

Andean Livelihood Strategies and the Livestock Portfolio

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Abstract

Rural livelihoods in the Andean region evolve in a setting shaped not only by the actions of people, but also by other factors often outside their control, such as climate variation, political and institutional change, and markets. A household economic portfolio approach framed in the context of rural livelihoods allows us to look at the patterns of change in an Andean community through the 1990s, as it adjusts to drought events, changing market conditions, and new institutions. A group of households from a community in the Bolivian *Altiplano* (high plateau) participated in a panel study that captured information on their activities, resources and life cycle characteristics. Household portfolios of both in-kind and cash income generating activities, which include sheep and cattle production, are constructed. Distinct strategies are found, which are shaped mostly by life cycle characteristics, and by access to resources and assets. Sheep, both *criollo* (native) and improved, play a key and constant role in the changing livelihood strategies. While other activities grow or shrink in response to market conditions – dairy and potato production – income from sheep does not, as this activity is closely linked to household consumption and welfare expenditures. Though the role of both sheep and cattle increase in prominence during climatic stress periods as an important coping mechanism to smooth consumption, differences exist among the diverse set of rural livelihood strategies identified and their impact on individuals, which require distinct policy interventions to foster security.

Introduction

Livestock plays many roles in the world, and its impact varies accordingly with each role. Livestock impacts the lives of people and the environment. Many internal and external events in turn impact the role of livestock on the welfare of rural families. 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 or endogenous to the interactions of activities at the household level. What are the conditions, factors, and behaviors that benefit rural households? What roles do livestock play?

The following sections present a framework for the analysis of livelihoods, economic portfolios and livestock assets; describe the setting, on-going 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 lessons on how 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.

A Framework to Analyze Rural Livelihoods and Household Strategies

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). 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 implying 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 that 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 other is left behind on purpose; or one is left behind as a result of bottlenecks. Recently a study of livelihoods globally (Blumberg et al. 1995) observed how similar strategies in far away 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 differs from control in that the latter implies a 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 is limited or opportunistic due to lack of institutions that allocate rights to individuals, the ability to sustain the natural resource base and other human assets is endangered (Zwarteveen and Meinzen-Dick 2001; Valdivia 2001).

The Household Economic Portfolio Rural livelihood strategies in the Andes are shaped by climate, access, and control of human, natural, productive, cultural and social capital (Bebbington 1999; de Haan 2000; Valdivia 2001a), markets, institutions, and the political environment (Ellis 1993; de Haan 2000; Ferguson 1992; Reardon et al. 1992). These strategies are diverse (Ellis 1998; Valdivia and Jetté 1997), especially when influenced by the actors' ability to link outside of agriculture (Bebbington 1999; de Haan 2000; Reardon et al. 1992), and life cycle family characteristics such as age, education, and the number of family members (Kusterer 1989; Valdivia and Jetté 1997).

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). In areas of greater risk, household strategies are expected to be more diversified as a means to minimize possible shocks from negative climate events, especially when loss-management strategies are limited (Dunn et al 1996).

Households with portfolios of economic activities which are diversified and have less 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).

The profile of the household economic portfolio (Figure 1) represents the relationship between assets/resources and activities (Conway and Chambers 1992; Valdivia and Gilles 2001). The choice set of activities of the household is constrained by the combination of different assets, resources, and forms of capital -- natural, human, productive, and social (Bebbington 1999) -- represented in the left hand side which can be accessed. History, economics, culture and social realities are conditions that impact the household's capabilities (de Haan 2000). This, and the ability to command intangibles shape the production decisions that are expressed in the combination of activities that the household pursues (right hand side of Figure 1). The household portfolio is an expression of the choice sets and activities.

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, an example are droughts. Times of shock are more difficult events such as the death of a family member, or the loss through floods of household assets. Depending on the event, the wealth in capitals, and the diversity of the household portfolio — only or mostly crops, crops and livestock, only or mostly livestock, or the ability to work of the farm — 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 between

Livestock, according to species, quality these and the structures in which they negotiate (de Haan 2000; Valdivia 2001). , and types of products it generates, plays 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 investments, and other forms of capital; livestock also plays an important role in coping with stress or shock (Fafchamps 1998) through sale. As part of the reproductive activity of the household, livestock is also a major source of protein, or it may be used as a form of investment in social, cultural or human capital, depending on who controls this asset. Cattle are often a productive capital that is not sold unless a major investment is intended. They 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. Gender in this context is a relevant variable of analysis to understanding the outcome of the management of this form of capital (Valdivia 2001).

