chaco region. Despite a lower level of organisation and cultural development compared to the *Aymara-Quechua* society, the lowlanders were successful in blocking attempts at encroachment and thus excluded highlanders from the Amazon Basin and Chaco region (Klein 1984).

The first Spanish conquistadors entered what is now Bolivia in 1535 and initiated a long period of colonialism which persisted until 1825 when Bolivia achieved national independence. Initially, the Spanish gave little attention to the Andean highlands (then referred to as the Upper Peru), but this dramatically changed with discovery of rich veins of silver at Porco and Potosí (Klein 1984). The Spanish began to exploit the mineral wealth of the highlands on a large scale by 1545. The indigenous people were forced to serve as slave labour in the silver mines. Loss of life due to poor working conditions in mines, in addition to that caused by imported diseases and military resistance against the Spanish, contributed to a marked population decline among indigenous groups. In some Upper Peru provinces it is estimated that about 90% of the indigenous people disappeared within 50 years of initial Spanish contact (Kolata 1993). Priorities of mining development included establishment of administrative centres at La Paz, Potosí and Charcas (now called Sucre), along with networks for agriculture and communication. Mineral export routes went to the Pacific Coast. Agriculture in the drier and colder highland systems subsequently evolved to incorporate mixes of indigenous and Spanish technology and management. Agriculture in the Valleys, however, developed more under the influence of Spanish innovations (see Section 2.3.2: *Regional historical highlights*).

Another important dimension of colonialism by the second half of the sixteenth century was the hacienda system, which involved numerous, private agricultural operations located on the best lands in a variety of agroecological regions of the Andean zone. During the colonial period haciendas were owned and managed by the Spanish and their descendants. These owners/managers were called hacendados. Hacendados used cheap indigenous labour from a landless worker class (about one-third of the peasant population) that had been created as a result of a breakdown of traditional indigenous communities. In parallel to the haciendas, however, were free Indian communities which maintained themselves on lower-quality lands. The free Indian communities comprised

the other two-thirds of the indigenous population and emerged to become the dominant form of traditional organisations in the highlands (Klein 1984). Despite revolutions and other dramatic social and political changes in subsequent centuries, it is noteworthy that the hacienda system managed to persist in various forms until 1952.

During the Spanish colonial period economic and political power was held by an elite class of mine owners, church leaders, hacendados and government officials. The latter were called *corregidores* and they collected tributes and taxes from the Indians. This elite class was initially comprised of a small minority of Spanish peninsulares (or Spanish-born) persons. The *Criollos* (members of new generations of ethnic Spanish born in the New World) began to gain economic power in mining and agriculture by the late 1700s. Another group emerged somewhat later, namely the *Mestizos* of mixed Spanish-Indian descent. The *Mestizos* tended to be merchants and artisans with little political power, who remained socially associated with the indigenous peoples and gradually became an important ethnic group by the early 1800s (Klein 1984). Increasing resentment by *Criollo* and *Mestizo* groups against Spanish government policies in the New World (i.e., trade barriers, upper-level administrative positions reserved for peninsulares, etc.), and influences of the French and American revolutions, led *Criollos* and *Mestizos* to rebel against the Spanish crown by the early 1800s. The indigenous people, on the other hand, were in constant rebellion against the Spanish. More than 100 such revolts instigated by indigenous people occurred in what is now Bolivia and Peru during the 1700s (Klein 1984).

Bolivia achieved independence through the efforts of several popularly supported *caudillos* (i.e., local leaders from *Criollo* and *Mestizo* ethnic groups) in conjunction with military campaigns led by people such as Simón Bolívar and José A. Sucre. A 15-year war for independence preceded establishment of the Bolivian Republic in August, 1825.

#### 2.2.2.2 1825 to 1950

After independence in 1825 until about 1840, a sequence of Bolivian governments helped organise a strong and cohesive state which played an important role in regional geopolitics (Hudson and Hanratty 1989). In 1846 the first national census was carried out and indicated a population of 1.25 million in the Andean region (with 89% as rural dwellers), and another 150 000 inhabitants in the

lowlands for a total national population of 1.4 million (Klein 1984). By the mid-nineteenth century the mining sector of Bolivia had begun to stagnate, and this contributed to a chaotic period of rule by the military caudillos (non-elected leaders). Political instability persisted until the 1880s and was ameliorated by recovery of the mining economy in the western and southern parts of the country and a strong agricultural presence in the Valleys of Cochabamba and Chuquisaca. Agricultural development was based on an expansion of the hacienda system; new generations of hacienda owners were Criollos and Mestizos. The hacienda system continued to grow and become more diverse (Klein 1995). This increase was in many instances achieved by hacendados (backed by the military elite) taking over the best remaining lands held by indigenous communities. Native peoples gradually lost ownership of their traditional lands and were forced to live in increasingly marginal areas. This growth in the hacienda system was accompanied by an increasing influence of Criollo and Mestizo populations in rural areas. Bolivia lost its access to the sea as a result of the Pacific War with Chile (1879-83); this conflict also reduced the power of the Bolivian military elite and initiated a period of modern, parliamentary-style government dominated by civilians. This parliamentary regime, however, was characterized by limited participation. Indeed, to have the right to vote and to hold public office one had to own real estate and be able to read and write (Malloy 1970).

Although mining shifted from silver to tin exploitation during the late 1800s, mining remained the most important economic activity in Bolivia, and was largely under the control of the private sector with very little government involvement. From 1932-5 Bolivia was engaged in the Chaco War with Paraguay, which Bolivia ultimately lost. As a result of instability created by the Chaco War, the following years were characterised by the alternation of traditional governments supported by the military establishment with experiments of "military socialism" spurred by officials who had come back from the Chaco with a reinforced sense of Bolivian nationalism (López 1993). Government involvement subsequently increased in the mining sector and emerging petroleum industry. The Chaco War also altered conventional wisdom to allow the Indian majority and lower economic classes (i.e., peasants, miners, etc.) representation in the central government. At the same time the rural labourers began to organise trade unions in some of the oldest haciendas in the

Valleys (Klein 1984). This widened opposition to the land owners from the traditional base of the remaining free indigenous communities.

Net growth of the national population was low between 1900 and 1950, with an annual rate on the order of 1.1% (Dr. José Castro, demographer, Instituto Nacional de Estadísticas, personal communication). By 1950 over 85% of the total population of Bolivia was still located in the Andean zone, and over 70% of Andean residents remained rural dwellers (GDRU 1994; 52). Most livelihoods in the Andes were still based on traditional agriculture. Management practices and types of domesticated plants (i.e., tubers, cereals, vegetables, fruits) and animals (i.e., camelids, sheep, cattle) still represented a blend of pre-hispanic and early colonial influences (Dollfus 1981; Dandler 1984). Rural land tenure continued to be dichotomous in nature, with haciendas on one hand and remnant, free communities of native peasants on the other. With few exceptions, the indigenous people still had no access to formal education and were thus effectively excluded from national politics (Malloy 1970). This disenfranchisement, combined with other elements of social and economic inequality and an upsurge in Bolivian nationalism, helped foment a new revolutionary climate by the 1940s and early 1950s.

#### **2.2.2.3 1951 to 1996**

The labour class, mainly comprised of miners and campesinos (introduced as a more contemporary term for rural peasants), provided a constituency for the MNR (Movimiento Nacionalista Revolucionario or National Revolutionary Movement). The MNR, primarily a middle-class political party led by Victor Paz Estenssoro, prevailed in the general elections in 1951 but was stymied by a last-minute military coup. The MNR, however, succeeded in overthrowing the military government on April 9, 1952. The National Revolution led to a number of popular political reforms and socio-economic changes during the 1950s and 1960s, prominently including full nationalisation of the larger mining and petroleum enterprises. Another outcome was the Land Reform Decree of August, 1953, in which land ownership in the Andean zone was returned to peasant communities and campesinos were released from lingering obligations to provide free labour for haciendas. This liberation had been preceded by an intense period of conflict between hacendados and campesinos that started after the April Revolution (Malloy 1970; Klein 1984). The revolution-

ary government expanded rural access to primary education and began to invest in agricultural research and extension.

Although many of these new initiatives held promise for rural Bolivians in general, the traditional agriculture of the Andean zone was still largely ignored (Urioste 1992). In contrast, most public investment in agriculture was targeted towards increasing production of cash crops in the tropical lowlands for domestic consumption and export; important target commodities included improved beef cattle, rice, sugar cane, cotton and soy bean. Investments for the lowlands occurred in the form of road construction, land donations, subsidised credit and building state-owned processing industries. A new class of private owners of large estates benefited from these policies, especially under the conservative military regimes that typically ran the country between 1964 and 1982 (Urioste 1992).

Andean campesinos were encouraged to migrate to the new settlement frontiers in the lowlands, but they commonly found opportunities restricted to seasonal harvests on large estates or marginal lands far from main roads and urban centres. These settlers often ended up in the humid Yungas of La Paz and Chapare to grow coffee, rice and tropical fruit. By the end of the 1970s, however, in response to an increasing international demand for narcotic drugs, many settlers switched to coca leaf production on a large scale. In 1990, coca leaf production comprised 8% of the agricultural GDP in Bolivia (GDRU 1994, 26).

The dramatic rise in production of coca leaf by the early 1980s also corresponded with a period of national economic stress induced by recession and hyperinflation. Hyperinflation was rooted in the accumulation of large fiscal deficits between 1975-81, financed with foreign loans, in a context where mining and natural gas represented more than 90% of total export revenues and 70% of state revenues. The initial driving factors at the beginning of the 1980s included declines in prices for key Bolivian exports and a decreasing productivity in the public mining sector, a sharp rise in international interest rates, and a fall in foreign lending in the wake of a regional debt crisis. The United States also withheld support because of an evaluation that the Bolivian government was failing to take action against drug trafficking. The value of the currency plummeted as a result of successive exchange rate devaluations and excessive issuance of money by the Central Bank to finance the public sector deficits.

Trade unions strongly resisted real depreciation in salaries and a wage/price spiral which exacerbated inflation (Morales 1991; Morales et al 1995). There were also natural disasters occurring at the same time. The Andean highlands endured a severe drought in 1982-3, while the tropical lowlands suffered from extensive flooding. These ecological calamities were related to disruption of climate along the Pacific coast as one outcome of El Niño (INTECSA 1993).

Between 1950 and 1992 the net growth rate for the national population began to accelerate and reached 2.1% per annum (GDRU 1994, 52). It is during these 42 years that a dichotomy between rural and urban population growth became most apparent. Rural populations have grown at an average of only 0.75% per annum while those in urban areas have grown 4% per annum, the latter having a doubling time of 16 years. The reduction in net growth of rural populations is even more evident when the time frame is broken up into smaller segments. Between 1950 and 1976, for example, rural populations grew by 1.15% per annum, yet between 1976 and 1992 this dramatically dropped to 0.1% per annum (GDRU 1994, 52). According to results of the 1992 Bolivian National Census (INE 1993), rural dwellers represented 42.5% (or 2.7 million) of the total national population of 6.4 million. This estimate of the percentage of urban dwellers is probably biased high because of greater difficulties enumerating rural people. For example, Albó (1995, 2-4) believed census figures underestimate rural people on the order of 7 to 15%. Despite economic incentives to populate the tropical lowlands, the highlands remain as home for the bulk (70%) of the national rural population. The transition zones (i.e., Yungas and Valleys) are home to 10%, while about 20% reside in the tropical lowlands [C. Jetté, IBTA/SR-CRSP, unpublished data based on census information in Montes de Oca (1989, 169-72)].

Since the mid-1980s the top priorities of Bolivian governments have been to facilitate economic stability by exerting tighter control on government finance, abolishing many public-sector interventions, and opening the country to foreign trade and investment (GASO 1995). For example, in 1985 the newly elected government of Victor Paz Estenssoro (his fourth term since 1952) implemented a strict economic adjustment and stabilisation programme that was successful in controlling inflation and promoting moderate economic growth. These policies have persisted dur-

ing the governments of Jaime Paz Zamora and Gonzalo Sánchez de Lozada to the present. The main elements of the programme have consisted of exchange rate stability; the liberalisation of trade and capital accounts including the elimination of import prohibitions and the legalisation of dollar deposits; the shutdown (especially in the mining sector) or the privatisation of public enterprises and the reduction of public employment; the elimination of wage indexing; increase of gasoline price to international levels; and the implementation of a value-added tax that is now the main source of fiscal revenue (Morales 1991). The adjustment and stabilisation programme has benefited from strong support of international financial institutions; in 1992, for example, foreign aid equalled more than USD 100 per capita (GASO 1995, 1). International credit has been commonly used to improve roads, both for domestic networks as well as export corridors. Efforts to attract foreign investment and technology to expand and modernize the energy and mining sectors have also been successful in recent years. It was foreseen that Bolivia would start to export large quantities of natural gas to Sao Paulo, Brazil, by 1999 (SIPFE 1996).

**National highlights of the agricultural sector (1980-96).** Despite fiscal successes since the mid-1980s, the adjustment and stabilisation programme has not reversed a long-term decline in rate of growth, and terms of trade, for Bolivian agriculture in general and campesino highland agriculture in particular (CEPAL 1982; Morales 1990; Healy 1991; Morales 1991, 15; Zeballos 1993, 30). There are several reasons for this. Prominent is the relatively low rate of return from large investments in the tropical lowlands. For example, large-scale, lowland enterprises have only yielded sustained increases in exports of soy bean, and this has been achieved through extensification rather than intensification (GDRU 1994, 166). Total production of important products from the Andean and transitional zones like potato, corn and barley have also decreased or stagnated, especially after 1985. This trend is alarming given that campesinos of the highlands, Valleys and Yungas have traditionally produced more than 30% and 90%, respectively, of domestic supplies of meat and plant-derived staples (Morales 1990, 21). The campesino economy has probably been negatively impacted by restriction in urban demand for food staples and recent increases in food imports, as well as increased interest rates and road transport costs (Morales

1991). The adjustment and stabilisation programme has indirectly affected these aspects through reduction of wages and salaried employees, and tight fiscal and monetary policy designed to attract capital deposits and reduce public deficits. Food subsidies have also come in the form of food aid (largely wheat donations), which has probably depressed prices of some traditional Andean commodities. Food aid increased as a result of the ecological disasters of 1982-3 (Prudencio 1993). Although cause and effect relations remain open to debate, depopulation of rural Andean communities (above) has likely resulted in losses of labor that have affected crop production (Painter 1992). The shift of many campesinos from a focus on food crop production to more profitable coca leaf also cannot be ignored (Pérez-Crespo 1991; Painter 1992).

