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Chapter 06: Household Socioeconomic Diversity and Coping Response to a Drought Year at San José Llanga

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Chapter 6

Household socioeconomic diversity and coping response to a drought year at San José Llanga

Diversidad socioeconómica familiar y respuestas de ajuste a un año de sequia en San José Llanga

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Summary

There were two main objectives for work described in this chapter: (1) Determine whether households at SJL pursued distinct economic strategies involving various mixes of livestock production, food crop production, wage labour and remittances; and (2) determine whether different strategies conferred different advantages in the ability of households to cope with a one-year drought. For the second objective it was expected that, compared to a near-average rainfall year, sheep sales and off-farm remittances during a drought year would be particularly important in mitigating potential declines in living standards for households. Households that were relatively more dependent on food crop production would be expected to suffer more in a drought year. All research was based on surveys conducted among 39 households in 1993 and 1995. Data were collected on various aspects of agricultural production, sources of income, expenditures and demographic profiles. In 1993 the annual precipitation was only 3% less than the long-term mean of 406 mm, while in 1995 annual precipitation was 40% lower than the long-term mean. Production of food crops reportedly declined in most instances in 1995 compared to 1993. Prices, however, rose on the order of 30 to 400% for food crops and 17 to 50% for livestock and livestock products during 1995 compared to that for 1993.

Cluster analysis was used to determine if households could be grouped according to distinct strategies. Ten variables were used as possible discriminating variables for clustering, but only three emerged as important. The cluster analysis revealed two major groups I called "active" and "passive." Active households were roughly twice as abundant as passive households in the sample. Life cycle factors such as age of household heads and size of the labour pool were important in defining active versus passive households. Active households had household heads in a "mid-career" stage of the life cycle with far more production resources, higher incomes and higher total welfare expenditures (i.e., consumption levels) compared to the passive households typically run by elderly people in a "retirement" stage of the life cycle. Passive households were further broken out into subgroups on the basis of number of adults in the household (i.e., singles versus couples). The active group was also further broken out into subgroups on the basis of those households dependent on improved livestock breeds and irrigated forages ("active/ improved") versus those dependent on indigenous livestock breeds and native, rain-fed forages ("active/Criollo"). Finally, the active/Criollo subgroup broke out further into sub-subgroups where households with a higher dependence on native range (active/Criollo/range) split off from those having access to some irrigated forage and markets to sell milk (active/Criollo/ PIL).

Two-way ANOVA was used to analyse year x subgroup interactions with the expectation that poorer subgroups, or subgroups with a higher dependence on food crops in the household portfolio, would exhibit greater relative declines in income and consumption during the drought year compared to that of other subgroups. Main effects of year revealed that the income from cultivated forage and livestock increased ($P<0.01$) in the drought year compared to the near-average year, and these components contributed to an overall 56% increase ($P<0.01$) in total income in 1995 compared to1993. Main effects of subgroup revealed large disparities in eight of 10 income categories over both years. For example, the active/ improved subgroup had a total annual income that was over seven-times more than that of passive/ singles. Year x subgroup interactions, however, were elusive in most cases; this was likely due to the modest sample size in conjunction with high inter-household variability. The general pattern was for all subgroups to increase incomes in 1995 compared to 1993, and in part this was due to the

positive price effect that drought had on commodity value. Active households invested more in irrigated forage production than passive households over the two years (P<0.01). Trends (P=0.07) suggested that compared to other subgroups, active/Criollo households increased their total income in the drought year due to sheep sales, which was the type of pattern I expected to see.

A multiple regression approach was used to determine what factors were important in relation to change in per capita consumption between 1993 and 1995. The idea was that households should seek tactics that would minimise change in consumption during perturbations. The regression was set up with change in per capita consumption as a function of six variables. The results revealed that change in per capita consumption was positively related (P<0.02) to changes in income, remittances and sheep inventory in the drought year of 1995, and negatively related to sheep inventory in 1993. Degree of household economic diversification was not significant (P=0.07) in this case. This supported the theory that sheep assets and remittances from off-farm help mitigate fluctuations in consumption due to drought.

It was concluded that indeed households at SJL could be broken out into subgroups with distinct socioeconomic characteristics. This validated a theoretical framework used to select clustering criteria. Household strategies were primarily conditioned by stage in the life cycle and secondarily by the types of resources controlled. The last level was conditioned by access to marketing outlets. To cope with a one-year drought, households at SJL used diverse means including reliance on sheep sales and remittances. They also took advantage of a positive price effect that occurred in the drought year for most food crops and livestock products. Results illustrated the utility of sheep sales to promote food security and household stability during drought in this community. At least for the drought year of 1995, market integration had a positive effect on the community. Campesinos were able to reap the positive price effect and buy goods in markets as well.