A Case Study: San José Llanga 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 (ENSO) events have an important impact in the agriculture of the Altiplano of Bolivia. El Niño of 1997-98 resulted in a drought in many parts of Bolivia, with the Altiplano contributing 53 percent of the \$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 3,786 m above sea level, it experiences a mean annual precipitation is 402 mm, with a coefficient of variation of 31%. The community spans 7,200 ha 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 towards dairy production and milk marketing. Improved sheep sell at high prices in the local and La Paz markets (Coppock and Valdivia 2001).

Periodic droughts and ENSO events affect this region (Washington-Allen 1993). During the 1983 and 1990 (El Niño events) total rainfall was 197.6 mm, and 231 mm, respectively. The differences in total rainfall during El Niño years show the inherent variability of this event in the

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

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 388.5mm, and in 1994-1995 was 241.9 mm. 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).

Other Events of the 1990s Several events took place during this decade. 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 towards the establishment of extensive areas of alfalfa was a more appropriate use of the land than crops such as potatoes. Towards the mid-1990s, a change towards a decentralized government was promoted, giving more power to the municipalities (Markowitz and Valdivia 2001; Baldivia 2000).

Methods

In studying livelihood strategies in this 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 fifty percent 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 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 reflected 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. 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). 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

Sympson³ (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). Within the productives, the intensive producer subgroup is active in new livestock technologies growing alfalfa and raising improved sheep and cattle, mostly dairy. On the other hand, the households identified as the extensives, who do not have access to alfalfa, 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 what is defined as a rural option (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 to be 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. The remittances seem to be under-reported. In terms of diversity of the economic portfolio, the rural strategies group is 3.3, those in the agricultural group 2.95, and the elderly's group 2.64 (Valdivia et al. 2000).

³

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

where: D is diversity index, p_i 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).

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

Livelihood Strategies in 1999. Three clear strategies are observed in 1999 (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 is used to purchase household products that guarantee daily sustenance and for school expenses. A decrease in the number of criollo sheep and an increase in improved sheep (Table 3) imply a net increase or accumulation of this asset in group number 1. In the group that produces potatoes for market in 1999, the amount of criollo sheep decreases, and although the number of improved grew until 1995 it then fell. The elderly's animals increase until 1995 and then shift from improved to criollo maintaining the same total number, the monetary value decreases.

The area planted to alfalfa also grew (Valdivia et al 2001). Potato production competed with other crops. The shift from crops to established alfalfa fields meant that herding the animals required more care, and access was limited. 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 on crops, and have a major role on potato production and selection for household consumption (Materer 2001). Women bargain in favor of welfare expenditures such as the quality of food consumed and supplies for children's schooling (Valdivia 2001). The diversity index for the dairy producers group is 5.1, the potato producers 2.68 and the elderly 1.67 (Valdivia et al 2001). Households that have a more diversified portfolio can cope better with changes in climate. The wealthy group measured in terms of livestock assets is able to diversify, while the other two groups lose or maintain their diversity.

Diversification and Livestock

The findings show that between 1993 and 1995 there is no significant difference in the growth or drop of diversification. In 1995 there is no significant difference between the 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 had a strong show in terms of the income generation, meaning that although diversity dropped income grew. A study of their income the previous year, during El Niño of 1997-98, shows that both potato producers and the elderly's production fell to half and third of 1998-99 (Valdivia et al 2000). The most important potato producers are in the zones located far away from the center of the Cantón. It is an area of poorer resources. 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. In the group with the agricultural strategy that produced potatoes in the last year, there was an increase in the number of animals that decreased after 1995, possibly sales to cope with the drought of 1997-1998. The income from sheep fell both in nominal and real terms between 1995 and 1999 for all groups--the income domain of women (Valdivia 2001), and a crucial income source for household food security. One reason may be that some cash income is generated by the sale of potatoes. 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 like potato and dairy grew, constrained by the type of resources that the household could access. The activities more resilient for farmers are related to livestock such as production of forages and milk. The growth also impacts diversity, with its reduction among the more vulnerable in terms of the number of activities, but also in the number of criollo sheep that are more resilient to poor feeds.