Recent government administrations have attempted to spur productivity and growth in both traditional (e.g., campesino highland) and modern (e.g., entrepreneurial lowland) sectors. According to public statements, the main obstacles to development of campesino highland agriculture are thought to include the harsh Andean climate, poor quality and limited extent of arable highland soils, continued reliance on indigenous technology, low levels of formal education among campesinos, lack of irrigation infrastructure, and excessive fragmentation of agricultural land in more densely populated areas due to land tenure problems and ineffective policies for agricultural marketing (C. Jetté, IBTA/SR-CRSP, personal observations). Problems of entrepreneurial lowland agriculture include continued reliance on outdated technology, a shortage of well-trained people, lack of security for land tenure and high transportation costs associated with a deficient infrastructure (MACA 1990a; SNAG 1993; SIPFE 1996).

Some measures have been taken to alleviate constraints in the agricultural sector, but positive impact remains limited. Noteworthy to this end is a 1990 government decree to strengthen and modernise IBTA (Instituto Boliviano de Tecnología Agropecuaria or Bolivian Institute of Agricultural Technology) which has been the national entity responsible for agricultural research. The decree re-focused the IBTA mandate to centre on technology generation, technology transfer and marketing to benefit low-income, rural producers (MACA 1990b, 10). The impetus to re-focus and re-organise IBTA involved a World Bank project conducted from 1992-7 which included funding



to augment professional salaries, rehabilitate field stations, enhance capacity for technology transfer and restructure the central administration (MACA/IBTA 1992).

Other agricultural initiatives include the Fondo de Desarrollo Campesino (FDC or Peasant Development Fund) which has been created to provide subsidies for infrastructure improvements and production credit under national money-market conditions to benefit economic development projects for rural communities in general, and formal associations of campesinos in particular. The FDC programme remains limited in scope because of low levels of funding and an inefficient bureaucracy (Marconi 1996, 35-37).

Perhaps the most significant of all recent policy changes has been the 1994 passage of the Ley de Participación Popular (or Popular Participation Act) by the Bolivian Congress. This Act provides legal status for campesino communities, creates rural municipalities and institutes a redistribution of 20% of total national tax revenues among such municipalities based on numbers of inhabitants (*Gaceta Oficial de Bolivia* 1994, 2-3). The law is intended to rectify the historical inequity between urban and rural areas. It is also intended to create opportunities for rural communities to better control their destinies and be more responsible in helping manage local health care, education and infrastructure improvements. In addition, a law regulating and clarifying processes related to land ownership and tenure was enacted in October, 1996. Provisions include that lands belonging to small producers or indigenous communal entities cannot be alienated, seized or taxed. Tenancy of medium and large private estates is also guaranteed insofar as the owners pay corresponding land taxes to municipalities. Local government administrations will be allowed to redistribute large tracts of land whose owners have not paid their taxes during two years, or had obtained their titles fraudulently in the past. The law foresees a 10-year process to survey and register all land properties in the country (MDSMA 1996). While national in scope, this law should primarily serve to help resolve land-use conflicts which have mostly emerged in the tropical lowlands (C. Jetté, IBTA/SR-CRSP, personal observation).

At the beginning of 1996 the government of President Sánchez de Lozada presented a strategy for sustainable rural development to the Consultative Group of Paris (CGP), comprised of international donors. By prioritising public investments in rural areas during the next five years (1997-2002),

the strategy is founded on objectives to expand and diversify agricultural exports, increase food production for domestic consumption, and raise incomes and living standards for rural producers (SIPFE 1996). The four pillars of the strategy include: (1) increased investment in human development (e.g., health and education); (2) increased emphasis on natural resource management; (3) increased investments in road and irrigation infrastructure; and (4) continued restructuring of the national system of agricultural research and technology transfer. For the last point, a significant discrepancy has been noted between the types of agricultural research typically performed and the acute needs of campesinos (SIPFE 1996). Agricultural research would be restructured to create five to seven eco-regional centres (with producer association delegates on their boards of directors) and competitive mechanisms for public fund allocation would be introduced. Government support of applied research and technology transfer activities for export commodities would be progressively privatised. The CGP has approved the new strategy in principle, but funding level remains to be determined (SIPFE 1996, 58).

## 2.3 Overview of the Bolivian Altiplano

### 2.3.1 Regional highlights of physical geography and environment

#### 2.3.1.1 Regional physical geography and soils

The Altiplano and mountains over 2000-m elevation represent about 27% of Bolivia's land area and contain 34% of Bolivia's rangelands (Alzérreca 1992). About 800 km in length from north to south, and having an average width of 130 km, the Altiplano stretches from the south-east corner of Peru through western Bolivia and eastern edge of Chile and ends in northwest Argentina (Figure 2.2).

The Altiplano is essentially a large, lacustral alluvial plain formed from sedimentary materials deposited in a series of inter-linked lake basins and tributaries (King 1962). The basins contain remnants of ancient lakes and vary in terms of soil salinity and water supply. It is notable that the central alluvial plain of the Altiplano is broken up by spurs, branches, ridges, peaks and transverse hills. These interceding barriers help diversify the Altiplano by creating subregions having varied edaphic features and climates. Sub-regions may

possess their own hydrological systems depending on orientation and size of physical formations (King 1962).

The Altiplano contains several internationally recognised landmarks. One such landmark is Lake Titicaca, which occurs in the more sub-humid, northern Altiplano at 3910-m elevation. With a surface area of 8600 km<sup>2</sup> (Kolata 1993), Lake Titicaca is the highest navigable body of fresh water in the world (Ambroggi 1965; Plate 2.3). Lake Titicaca is fed by several rivers that flow down the west-facing slopes of the eastern Cordilleras. It discharges into the Desaguadero River that flows some 320 km to the southeast and then empties into Lake Poopó. Lake Poopó is located in a more semi-arid portion of the Altiplano and is characterised by its shallow, saline water. To the southwest of Lake Poopó are the salt flats (salares) of Coipasa and Uyuni. The Uyuni flats comprise the largest surficial salt crust on earth (Figure 2.3).

Salinity of soils and water is a critical constraint for agriculture on the Altiplano; in some cases salinisation is entirely an endogenous (geomorphic or hydrological) process that cannot be appreciably altered by management, while in others management may play a role in lessening negative effects, especially in cropping systems (see Chapter 3: *Ecology and natural resources of San José Llanga*).

Still youthful in geological terms, the Andean region was once ocean floor and thus subject to high salt accumulation during bedrock formation. Today, the salinity of Altiplano soils is a function of the high concentrations of salts in soil parent materials and salinity level is locally exacerbated by soil deposition processes and features of the hydrologic cycle (Ambroggi 1965). For example, erosion is continually moving fresh, saline rock from mountain slopes towards the floor of the Altiplano where it will become part of the soil. The dry climate drives high rates of evapotranspiration of surface water, which increases salt concentrations in water bodies. High evapotranspiration also increases salinity in top soil through capillary action of subsurface water. Because the Altiplano is a closed basin, there is no chance for precipitation to leach salts out of the system. Additions of fresh water from rainfall, snow and glacial melt are insufficient to compensate for water loss to evapotranspiration and thus mitigate salinity of water bodies (Ambroggi 1965). Various regions of the Altiplano differ in degree of salinisation and, over a long period of time, large areas of the



Plate 2.3. *Vista of Lake Titicaca. Note cultivated terraces near the lake shore.* Photograph: Lita Buttolph

Altiplano are enduring decreases in vegetation cover due to increases in soil and water salinity (Salm and Gehler 1987; Lorini 1995).

Lake Titicaca, Lake Poopó, and the salares are remnants, respectively, of ancient lakes named Ballivian, Minchin and Tauca [Servant and Fontes (1978) cited in Kolata (1993)]. Lake Ballivian is the oldest of the lakes, but the precise ages are unknown. Lake Titicaca represents about 50% of the original area covered by Lake Ballivian. Extinct Lake Minchin existed over 29 000 years BP. Extinct Lake Tauca occurred between 11 000 and 17 000 years BP. These lakes covered large portions of the Altiplano during the Quaternary Period, when the earth's climate was characterised by alternating periods of glaciation and inter-glaciation [Servant and Fontes (1978) cited in Kolata (1993)]. The salares of Coipasa and Uyuni are an outcome of the desiccation of Lake Tauca during a period of dry climate from 10 000 to 3500 BP. Since 3500 BP the climate has been wetter, with a resulting increase in levels of contemporary lakes on the Altiplano (Coudrain-Ribstein et al 1995). In general, one can view the Uyuni salt flats as a remnant "central drain" at the lowest elevation for all inter-linked basins on the Bolivian Altiplano. At a regional scale, therefore, soil salinity tends to increase, while elevation decreases, as one travels towards the Uyuni salt flats from any direction.

The Altiplano was also a region of major volcanic activity during the late Miocene and Pleistocene (King 1962). This helps explain the abundance of lava (andesite) and ash (ignimbrite) in extensive Altiplano areas bordering the Cordilleras, especially to the west (King 1962). In general, the mountain slopes of the Cordilleras are covered with unweathered rock and soil is poorly de-

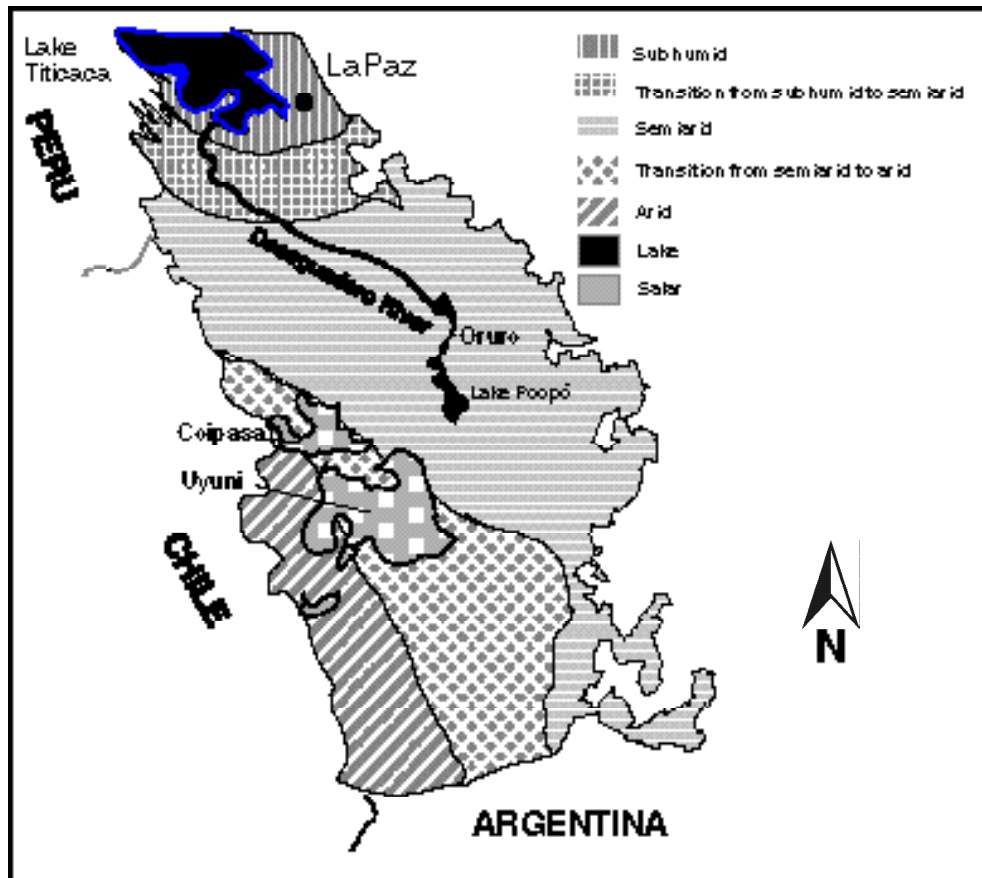


Figure 2.3. Major ecological regions of the Bolivian Altiplano. Source: Adapted from Beck (1988)

veloped (Rutsatz and Fisel 1984). Foothills at lower elevations are still covered with fresh rock, but weathering has created some sandy and stony soils. Further downslope there are alluvial fans, small plateaus and gradual inclines leading to the central plains. The central plains, overall, are represented by formations such as sedimentary terraces, alluvial fans and flood plains. The central plains to the south gradually descend towards Lake Poopó and the salares. There is a concomitant textural gradient of soils from sandy-silty to clay-silty and heavy clay, with lacustrine (e.g., old lake bed) soils commonly having higher content of soluble salts (Rutsatz and Fisel 1984). There is also sandy soil resulting from aeolian (wind) deposition which is commonly found over sedimentary formations, and this has contributed to stabilised and active sand dunes throughout the Altiplano. Sand dunes increase in frequency and extent from the semi-arid zone to more arid zones in the southwest Altiplano. The composition of aeolian and fluvio-lacustrine deposits is variable, and includes

conglomerates of sand, clay, silt, latites, salt and lignite (CIACER/GEOBOL 1985).

### 2.3.1.2 Regional environment

The climate of the Altiplano is mainly characterised by marked seasonal fluctuation in precipitation and, to a lesser extent, temperature. Given that Bolivia is in the southern hemisphere the cooler season (winter) occurs from June to August, while the warmer season (summer) occurs from December to February. The winter months are drier while summer months are wetter. There typically is a large daily variation in air temperature; daily variation is usually larger than seasonal variation and the daily spread can range from 28° to 38°C. Frost can occur anytime during the growing season (IBTA 1992). Such fluctuations pose significant challenges for production of forages and food crops.

The rainy season gradually begins in September, with most rainfall occurring from November through March or April. There is a strong gradient from the northeast to the southwest along which

both mean temperature and precipitation decline (Mourguiart et al 1995). Whereas to the north the average daily temperature is 11°C and the average annual precipitation exceeds 600 mm (with 900 mm per annum along the shores of Lake Titicaca), to the southwest the average daily temperature is 7°C and annual precipitation drops to <200 mm per year. The contrast between nocturnal and diurnal temperature is also most pronounced to the southwest where a range of 36°C has been reported (Vacher et al 1992, 512-3; de Morales 1990, 76). Owing to limitations imposed by cool ambient temperatures, net primary productivity is low with slow rates of nitrogen cycling (Dollfus 1981, 22). Detailed climate diagrams for the entire Altiplano can be found in FAO (1975), Lorini (1987) and de Morales (1990).

The Altiplano has been described as the realm of the "puna". The term puna refers to an open landscape comprised of small and medium-stature plants with little tree cover (Ellenberg 1979). Vegetation physiognomy is commonly dominated by shrub-like plants along mountain footslopes, tall bunchgrasses at intermediate elevations (such as alluvial terraces), and short grasses and halophytes (e.g., salt-tolerant plants) on lower-elevation plains with higher water tables. Plant communities and vegetation cover also change according to spatial and temporal gradients of thermal and moisture regimes.

