

Andean Livelihood Strategies and the Livestock Portfolio

Corinne Valdivia

Corinne Valdivia is research associate professor of agricultural economics at the University of Missouri-Columbia.

Introduction

Livestock plays many roles in the lives of people and the environment. At the same time, the way in which livestock impact on the welfare of rural families depends on internal and external events to the household. Natural hazards, market uncertainties, political unrest, and government policies are among the many external forces that have an effect on individuals, households, and communities. Internal ones may be idiosyncratic shocks or endogenous changes that affect relations within the household. What are the conditions, factors, and behaviors that benefit rural households and individuals? What roles do livestock play in this process, and how external events shape household relations, within and outside?

The following sections present a framework for the analysis of livelihoods, economic portfolios and livestock assets; describe the setting, ongoing livelihood strategies of Andean rural households in an *Altiplano* community between 1992 and 1999, and the gendered nature of production activities; develop quantitative methods to evaluate the diversity of household portfolios and the roles livestock assets play; and discuss the implications of the changing composition of these portfolios resulting from external forces and policy alternatives. Quantitative analysis through time provides a dynamic perspective of the changes, and the measurement of diversity of household activities, lessons on how livestock and other assets can reduce rural livelihood vulnerability. The goal of this research thrust is to provide a framework of analysis that contributes to an understanding of rural household strategies and their resilience, and draw lessons on the constraints and opportunities to improve the welfare of rural families in the Andes.

Rural Livelihood Strategies

A livelihood encompasses the income generating activities pursued by a household and its individuals, and the social institutions, intrahousehold relations, and mechanisms of access to resources through the life cycle (Ellis 1998). The purpose of understanding livelihood strategies is to shed light on how and when individuals, households, and groups negotiate among themselves, with their communities, markets and society to improve their well being or reduce food insecurity by appropriating the benefits from their assets, activities, and investments (Valdivia and Gilles 2001; Winters et al. 2002). The interaction between actors and structure are the bases for processes of social inclusion and exclusion (de Haan 2000). The exclusion of groups refers to lack of access by groups or individuals to resources in order to achieve a sustainable livelihood; sustainability implies resilience and social inclusion (de Haan 2000:343). Human, natural, financial, social, and physical capitals are resources or vital capitals (de Haan 2000; Conway and Chambers 1992; Bebbington 1999). Access and claims are based on networks, institutions, or relationships, which constitute their social capital (World Bank 1998; De Haan 2000:345-6). Non-market institutions as means to access resources or assets (Valdivia and Jetté 1997) are therefore also a form of social capital.

Adaptation to stress and shock is an important dimension of family welfare. Some adaptations take place in anticipation of a possible event, such as choosing activities in an economic portfolio to account for seasonality of income generation. Others take place ex-post, to adapt to an event. In both cases human agency is the hinge between actors (individuals, households, communities) and structure (de Haan 2000: 349). Agency is defined as the capacity of people to integrate experiences into their livelihood strategies and to seek outlets for ambitions and solutions to problems, embodied in the individual but embedded in social relations through which agency becomes effective (de Haan 2000), recognizing that structural bottlenecks and barriers exist that are negotiated. De Haan defines structure as the shell in which the

five capitals are embedded. The structure has three parts: a social that consists of the rules that govern common norms (social capital); an economic that is defined by the forces of supply and demand; and a political part expressed by the power relations. According to de Haan (2000:351) structure often determines the direction of the outcome, although through agency it can change. The argument is that the relationship is not deterministic. Structures are no longer believed to determine the final outcome of a livelihood strategy, nor the individual's action alone, determines the outcome. Exclusion, and therefore inability to sustain a livelihood (de Haan 2000), is one of the outcomes from two possible conditions: one, in which in order for a group to succeed the other on purpose is left behind; or one is simply left behind because of bottlenecks. A global study of livelihoods (Blumberg et al. 1995) observed that similar strategies in geographically disparate localities can bring about similar outcomes, and, similar phenomena like structural adjustment can bring about very different outcomes (Blumberg et al. 1995; Valdivia 2001). The articulation of forms of production and social relations with the agency of individuals, households, and communities, in markets and society at large have resulted in two possible opposing outcomes: expropriation, or accumulation (Ferguson 1992; Blumberg et al. 1995).

When individuals, households, or groups access and use resources, these become assets that create a stream of benefits (Valdivia and Gilles 2001). Access gives individuals the capability (Bebbington 1999) to build their livelihoods. "Assets are not only 'things' to allow survival, but they are also the basis of agents of power to act" (Bebbington 1999:2022). Access though, differs from control in that the latter implies a recognized form of ownership or right to the stream of benefits derived from the resource (Zwarteveen and Meinzen-Dick 2001; Agarwal 1994; Valdivia 2001). For example, women often have access through male mediation (Zwarteveen and Meinzen-Dick 2001). Differences in control and property rights (Agarwal 1994) may lead to inefficient management and threaten the welfare and food security of rural families (Quisumbing et al. 1995; Zwarteveen and Meinzen-Dick 2001).

The ability to negotiate with others and with markets, in order to capture the stream of benefits generated through the use of capitals/assets accessed and the labor invested through the life cycle, are shaped and mediated by culture, society, policies, environment, and global markets. When access to this benefit stream is circumscribed, as in the case of water in India, limited and opportunistic individual use threatens the ability to sustain the

natural resource base, thus endangering other assets (Zwarteveen and Meinzen-Dick 2001).