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. In these households the number of total sheep is comparable between both groups but the number of improved is higher in the dairy producers due to their access to alfalfa fields. Comparing number of sheep in the extensive-93, potato producers-99,

the total number of sheep decreases. With income domain of sheep under the control of women, this implies that the income they control decreases, while at the same time the vulnerability of this group increases. 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, 5.5 head in 1999, 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 the outside 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 that are extensive producers then and now potato producers continue to lose diversity. More vulnerability and a decrease of sheep numbers, with high competition for labor to invest in potato production resulted in a loss of diversity that may reduce the access to protein in the diet, as sheep are the principal source of local animal protein.

Conclusions

The theoretical frameworks used to construct livelihood strategies showed robust characteristics such as the flexible nature of the strategies they pursue. The quantitative approach shows that this framework yields consistent/robust results in terms of the significance of the variables considered to capture the diverse strategies. These strategies are dynamic, as shown by the driving income sources that changed for some groups in a given year. And finally the identified groups reflected the changes in the diversity index that provided insights in a dynamic sense of which groups are become more vulnerable to shocks and stresses, especially those driven by climate.

The households that are less vulnerable have a larger amount of capital for investment, access to resources that facilitate livestock production, and as a result also have insurance mechanisms to protect them from crop losses, namely credit from milk production (Materer, 2001). This group is able to build their land and animal assets.

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 portfolios, and on the empowerment of the individuals that manage the environment, the food

security and the education of families in the Andes. Alfalfa once established, withstands natural hazards, but it is also important to understand if there are consequences to the greening effect of forage crops in the Altiplano. Market opportunities are also, now, providing cash income to families that cannot rely on dairy. Although potatoes are grown as a commercial activity, this crop continues to be vulnerable to frost, floods, and drought.

What are the policy implications from the differences 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 for coping strategies, such as pulling out children from school to reduce expenditures (Materer, 2001). Second, because sheep are the domain of women, policies that reduce the need to sell this type of asset would maintain their role as food providers, and the ability to bargain in favor of their children.

The growth in concentration of income on potatoes, on the one hand, has increased the market integration of many households in San José. The increases income during good production years can increase savings in the form of livestock, if there is no oversupply of potatoes which would drive prices down. 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 is increasing vulnerability. The advantage of the dairy production is that it can be used as collateral for credit to cover 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.

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 household, considerations of what animals as assets contribute, and what new technologies and policies bring about are necessary to evaluate tradeoffs. A changing, more stable and green landscape, may not necessarily translate to reduced household vulnerability if women do not retain control of this small animal.

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Table 1. Income Sources by Strategy, in San José Llanga. 1993. (Bolivianos)
Rural Livelihood Strategies in San José Llanga 1993

Strategy	Productive Improved	Productive Criollo	The Elderly
Income Activities	1	2	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.

Exchange rate of \$1=4.05Bolivianos.

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

Income Source	1995			1999			
	Strategy	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: \$1=4.7Bs in 1995; \$1 = 6Bs in 1999.

Milk delivery to PIL multiplied by 1.48Bol/liter of 10 months.

Values for 1995 (Valdivia and Jette, 1997)

Welfare expenses include milk sales.

*No significant differences in income, ANOVA Post Hoc Analysis

Differences in income from cattle sheep and crops for 1999 ANOVA.

Food Crops Value in 1999 includes total production.

Table 3. Identified Groups of Households and Their Characteristics in 1993 in San José 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

Group 1: 1993 is intensive producers; rural strategy in 1995; and dairy producer's average of two subgroups.

Group 2: 1993 are the extensive producers; in 1995 the agricultural strategy; and in 1999 the potato producers.

Group 3: in 1993 is the average of two sub groups of elderly; in 1995 is one group of elderly and in 1999 is one group of elderly. Source for 1993 and 1995 data in Valdivia and Jetté (1997).

Figure 1: The Household Economic Portfolio