Despite high variability in local climate and soils on the Altiplano, four major ecological types of puna are commonly recognised based on degree of humidity or aridity. These include: (1) humid/sub-humid; (2) semi-arid; (3) arid; and (4) hyper-arid (Cabrera 1957, 1968; Troll 1968; Dollfus 1981; Ellenberg 1981). Altitude can also serve as a secondary factor in classification of puna. For example, over 4100-m elevation there are tundra-type plant communities consisting of small grasses, dwarf shrubs and "cushion plants"; these communities are referred to as high puna. Climatic conditions of the high puna (especially the low temperatures) exert great limitations on many forms of crop and animal agriculture. In the Cordilleras and in the Altiplano, however, there are patches of perennial and ephemeral wetlands (natural and man-made) called bofedales that are critical for camelid production systems (Caro 1992; Genin and Alzérreca 1995).

A more-crude categorisation of puna as sub-humid, semi-arid and arid roughly corresponds to latitudinal and administrative divisions commonly used in Bolivia to demarcate northern, central and

southern regions of the Altiplano, respectively (Figure 2.3). This division, however, does not take into account effects of the northwest to southeast climate gradient (described above) which can lead to erroneous generalisations. For example, although the central Altiplano is typically referred to as uniform semi-arid puna, some areas are more representative of arid puna due to local effects of the climate gradient. Similarly, several municipalities of the Ingavi and Pacajes provinces to the north near Lake Titicaca are categorised as sub-humid, but in fact are semi-arid. For a general quantification based on Figure 2.3, the sub-humid area is about 6% of the Bolivian Altiplano. The semi-arid, arid and hyper-arid areas are about 54, 23 and 14%, respectively. The saltflats are about 3% of the surface area.

The sub-humid puna corresponds mainly to the general area encompassing Lake Titicaca. This is a region where cultivation occurs more extensively, especially near the lake shores where risk of frost is almost nil and precipitation is elevated compared to surrounding areas. Annual precipitation ranges from 600 to 900 mm and very little occurs as snow. Favourable influences of the lake on local climate are restricted, however, to within one kilometer of the shoreline (Vacher et al 1992, 513-4). Throughout the rest of the Altiplano the risk of frost increases and cultivation strategies are modified accordingly.

Important vegetation of different climate zones has been described by Tosi et al (1975), Lara and Alzérreca (1986) and Beck (1988). Aquatic and emergent vegetation associated with the shallows of Lake Titicaca include important forages such as *tatora* (from *Quechua* vernacular; *Schenoplectus tatora*), *totorilla* (*Scirpus rigidus*), *Miriophyllum* spp. and *Elodea* spp. Criollo cattle submerge and feed on this aquatic vegetation, otherwise vegetation is harvested via cut-and-carry methods to storage facilities on shore (Dr. H. Alzérreca, rangeland ecologist, personal observation). On rain-fed, semi-humid sites near the lake, vegetation on deeper alluvial soils is dominated by *chilligua* (*Festuca dolichophylla*) while *ichu* (*Stipa ichu*) occurs more on drier and shallower soils associated with hillslopes. Scattered shrubs of the genera *Colletia*, *Cassia* and *Satureja* are found on the plains, slopes and foothills of the sub-humid Altiplano. There are a few introduced tree species established on more favourable sites, including *Eucalyptus*, *Pinus* and *Cupressus* spp.

The semi-arid puna coincides with the environs of the Desaguadero River and Lake Poopó

and also includes regions north of Potosí province below 4100-m elevation (Figure 2.3). The semi-arid puna is characterised by an annual precipitation from about 400 to 600 mm. The agropastoral peasant community of San José Llanga, the main subject of this volume, occurs in semi-arid puna with about 400 mm average annual precipitation (see Chapter 3: *Ecology and natural resources of San José Llanga*). Extensive areas of the semi-arid puna, mainly on foothills and mountain slopes less prone to frost, have endured cultivation for centuries (Plate 2.4a,b). Fallow fields on these sites have been important for livestock grazing. Native vegetation has been appreciably altered as a result; often only inaccessible relict sites offer indications of original plant species composition and diversity (Ellenberg 1979; Ruthsatz and Fisel 1984). Across much of the uncultivated, semi-arid puna vegetation physiognomy is dominated by small-stature, shrubby taxa; communities have mixtures of shrubs and grasses referred to as shrub-steppe. Shrubs include important indigenous species such as *Parastrephia lepidophylla* (*thola* in the Aymara vernacular), *Adesmia spinosissima*, *Baccharis microphylla*, *Satureja parvifolia*, *Junellia minima* and *Tetraglochin cristatum* on well-drained soils. Halophytes such as *Suaeda foliosa*, *Atriplex* spp, *Anthobrium triandrum*, *Salicornia peruviana* and *Parastrephia phyllicaeformis* are common on medium to heavy-textured soils with variable salinity. Short-grass (i.e., *gramada*) and tall-grass (i.e., *pajonal*) vegetation types are also common in semi-arid sites. Key tall-grass species on well-drained soils include *Stipa ichu*, *S. depauperata*, *Nasella pubiflora*, *Festuca orthophylla* and

*Aristida asplundii*. Key tall-grass species on medium-textured soils include *Festuca dolichophylla*, *Bromus uniloides*, *Hordeum muticum*, *Calamagrostis vicunarun* and *C. curvula*. Short grasses like *Distichlis humilis* and *Mulhenbergia fastigiata* are common on medium to heavy-textured soils with higher water tables and elevated site salinity. Hydrophytes such as *Carex* spp, *Scirpus atacamencis*, *Arenaria* sp, *Patomogeton* spp and *Miriophyllum* sp are present in wetlands (e.g., bofedales) and along shorelines of rivers, springs, lakes and ponds. Extent of vegetation cover greatly varies according to proximity to rivers, grazing management, depth to the water table, salinity of water and soil, and other physical and chemical soil features (see Chapter 3: *Ecology and natural resources of San José Llanga*). Cultivation in the semi-arid puna is performed under high risks of failure due to drought and frost. For example, Le Tacon et al (1992) determined that risk of potato plants being negatively affected by frost ranges from probabilities of 0.15 to 0.90 in the semi-arid puna depending on local conditions.

The arid puna has an average annual precipitation from 200 to 400 mm and includes portions of the western and southern Altiplano (Figure 2.3). Cultivation is restricted to small areas having favourable microclimates and soils. Llama pastoralism dominates in the arid puna as the traditional agricultural activity (PSP 1992). Vegetation of the arid puna is represented more by a shrubland (i.e., *tholares*) physiognomy. The dominant shrub again is *thola* (*P. lepidophylla*) and other important shrub genera include *Baccharis*, *Fabiana* and *Tetraglochin*. Tall-grass communities (*pajonal*) are more rare than in the semi-arid puna,



a



b

Plate 2.4 (a,b). (a) Vista of foothills terrain associated with the semi-arid puna at the edge of the Cordilleras and (b) typical foothill production system of the semi-arid puna with hillside cultivation, grazing land in the valley bottoms and a settlement in-between. Photographs: (a) D. Layne Coppock and (b) Brien E. Norton

but they are dominated by genera such as *Festuca* (especially *F. orthophylla*), *Stipa* and *Calamagrostis*. Halophytes continue to be common near salares, rivers and shorelines of lakes. Vegetative cover tends to be low and highly variable.

In the hyper-arid puna, with annual precipitation <200 mm, the predominant vegetation becomes more exclusively shrubby and plants tend to be more widely spaced as intensity of competition for moisture increases. The most abundant shrubs belong to the genera *Fabiana*, *Chuquiraga*, *Lampaya*, *Adesmia*, *Junellia* and *Baccharis*. Very scattered tall grasses (i.e., *Calamagrostis*, *Festuca*, *Stipa* spp.) are found adjacent to water sources and on mountainsides (Rutsatz 1977).

It is often assumed that the rangelands of the Altiplano have been gradually degraded by overgrazing from livestock (LeBaron et al 1979; Posnansky 1982; McCorkle 1990). Some theories put more blame on introduced cattle and sheep for causing degradation due to foraging behaviour and hoof morphology adverse to fragile soils and vegetation (Posnansky 1982). Alternative theories suggest that climate fluctuations play a crucial role in determining range trend in arid lands (see Chapter 3: *Ecology and natural resources of San José Llanga*).

## 2.3.2 Regional historical highlights

### 2.3.2.1 Pre-historic times to 1524

The Altiplano is the origin for some of the most important indigenous civilisations of Bolivia. Archaeological studies have identified several sites inhabited by hunter-gatherers in the central and southern Altiplano between 10 500 and 4500 BP (Bouysse-Cassagne 1992, 480). One of the oldest sites, a relict of the Viscachani culture tentatively dated at 17 000 years BP (PNUD/AECI/MOPI-SGMA 1990), is located 25 km north of the IBTA/SR-CRSP study site at San José Llanga. It is estimated that pastoralism of llama and alpaca, with crop cultivation as a secondary activity, has existed for over 7000 years in the Andean zone (Browman 1974). Intensive agriculture was already practised in the Lake Titicaca basin around 3000 years BP (Erickson 1992), but reached a rather remarkable level of development (based on extensive irrigation systems) about 1000 years BP during the *Tiwanaku* period (Kolata 1993).

According to Bouysse-Cassagne (1992), *Aymara*-speaking groups began to expand through-

out the Altiplano around 800 to 900 years BP and consolidated their control over the region around 1450 by virtue of an alliance with Incan invaders. Bouysse-Cassagne (1987, 84) estimated the total population in *Aymara* territories (including a Peruvian sector to the west of Lake Titicaca) at one to two million by the year 1500.

The *Aymara* peoples traditionally organised themselves into kinship-based groups called *ayllu*. The term *ayllu* is roughly translated as a synonym for “community,” but *ayllu* actually refers to more complex levels of indigenous social organisation that have progressively disappeared from the Altiplano. The basic principle for belonging to an *ayllu* was to be descended from a common male ancestor; the ancestral figure could be real or fictitious (Carter and Albó 1988).

The *Aymara* civilisation (and later the *Aymara-Quechua* civilisation) on the Altiplano was largely based on agropastoral production systems (Bouysse-Cassagne 1987). The pastoral component prominently included camelids unique to Latin America (Plate 2.5a,b). Domesticated llama (*Llama glama*) were primarily used for fibre, meat, manure and portage. Domesticated alpaca (*L. pacos*) were primarily used for production of high-value fibre and to a lesser extent, meat. Wild vicuña (*Vicugna vicugna*) were periodically rounded-up in large numbers, shorn for fibre and released (Franklin 1971). The exceedingly fine vicuña fibre has been the most valuable camelid product in recorded history (Walker 1984). Cultivated crops of the early *Aymara* civilisation (Plate 2.6a,b) were dominated by potatoes [*Solanum* spp.; the *Aymara* recognised over 250 varieties of tubers [La Barre (1947) cited in Bouysse-Cassagne (1987, 213)] and highly nutritious grains of the *Chenopodiaceae* family including quinoa (*Chenopodium quinoa*) and cañawa (*C. palidicaule*). Also prevalent were oca (*Oxalis tuberosus*) and ullucu (*Ullucus tuberosus*). As is the case today, drought and frost were significant risks for crop production, thus the *Aymara* tended to rely more on pastoralism for survival. Recent evidence has been interpreted to indicate that extensive irrigation systems also mitigated micro-climates for crops and thus reduced frost risks (Erickson 1986). Families often had large herds of camelids (Bouysse-Cassagne 1987; Murra 1988). Cropping plots were typically managed with two to three years in production followed by a long (i.e., two to 13-year) fallow to facilitate recovery of plot fertility under extant conditions of aridity and cold temperatures (Hervé 1994, 20). Plots were often placed



a



b

Plate 2.5 (a,b). *Common indigenous camelids of the Altiplano: (a) Llama and (b) vicuña.* Photographs: Lita Buttolph

on hillsides to mitigate against high risks of frost characteristic of the alluvial valleys.

In addition to their extensive use of the Altiplano, the *ayllus* of the *Aymara* controlled territory from the Pacific coast associated with the western Cordillera to the Valleys and Yungas associated with the eastern Cordilleras (Murra 1975, 1988). In this altitudinal gradient various crops were produced according to their ecological adaptations, such as potato and *quinoa* in the Altiplano, maize in the Valleys and coca in the Yungas (Kolata 1993). Hillside agriculture was common but required substantial labour for field preparation, terracing, weeding and additional crop production practices such as fertilisation (with llama manure, seabird guano

or fish heads, depending on location), mixed cropping, fallowing, irrigation, etc. (Donkin 1979). Many of the indigenous domesticated agricultural species, technologies and management methods of the early *Aymara* civilisation, their predecessors (*Tiwanacotas*) and later *Quechua* (Kolata 1993) proved to be ecologically, socially, culturally and economically adapted to Andean environments (van Kessel 1992). Some of these techniques are still used today in the Andes (Donkin 1979). Overall, this contributed to a pattern of vertical integration of resource use in complementary agroecological zones. This was a common risk-mitigating tradition among Andean peoples (Murra 1975, 1988; Golte 1980). Bouysse-Cassagne



a



b

Plate 2.6 (a,b). *Common indigenous plant crops of the Altiplano: (a) mixture of local and introduced potato varieties and (b) quinoa, an important cereal adapted to high elevations.* Photographs: Christian Jetté



(1987, 336) speculated that exploitation of multiple agroecological zones began when the *Aymara* initially colonised some High Valleys prior to contact with the Inca circa 1450; this colonisation may have been an attempt to solve problems on the Altiplano related to high population pressure. Population shifts of the *Aymara* towards the High Valleys and Yungas subsequently increased in the next 50 years, where they progressively adopted the *Quechua* language. More *Aymara* also moved to the High Valleys and Yungas as a consequence of establishment of haciendas during the Spanish conquest to escape obligation to work in the mines and avoid paying tributes to the Spanish.

### 2.3.2.2 1525 to 1824

As previously reviewed, one of the most dramatic outcomes of the Spanish conquest in Bolivia was the large drop in population of indigenous people like the *Aymara*. Sánchez-Albornoz (1978, 34) reported that demographic impacts resulting from the population decline persisted until the year 1700. Other outcomes of Spanish colonialism included restrictions in land access for indigenous peoples as well as changes in agricultural systems and technology.

The *Aymara* have been at least partially integrated into a cash economy since the early years of Spanish colonialism (Sebill 1989). To preserve their ownership rights and access to traditional *Aymara* lands, *ayllus* had to pay taxes and tributes to Spanish authorities. They also were forced to purchase goods from Spanish provincial rulers (corregidores) at high prices (Klein 1995, 151). *Ayllus* supplied labour to work large mines in locations like Potosí. Tributes were paid as cash and in-kind. It is notable that *ayllus* could generate sizable production surpluses during this period.

The *ayllus* elaborated various strategies to endure or avoid obligations to the Spanish. The *Aymara* often rebelled against the corregidores. The *Aymara* adapted to changing economic circumstances that were largely determined by cycles of expansion and recession of the mining sector. The *Aymara* obtained cash in innovative ways, including use of llamas to haul goods long distances, selling fuel (i.e., wood and manure) to mines and growing cities, cultivating cash crops, and by serving as temporary paid workers in mines and haciendas in some instances. In times of recession many former emigrants returned to their home areas and people tended to rely more on a barter economy (Harris et al 1987; Sebill 1989; Rivera 1992; Klein 1995).