The Household Economic Portfolio

The capabilities of decision makers, and their assets (tangible and intangible), are the basis for the set of economic activities the family pursues (Chambers and Conway 1992; Valdivia et al. 1996; Ellis 1998). The household portfolio is an expression of the choice set defined by access and control of resources, and the nature of the assets possessed. A profile of the household economic portfolio describes the relationship between these assets and resources, and the activities households engage in (Conway and Chambers 1992; Valdivia and Gilles 2001). The combination of quantity and quality of various assets, resources, and forms of capital—natural, human, productive, and social (Bebbington 1999)—define the asset portfolio. This portfolio constrains the choice set of activities of the household. History, markets, culture and society are internal and external conditions that impact the household's capabilities (de Haan 2000). The members of the household capability and command intangibles shape the production decisions observed in the combination of activities that is the household economic portfolio. The portfolio is an expression of a livelihood strategy.

Diversification

In the Andes, climate, the environment, how markets function, and the political environment (de Haan 2000; Ferguson 1992; Reardon et al. 1992; Valdivia 2001a) are factors that create uncertainty. Many of the possible outcomes are risky, such as crop failure, low prices and lack of insurance against losses, and road blocks that interfere with marketing. To address these risks, strategies are diverse (Ellis 1998; Valdivia and Jetté 1997). The nature of how they diversify depends on the actor's ability to link to markets outside of agriculture; selling labor is an example (Bebbington 1999; de Haan 2000; Reardon et al. 1992). It also depends on life cycle characteristics of the family such as age, education, and the number of family members that can work (Kusterer 1989; Valdivia and Jetté 1997), and the number of children and their care.

Diversification of the household set of activities (the economic portfolio) is the expression of these characteristics and of agency. Risk management, coping with shocks, and resource use maximization explain the diversification observed in the Andean region (Cotlear 1989; Valdivia et al. 1996; Mayer 2002). In areas of greater climatic risk, household strategies are expected to be more diversified as a means to minimize possible shocks from

adverse climate events, especially when loss-management strategies are limited (Dunn et al. 1996).

Households with portfolios of economic activities which are diversified and have fewer covariant activities will be better able to cope with climatic risk (Reardon et al. 1992; Dunn et al. 1996). As income grows, and families move away from food insecurity, some expect them to specialize and use insurance markets to negotiate risk (von Braun et al. 1989). Others argue that portfolio diversification grows with accumulation (Kusterer 1989), as a strategy that maximizes use of resources (Ellis 1998) and exists with greater levels of commercialization and wealth (Cotlear 1989).

Households with differing varieties and densities of networks can build relations in and outside of agriculture. The relations are instrumental in the ability to cope in times of stress or shocks. The more diversified the better the ability to cope. Times of stress are events that impose difficulties on livelihood strategies, for example, drought. Times of shock are more difficult, or even traumatic events such as the death of a family member, or the loosing ones home to a flood. Depending on the event, the wealth in capitals, and the diversity of the household economic portfolio, some families will be able to cope and others will become more vulnerable. The framework proposes that coping ability may be explained by these tangibles and intangibles, and the way these articulate in a context—structure. Agency of households, individuals and communities are the hinges or articulation of livelihoods with structures in which they negotiate (de Haan 2000; Valdivia 2001).

Livestock Portfolio

Livestock species, for example cattle, sheep, goats and poultry, their quality (improved versus local), the types of products these species generate and who controls the income stream, define their many roles in the economic portfolio and the livelihoods of individuals and families. Livestock, as a store of wealth or asset, fills the vacuum of savings institutions and is liquidated to invest in profitable activities, in human capital, and other forms of capital such as fertilizer, machinery and land; livestock also plays an important role in coping with stress or shock (Fafchamps 1998), by selling small animals to buy food when crops fail. Cattle are often a productive capital (Zimmerman and Carter 2003) that is not sold unless a major investment is intended. It can be used as collateral to obtain productive capital. Sheep and goats on the other hand, are small stock more easily converted into cash, and because of their size can also be consumed. As part of the

reproductive activities of the household, animals, often sheep or goats, are major sources of sustenance, and are sold for social events, or to send children to school (human capital investment), if women control the income stream generated. Gender is, therefore, critical in studying out-comes of the livestock portfolio (Valdivia 2001). I propose that the nature of the livestock portfolio plays a role in the outcome of vulnerability versus security through time.

A Case Study: San José Llang in the Bolivian Altiplano

In this section we explore the role that livestock production played in the livelihood strategies of Andean families of the Bolivian Altiplano. The case will illustrate the diversity of roles and their changes, and how these may affect individuals and assets.

The Setting

Droughts, frosts, floods and El Niño Southern Oscillation (ENSO¹) events (Stern and Easterling 1999) have an important impact in the agriculture of the Altiplano of Bolivia. El Niño of 1997-1998 resulted in a drought in many parts of Bolivia, with the Altiplano contributing 53% of the US\$527 million losses suffered (Jovel 1998). Production of food crops fell during El Niño year and carried through to 1998-1999, as farmers were unable to recuperate production to cover their seed needs. Among these were potato and quinoa, two important traditional food crops grown in the Andes (Jovel 1998).