Resumen

Los dos objetivos principales del trabajo que se presenta en este capítulo fueron: (1) determinar si las unidades económicas familiares de San José Llanga desarrollaron diferentes estrategias de reproducción social, consistentes en diversas combinaciones de actividades ganaderas, agrícolas, asalariadas y de obtención de remesas familiares; y 2) determinar si estrategias diferentes dieron ventajas para enfrentar la sequía del año 1995. Con respecto al segundo objetivo, se esperaba que la venta de ovinos y las remesas hubieran sido especialmente importantes en un año de sequía, para así mitigar los efectos negativos al bienestar familiar. Se suponía que las unidades económicas familiares más dependientes de los cultivos sufrirían más en un año de sequía. La investigación que se presenta aquí se basa en datos recolectados de 39 familias de la comunidad en 1993 y 1995. La información recogida incluyó aspectos de la producción agropecuaria, fuentes de ingreso, gastos, y las características demográficas de los miembros de cada familia. La precipitación anual en 1993 fue 3% menor que la media a largo plazo de 403mm, mientras que la de 1995 fue 40% menor. La producción de cultivos alimenticios disminuyó en casi todas las familias, si se compara con los niveles de 1993. Sin embargo, los precios crecieron entre 30 y 400% en estos cultivos, y de 17 a 50% en ganadería y sus productos, reflejando un detrimento de los términos de intercambio entre ambas actividades.

Se utilizó el análisis de conglomerados para determinar si las unidades económicas familiares podían ser agrupadas de acuerdo a diferentes estrategias. Las variables que se utilizaron en el análisis fueron 10, de las cuales tres resultaron ser las más importantes. El análisis de conglomerados reveló dos grupos, que denominamos el activo y el pasivo; el primero se caracterizó por tener aproximadamente el doble de unidades económicas familiares (UEF). Los factores que identifican el ciclo de vida, por ejemplo la edad del jefe de la UEF, y el tamaño de la oferta de mano de obra familiar, fueron factores de diferenciación. Las unidades económicas familiares activas tenían jefes de la unidad en la etapa intermedia de su fase productiva, con más recursos productivos, mayores ingresos y un mayor nivel de gastos para el consumo familiar. Esto en comparación a las unidades económicas familiares pasivas que consistían de miembros ya mayores y "retirados" de las actividades productivas. Los pasivos se subdividían en casados o parejas, y viudos sobre la base del número de miembros de la UEF. Las familias activas también se subdividieron en dos grupos, pero por el tipo de la producción ganadera: si tenían animales criollos o mejorados, con acceso a forrajes, o dependientes de áreas de pastoreo. Finalmente

el subgrupo de los criollos, dependientes de las áreas de pastoreo, se dividió en dos, uno con mayor dependencia en pastos nativos, mientras el otro tenía ganado criollo con acceso a las áreas irrigadas donde se cultivó forraje, y por lo tanto se vendía leche a la PIL.

Con el análisis de variancia se estudiaron las interacciones entre año y subgrupo. La expectativa era que los subgrupos más pobres, con mayor dependencia en los cultivos alimenticios dentro del portafolio de la UEF, serían los más afectados con la disminución del ingreso y del consumo durante la sequía, en comparación a los otros subgrupos. Los efectos de año revelaron que el ingreso por forraje y ganadería creció significativamente ($p< 0.01$) durante el año de la sequía, en comparación a 1993. Estos componentes contribuyeron 56% al incremento del ingreso total de 1995 ($p<0.01$) comparado al de 1993. Los efectos principales del subgrupo mostraron desigualdades grandes en ocho de las diez categorías del ingreso. Por ejemplo, el grupo activos/mejorado tuvo un ingreso promedio anual que fue 7 veces más grande que el de los pasivos/viudos. Las interacciones año x subgrupo, sin embargo, no fueron significativas, lo cual se debe muy probablemente al problema de tamaño de muestra, en combinación con la alta variabilidad del ingreso. En general con respecto a 1993, todos los subgrupos incrementan los ingresos en 1995. Las UEF activas invirtieron más en la producción de forraje con riego entre los dos años ($P<0.01$). Las tendencias ($P=0.07$) sugieren que el grupo de los activos/criollo incrementó el ingreso total durante la sequía con la venta de ovinos, que era la estrategia que se esperaba encontrar.

Se utilizó el modelo de regresión linear múltiple para analizar los factores que afectan el cambio del consumo per cápita entre 1993 y 1995. La idea central consistía en que las familias desarrollarían estrategias para reducir los efectos de la sequía en el consumo de la familia. La regresión incluyó el cambio en el consumo como la variable dependiente. Las variables exógenas fueron en el cambio del ingreso entre 1993 y 1995 ($P<0.02$), el nivel de las remesas en el 95, y el inventario de ovinos en 1995, los cuales se esperaba que tuvieran una relación positiva, mientras que el inventario de ovinos de 1993 tendría una correlación negativa. El nivel de diversificación del portafolio económico fue casi significativo, si elegimos como nivel crítico el 5% ($P=0.07$). Esto confirma la teoría que sostiene que el capital ovino y las remesas provenientes del empleo fuera de la UEF, ayudan a mitigar los efectos de la sequía.