The traditional Andean pattern of vertical integration of natural resource use involving the Altiplano, Yungas and High Valleys was gradually broken-up by Spanish colonialists, both as an outcome of active interference and as a consequence of hacienda expansion (Carter and Albó 1988). Technologies and management practices imported from Mediterranean environments of southern Europe were often well-suited for haciendas in the Yungas, Valleys, High Valleys and immediate vicinity of Lake Titicaca. By the end of the colonial period in 1825, it has been estimated that one-third of formerly communal lands held by indigenous Andean peoples had come under control of the haciendas (Carter and Albó 1988, 453). Although most of the new, imported agricultural technology was initially confined to haciendas, *Aymara* producers rapidly adopted innovations that could endure conditions on the Altiplano. Criollo breeds of sheep and cattle (Plate 2.7a,b), as well as equines (i.e., horses, donkeys), barley, wheat, oats, alfalfa and the iron plough were important innovations to arrive during the colonial period (Dollfus 1981).

### 2.3.2.3 1825 to 1952

Throughout the Incan occupation, Spanish colonial period and first decades of the new Republican Era, the *Aymara* had demonstrated a remarkable resilience and adapted to a wide variety of difficult social and economic circumstances. This adaptive ability, however, was severely tested again during the late 1800s (Klein 1995). An abrupt change corresponded to new heights of productivity and profitability in the mining sector, a triumph of emergent capitalism, rapid growth in populations of other ethnic groups (i.e., Criollo, Mestizo) throughout the nation, and a return to elitism, racism and other aspects of institutionalised discrimination. Privately owned property and European culture were considered attributes of “cultural progress” by 1890, and indigenous Andean peoples (referred to at this time as “Indios”) were accused of being ignorant, lazy and inefficient in their agricultural production practices. The Bolivian government declared null and void communal property titles held by *ayllus* that had been obtained from the Spanish crown, and then initiated widespread sales of such lands. The process was plagued by fraud and violence and many *ayllus* that intended to buy back their lands were ultimately dispossessed (Antezana 1992; Klein 1995). The hacienda system, never terminated at independence in 1825, suddenly expanded once





a



b

Plate 2.7 (a,b). Livestock breeds introduced by the Spanish in the 1500s: (a) Criollo sheep and (b) Criollo cattle. Photographs: Christian Jetté

again on the Altiplano, especially in the Department of La Paz. Land under hacienda control more than doubled by 1900 (Carter and Albó 1988, 455). These forces also tended to break up many residual elements of vertical integration and resource use across agroecological zones that were still held by a few *ayllus*. It is notable, however, that some *ayllus* were able to keep control of land in multiple agroecological zones, which has persisted until contemporary times. These *ayllus* occur north of Potosí where the Altiplano and High Valleys are contiguous (Rivera 1992).

Population size among the *Aymara* remained low throughout much of the 1800s. The population still had a low base level and was in a gradual recovery phase following the Spanish-induced decimation; there were also persistent, high rates of child mortality (Klein 1995). Epidemics continued to periodically ravage the Andean countryside despite the relatively high degree of dispersion of rural residents. A case-in-point was a widespread and deadly outbreak of typhoid fever in the mid-1800s (Medicaneli et al 1993).

The contemporary generation of hacienda owners on the Altiplano at the beginning of the 20th Century were not progressive and did not invest much in their properties. Some introduced pure-bred, exotic cattle and sheep (Cardozo 1994), but few hacendados bothered to fence off their grazing lands. Consequently, improved animals back-crossed with Criollo stock. Some hacendados owned land in different agroecological zones and managed to replicate some of the traditional risk-mitigating practices evident centuries earlier with the *Aymara* (Klein 1995). Hacendados contributed to a new wave of social strife by attempting to re-impose peasant

servitude among the locals. In some cases peasants worked on haciendas as share croppers. Haciendas could generate large profits because of their ability to coerce free labour and control regional marketing of agricultural products (CEPAL 1982; Dandler 1984).

#### 2.3.2.4 1953 to 1996

An important result of the Land Reform Act of 1953 was that the hacienda system finally ended nation-wide. On the Altiplano and in the densely populated Yungas and High Valleys the hacendados sold or transferred hacienda lands to campesino communities (Heath et al 1969; Albó 1979; Dandler 1984). Other major effects of land reform included elimination of the traditional mestizos and criollos (rural elite) class and freeing-up and diversification of regional marketing channels (Preston 1977; Dandler 1984). This all eventually assisted dissemination of new production technologies on the Altiplano including chemical fertilisers, tractors, new varieties of seeds and improved breeds of livestock (C. Jetté, IBTA/SR-CRSP, personal observation).

Campesinos have since embraced some of the innovations, and as a result a gradient of mestizo (or mixed) production systems occurs today throughout much of the Altiplano. Indigenous components of production systems (i.e., camelids, traditional cereal crops, etc.) predominate more in drier and colder locales. Introduced components tend to be more common in sub-humid agropastoral areas (especially under irrigation) and to a lesser extent in semi-arid agropastoral areas. The track record of agricultural innovations on the Altiplano is often equivocal, however, with both positive and negative aspects. Some outcomes

of innovation adoption at the semi-arid site at San José Llanga are reviewed in Chapter 3: *Ecology and natural resources of San José Llanga* and Chapter 7: *Patterns of technology adoption at San José Llanga*.

There are examples where traditional Andean plant and animal products are becoming marginalised by modernisation. Staples such as the “bitter potato” (or *luk'i* in Aymara vernacular; regarded as frost resistant), *cañawa* and *quinoa* are being substituted in campesino diets by less nutritive, but easier to prepare, foodstuffs such as rice, wheat and pasta (Dandler 1984; Orlove 1987). For livestock, the best example of marginalisation may be the llama (Plate 2.5a; *Ayllu Sartañani* 1992; Caro 1992; Valencia and Jetté 1995). Although it is widely recognised that the llama is the domestic ruminant best adapted to rangeland conditions of the Altiplano, llama are now almost exclusively bred only north of Potosí and in hyper-arid areas of the western and southern Altiplano. Llama have become marginalised because other means have been found to provide similar productive functions—trucks now transport goods long distances, sheep provide fiber, capital storage and more marketable meat. For the latter point, urbanites prefer beef and mutton as a source of animal protein and often have a strong prejudice against consumption of llama meat (Sammels and Markowitz 1994). In contrast to this general trend, however, there are reports of increasing demand for llama meat and alpaca wool in recent years on the western Altiplano. There the value of llama meat has risen to a level similar to that for sheep, while the value of alpaca wool has risen five-fold [Luis Ticona, president of AIGACAA (Asociación Integral de Ganaderos en Camélidos de Andes Altos), personal communication].

Although the Land Reform Act of 1953 considerably improved conditions for campesinos, the subsequent decades have been adverse for Andean agriculture. Altiplano communities have been particularly affected by a gradual deterioration in terms of trade, depression of the mining sector and a shifting attention of government towards opportunities in the tropical lowlands [see sub-section under Section 2.2.2.3: *National highlights of the agricultural sector (1980-96)*]. In general, fibre markets have also suffered declines due to an inability of the national textile sector (both industrial and craft components) to compete with high import levels of cheap fabrics (Eróstegui 1990).

The Land Reform Act of 1953 took place in a national context of accelerating population growth

and increasing pressure on land. Pressure on land has been particularly evident in the High Valleys and densely populated areas around Lake Titicaca (Dandler 1984; Carter and Albó 1988). Today, the Andean zone and High Valleys of Bolivia are home to about 2.4 million people [C. Jetté, IBTA/SR-CRSP, unpublished data based on 90% of figures from the Bolivian National Census for 1992 (INE 1993)]. When only the rural Altiplano is considered, the current population is about 900 000, or 30% of all rural dwellers in Bolivia.

Land degradation and changing economic opportunities have fueled a large migration of campesinos from rural areas to urban centres since the mid to late 1970s. A good example is provided by the city of El Alto, which originally was a small suburb of La Paz; between 1976 and 1992 El Alto had a net annual population growth rate of 9.2% (Morales et al 1995, 95). The largest component of this growth has been emigrants from the rural Altiplano, consequently contributing to population declines and demographic shifts in neighbouring Altiplano districts (Figure 2.4). As a consequence, El Alto has recently become the fourth largest city in Bolivia after La Paz, Santa Cruz and Cochabamba (Franquerville and Aguilar 1988).

The recent decline in rural populations has been most evident in the arid central and southern Altiplano; population change in these areas has averaged -2% per annum (INE 1993). Effects of population loss have not been fully evaluated. We speculate, however, that declines in population probably have helped alleviate pressure on land in some instances. From another perspective, loss of large numbers of people between the ages of 15 and 45 years creates labour shortages in some communities, especially where labour is vital for sustainable production. One case in point would be maintenance of hillside cultivation systems (Painter 1992).

Human population density on the Altiplano decreases along the aforementioned climate gradient from the humid/sub-humid northeast to the arid (and colder) southwest (Muñoz-Reyes 1982; C. Jetté, IBTA/SR-CRSP, unpublished data). In the humid/sub-humid puna to the north the population density averages 25 to 37 persons per square kilometer. This is the highest population density on the Altiplano and it coincides with the greatest concentration of cultivation. Besides potato, *quinoa*, and barley, which are the main crops throughout the Altiplano, there are faba beans (*Vicia faba*), onions and other vegetables in the humid/

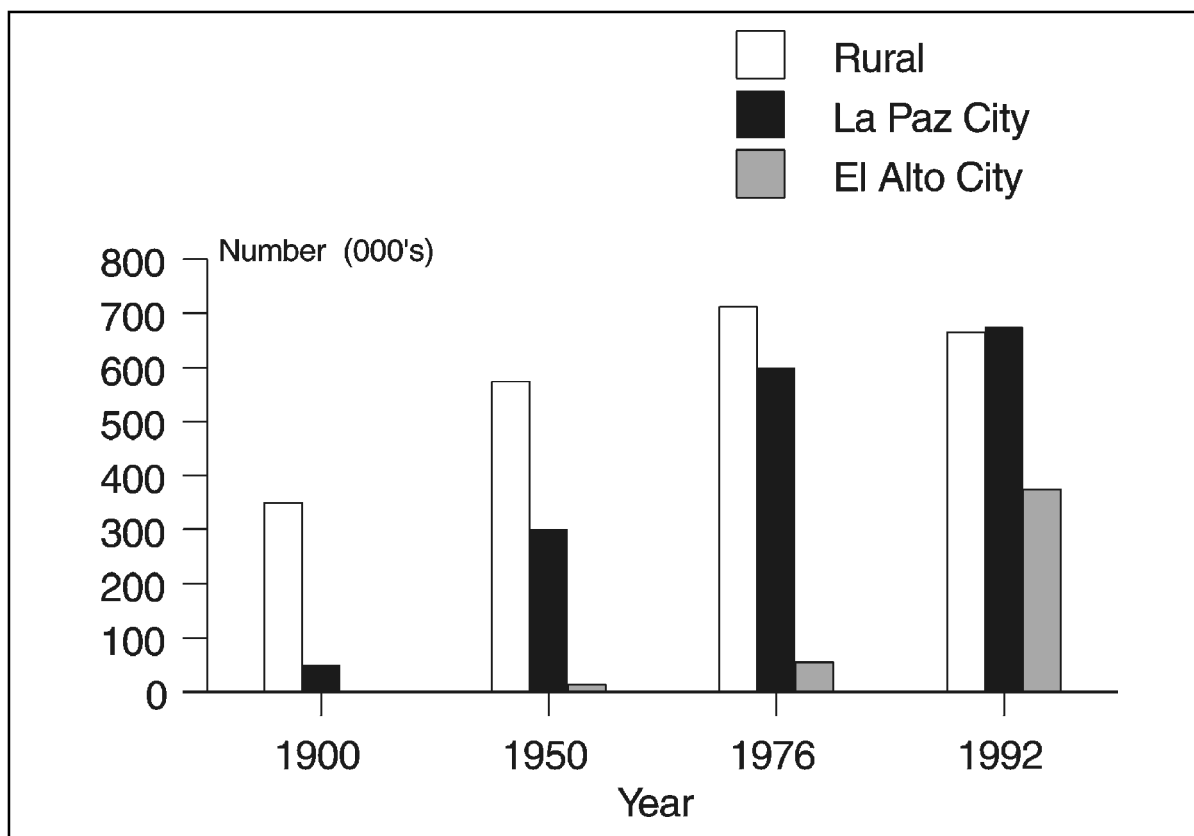


Figure 2.4. Change in human population between urban and rural locations on the Bolivian Altiplano, Department of La Paz, 1900-92. Sources: Created from data in Sandoval and Sostres (1991) and Municipalidad de La Paz (1995)

sub-humid north. Since the early 1980s the humid/sub-humid north has witnessed increased production of barley, alfalfa, beef cattle and dairying while sheep production has declined (Erickson 1986; PSP 1992; Paz Ballivián 1992). The majority of households manage from four to 15 cattle and 10 to 40 sheep (Paz Ballivián 1992; Castillo 1994). Hog production may also be locally significant in some of these sectors (Dr. H. Alzérreca, rangeland ecologist, personal observation).

In the semi-arid puna of the central and east-central Altiplano, human population density averages from 2 to 15 persons per square kilometer (Muñoz-Reyes 1982; Mr. C. Jetté, IBTA/SR-CRSP, unpublished data). The more densely populated sectors occur to the north of Potosí and in a wide band associated with the tarmac highway that connects La Paz with the cities of Oruro and Challapata. Population density gradually decreases towards more arid regions to the west and south. The semi-arid puna is where the largest concentrations of sheep and llama occur. In sectors closer

to markets and urban areas llama tend to disappear and cattle production increases in the form of dairying and finishing beef animals. In the semi-arid provinces of Aroma and Pacajes (in the Department of La Paz) households generally possess from one to 12 cattle (average: four to seven), with sheep flocks on the order of 10 to 200 head (average: 40 to 80; Birbuet 1989; Jetté et al in press). The western sector the Department of Oruro has a population density of only two persons per square kilometer. Tichit (1995, 86) recorded the following range of livestock holdings for campesino families in Oruro: Llamas, 50 to 150; sheep, 80 to 120; and alpaca, four to 40. On the eastern side of the Altiplano in a region to the north of Potosí called Macha, the population density averages 10 to 15 persons per square kilometer (Caro 1992, 77). Caro (1992) also reported flock figures for Macha households as ranging from 75 to 400 llama and 30 to 300 sheep.