San José Llanga is an agropastoral community and Cantón² in the Province of Aroma, Department of La Paz in the Bolivian Altiplano. Located 116 km south of La Paz, Bolivia's capital in the central Altiplano, at 3,786 meters above sea level. Patacamaya is the closest local market. The community spans 7,200 hectares of land, with six settlements or neighborhoods (Valdivia and Jetté 1997). Fallow agricultural land and crop residues are important in the integration of crop and livestock production. The community exhibits diverse production strategies, growing traditional food crops such as potatoes and quinoa, as well as raising cattle and sheep, both *criollo* and improved. Improved cattle are geared toward dairy production and milk marketing. Improved sheep sell at high prices in the local and La Paz markets (Coppock and Valdivia 2001).

Mean annual precipitation is 402 millimeters, with a coefficient of variation of 31%, indicating variability from year to year. Periodic droughts and ENSO events affect this region (Washington-Allen 1993). During the 1983 and 1990 (El Niño events) total rainfall was 197.6

millimeters and 231 millimeters, respectively. The differences in total rainfall during *El Niño* years show the inherent variability of this event in the highlands. Even if producers are aware of an *El Niño* year, the variation as expressed by the range in outcome is large. In non-ENSO years, rainfall is also erratic. Annual rainfall in 1992-1993 was 388.5 millimeters, and in 1994-1995 was 241.9 millimeters. Farmers also deal with uncertainty of the onset and variation in rainfall throughout the growing season. Frost events are an added risk to many crops, potato and quinoa being more vulnerable than others (Le Tacon et al. 1991). Spatial variation with several plots of different soil types geographically dispersed, staggered planting, and use of several potato varieties are ways to reduce the effect of variability (Le Tacon et al. 1991).

National politics and food policy have also affected local livelihoods. Starting in the 1980s, Bolivia went through a process of structural adjustment. During the 1990s, dairy production was an activity promoted to improve access to milk in cities like La Paz (Markowitz and Valdivia 2001). With the support of the Danish government, dairy production became a stable source of income as prices were supported by this initiative, and credits in kind were provided to improve breeds and produce forages, such as alfalfa. Dairy production was the event that impacted the region the most and can be seen in the changing landscape of the Altiplano. Policy-wise, government agencies believed that a move toward the establishment of extensive areas of alfalfa was a more appropriate use of the land than crops such as potatoes. By the mid 1990s, a change toward a decentralized government was promoted, which gave more power to municipalities (Markowitz and Valdivia 2001; Valdivia 2000).

Methods and their Context

In studying livelihood strategies in the Altiplano region three household surveys were conducted at different points in time, 1993, 1995, and 1999. Cluster analysis was used to identify strategies for 1993, 1995, and 1999 and has been reported elsewhere (Valdivia 2001; Coppock and Valdivia 2001; Valdivia et al. 1996; Valdivia et al. 2001). The household surveys recorded production, consumption, income, and resources of the household—the unit of analysis. Approximately 50% of the families of the community were interviewed (45 families) each time, to identify the types of production strategies pursued during drought and non-drought years. The sample in 1995 contained 39 of the originally selected families, and 29 of them in 1999. Families were lost mainly due to migration

and deaths. Two families chose not to participate in 1999. Other households were selected at random to complete a sample size of 45.

To identify strategies using the household livelihood strategies approach, nine variables were identified for cluster analysis (Valdivia and Jetté 1997; Ellis 1993; Valdivia et al. 2001). This approach grouped households with similar strategies, expressed in the composition of their household economic portfolios. The variables captured stage in the life cycle, social capital, types of technologies used (either intensive or extensive cattle and sheep), market integration, accumulation (investment capacity) in technologies less vulnerable to drought and frost, household consumption, and rural urban linkages represented by income from outside of agriculture.³ Correlation among variables (non significance) was the final criteria in selecting the variables.

Age and access to labor capture life cycle effects on rural livelihood strategies. Irrigated land, using forage area, represent resources owned that are less vulnerable to drought. Criollo sheep and criollo cattle represent indigenous technologies resilient in times of drought, but offering lower returns. Social capital is imbedded in these variables because the concept of access is used: for example, animals accessed include share grazing where households obtain animals by taking care of other people's animals. In land it includes the area managed and not only the owned. Improved sheep measures an intensive technology, along with improved cattle; both reflect market integration and production of a cash crop, in this case dairy.

An important dimension of keeping sheep and cattle separate is that the former is the income domain of women in this region. Case study and survey research (Valdivia et al. 1993; Sherbourne et al. 1995; Valdivia 2001) in San José finds that women have control over the day to day decisions of sheep, as well as the marketing. Their time is also invested in these activities, in many cases with assistance of the children (Sherbourne et al. 1995). This is not the case in dairy where activities are shared with the man, especially milking, and when the man is away, herding. Men are in charge of breeding and marketing decisions for cattle. A regression study (Valdivia 2001a) finds that sheep are a significant factor in explaining household consumption. Wage is a source of off-farm income, and captures non-agricultural activities to diversify to non-covariant income sources; remittances, an indicator of networks outside the community, is also a rural-urban linkage.

Finally consumption (in-kind and cash production for consumption) measures the ability to secure food for

the household. This variable represents food crop production (especially potatoes) for consumption and sale, as well as income generated from sheep sales. The production of food crops is a shared activity by men and women, and often children when they are old enough. Women have a main say on the varieties planted (Materer 2001). Net income from cattle indicates the ability to capitalize and invest in new opportunities, as well as migrate through pull effects to other regions.