Se concluyó que efectivamente las UEF en SJL pertenecen a distintos grupos socioeconómicos que tienen diferentes estrategias de reproducción familiar. Esto también sustenta el marco teórico que se utilizó para determinar los criterios de diferenciación. Las estrategias familiares se distinguen, en primer lugar, por etapa en el ciclo de vida, y en segundo lugar por el tipo y cantidad de recursos que la familia controla. El último factor de diferenciación es el tipo de mercado al que la familia tiene acceso. Para poder sobrellevar el año de la sequía, las UEF en SJL utilizaron diversos fondos, entre ellos la venta de ovinos y remesas. También se beneficiaron los que cosecharon, debido al incremento de los precios agropecuarios. En esta comunidad, los resultados obtenidos muestran que la venta de ovinos jugó un rol importante en la seguridad alimentaria y estabilidad de la UEF durante la sequía. Por lo menos para el año de sequía de 1995, la integración al mercado tuvo un efecto positivo en la comunidad. Ellos cosecharon los efectos positivos del incremento de los precios, y a la vez pudieron adquirir los bienes que necesitaban a través del mercado.

6.1 Introduction

In Chapter 4 (*Household economy and community dynamics at San José Llanga*) we described how households at SJL differed in terms of social and economic attributes. For example, households had varied access to production resources. Households differed in level of income, capital assets, degree of market participation and use of social networks to access resources.

The first objective of work presented in this chapter was to examine if households at SJL indeed pursued different economic strategies. For example, would some households rely more on crops, livestock, wage labour or various mixtures of these enterprises, and why? The second objective was to determine how different economic strategies influenced household sustainability, namely the ability to generate wealth, be opportunistic and cope with drought. In particular, I was interested in the role of livestock (especially small ruminants), off-farm employment and income transfers in mitigating fluctuations in household income (Rosenzweig and Wolpin 1985; Kusterer 1989; Fafchamps 1992; Reardon et al 1992; Webb

1992; Fafchamps et al 1998). Households that rely on food crop production could be expected to suffer marked declines in income due to drought since crop yields would be reduced. Having livestock, wage labour, and/or options for income transfers would be important to maintain income and hence enhance food security in a drought year. A mix of enterprises, also referred to as a diversified portfolio, has been found important elsewhere in promoting food security and sustainability among peasant households in variable environments (Cotlear 1989; Kusterer 1989; von Braun et al 1989; Reardon et al 1992). Some researchers have found that as income increases the level of diversification decreases, especially with well-developed markets (von Braun et al 1989). Others have found diversification and income growth go hand-in-hand to fully utilize resources (Ellis 1993) and/or because markets are unreliable (Fafchamps 1992). In the southern Andean region of Peru diversification grew with commercialisation (Cotlear 1989).

6.2 Methods

To understand the rationale for production, land use and income generation in SJL it was necessary to identify driving forces influencing decisions, the social relations that govern decisions, and economic forms of production that interact with markets. With this perspective in mind we developed a typological framework guided by theory from household economics and political economy. While the unit of analysis was the household, it is important to realise that households integrate a variety of intra- as well as inter-household variables. Such variables include interactions among individuals and households within the community in terms of market and non-market relations. We essentially analyzed "snapshots" of households over time that depict production strategies. Production strategies are defined here in terms of the portfolio of enterprises that each household was engaged in. A portfolio is an outcome of a multitude of inter-linked decisions involving production, consumption and marketing (Fafchamps 1992; Ellis 1993). To give an example of inter-linked decisions, we know that if food markets are unreliable, households will produce food for themselves. We know that if access to resources in the community is difficult or uncertain, families will incorporate other income-generating activities. In the case of access and control of land, social relations are often more important than markets (Alberti and Mayer 1974).

A review of more than 200 studies of rural households showed that households exhibit a hierarchical goal-seeking behaviour (Kusterer 1989). The life cycle of households shapes the basic process of seeking day-to-day economic security (Kusterer 1989; Norman 1992). Progression occurs through various stages. There is an initial survival stage followed by stages where households grow and accumulate more resources over time. Ultimately, if successful, households will accumulate enough to bequeath substantive resources to descendants, thus ensuring the reproduction of households from one generation to the next. During the life cycle a threshold is reached whereby households begin to diversify their economic portfolios as long as their current welfare situation is not threatened. It is within this framework that coping strategies were studied here.