In the arid puna to the southwest human population density is very low (i.e., <1 person per

square kilometer; Muñoz-Reyes 1982; C. Jetté, IBTA/SR-CRSP, unpublished data). This is a region where *quinoa* dominates cultivation. *Quinoa* is the only cereal like crop in Bolivia that can endure the low temperatures and scant precipitation characteristic of the arid puna. Campesinos breed llama and sheep and are also engaged in harvesting salt for market. Caro (1992) cites work performed in the extreme south of the arid puna in which household livestock holdings averaged around 100 llama; households having >400 llama were regarded as wealthy. In another community to the west of the salar of Uyuni, llama flocks averaged 77 head with a range of 17 to 180 head. Sheep flocks averaged 114 head with a range of 17 to 229 (PSP 1992). Even today one can encounter large caravans of llama in the arid puna transporting salt to High Valleys where herders will barter it. Many peasants also conduct such trade, however, using trucks [Molina-Rivero (1987) cited in Harris et al (1987, 607-636)].

The high puna is synonymous with alpaca-dominated systems. Roughly three-fourths of Bolivia's alpaca production tends to be concentrated in high puna either north of Lake Titicaca above 4300 elevation, or in the Sajama and Pacajes provinces of Oruro and La Paz, respectively (Tichet 1991). Alpaca flocks in the high puna range in size from 15 to 2000 animals. Families in the high puna have been documented as having average livestock holdings comprised of around 100 alpaca, 30 sheep and 40 llama (Caro 1992, 80).

The face of poverty in Bolivia, as variously measured in terms of illiteracy, child mortality and limited access to potable water, health services and adequate housing, remains pre-eminently Andean and rural (Morales 1992; UDAPSO/INE/UPP/UDAPE 1993). Despite such observations, the proportion of total public spending in the rural Andes has never exceeded 10% until very recently (Morales 1990, 25; SNAG 1993, 3). In 1991 the state-controlled Agricultural Bank of Bolivia (Banco Agrícola de Bolivia) was closed; this had been the main credit source for campesinos but it had a long history of political interference and mismanagement. Since the mid-1980s the main development agents of the rural Altiplano have been non-governmental organisations (NGOs) and various forms of international co-operation. The impact of such groups has been limited, however, by lack of co-ordination and continuity of programmes (Van Niekerk 1992).

## 2.4 Overview of the study area at San José Llanga

### 2.4.1 Local environment

Our study site at San José Llanga (henceforth referred to in this chapter as SJL) is located in the east-central Altiplano between 17 20' and 17 30' South Latitude and 67 45' and 68 00' West Longitude, approximately 120 km southeast of the cities of La Paz and El Alto and 17 km south of the locally important town of Patacamaya. In the 1990s La Paz and El Alto have attained a combined population of over 1.1 million persons, while Patacamaya had a population of about 6000 in 1992 (GDRU 1994, 57). On the political map, SJL is a cantón (or district) that is part of the Umala municipality of Aroma Province, Department of La Paz (Figure 2.5). The Aroma province was home to about 66 000 persons in 1992, with the bulk of the population <24 years of age (Figure 2.6).

The Cantón of SJL has an area of 7200 hectares at an elevation between 3725 and 3786 m. The Cantón of SJL is typified by a relatively flat landscape (Plate 2.8a-c). A main town or barrio with 245 residents consists of a town square, church, a few shops and residences augmented with earthen-walled corrals (Plate 2.9a,b). The Cantón of SJL lies in what is typically referred to as the Patacamaya Basin. This basin is a flat, extensive, fluvio-lacustrine plain largely defined by the environs of the saline, perennial Desaguadero River, which runs about 15 km to the southeast of SJL. A portion of the water from the Desaguadero River is transported by a 23-km, unlined canal to SJL for irrigation of alfalfa. This canal was built in 1984 (see material that follows later in this section and also see Chapter 3: *Ecology and natural resources of San José Llanga*).

The rain-fed, seasonal *Khora Jahuíra* River offers fresh water during the rainy season and runs directly into the Cantón of SJL near the main town or barrio. This river was diverted more than a century ago by the campesinos to irrigate crops and some of the rangelands. Another perennial river called the Kheto occurs near the eastern boundary of the Cantón of SJL, and during the rainy season the Kheto River may flood and inundate rangelands at lower elevations. For maps and further details see Figures 3.2 to 3.4 in Chapter 3 (*Ecology and natural resources of San José Llanga*).

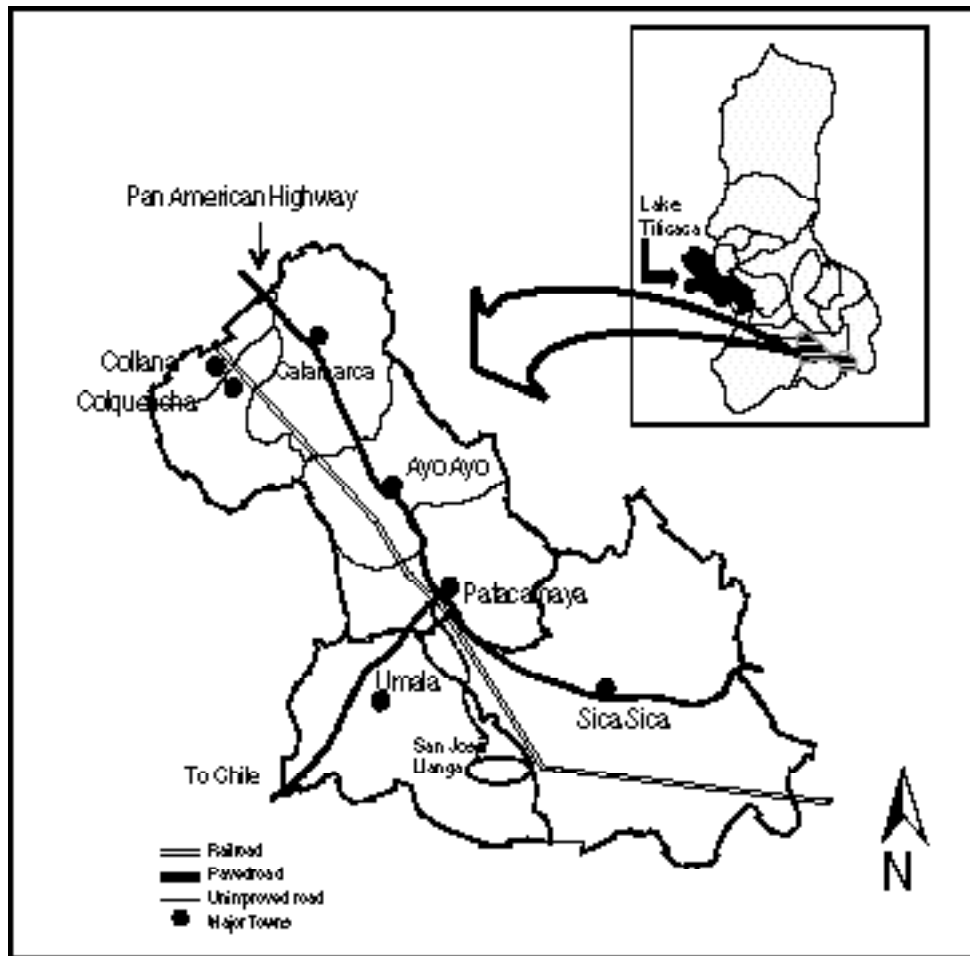


Figure 2.5. Map of Aroma Province in the Department of La Paz on the Bolivian Altiplano. Source: C. Jetté (IBTA/SR-CRSP, unpublished)

Climate data representing the Cantón of SJL have been collected over the past 42 years at the Patacamaya Experiment Station. This station is located 5 km to the west of the town of Patacamaya and 17 km north of the main barrio of SJL. The Patacamaya Experiment Station was established in 1958 and has been administered by IBTA. Climate data indicate that SJL is a semi-arid environment with significant risk of drought and common occurrence of crop-damaging frosts. Chapter 3 (*Ecology and natural resources of San José Llanga*) covers climate in detail.

The environment at SJL has influenced development of a complex and sophisticated agropastoral production system. The campesinos cultivate under rainfed, surface-irrigated and sub-irrigated situations. They also raise sheep and cows with improved and traditional (Criollo) breeds

often mixed in the same herds. Sheep dominate livestock production, typical of the semi-arid puna. About 48% of the area of the Cantón of SJL is native rangeland (including rain-fed and sub-irrigated sites), about 36% is dedicated to rain-fed cultivation mainly on an alluvial terrace (and to a lesser extent on alluvial fans), 5% is permanent, improved pasture and 1% is for surface-irrigated cultivation (see Chapter 3: *Ecology and natural resources of San José Llanga*). Unlike other neighbouring production systems in the semi-arid puna (such as at Pumani, for example; Hervé 1994), the relatively flat landscape at SJL does not allow use of steep, hillside cultivation to mitigate severe frost risk. Some protection from frost is offered, however, by the uneven topography of the alluvial terrace (Chapter 3: *Ecology and natural resources of San José Llanga*).

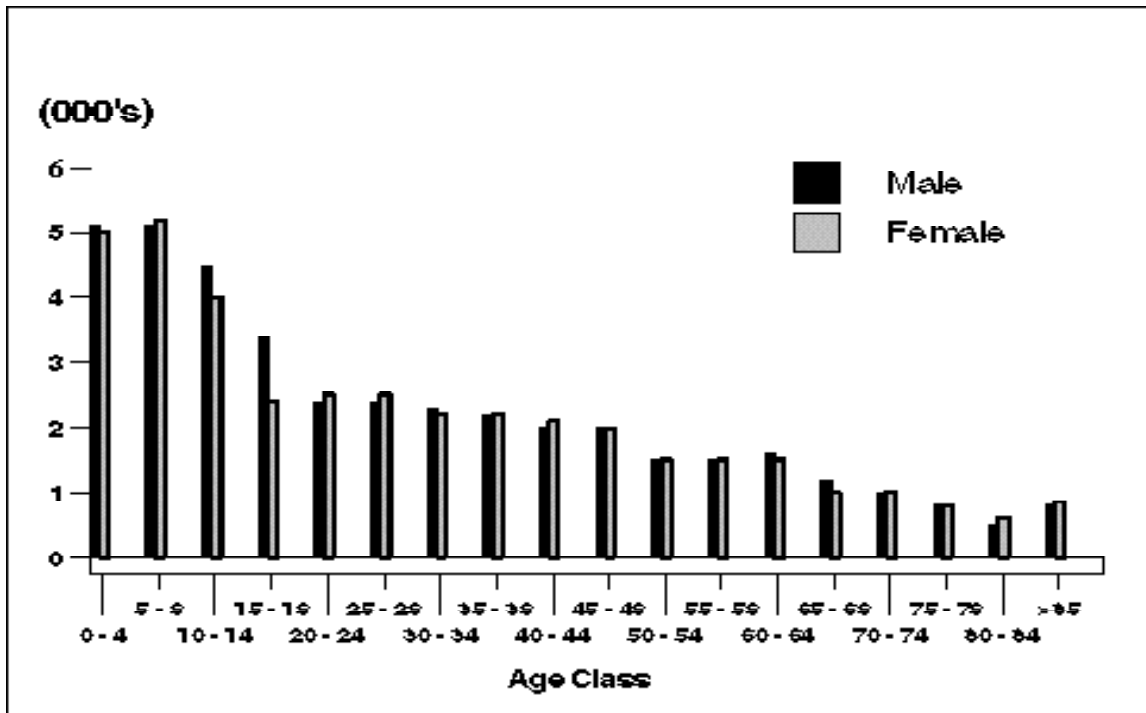


Figure 2.6. Age distribution by gender for people inhabiting Aroma Province in the Department of La Paz on the Bolivian Altiplano in 1991. Source: Created from data in INE (1992)

Despite the lack of hillside cultivation, the SJL site is representative of many locations on the semi-arid puna. The SJL site represents communities which tend to be closer to markets, have greater access to sub-surface water, and where beef and dairy production have emerged during the last decade in response to changing urban market opportunities and favourable government policies. The SJL community also has features which illustrate coping strategies found in more arid sectors, including the southern terminus of the Desaguadero River and the basin of Lake Poopó (Figure 2.3).

#### 2.4.2. Local society

Centuries ago people of the San José area were part of a larger *ayllu* named Llanga that was progressively split up during the Spanish colonial era (Paredes 1984). At the end of the eighteenth century the people of SJL had thus been cut off from resources traditionally held by the Llanga *ayllu*, but they were still able to sustain themselves and maintain their independence. Even with the resurgence of hacienda domination on the Altiplano by

the late 1800s (which claimed some neighbouring Indian communities) the people at SJL remained free. The residents of SJL were part of a larger indigenous group called *Umala* that was renowned for fierce defence of its lands against hacienda encroachment (Paredes 1984). Some current residents of SJL are shown in Plate 2.10(a,b).

From 1953, the Land Reform National Council typically gave free indigenous communities like SJL a collective (*pro indiviso*) title to the land they occupied. Within such communities higher-value lands (such as those used for cultivation) were assigned to households a long time ago. These households had real rights of possession except for a few restrictions on property transfer (Cala and Jetté 1994). For example, the main restriction on sale of arable land is that it can only be sold to someone from outside SJL if the prospective buyer is approved in advance by a council of community residents. With respect to rights of trespass, livestock may freely cross cultivation plots on their way to water or grazing land during times of year when potential damage to crops is minimal. Moreover, post-harvest or fallowed plots are regarded as freely accessible for



a



b



c

Plate 2.8 (a-c). Typical scenes of the agricultural system at San José Llanga: (a) cattle and sheep grazing on unimproved rangelands, (b) potato fields prior to harvest and (c) sheep grazing on subirrigated alfalfa (also referred to as alfalfares). Note the contrast of the flat terrain at SJL compared to that of hillside systems in Plate 2.4. Photographs: (a) Jim Yazman and (b,c) Christian Jetté

grazing throughout the ensuing dry season. Unlike many other indigenous communities, however, SJL does not have a communally managed system of sectoral fallowing (Orlove and Godoy 1986; Hervé 1994). What this means is that there is no collective determination of fallow duration, with each household free to cultivate its plots at any point in time. This way fallowing and cultivated plots are intermixed, which makes herding more labour intensive, as livestock feeding in fallow fields are not allowed to enter adjacent cultivated plots.

In contrast to the pattern of real ownership assigned to arable lands, it was typical that the grazing lands (of lower value compared to cropland) did not become owned by individuals but were instead communally used. In SJL these lands have been progressively divided up since



a



b

Plate 2.9 (a,b). Typical scenes of settlements at San José Llanga: (a) Plaza of the main Barrio and (b) houses with earthen-walled corrals. Photographs: (a) Brien E. Norton and (b) Christian Jetté



a



b

Plate 2.10 (a,b). Aymara residents of San José Llanga: (a) Women herders and (b) men and women at a town meeting. Photographs: (a) Lita Buttolph and (b) Christian Jetté

the 1950s among the resident households by action of local committees or leaders. Today, unlike many other communities, however, very little grazing land at SJL is truly communally used. Rather, the general pattern at SJL is one of private use of grazing plots when vegetation is abundant, and communal use of grazing during drier periods of the year (see Chapter 5: *The grazing livestock of San José Llanga*).