The diversity of the household economic portfolio is calculated with the Inverse Simpson⁴ (Valdivia et al. 1996; Valdivia and Jetté 1997). The index measures the number of activities and evenness in the contribution to income of each activity. By analyzing the household strategies, a pattern is revealed as to how families produce in a climatic variable zone. The meaning of the cluster groupings is explored in the next section by looking at the household income sources in a non-negative climate year (1993), the drought of 1995, and 1999, a year of production following El Niño event of 1997-1998. Implications for households and individuals are discussed in terms of the role of livestock in food security (buffer stock and reproductive activity), empowerment, human capital investment, and biodiversity (natural capital).

Findings

Livelihood Strategies in 1993

Table 1 presents the income sources (both cash and in-kind income) in Bolivianos for the three groups identified by their life cycle status (productive and the

elderly) and access to resources within the productive (intensive and extensive) group.

Within the productives, the intensive producer subgroup is active in new livestock technologies growing alfalfa and raising improved sheep, and mostly dairy cattle. On the other hand, the households identified as the extensives, who do not have access to alfalfa tend to rely mostly on extensive grazing to feed their cattle and criollo sheep. The elderly relied mostly on income transfers from family members and some potato production for their consumption. The diversity index of the portfolio for the innovators group was 3.57, for the extensive 3.24 and for the elderly 2.26 (Valdivia and Jetté 1997).

Livelihood Strategies in 1995

Households during this year are confronted with production problems because the rains are delayed and low. A group of households with linkages outside the community and with large sums of money emerges. Another group depends mostly on agriculture to cope with climatic perturbation. As a result these households sell livestock.

Table 2 shows the clear growth in income from wages by those in the rural option, as defined by Bebbington (1999), due to their linkages, while it also shows that the extensive, less wealthy, depend on sales of sheep and cattle to cope. The elderly appear as the most vulnerable. Members in this group do not have the capacity to work as before, making their main source of income the remittances they receive from family members.⁵ In terms of diversity of the economic portfolio, the rural strategies

Table 1
Income Sources by Strategy, in San José Llanga, 1993 (Bolivianos)

Income Activities	Rural Livelihood Strategies		
	Productive Improved 1	Productive Criollo 2	The Elderly 3
Food income	2,534	1,279	550
Sheep income	1,339	847	285
Cattle income	2,701	1,414	56
Milk income	917	271	8
Wages	1,000	299	120
Other incomes	192	47	374
Welfare Expenses	5,981	2,743	729

Source: Valdivia and Jetté (1997) where groups were identified through cluster analysis with 45 observations. Productive improved refers to a group with improved cattle and sheep, also associated with alfalfa fields; Productive criollo refers to a group that mostly had native animals, and extensive grazing practices. The elderly refers to older people in the community, with significantly less labor available for production.

Exchange rate in 1993: US\$1 = 4.05 Bolivianos.

Table 2
Income Sources by Strategy in 1995 and 1999, in San José Llanga (Bolivianos)

Income Source Strategy	1995			1999		
	Rural	Agricultural	Elderly	Dairy Producers	Potato Producers	Elderly
Income Activities	1	2	3	1	2	3
Food Crops Value*	1,784	1,475	802	4,417*	13,720	2,250*
Sheep	2,081	1,477	489	1,728*	1035*	188
Cattle	2,431	3,886	683	10,933*	7,442*	642
Milk Sales	932	1,179	58	1585	855	148
Wages	4,809	681	301	0*	317*	135*
Other Income	104	352	284	65*	208*	130*
Welfare Expense	9,703	5,144	1,944	6,164*	7,637*	1,803

Source: Surveys 1995 and 1999. Exchange rate: US\$1 = 4.7Bs in 1995; US\$1 = 6Bs in 1999.

Milk delivery to PIL (milk processing plant) multiplied by 1.48 Bolivianos/liter of 10 months.

Source for income values for 1995 in Valdivia and Jette (1997).

Welfare expenses include milk sales.

*No significant differences in income between identified groups, for a given income source in 1999; Analysis of Variance (ANOVA) Post Hoc Analysis.

* Food Crops Value in 1999 includes total production.

group is 3.3, those in the agricultural group 2.95, and the elderly's group 2.64 (Valdivia et al. 2000). There is loss of diversity in the agricultural group and the elderly group. A study of livelihood strategies in this community that analyzed the role of potatoes (Materer 2001) showed that the elderly people resort to very diverse strategies to maintain a level of income that will sustain them.⁶

Livelihood Strategies in 1999

Three clear strategies are observed in 1999 (see Table 2). This is a year that follows the El Niño Event of 1997-1998. The elderly group continues with a consistent strategy of focusing on transfers to a lesser degree and continues to produce potatoes for household consumption. Besides remittances, the elderly in San José have small businesses, work for others taking care of children, and produce some commodities for their own and their children's use. The elderly often share-farm with their children, who come to work in the fields during planting and harvest. At harvest they share in the output. What differentiate the two productive subgroups in this year are the economic activities that dominate their income. One subgroup focuses on dairy and has increased consistently its production. The other subgroup is focusing on potato production. This subgroup in the past produced potatoes mainly for consumption and now is responding to the market demands. Livestock production in this group is decreasing.

The income trends from Tables 1 and 2 show an impact on individuals within the household, as the income from sheep production, the domain of women, falls. The income generally is used to purchase household goods like food (sugar, cooking oil, noodles), clothing, and school supplies.

Changes in the composition of livestock assets through time, by livelihood strategy, are summarized in Table 3. Group number 1 identifies households that were intensive producers in 1993, pursued a rural strategy in 1995, and are producers of dairy products in 1999. Group 2 represent the households that were extensive livestock producers in 1993, mostly relied in agriculture during the drought of 1995, and today dedicate most of their effort to potato production. Finally, group 3 are the elderly in the community.