The differential rights and responsibilities for use of cropping and grazing lands at SJL underpin crucial aspects of stability and resilience of the agropastoral production system in response to environmental and economic perturbations. Communal authorities at SJL are responsible for enforcing rules of land use. These authorities include the *jilikata* (also called the Secretary of Justice) and two *Agentes de campo* (field agents), one for agriculture and the other for livestock (Cala 1994).

Today the Cantón of SJL consists of six socially distinct communities along with associated croplands and grazing lands. The six communities are defined according to factors of kinship and residence. The six communities occur either in the form of small settlements where the density of houses and other physical structures appears to increase, such as at *Callunimaya*, *Inkamaya* and *Espíritu Willq'i* with estimated populations of 45, 75 and 35 people, respectively, or as one larger settlement or main barrio [with a central square and other physical attributes of a town; Plate 2.9(a,b)]. The main barrio, however, is actually an aggregate of three social communities (i.e., *Savilani*, *Barrio* and *T'olatia*). This main barrio, again, has a total population of about 245 people (C. Jetté, IBTA/SR-CRSP, unpublished data).

The people of SJL have traditionally linked with larger neighbouring communities for market access and social activities. Until the 1960s the Cantón of SJL was most influenced by the economics and politics of the community of *Umala*, represented by a very old Mestizo town known for religious festivities and its silversmith industry. *Umala* is located about 10 km from the main barrio of SJL. Specific historical linkages between *Umala* and SJL included the obligation for SJL residents to assist the town's political and religious authorities with some services such as cleaning and communication, and to provide them with fuelwood. The SJL residents also participated actively in the celebration of the *Umala* annual religious festival, which was the occasion of an important commercial fair. The importance of *Umala* to SJL began to decline after implementation of land reform in the early 1950s. This was because, as in many other Mestizo towns in the Altiplano, the pre-revolutionary political and religious influences of *Umala* authorities was undermined. The silversmith industry declined and the town could not resist competition from new commercial fairs located closer to main roads (C. Jetté, IBTA/SR-CRSP, unpublished observations).

The Cantón of SJL started to become more influenced by the town and environs of Patacamaya in the 1950s. By the 1960s some SJL residents began to take advantage of the new Patacamaya Experiment Station, which has been previously described. Innovative campesinos gained access to extension workers and researchers based at the station, and one outcome was creation of agricultural co-operatives throughout the region, with support of the Agricultural Bank of Bolivia. One



such co-operative played a leading role in introducing new technologies and management practices into the Cantón of SJL. Innovations included use of tractors, chemical fertilisers, pesticides, new potato varieties for urban markets, alfalfa and improved breeds of sheep (see Chapter 3: *Ecology and natural resources of San José Llanga*, Chapter 4: *Household economy and community dynamics at San José Llanga*, and Chapter 7: *Patterns of technology adoption at San José Llanga*).

Links between the Cantón of SJL and the town of Patacamaya greatly accelerated by the late 1980s. In 1988 a development project sponsored by the European Economic Community (EEC) resulted in construction of a 16-km gravel road from Patacamaya town to the main barrio of SJL. This road effectively severed most residual linkages between SJL and *Umala* and established strong, new ties between SJL and Patacamaya. Patacamaya is a rapidly growing town centrally located on the Pan American Highway, which connects La Paz with Oruro and now provides an export corridor between Bolivia and Arica, Chile (Figure 2.5). The town of Patacamaya provides a variety of educational and other support services for the campesinos of SJL, but the most pervasive impact is related to development of new and reliable markets for agricultural products.

Formal financial institutions occur in the region, but have undergone recent changes (Rojas 1995). The main public-finance institution in the area since the 1960s, the Agricultural Bank of Bolivia, closed in 1991. Some non-governmental organisations previously provided in-kind credit to be used as agricultural inputs, but these gradually failed. New private financial institutions have recently appeared, however, in Patacamaya and Lahuachaca (Rojas 1995). These institutions lend small amounts of money for a variety of objectives on a short-term basis at high rates of interest. Communal authorities or groups of neighbours are asked to guarantee loans for individuals. Although Rojas (1995) reports that demand for such loans is increasing in the region, this has not been observed among campesino households of SJL (Dr. C. Valdivia, IBTA/SR-CRSP, personal observation). Lotteries and other informal, non-market mechanisms are employed at SJL to help residents obtain expensive livestock (e.g., dairy cattle) or secure access to land, labour, sheep and credit (Section 4.3.4: *Non-market factors in resource access*).

The inauguration of the road between SJL and Patacamaya town in 1989 encouraged a group of

SJL residents to create a local association of milk producers with the support of Fomento Lechero, an extension programme financed by Danchurchaid (of Denmark). This programme assisted milk production and delivery to a milk processing plant operated by PIL (Programa de Industrialización Lechera). The PIL was originally created as a parastatal network throughout Bolivia. The PIL of the Altiplano was created to help provide a milk processing and wholesale outlet for La Paz (Sherbourne et al 1995). The PIL worked with communities to provide credit and technical assistance to farmers who wanted to get involved with small-scale dairying. This assistance has often been focussed around procurement and management of improved dairy cattle. Each community has a PIL office in the main plaza where participating households report each morning to record their milk deliveries. Locally elected or appointed officials provide administration. The PIL sends a truck to the main barrio of SJL each morning to collect milk. Payments to members occur twice per month. Recently, the PIL office at SJL has been augmented with a refrigeration unit which increases flexibility in milk collection and handling (Sherbourne et al 1995). While operating as a parastatal, the PIL offered subsidies to members. The PIL processing plants at La Paz and Cochabamba, however, were privatised in late 1996. Local associations of milk producers now own 22% of the shares of the new private enterprise called PIL Andina (C. Jetté, IBTA/SR-CRSP, personal observations). Other implications of this programme are reviewed in Chapter 6 (*Household socioeconomic diversity and coping response to a drought year at San José Llanga*) and Chapter 7 (*Patterns of technology adoption at San José Llanga*).

The construction of the 23-km irrigation canal to bring water from the Desaguadero River to SJL was vital for development of more alfalfa plots under irrigation in the southeastern portion of the cantón. The salinity of these waters, however, poses problems for longer-term sustainability for these plots (Chapter 3: *Ecology and natural resources of San José Llanga*). All communities in SJL collaborated on this project with three other surrounding communities (namely, *T'uluma*, *Wari Chullpa*, and *Wancaroma*). Some support was provided by the World Food Programme (WFP). By expanding alfalfa cultivation, this irrigation project has allowed campesinos at SJL to better support smallholder dairying and production of improved sheep breeds by providing crucial nutritional resources during the dry season. As a consequence, in less than

five years the Patacamaya Basin has become one of the most important milk production areas in the Department of La Paz (Illanes et al 1995).

As previously reviewed, the Popular Participation Act passed by the Bolivian congress in 1994 provides for the creation and funding of rural municipalities through national tax revenues. This law should provide a vital stimulus for development of the Altiplano, and may also contribute to a resurgence of the community of *Umala* as the seat of local government and reinvigorate connections between *Umala* and the Cantón of SJL. Indeed the first mayor elected for *Umala*, in 1995, is a resident of SJL. This result is indicative of broader political change in a country where native people, although the majority of the population, gained the right to formal citizenship just 40 years ago. Reflective of such change, in 1993 the electorate chose an *Aymara* as vice president of Bolivia, namely Mr. Victor Hugo Cárdenas, the highest public office ever held by a member of an indigenous ethnic group. The adoption of the Popular Participation Act and other legislative reforms that broaden indigenous cultural and territorial rights has contributed to important changes. Now the challenge for Bolivia is to make significant breakthroughs to improve the economic conditions of its rural inhabitants.

## 2.5 Conclusions

This chapter provides an overall context for the SR-CRSP project at SJL. This broad review has revealed important issues relevant to understanding social and ecological dynamics on the Altiplano. Understanding these dynamics, in turn, is important for projects which aspire to alter or improve traditional agricultural production systems.

### 2.5.1 Recent policy shifts

Perhaps our most important finding is that despite a long and illustrious history of the *Aymara* prior to the 1500s, only very recently have national policies been even remotely favourable for the economic advancement of the *Aymara*. It is little wonder that economic deprivation appears to be a pervasive outcome for *Aymara* communities on the Altiplano.

Recent shifts in the national and regional policy environments may have positive consequences for the *Aymara*. These include: (1) Gradual democratisation, which has resulted, for example, in the election of the first *Aymara* vice president; (2) improved fiscal management of the nation,

which has created more economic opportunities in urban areas; (3) the recent Popular Participation Act provides a framework for increasing investment for community-based development on the Altiplano; (4) a re-focusing of activities for public agencies such as IBTA on technology generation and extension to better meet needs of rural communities; and (5) attempts to spur income-generating activities such as smallholder dairying on the Altiplano through parastatal organisations. Given apparent progress in this policy setting, the key is for *Aymara* communities, development agents and research entities to seize opportunities for progress now.

Some trends still appear unfavourable, however, for people like the *Aymara* on the Altiplano. These include: (1) high levels of food imports, which may depress commodity prices; (2) perceived land degradation; (3) a continued prioritisation of inputs for agriculture in the tropical lowlands at the expense of agriculture in the temperate highlands; and (4) unfavourable agricultural marketing policies.

### 2.5.2 General features of San José Llanga

Our research site at SJL is characterised by key features. These can be grouped according to the environment and socioeconomics. These features help define the degree to which results from the SJL study site could be extrapolated to other locations.

Like most production systems on the Altiplano, the Cantón of SJL is largely defined by its position and elevation on the landscape. It is a production system which relies on exploitation of the alluvial plains for cultivation and grazing. It therefore is not representative of production systems found in the nearby foothills of the Cordilleras. One obvious and basic consequence of landscape position is that the residents of SJL are not able to use hillside agriculture. This affects cropping and herding strategies, labour demands, risk profiles, etc. Another less-obvious consequence of landscape position is that compared to hillside production systems, the Cantón of SJL probably resembles more of a resource "sink" where nutrients, salts, soil and water slowly accumulate from surrounding areas. Unlike hillside systems, therefore, soil erosion due to heavy grazing or cultivation should be much less of an issue at SJL. Conversely, soil salinity could be more of a problem at SJL compared to that for hillside systems. All of

these landscape features should have profound influences on ecological and agricultural dynamics at SJL. They also have a bearing on the debate concerning biotic versus abiotic control of land-degrading processes; this will be discussed in subsequent chapters. Finally, it is evident that the people of SJL have engaged in ambitious engineering projects to modify water delivery systems. Human modification of the landscape thus occurs.

Today, the people at SJL have reasonably good access to markets. As will be discussed, this market access has likely affected the composition of crops and livestock at SJL and is probably important to how the community is able to cope with ecological and economic stress. From a historical perspective, such coping ability at SJL has probably been greatly compromised by the parcelisation of the Llanga *ayllus* due to hacienda encroachment.

By virtue of their proximity to markets and the Patacamaya Experiment Station, the residents of SJL have reasonably good access to novel agricultural technology. A general survey of crops and livestock also suggests that SJL incorporates a Mestizo technical culture in which mixes of indigenous and Spanish innovations occur. This latter feature is fairly common on the Altiplano. The dominance of sheep is typical in this part of the semi-arid puna. Proximity to markets also means proximity to major urban centres, which points to the likelihood of other social and economic influences such as enticements which draw rural youths to emigrate.

Finally, it is important to note that, in contrast to many of their neighbours, the people of SJL largely remained free from acute internal interference from colonial powers. The people of SJL have therefore been able to exert a higher degree of self-determination compared to many neighbouring communities. This has probably manifested itself in various aspects of resource use and resource tenurial regimes at SJL. One interesting finding is that land tenure at SJL varies with quality of land; higher value croplands tend to be privately used while lower value range is communally used.

In summary, at a general level of resolution, the Cantón of SJL is a patchwork of socioeconomic and ecological attributes which make it appear unique. One could probably make the same conclusion about any site on the Altiplano. Research findings from SJL, however, would probably be most comparable to those from other sites

on the semi-arid puna where (1) alluvial plains are the primary landscape type that is exploited; (2) access to markets and technology is reasonably good; and (3) indigenous culture for making resource-use decisions has been largely maintained. With regard to favourable proximity to markets and novel technology, the Cantón of SJL can serve as a "living laboratory" to observe effects of market integration and technology diffusion on an otherwise traditional campesino community.

## 2.6 Literature cited

Albó X. 1979. *¿Bodas de Plata? O Requiem para una Reforma Agraria*. Cuadernos de Investigación 17. CIPCA (Centro de Investigación y de Promoción del Campesino), La Paz, Bolivia. 103 pp.

Albó X. 1995. *Bolivia Plurilingüe*. Cuadernos de Investigación 44, vol. 1. UNICEF/CIPCA (Fondo de las Naciones Unidas para la Infancia/Centro de Investigación y de Promoción del Campesino), La Paz, Bolivia. 249 pp.

Alzérrec H. 1992. *Producción y Utilización de los Pastizales de la Zona Andina de Bolivia*. REPAAN/IBTA (Red de Pastizales Andinos/Instituto Boliviano de Tecnología Agropecuaria). Imprenta Papiro. La Paz, Bolivia. 146 pp.

Ambroggi R. 1965. *Hidrología del Altiplano de Bolivia*. Informe preliminar del fondo especial de las Naciones Unidas, La Paz, Bolivia. 11 pp.

Antezana A. 1992. *Estructura Agraria en el Siglo XIX*. CID (Centro de Información para el Desarrollo), La Paz, Bolivia. 218 pp.

Ayllu Sartañani. 1992. *Pachamamax Tipusiwa (la Pachamama se Enoja)*. I: *Qhurqhi*. Aruwiyiri editorial. La Paz, Bolivia. 208 pp.

Beck E. 1988. Las regiones ecológicas y las unidades fitogeográficas de Bolivia. En: de Morales C. (ed), *Manual de Ecología*. Instituto de Ecología, Universidad Mayor de San Andrés, La Paz, Bolivia. pp. 233-271.

Birbuet G. 1989. *La Ganadería Campesina en Pacajes: Estudio en el rea de Caquiaviri y Comanche*. SEMTA (Servicios Múltiples de Tecnología Apropiada), La Paz, Bolivia. 134 pp.

- Bouysse-Cassagne T. 1987. *La Identidad Aymara. Una Aproximación Histórica (Siglo XV, Siglo XVI)*. HISBOL/IFEA (Instituto de Historia Social Boliviano/Instituto Francés de Estudios Andinos), La Paz, Bolivia. 443 pp.
- Bouysse-Cassagne T. 1992. Past and present human populations. In: Dejoux C. and Ittis A. (eds), *Lake Titicaca. A Synthesis of Limnological Knowledge*. Kluwer Academic Publishers, Dordrecht, Holland. pp. 473-494.
- Brockmann C. (ed). 1986. *Perfil Ambiental de Bolivia*. USAID/IIIDE (United States Agency for International Development/Instituto Internacional Para el Desarrollo y Medio Ambiente), La Paz, Bolivia. 164 pp.
- Browman D. 1974. Pastoral nomadism in the Andes. *Current Anthropology* 15:188-196.
- Cabrera A. 1957. *La Vegetación de la Puna Argentina*. Revista de Investigaciones Agrícolas, Tomo XI, No. 4, Buenos Aires, Argentina. 412 pp.
- Cabrera A. 1968. *Ecología Vegetal de la Puna*. Colloquium Geographicum. Ferd Dummlers Verlag, Bonn, Germany. 91 pp.
- Cala E. 1994. *El Sistema de Tenencia de Tierras en la Comunidad San José Llanga*. BA tesis, Universidad Mayor de San Andrés, La Paz, Bolivia. 147 pp.
- Cala E. and Jetté C. 1994. *Posesión y Control de Tierras en Una Comunidad del Altiplano Central*. IBTA/SR-CRSP (Instituto Boliviano de Tecnología Agropecuaria/ Small Ruminant Collaborative Research Support Program) IBTA 138/ Boletín Técnico 07/SR-CRSP 09, La Paz, Bolivia. 37 pp.
- Cardozo A. 1994. Antecedentes de la ganadería bovina en la región Andina de Bolivia. En: Hervé D. and Rojas A. (eds), *Vías de Intensificación de la Ganadería Bovina en el Altiplano Boliviano*. ORSTOM/DANCHURCHAID (Institut Français de Recherche Scientifique pour le Développement en Coopération/Cooperación Técnica de la Iglesia Danesa), La Paz, Bolivia. pp. 15-19.
- Caro D. 1992. The socioeconomic and cultural context of Andean pastoralism. In: Valdivia C. (ed), *Sustainable Crop-Livestock Systems for the Bolivian Highlands. Proceedings of an SR-CRSP (Small Ruminant Collaborative Research Support Program) Workshop held at Lubbock, Texas, USA, 14-17 May 1991*. University of Missouri, Columbia, Missouri, USA. pp. 71-92.
- Carter W. y Albó X. 1988. La comunidad Aymara: Un mini-estado en conflicto. En: Albó X. (comp), *Raíces de América. El mundo Aymara*. Alianza Editorial, Madrid, España. pp. 451-492.
- Castillo A. 1994. Viabilidad económica de la producción lechera en las zonas norte y centro del Altiplano. En: Hervé D. and Rojas A. (eds), *Vías de Intensificación de la Ganadería Bovina en el Altiplano Boliviano*. ORSTOM/DANCHURCHAID (Institut Français de Recherche Scientifique Pour le Développement en Coopération/Cooperación Técnica de la Iglesia Danesa), La Paz, Bolivia. pp. 160-168.
- CEPAL (Comisión Económica para América Latina). 1982. *Campesinado y Desarrollo Agrícola en Bolivia*. CEPAL (Comisión Económica para América Latina), Santiago, Chile. 121 pp.
- CIACER/GEOBOL (Centro de Investigaciones y Aplicaciones de Censores Remotos/Geología Bolivia). 1985. Suelos. In: *Estudio Integrado de los Recursos Naturales del Departamento de La Paz*. CORDEPAZ (Corporación de Desarrollo del Departamento de La Paz), La Paz, Bolivia. 222 pp.
- Coudrain-Ribstein A., Pratz B., Quintanilla J., Zuppi G., Jusserand C. y Cahuaya D. 1995. La salinité de la ressource en eau souterraine de l'Altiplano central. En: Ribstein P. and Francou B. (eds), *Agua Glaciares y Cambios Climáticos en los Andes Tropicales*. ORSTOM/UMSA/SENAMHI/CONAPHI (Institut Français de Recherche Scientifique Pour le Développement en Coopération/Universidad Mayor de San Andrés/Servicio Nacional de Meteorología e Hidrología/Comité Nacional para el Programa Hidrológico Internacional), La Paz, Bolivia. pp. 97-107.
- Dandler J. 1984. El desarrollo de la agricultura, políticas estatales y el proceso de acumulación en Bolivia. *Estudios Rurales Latinoamericanos* 7: 81-143.
- Dollfus O. 1981. *El Reto del Espacio Andino*. IEP (Instituto de Estudios Peruanos), Lima, Perú. 141 pp.

- Donkin R. 1979. *Agricultural Terracing in the Aboriginal New World*. Viking Fund Publications in Anthropology, no. 56. Wenner-Gren Foundation for Anthropological Research, Inc., and The University of Arizona Press, Tucson, Arizona, USA. 196 pp.
- Ellenberg H. 1979. Man's influence on tropical mountain ecosystems in South America. *Journal of Ecology* 67:401-416.
- Ellenberg H. 1981. *Desarrollar Sin Destruir*. Instituto de Ecología, Universidad Mayor de San Andrés, La Paz, Bolivia. 55 pp.
- Erickson C. 1986. Agricultura en camellones en la cuenca del Lago Titicaca: Aspectos técnicos y su futuro. En: de la Torre C. y Burga M. (eds). *Andenes y Camellones en el Perú Andino: Historia Presente y Futuro*. CNTC (Consejo Nacional de Ciencia y Tecnología), Lima, Perú. pp. 331-350.
- Erickson C. 1992. Prehistoric landscape management in the Andean highlands: Raised-field agriculture and its environment impact. *Population and Environment Journal* 13:285-301.
- Eróstegui R. 1990. La industria textil boliviana. En: Eróstegui R. (ed), *La Industria: Problemas y Perspectivas*. ILDIS (Instituto Latinoamericano de Investigaciones Sociales), La Paz, Bolivia. pp. 151-163.
- FAO (Food and Agriculture Organization). 1975. *Estudio Agroclimatológico de la Zona Andina*. Proyecto Inter-institucional en Agroclimatología, FAO, Roma, Italia. 236 pp.
- Franqueville A. y Aguilar G. 1988. *El Alto de La Paz. Migraciones y Estrategias Alimentarias en Bolivia*. INAN/ORSTOM (Institut National de Alimentación y Nutrición/Institut Français de Recherche Scientifique Pour le Développement en Coopération), La Paz, Bolivia. 163 pp.
- Franklin W. 1971. High, wild world of the vicuña. *National Geographic* 143:76-91.
- Freeman P., Cross B., Flannery R., Harcharik D., Hartshorn G., Simmonds G. and Williams J. 1980. *Bolivia: State of the Environment and Natural Resources - a Field Study*. USAID (United States Agency for International Development) contract no. PDC-C-Q247. JRB Associates, Inc., McLean, Virginia, USA. ca. 300 pp.
- Gaceta Oficial de Bolivia*. 1994. *Ley de Participación Popular*. Anno XXXIV, No 1828. La Paz, Bolivia. 20 pp.
- GASO (Grupo de la Agenda Social). 1995. *Bolivia. Desarrollo Diferente para un País de Cambios. Informe Final de la Misión Piloto Sobre Reforma Socio-Económica en Bolivia*. BID (Banco Interamericano de Desarrollo), La Paz, Bolivia. 274 pp.
- Gastó J., Cosio F. y Panario D. 1993. *Clasificación de Ecoregiones y Determinación de Sitio y Condición: Manual de Aplicación a Municipios y Predios Rurales*. REPAAN/CIID (Red de Pastizales Andinos/Centro Internacional de Investigaciones para el Desarrollo), Santiago, Chile. 253 pp.
- GDRU (Grupo de Desarrollo Rural). 1994. *Bolivia. Anuario Estadístico del Sector Rural 1994*. CID (Centro de Información para el Desarrollo), La Paz, Bolivia. 331 pp.
- Genin D. y Alzérreca H. 1995. Reseña de la vegetación de la zona de Turco. En: Genin D., Picht H., Lizarazu R. y Rodríguez T. (eds), *Waira pampa. Un Sistema Pastoril Camélidos - Ovinos del Altiplano rido Boliviano*. ORSTOM/CONPAC/IBTA (Institut Français de Recherche Scientifique Pour le Développement en Coopération / Programa de Autodesarrollo Campesino fase de Consolidación/Instituto Boliviano de Tecnología Agropecuaria), La Paz, Bolivia. pp 35-56.
- Golte J. 1980. *La Racionalidad de la Organización Andina*. IEP (Instituto de Estudios Peruanos), Lima, Peru. 124 pp.
- Harris O., Larson B. y Tandeter E. (comp). 1987. *La Participación Indígena en los Mercados Surandinos. Estrategias y Reproducción Social, Siglos XVI a XX*. CERES (Centro de Estudios de la Realidad Económica y Social), La Paz, Bolivia. 768 pp.
- Healy K. 1991. *Structural Adjustment, Peasant Agriculture and Coca in Bolivia*. Unpublished paper presented at the XVI International Congress of the Latin American Studies Association, Washington, DC, USA. 49 pp.

- Heath D., Erasmus C. and Buechler H. 1969. *Land Reform and Social Revolution in Bolivia*. Praeger Press, New York, New York, USA. 464 pp.
- Hervé D. 1994. Desarrollo Sostenible en los Andes Altos. Los sistemas de cultivo con descanso largo pastoreado. En: Hervé D., Genin D. y Rivière G. (eds), *Dinámicas del Descanso de la Tierra en los Andes*. ORSTOM/IBTA (Institut Français de Recherche Scientifique Pour le Développement en Coopération/Instituto Boliviano de Tecnología Agropecuaria), La Paz, Bolivia. pp. 15-36.
- Hudson A. and Hanratty D. (eds). 1989. *Bolivia: A Country Study*. Federal Research Division of the United States Library of Congress, Washington, DC, USA.
- IBTA (Instituto Boliviano de Tecnología Agropecuaria). 1992. *Análisis Ex-Ante de Alternativas Tecnológicas. Proyecto Sistemas de Producción en el Altiplano Boliviano*. IBTA Boletín Técnico no. 128, La Paz, Bolivia, 74 pp.
- Illanes P., Cuesta M. y Céspedes J. 1995. *Adopción de Tecnología en la Producción Lechera. Estudio de Caso de la Comunidad San José Llanga*. IBTA/SR-CRSP (Instituto Boliviano de Tecnología Agropecuaria/Small Ruminant Collaborative Research Support Program) IBTA 147/Boletín Técnico 15/SR-CRSP 17, La Paz, Bolivia. 35 pp.
- INE (Instituto Nacional de Estadísticas). 1993. *Censo 1992. Resultados Finales*. Vol. 2, 4, y 5. INE, La Paz, Bolivia. 233 pp.
- INTECSA (Internacional de Ingeniería y Estudios Técnicos Sociedad Anónima). 1993. *Plan Director Global Binacional de Protección-Prevención de Inundaciones y Aprovechamiento de los Recursos del Lago Titicaca, Río Desaguadero, Lago Poopó y Lago Salar de Coipasa (Sistema T.D.P.S.). Estudio de Climatología*. Republicas de Perú y Bolivia. EEC (European Economic Community), La Paz, Bolivia. 581 pp.
- Jetté C., Loyza V. y Rojas R. In press. Monografía de la Provincia Aroma. Situación social y pobreza. En: CIDES/UMSA/PNUD (Centro de Investigación para el Desarrollo/Universidad Mayor de San Andrés/Programa de las Naciones Unidas para el Desarrollo), *Desarrollo Humano y Pobreza en las Provincias de Caranavi y Aroma*. CID (Centro de Información para el Desarrollo), La Paz, Bolivia. pp. 99-170
- King L. 1962. *The Morphology of the Earth: A Study and Synthesis of World Summaries*. Hafner Publishing Company, New York, New York, USA. 699 pp.
- Klein H. 1984. *Historia General de Bolivia*. Editorial Juventud, La Paz, Bolivia. 361 pp. [original title, publisher and publication date: *Bolivia: The Evolution of A Multi-Ethnic Society*. Oxford University Press, Oxford, UK, 1982.]
- Klein H. 1995. *Haciendas y Ayllus en Bolivia*, ss. XVIII y XIX. Instituto de Estudios Peruanos, Lima, Peru. 236 pp. [original title, publisher, and publication date: *Haciendas & Ayllus. Rural Society in the Bolivian Andes in the Eighteenth and Nineteenth Centuries*. Stanford University Press, Stanford, California, USA, 1993.]
- Kolata A. 1993. *The Tiwanaku: Portrait of an Andean Civilization*. Blackwell Publishers, Cambridge, Massachusetts, USA. 317 pp.
- Lara R. y Alzérreca H. 1986. Pastizales. En: Brockman C. (ed), *Perfil Ambiental de Bolivia*. USAID/IIDA (United States Agency for International Development/Instituto Internacional para el Desarrollo), La Paz, Bolivia. pp. 82-96.
- LeBaron A., Bond L., Aitken P. and Michaelsen L. 1979. An explanation of the Bolivian highlands grazing-erosion syndrome. *Journal of Range Management* 32:201-208.
- López C. 1993. *Biografía de Bolivia*. Editorial Juventud, La Paz, Bolivia. 166 pp.
- Lorini J. 1987. *Climatología de la Cuenca del Lago Titicaca (Bolivia-Perú)*. Proyecto: Evaluación de los Recursos del Lago Titicaca. OLDEPESCA (Organización Latinoamericana de Pesquería), Lima, Perú. 48 pp.
- Lorini J. y Libermann N. 1983. El clima de la provincia Aroma del departamento de La Paz-Bolivia. En: Comité de Redacción del Instituto de Ecología (eds), *Ecología en Bolivia*. No. 4. Revista del Instituto de Ecología. La Paz, Bolivia. pp. 19-29.