A decrease in the number of criollo sheep and an increase in improved sheep imply a net increase or accumulation of this asset in group 1. In the group that produces potatoes for market in 1999, the number of criollo sheep falls, and although the number of improved sheep increased until 1995, it then fell. The elderly's animals increase until 1995 and then shift from improved to criollo; thus while maintaining the same total number, the monetary value decreases.

The area planted to alfalfa also expanded (Valdivia et al. 2001), competing for land with potato production. The reallocation of food crops to alfalfa fields meant that sheep

Table 3
Animal Assets by Household Group for 1993, 1995,
and 1999 in San Jose Llanga, La Paz, Bolivia

Sheep and Cattle Assets in San José Llanga By Group
(number of head)

	Group 1	Group 2	Group 3
Criollo Sheep			
1993	4.2	20.2	3
1995	4.7	17.5	1.2
1999	1.6	8.2	6.2
Improved Sheep			
1993	27.2	6.9	1
1995	42.3	11.2	6.2
1999	37	13	2.2
Criollo Cattle			
1993	0.3	2.5	0.7
1995	1.3	2.4	0.6
1999	.25	3.5	0.3
Improved Cattle			
1993	4.8	1.3	0.2
1995	5.8	5.2	0.6
1999	6.5	2	0.7

Note: Group 1: This group includes intensive livestock producers in 1993, households following a rural income strategy in 1995, and those dedicated to dairy production in 1999.

Group 2: This group includes producers using extensive grazing in 1993, mostly agricultural production as their income strategy in 1995, and they are mainly potato producers in 1999.

Group 3: This group represents the elderly in each year. Sources for the group data are Valdivia and Jetté (1997) and Valdivia et al. (2000).

Source for 1993 and 1995 data in Valdivia and Jetté (1997).

herding required more care for two reasons. First, fewer fallow fields were available for grazing. Second, alfalfa fields were private so more care was needed not to invade these fields.

This shift in income domains may impact food security because the capacity to bargain is improved by having assets and income within the household. Women share with men production decisions about crops, and decide the varieties and amount of potato production, and the selection for consumption, seed and sales (Materer 2001). Women bargain in favor of welfare expenditures such as the quality of food consumed and supplies for children's schooling (Valdivia 2001).

Diversification is a critical area in terms of coping with adverse climate events. The diversity index for the dairy producers group is 5.1, for the potato producers 2.68, and for the elderly 1.67 (Valdivia et al. 2001). A greater index

indicates a more diversified portfolio, implying better coping capacity. The wealthy group in terms of livestock assets is able to diversify, while the other two groups maintain or lose diversity through time.

Diversification and Livestock

Findings from this panel study show that between 1993 and 1995 there is no significant difference in the level of diversification. In 1995 there is no significant difference between the two productive subgroups in the degree of diversification of the economic portfolio (Valdivia 2001). There is a direct correlation between wealth and diversity, mostly explained by greater access to resources. There is an inverse correlation between elderly and diversification, explained by the fact that resources and assets are being bequeathed by elderly rural households to their children (Valdivia 2001). It is clear that in 1999 potato producers did well in terms of the income generation, meaning that although diversity dropped, income grew. This contrasts with the previous year, El Niño of 1997-98, when potato producers and the elderly's production fell to a half and third (Valdivia et al. 2000). Such a variation suggests that households concentrating mostly on potato production have a highly variable and risky income strategy, vulnerable in drought years (Valdivia et al. 2000). With livestock assets dropping in this group, the degree of vulnerability increases further.

Land area used for forage production increased, and so did the number of cattle assets of the productives, with the group of dairy producers maintaining a steady increase of animals, both sheep and cattle. Those that looked to agriculture (animal sales) in 1995 and produced potatoes in 1999, had experienced an increase in the number of animals until 1995. Sales of animals to cope with the drought of 1997-1998 drove numbers down. The income from sheep fell both in nominal and real terms between 1995 and 1999 for all groups—this is significant in that it represents the income domain of women (Valdivia 2001), and is crucial for household food security. A cash income activity that has taken the place of sheep is potato production. This is fine in years when the climate is favorable, but becomes a problem when a drought takes place.

Competing economic activities that have clear market incentives (e.g., potato and dairy) grew, but were constrained by the type of resources households could access. The more resilient activities in terms of adverse climate events are related to livestock. Criollo animals, sheep and cattle, are more resilient as these require less quality feed. Established alfalfa fields are more resilient to drought

than potatoes and other annual food crops. Finally, dairy may be affected with drought but not as much as crops during drought. The growth of these activities contributes to diversity. A reduction of sheep among the vulnerable reduces the index, and it also means a loss of more resilient portfolio

Implications for Food Security and Nutrition, Empowerment, and Biodiversity

The panel analysis shows a drop in diversity for those households that concentrate in the commercial production of potatoes. The total number of sheep is greater in the dairy group (Table 3), although not in criollo sheep. Access to alfalfa fields for dairy allows this group to feed so many improved sheep. Comparing number of sheep in the extensive-1993, potato producers-1999, the total number of sheep decreases. With sheep being the income domain of women, this implies there is a loss of income under their control, while at the same time the vulnerability do to income variability grows. With food purchases linked to women (Sherbourne et al. 1993; Valdivia 2001), the fact that their income decreases reiterates the situation of vulnerability. The amount of cattle, 6.5 head in 1999 (Table 3), increases slightly, with a higher proportion of criollo for the potato producer group. Access to forage is still a constraining factor, as is labor competition between crops and livestock production. The dairy producers have a significant increase in the number of sheep, and double their access to forage. This contributes to maintaining a more diversified portfolio, and income for food derived from sheep sales is greater than in the other two groups.

In times of stress, such as the drought of 1995, households with improved cattle and forages, as well as linkages to outside markets, cope by generating income off the farm. There is less need to liquidate livestock assets, and as a consequence the growth of the herd suffers less. Diversity in 1995 falls slightly and more than recovers in 1999 for those with higher improved cattle numbers. This group, because of their dairy production activities, has access to credit that can be used when their crops are lost (Materer 2001). The elderly, and those individuals that were extensive producers then, and now are potato producers continue to lose diversity. A decrease of the diversity index and increase in income variability (Zimmerman and Carter 2003) and less coping capacity in consumption, along with a decrease of sheep numbers due to sales and labor competition from potatoes, may also result in a loss of access to protein in the family diet, as sheep are the principal source (Murillo and Markowitz 1995).

Conclusions

The theoretical framework used to identify distinct livelihood strategies yielded robust results. Strategies are flexible, changing through time. The quantitative approach using cluster analysis techniques yielded consistent results in terms of significant variables that captured diverse strategies. These strategies are dynamic, as shown by the driving income sources that changed for some groups in a given year. Finally, identified groups show changes in diversity that are consistent with the dynamics of loss of livestock sales due to shocks and stresses driven by climate.

The less vulnerable households have both more capital for investment and greater access to resources (credit, land quantity and quality) that facilitate livestock production, and buffer its vicissitudes, namely credit from milk production (Materer, 2001). This group is able to build their land and animal assets (asset accumulation through dairy and off-farm linkages), and are able to smooth consumption (Morduch 1995; Zimmerman and Carter 2003).

The market incentives in place contributed to the boom of dairy production. It is important to monitor the consequences of the strategies on diversity of the environment, on the diversity of the portfolios, and on the empowerment of the individuals who manage the environment, the household's food security, and the education of children in the Andes (Sherbourne et al. 1995; Materer, 2001). Alfalfa, once established, withstands natural hazards providing a reliable source of feed for cattle. But it is also important to understand the consequences of the greening landscape due to alfalfa in the Altiplano in terms of losses in income domain for women. Potato marketing opportunities are providing cash income to families that cannot rely on dairy. Potatoes, however, are vulnerable to frost, floods, and drought, and therefore cash income varies with climate events. It also varies with market fluctuations. Both effects—climate and markets—increase income variability, and a situation where families not smoothing consumption of food and schooling, and where they have been also losing assets.

What are the policy implications from the differences in outcomes found regarding vulnerability? First that access to employment and to credit for seed purchases (or assistance with seed distribution) after a drought decreases the need to liquidate their livestock assets, both cattle and sheep. This would decrease the need to pull out children from school or reduce expenditures or reductions in food consumption (Materer 2001), both coping mechanisms actually affecting human capital. Second, if the need to

deplete sheep is reduced by the previous alternatives, women's assets would be protected and continued to be used for food purchases and school supplies for their children, and women would continue to maintain their bargaining power.

The growth in concentration of income from potatoes, on the one hand, has increased the market integration of many households in San José. The growth in income during good production years may increase savings in the form of livestock, if there is no oversupply of potatoes which would drive prices down (Sadoulet and de Janvry 1995). But when the climate does not cooperate, as happens more often than not, livestock assets are depleted to compensate for the losses which include the seed produced. The loss of assets and increased reliance on one source of income results in greater vulnerability. Dairy production is more resilient in that it can be used as collateral for credit to purchase potato seed after losses in potato production. This again highlights the importance of aid programs to focus on assistance that provides seeds and inputs to invest in a new production year preventing asset depletion.

Sheep have three functions: first, a source of milk, wool and meat; second, a source of cash when sold; and third, a source of savings to buffer stress or shock events. An income domain for women, these assets are important because their managers use them to invest in the welfare of their families, particularly nutrition and education. This is why policies should contribute to building their capacity to retain these assets. Policies such as the promotion of forages permit an increase in improved sheep. Criollo sheep, on the other hand, are a valuable asset even without forages. As new interventions are explored to improve the coping strategies of Andean households, considerations of what animals as assets contribute, and what new technologies and policies bring about, are necessary to evaluate tradeoffs in wellbeing. A changing, more stable and green landscape, may not necessarily translate in reduced household vulnerability, if women are not able to retain control of this small animal, or find alternatives assets in their domain.

Acknowledgments

This paper was presented at invited session entitled, "Contentments and Contentions; Living with Livestock," at the 100th Annual Meeting American Anthropological Association, 29 November-2 December 2001, Washington, DC. I am grateful for the support of the Office of Global Programs, National Oceanic and Atmospheric Administration

provided partial funding for this research through grant NA96GP0239. I also acknowledge the SR-CRSP, USAID Grant no. 138-G-00-0046-00, which funded research on Sustainable Agropastoralist Systems in the Andes, from 1992 to 1996, source of the studies I conducted with Christian Jetté in 1993 and 1995. I am especially grateful to the people of San José Llanga for welcoming us and participating in the research; to Ramiro Carrillo for his outstanding work in the field; to Justina Condori and Edgar Cala for the application of the survey in 1999; and the support of Mariana Cruz of the International Potato Center for the creation of the data base. I appreciate the invitation of the organizers of the panel and their comments. I am grateful to the anonymous reviewers and to Lisa Markowitz for their comments. Any errors in this article are entirely mine.