- Lorini J. 1995. El ecosistema altiplánico, situación actual. En: Tejada E. y Defilippis D. (eds), *Lineamientos de Políticas para el Desarrollo Sostenible del Recurso Camélido. Documentación del Seminario Taller Nacional*. RBPC/PRODENA/CERENA (Red Boliviana de Producción de Camélidos/Asociación Boliviana Pro-defensa de la Naturaleza/Centro de Economía y Recursos Naturales), La Paz, Bolivia. pp. 39-44.
- MACA (Ministerio de Asuntos Campesinos y Agropecuarios). 1990a. *Lineamientos de Política Agropecuaria*. Internal Report. Subsecretaría de Desarrollo Agropecuario, Proyecto MACA/FAO/PNUD (Ministerio de Asuntos Campesinos y Agropecuarios/Food and Agriculture Organization/Programa de las Naciones Unidas para el Desarrollo), BOL/88/201, La Paz, Bolivia. 64 pp.
- MACA (Ministerio de Asuntos Campesinos y Agropecuarios). 1990b. *Decreto Supremo No. 22565 de Fortalecimiento y Modernización del IBTA*. Serie Documentos Legales y Administrativos no. 1. MACA, La Paz, Bolivia. 20 pp.
- MACA/IBTA (Ministerio de Asuntos Campesinos y Agropecuarios/ Instituto Boliviano de Tecnología Agropecuaria). 1992. *IBTA. Instituto Boliviano de Tecnología Agropecuaria*, MACA/IBTA, Imprenta papiro, La Paz, Bolivia. 36 pp.
- Malloy J. 1970. *The Uncompleted Revolution*. University of Pittsburgh Press, Pittsburgh, USA. 396 pp.
- Marconi R. 1996. *ONG's y Crédito Rural en Bolivia*. FINRURAL (Asociación de Instituciones Financieras para el Desarrollo Rural), La Paz, Bolivia. 74 pp.
- McCorkle C. (ed). 1990. *Improving Andean Sheep and Alpaca Production: Recommendations From a Decade of Research in Peru*. SR-CRSP (Small Ruminant Collaborative Research Support Program). University of Missouri, Columbia, Missouri, USA. 220 pp.
- MDSMA (Ministerio de Desarrollo Sostenible y Medio Ambiente). 1996. *Ley del Servicio Nacional de Reforma Agrario*. MDSMA, La Paz, Bolivia. 23 pp.
- Medicaneli X., Jimenez R. and Quiton M. 1993. *Historia Demográfica de Aroma-Umala-San José*. Unpublished research report. IBTA/SR-CRSP (Instituto Boliviano de Tecnología Agropecuaria/ Small Ruminant Collaborative Research Support Program), La Paz, Bolivia. 130 pp.
- Montes de Oca I. 1989. *Geografía y Recursos Naturales de Bolivia*. Imprenta superel, La Paz, Bolivia. 574 pp.
- de Morales C. 1990. *Bolivia. Medio Ambiente y Ecología Aplicada*. Instituto de Ecología, Universidad Mayor de San Andrés, La Paz, Bolivia. 318 pp.
- Morales J. 1990. Impacto de los ajustes estructurales en la agricultura campesina Boliviano. En: Toranzo C. (ed), *El Impacto de la NPE (Nueva Política Económica) en el Sector Agropecuario*. COTESU/MACA/ILDIS (Cooperación Técnica Suiza/Ministerio de Asuntos Campesinos y Agropecuarios/Instituto Latinoamericano de Investigaciones Sociales), La Paz, Bolivia. pp. 9-69.
- Morales R. 1991. *The Impact of the Macroeconomic Policy Reform on Poverty, Household Food Security and Nutrition in Bolivia*. Unpublished paper presented at a workshop on Economic Policy Reforms and the Poor in Latin America, held in Cali, Colombia, October 1991. Econométrica, La Paz, Bolivia. 48 pp.
- Morales R. 1992. *Estudio Sobre reas de Pobreza Rural en Bolivia*. Second edition. Caritas, La Paz, Bolivia. 248 pp.
- Morales R., Azero R., Szmuckler A. and Mollinedo F. 1995. *Desarrollo Humano en la Montañas. Informe del Desarrollo Humano de la Ciudad de La Paz*. GMLP/UNDP(Gobierno Municipal de La Paz/Programa de las Naciones Unidas para el Desarrollo), La Paz, Bolivia. 277 pp.
- Mourguiart P., Argollo J. y Wirrmann D. 1995. Evolution paléohydrologique du bassin du lac Titicaca au cours de l'holocène. En: Ribstein P. and Francou B. (eds), *Aguas Glaciares y Cambios Climáticos en los Andes Tropicales*. ORSTOM/UMSA/SENAMHI/CONAPHI (Institut Français de Recherche Scientifique Pour le Développement en Coopération /Universidad Mayor de San Andrés/Servicio Nacional de

- Meteorología e Hidrología/Comité Nacional para el Programa Hidrológico Internacional), La Paz, Bolivia. pp. 161-169.
- Muñoz-Reyes J. 1982. *Geografía y Recursos Naturales de Bolivia*. Academia Nacional de Ciencias de Bolivia, La Paz, Bolivia. 515 pp.
- Murra J. 1975. El control vertical de un máximo de pisos ecológicos en la economía de las sociedades Andinas. En: Murra J. (ed), *Formaciones Económicas y Políticas del Mundo Andino*. IEP (Instituto de Estudios Peruanos), Lima, Perú. pp. 59-115.
- Murra J. 1988. El Aymara libre de ayer. En: Albó X. (comp), *Raíces de América. El Mundo Aymara*. Alianza Editorial, Madrid, España. pp. 51-73.
- Orlove B. 1987. Stability and change in highland Andean dietary patterns. In: Harris M. and Ross E. (eds), *Food and Evolution: Toward a Theory of Human Food Habits*. Temple University Press, Philadelphia, Pennsylvania, USA. pp. 481-515.
- Orlove B. and Godoy R. 1986. Sectoral fallowing systems in the central Andes. *Journal of Ethnobiology* 6:169-204.
- Painter M. 1992. Changes in highland land use patterns and implications for agropastoral development. In: Valdivia C. (ed), *Sustainable Crop Livestock Systems for the Bolivian Highlands. Proceedings of an SR-CRSP (Small Ruminant-Collaborative Research Support Program) Workshop held at Lubbock, Texas, USA, May 1991*. University of Missouri, Columbia, Missouri, USA. pp. 92-121.
- Paredes R. 1984. *La Provincia de Sicasica*. Second edition. Isla, La Paz, Bolivia. 62 pp.
- Paz Ballivián D. 1992. *Región y Desarrollo Agrario*. Vol II, Zona 01. ANCB (Academia Nacional de Ciencias de Bolivia) Secretaria Ejecutiva PL-480, La Paz, Bolivia. 88 pp.
- Pérez-Crespo C. 1991. *Migration and the Breakdown of a Peasant Economy in Central Bolivia*. IDA (Institute for Development Anthropology) Working Paper Number 82. State University of New York, Binghamton, New York, USA. 39 pp.
- PNUD (Programa de las Naciones Unidas para el Desarrollo). 1994. *Informe Sobre Desarrollo Humano 1994*. FCE (Fondo de Cultura Económica), México D.F. 243 pp. [original author, title and publisher: UNDP (United Nations Development Programme). 1994. *Human Development Report 1994*. Oxford University Press, New York, New York, USA].
- PNUD/AECI/MOPI-SGMA (Programa de las Naciones Unidas para el Desarrollo/Agencia Española de Cooperación Internacional/Ministerio de Obras Públicas y Urbanismo/Secretaría General del Medio Ambiente). 1990. *Desarrollo y Medio Ambiente en América Latina y el Caribe: Una Visión Evolutiva*. Secretaría General Técnica-MOPU. Imp. Neografis. Madrid, España. 231 pp.
- Posnansky M. 1982. Los efectos sobre la ecología del altiplano de la introducción de animales y cultivos por los españoles. En: Geyger E. y Arze C. (eds), *Ecología y Recursos Naturales en Bolivia*. Instituto de Ecología, University Mayor de San Andrés. La Paz, Bolivia.
- PSP (Proyecto Sistemas de Producción). 1992. *Resultados del Sondeo de Cinco Comunidades del Altiplano Boliviano*. Publicaciones técnicas no 2. IBTA/CIID (Instituto Boliviano de Tecnología Agropecuaria/Centro Internacional de Investigación para el Desarrollo), La Paz, Bolivia. 143 pp.
- Preston D. 1977. *Rural-Urban Interaction and the Market Systems: The Bolivian Altiplano After Land Reform*. Working Paper No. 174. University of Leeds, Leeds, UK. 27 pp.
- Prudencio J. 1993. El impacto de las donaciones alimentarias en Bolivia. En: MCTH (Misión Cooperación Técnica Holandesa) (eds), *Autosuficiencia o Inseguridad Alimentaria: El Rol de los Alimentos Donados en Bolivia*. ILDIS (Instituto Latinoamericano de Investigaciones Sociales), La Paz, Bolivia. pp. 33-60.
- Rivera S. 1992. *Ayllus y proyectos de desarrollo en el norte de Potosí*. Editorial Aruwiwiri, La Paz, Bolivia. 192 pp.
- Rojas R. 1995. *Mercados Financieros Rurales en la Región Andina. Zona de Estudio: La Paz*. CEP (Centro de Estudios y Proyectos). La Paz, Bolivia. 35 pp.



- Ruthsatz B. 1977. *Pflanzengesellschaften und Ihre Lebensbedingungen in den Andinen Halbwüsten Nordwest-Argentiniens*. Dissertationes Botanica. Band 39. Vaduz, Austria. 168 p.
- Ruthsatz B. and Fisel U. 1984. The utilization of natural resources by a small community in the highlands of Bolivia and its effects on vegetation cover and site conditions. In: *Erdwissenschaftliche Forschung*. Band XVIII. Franz Steiner Verlag Wiesbaden GmbH, Stuttgart, Germany. pp. 211-234.
- Salm H. y Gehler E. 1987. La salinización del suelo en el altiplano central de Bolivia y su influencia sobre la cobertura vegetal. En: CRIE (Comité de Redacción de Instituto de Ecología) (eds), *Ecología en Bolivia*. Revista del Instituto de Ecología, No. 10. La Paz, Bolivia. pp. 37-48.
- Sammells C. y Markowitz L. 1994. *Carne de Llama: Alta Viabilidad, Baja Visibilidad*. IBTA/SR-CRSP (Instituto Boliviano de Tecnología Agropecuaria/Small Ruminant Collaborative Research Support Program) IBTA 140/Boletín Técnico 09/SR-CRSP 09, La Paz, Bolivia. 32 pp.
- Sánchez-Albornoz N. 1978. *Indios y Tributos en el Alto Perú*. IEP (Instituto de Estudios Peruanos), Lima, Peru. 224 pp.
- Sandoval G. y Sostres F. 1991. *La Ciudad Prometida*. ILDIS (Instituto Latinoamericano de Investigaciones Sociales), La Paz, Bolivia. 230 pp.
- Sebill N. 1989. *Ayllus y Haciendas. Dos Estudios de Caso Sobre la Agricultura Colonial en Los Andes*. HISBOL (Instituto de Historia Social Boliviana), La Paz, Bolivia. 142 pp.
- Sherbourne J., Dunn E., Valdivia C. and Nolan M. 1995. *Agropastoral Production Systems, Intra-household Resource Allocation and Household Members Domains: Five Case Studies from the Community of San José Llanga*. IBTA/SR-CRSP (Instituto Boliviano de Tecnología Agropecuaria/Small Ruminant Collaborative Research Support Program). IBTA 171/Boletín Técnico 39/SR-CRSP 37. 50 pp.
- SIPFE (Secretaría de Inversión Pública y Financiamiento Externo). 1996. *La Estrategia para la Transformación Productiva del Agro*. Presentación del gobierno de Bolivia al Grupo Consultivo (Paris, Francia, March 1996). Ministerio de Hacienda. La Paz, Bolivia. 70 pp.
- SNAG (Secretaría Nacional de Agricultura y Ganadería). 1993. *Estrategia de Desarrollo Agropecuario 1994/2003. Un Camino Contra la Pobreza*. Internal document. SNAG, La Paz, Bolivia. 159 pp.
- SR-CRSP (Small Ruminant Collaborative Research Support Program). 1994. Republic of Bolivia. In: Johnson S. (ed), *SR-CRSP Annual Report 1994*. Management Entity, SR-CRSP, University of California, Davis, California, USA. pp. 1-70.
- Le Tacon P., Vacher J., Eldin M. y Imaña E. 1992. Los riesgos de helada en el Altiplano Boliviano. En: Morales D. and Vacher J. (eds), *Actas del VII Congreso Internacional Sobre Cultivos Andinos*. IBTA/ORSTOM/CIID (Instituto Boliviano de Tecnología Agropecuaria/ Institut Français de Recherche Scientifique Pour le Développement en Coopération/Centro Internacional de Investigación para el Desarrollo), La Paz, Bolivia. pp. 287-291.
- Tichit M. 1991. *Los Camélidos de Bolivia*. FADES (Fundación para Alternativas de Desarrollo) and Editorial EDOBOL, La Paz, Bolivia. 154 pp.
- Tichit M. 1995. Diversidad de la actividad ganadera en las unidades de producción de Turco marka. En: Genin D., Picht H., Lizarazú R. y Rodríguez T. (eds), *Waira pampa. Un Sistema Pastoril Camélidos - Ovinos del Altiplano rido Boliviano*. ORSTOM/CONPAC/IBTA (Institut Français de Recherche Scientifique Pour le Développement en Coopération/Programa de Autodesarrollo Campesino fase de Consolidación/ Instituto Boliviano de Tecnología Agropecuaria), La Paz, Bolivia. pp. 73-89.
- Tosi J., Unzueta O., Holdridge L. y Gonzales A. 1975. *Mapa Ecológico de Bolivia*. MACA (Ministerio de Asuntos Campesinos y Agropecuarios), La Paz, Bolivia. 308 pp.
- UDAPSO/INE/UPP/UDAPE (Unidad de Análisis de Políticas Sociales/Instituto Nacional de Estadísticas/Unidad de Políticas de Población/Unidad de Análisis de Políticas Económicas). 1993. *Mapa de Pobreza. Una Guía Para la Acción Social*. UDAPSO/INE/UPP/UDAPE, La Paz, Bolivia. 389 pp.

Urioste M. 1992. *Fortalecer las Comunidades*. AIIPE/PROCOM/TIERRA (Asociación de Instituciones de Promoción y Educación/ Programa de Contención Migratoria/Taller de Iniciativas Rurales y Reforma Agraria), La Paz, Bolivia. 264 pp.

Vacher J., Brasier de Thuy E. and Libermann M. 1992. Influence of the lake on littoral agriculture. In: Dejoux C. and Iltis A. (eds), *Lake Titicaca. A Synthesis of Limnological Knowledge*. Kluwer Academic Publishers, Dordrecht, Holland. pp. 511-522.

Valencia S. y Jetté C. 1995. *Estrategias de Reproducción Familiar y Tenencia de Recursos, en una Comunidad del Altiplano Occidental*. IBTA/SR-CRSP (Instituto Boliviano de Tecnología Agropecuaria/Small-Ruminant Collaborative Research Support Program) IBTA 172/Boletín Técnico 40/SR-CRSP 38, La Paz, Bolivia, 40 pp.

Van Niekerk N. 1992. *La Cooperación Internacional y la Persistencia de la Pobreza en los Andes Bolivianos*. UNITAS/MCTH (Unión Nacional de Instituciones para el Trabajo Social/Misión de Cooperación Técnica Holandesa), La Paz, Bolivia. 178 pp.

van Kessel J. 1992. Tecnología Aymara: un enfoque cultural. En: Van Denberg H. and Schiffers N. (eds), *La Cosmovision Aymara*. HISBOL/UCB (Instituto de Historia Social Boliviana/Universidad Católica Boliviana), La Paz, Bolivia. pp. 187-219.

Walker R. 1984. *Vicuñas and Pastoralists on the Peruvian Altiplano*. Unpublished report. Range Honors Program, Department of Range Science. Utah State University, Logan, Utah, USA. 125 pp.

Zeballos H. 1993. *Agricultura y Desarrollo Económico II*. CID (Centro de Información para el Desarrollo), La Paz, Bolivia. 302 pp.