Notes

1. ENSO stands for El Niño Southern Oscillation. El Niño is a term that described the unusually warm waters along the coast of Ecuador and Peru typically near Christmas time. El Niño, a Spanish word, refers to the Christ child. El Niño today refers to a broader scale phenomenon that still consists of unusually warm water occasionally forming in the tropical eastern and central Pacific. El Niño events recur every 3 to 7 years. Its counterpart is La Niña, cooler than normal sea-surface-temperatures (SSTs) across the equatorial eastern and central Pacific. Together they represent opposite extremes of the ENSO cycle.

2. San José was recognized as a Cantón in the middle, or over the 1990s.

3. The operational variables chosen were: 1) household labor available measured in adult equivalents (Valdivia and Jetté 1997); 2) age of the head of the household; 3) number of criollo/local sheep; 4) number of improved sheep; 5) number of head of criollo cattle; 6) improved cattle; 7) forage irrigated area in hectares; 8) monetary value of assets for investment (represented in the value of cattle liquidated); 9) monetary value of wages received and income transfers; and 10) consumption (estimated monetary value of in-kind production and cash expenditures).

4.

$$D = 1 / \sum_{i=1}^n p_i^2$$

where: D is diversity index, pi is the income share derived from activity i in the n portfolio of economic activities (Valdivia et al. 1996; Valdivia and Jetté, 1997; Valdivia et al. 2001).

5. Remittances seem to be under-reported.

6. This is not captured in the way questions are asked in the household survey.

References Cited

- Agarwal, Birna
 1994 Gender and Command Over Property: A Critical Gap in Economic Analysis and Policy in South Asia. *World Development* 22(10):1455-1.
- Baldivia, José. ed
 2001 Fortalecimiento de la gestión estratégica del Ministerio de Agricultura Ganadería y Desarrollo Rural (MAGDR). *Agenda Estratégica para el Altiplano*. Marco Conceptual. [Strengthening Strategic Management in the Ministry of Agriculture Livestock and Rural Development (MAGDR) Strategic Agenda for the Altiplano. Conceptual Framework.] La Paz, Bolivia: PNUD (UNDP) and MAGDR. Mimeograph.
- Bebbington, Anthony
 1999 Capitals and Capabilities: A Framework for Analyzing Peasant Viability, Rural Livelihoods and Poverty. *World Development*. 27(12):2021-2044.
- Blumberg, Rae L.
 1995 Introduction: Engendering Wealth and Well-being in an Era of Economic Transformation. *In* *EnGENDERing Wealth and Well-Being. Empowerment for Global Change*. Rae L. Blumberg, Cathy A. Rakowski, Irene Tinker, and Michael Monteón, eds. Pp. 1-14. San Francisco: Westview Press.
- Chambers, R., and G. R. Conway
 1992 Sustainable Rural Livelihoods: Practical Concepts for the 21st Century. Discussion Paper 96. London: Institute of Development Studies.
- Coppock, D. Layne, and Corinne Valdivia, eds.
 2001 Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San José Llanga. Department of Range Sciences. Logan: Utah State University.
- Cotlear, Daniel
 1989 Desarrollo campesino en los Andes. Lima: IEP Instituto de Estudios Peruanos.
- De Haan, Leo. J.
 2000 Globalization, Localization and Sustainable Livelihood. *Sociologia Ruralis*. 40(3): 339-365.
- Dunn, Elizabeth G., Nicholas Kalaitzandonakes, and Corinne Valdivia
 1996 Risk and the Impacts of Micro-enterprise Services: Assessing the Impacts of Micro-enterprise Services (AIMS). Washington DC: MSI.
- Ellis, Frank
 1993 Peasant Economics: Farm Households and Agrarian Development. London: Cambridge University Press.
 1998 Household Strategies and Rural Livelihood Diversification. *The Journal of Development Studies*. 35(1):1-38.
- Engle, Patrice
 1995 Father's Money, Mother's Money, and Parental Commitment: Guatemala and Nicaragua. *In* *EnGENDERing Wealth and Well-Being. Empowerment for Global Change*. Rae L. Blumberg, Cathy A. Rakowski, Irene Tinker, and Michael Monteón, eds. Pp. 155-180. San Francisco: Westview Press.
- Fafchamps, Marcel
 1992 Cash Crop Production, Food Price Volatility, and Rural Market Integration in the Third World. *American Journal of Agricultural Economics* 74:90-99.
- Fafchamps, Marcel, C. Udry, and K Czukas
 1998 Drought and Saving in West Africa: Are Livestock a Buffer Stock? *Journal of Development Economics* 55(2):273-305.
- Ferguson, Anne E.
 1992 Differences among Women Farmers: Implications for African Agricultural Research Programs. Publication No. 93-3. Lexington Kentucky: INTSORMIL
- Koc, M., and K. Dahlberg
 1999 The Restructuring of Food Systems: Trends, Research and Policy Issues. *Agriculture and Human Values* 16(2):109-116.
- Jovel, R., A. Tapia, and I. Thomson
 1998 Bolivia: Evaluación de los Daños Originados por el Fenómeno de El Niño en 1997-1998. La Paz Bolivia: Corporación Andina de Fomento.
- Kusterer, K.
 1989 Small Farmer Attitudes and Aspirations. USAID Program Evaluation Discussion Paper No. 26. Washington, DC: USAID.
- Le Tacon, Ph., J. Vacher, M. Eldin, and E. Imaña
 1991 Riesgos de Helada en el Altiplano Boliviano. *In* *Actas del VII Congreso Internacional sobre Cultivos Andinos*. D. Morales and J. Vacher, eds. Pp. 287-291. La Paz, Bolivia: CICA.
- Materer, Susan
 2001 The Role of Potato Production in Diversified Household Economic Portfolios: Study of San José Llanga, Bolivia. M.S. thesis, University of Missouri-Columbia.
- Markowitz, Lisa, and Corinne Valdivia
 2001 Patterns of Technology Adoption at San José de Llanga: Lessons in Agricultural Change. *In* *Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San Jose de Llanga*. D. L. Coppock and C. Valdivia, eds. Pp. 239-256. Logan: Department of Rangeland Resources, Utah State University.
- Mayer, Enrique
 2000 The Articulated Peasant. Boulder CO: Westview Press.

- Moghadam, Valentine
2002 Gender Dynamics of Restructuring in the Semi-periphery. *In* *EnGENDERing Wealth and Well-Being. Empowerment for Global Change*. Rae L. Blumberg, Cathy A. Rakowski, Irene Tinker, and Michael Monteón, eds. Pp.17-37. San Francisco: Westview Press.
- Morduch, Johnathan
2003 Income Smoothing and Consumption Smoothing *Journal of Economic Perspectives* 9(Summer):103-114.
- Murillo, Carmen, and Lisa Markowitz
1995 Food and Nutrition in San José Llanga, an Agropastoral Community in the Central Altiplano of Bolivia. Technical Report IBTA 173/SR-CRSP 39/La Paz.
- Quisumbing, A., L. Brown, H. Feldstein, L. Haddad, and C. Peña
1995 Women: The Key to Food Security. Washington, DC: International Food Policy Research Institute.
- Rakowski, Cathy
1995 Conclusions. *Engendering Wealth and Well-Being: Lessons Learned*. *In* *EnGENDERing Wealth and Well-Being. Empowerment for Global Change*. Rae L. Blumberg, Cathy A. Rakowski, Irene Tinker, and Michael Monteón, eds. Pp. 285-294. San Francisco: Westview Press.
- Rearson, Thomas, Christopher Delgado, and Peter Matlon
1992 Determinants and Effects of Income Diversification Amongst Farm Households in Burkina Faso. *Journal of Development Studies*. 28(2):264-296.
- Rosenzweig, Mark R., and Hans P. Binswanger
1993 Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments. *The Economic Journal* 102(January):56-78
- Schucksmith, M.
1993 Farm Household Behavior and the Transition to Post-Productivism. *Journal of Agricultural Economics*. 44(3):466-478.
- Sherbourne, Jennifer L., Elizabeth G. Dunn, Corinne Valdivia, and Michael F. Nolan
1995 Agropastoral Production Systems, Intra-household Resource Allocation and Household Member's Domains: Five Case Studies from the Community of San José Llanga. Technical Report SR-CRSP/IBTA [Small Ruminant Collaborative Research Support Program and Instituto Boliviano de Tecnología Agropecuaria.] La Paz, Bolivia.
- Stern, Paul C., and William E. Easterling, eds.
1999 Making Climate Forecasts Matter. Washington, DC: National Academy Press.
- Valdivia, Corinne
2001 Gender, Livestock Assets, Resource Management, and Food Security: Lessons from the SR-CRSP. *Agriculture and Human Values* 18(1):27-39.
2001a Household Socioeconomic Diversity and coping Response to a Drought Year at San José Llanga. *In* *Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San Jose de Llanga*. D. L. Coppock and C. Valdivia, eds. Pp. 217-238. Logan: Department of Rangeland Resources, Utah State University.
- Valdivia, Corinne, and Jere L. Gilles
2001 Gender and Resource Management: Households and Groups, Strategies and Transitions. *Agriculture and Human Values* 18(1):5-9.
- Valdivia, Corinne, Elizabeth Dunn, and Christian Jetté
1996 Diversification, a Risk Management Strategy in an Andean Agropastoral Community. *American Journal of Agricultural Economics*. 78(5):1329-1334.
- Valdivia, Corinne, and Christian Jetté
1997 Peasant Household Strategies Technologies and Diversification in Andean Fragile Lands. *Agricultural Economics Working Paper*. AEWP-1997-6. Columbia: University of Missouri.
- Von Braun, J., D. Hotchkiss, and M. Immink
1989 Nontraditional Export Crops in Guatemala: Effects on Production, Income, and Nutrition. Research Report 73. Washington, DC: IFPRI.
- Walker, T. S., and N. S. Jodha
1986 How Small Farm Households Adapt to Risk. *In* *Crop Insurance for Agricultural Development*. Peter Hazel, Carlos Pomareda, and Alberto Valdés, eds. Baltimore: Johns Hopkins University Press.
- Washington-Allen, Robert
2004 Historical Analysis of Land Use/Land-cover Change on the Bolivian Altiplano: A Remote Sensing Perspective. M.S. thesis, Utah State University.
- Winters P., B. Davis, and L. Corral
2002 Assets, Activities and Income Generation in Rural Mexico: Factoring in Social and Public Capital. *Agricultural Economics* 27:139-156.
- Zimmerman, Frederick J., and Michael R. Carter
2003 Asset Smoothing, Consumption Smoothing and the Reproduction of Inequality Under Risk and Subsistence Constraints. *Journal of Development Economics* 7:233-260.