6.2.1 Data collection

Data used for this chapter came from several sources. One prominent source was a formal socioeconomic survey of 45 households in 1993 by Drs. E. Dunn and C. Valdivia (IBTA/SR-CRSP, unpublished data); other results from this 1993 survey are reported in Section 4.3.3: *Household production system*. The same survey instrument was implemented among 39 of the same households at the end of the annual production cycle in May, 1995, by Dr. C. Valdivia and Mr. C. Jetté (IBTA/SR-CRSP, unpublished data). The survey recorded estimates of commodities produced, land area cultivated, agricultural production, cash income, expenditures and demographic features of households. Interviews were conducted in Spanish and *Aymara* to foster joint participation by male and female heads of household (Valdivia et al 1995).

The two survey years markedly differed in terms of precipitation. In 1992-3 the annual rainfall was 389 mm, only 3% below the long-term mean of 406 mm (see Section 3.3.1: *Climate*). In 1994-5 the annual rainfall was 242 mm, or about 40% below the long-term mean and the third-lowest annual total in the past 36 years. We therefore regarded 1994-5 as a "drought year." Crop production for 1994-5 was hindered in general by a delay in the onset of the rainy season as well as by pervasive frost damage (Valdivia and Jetté 1998). As previously reviewed in Section 3.3.1.2: *Air temperature and frost*, drought and risk of frost appear linked. Interviews with campesinos (i.e., peasants) confirmed that 1994-5 was indeed a below-average year for crop production in general, but not all crops

were negatively affected. For example, farmers considered 1994-5 to be a better year for potato production compared to 1992-3, while the reverse was true for *quinoa* [N=20 households interviewed by Céspedes and Rodríguez (1996)]. In addition, while production probably declined for most crops in 1992-3, prices tended to rise, giving an economic advantage to those households which had enough land to produce a marketable surplus. Relative prices for commodities such as *kara grano* (e.g., a wheat-like grain) and potatoes increased between 30 to 50% in 1994-5 compared to 1992-3, decreasing the purchasing power of those families that were unsuccessful in producing their own crops.

Other price changes for crops coincided with change in crop yields. The 1994-5 prices for *quinoa*, faba beans, barley grain, forage barley, *cañawa* and alfalfa increased by 400, 300, 200, 100, 70 and 60%, respectively, relative to prices in 1992-3 (Dr. C. Valdivia, IBTA/SR-CRSP, unpublished data). In contrast, the 1994-5 prices for improved sheep were 46% higher, Criollo sheep were 18% higher, milk was 50% higher per litre, and live cattle were 17% higher. The rate of growth was greater for crops due to the drought and frost, the terms of trade being negative towards livestock as an enterprise. The exchange rate of Bolivianos per USD rose 10% from 4.05 to 4.50 between 1993 and 1995 (Dr. C. Valdivia, IBTA/SR-CRSP, unpublished data).

6.2.2 Data analysis

6.2.2.1 Identification of socioeconomic groups

Cluster analysis (Aldenderfer and Blashfield 1984; Romesburg 1990) was used to determine if households could be broken out into socioeconomic groups with distinct strategies (i.e., distinct economic portfolios). Ten variables were used for the cluster analysis. Selection of variables was primarily guided by the previously mentioned framework dealing with the life cycle. Variables are listed below:

(1) Stage of the life cycle for each household. Stage of the life cycle plays a vital role in defining producer social and economic behaviour (Deere and de Janvry 1981; Kusterer 1989). Age of the male head of household (MHH) was one of the proxy variables used for stage of life cycle. Age of the female head of household (FHH) was used if a MHH was absent;

(2) Labour pool for each household. Labour is a critical component that underlies resource exploitation tactics and also changes through the life cycle, so it is another indicator of life stage (Deere and de Janvry 1981; Cotlear 1989; Ellis 1993). A cumulative index for labour pool was used for each household based on age of household members (Deere and de Janvry 1981; Paredes 1995). People >15 years old (i.e., "adults") were given a rank of 1.0, while persons nine to fourteen, six to eight, and four to five years of age had weighted ranks of 0.6, 0.3 and 0.1, respectively (Valdivia and Jetté 1996);

(3) Amount of higher-quality land accessed per household. Land quality in terms of the soil fertility and quantity and quality of soil water resources has a large role in promoting productivity and stability for food and forage crops (Hopkins and Barrantes 1987; Montes de Oca 1989). At SJL the highest quality land was typically used under irrigation for forage production (i.e., alfalfa, forage barley, etc.). Land quality was therefore quantified using total area of cultivated forage accessed per household as a proxy variable;

(4) Household reliance on novel animal production technology for income generation and food production. The number of improved sheep (i.e., improved crosses) owned by each household was used as an indicator of reliance on novel animal production technology. Improved sheep also reflect access to cultivated forage. See Section 4.3.1 (*Human population and resource base*) and Section 5.3.3 (*Management and productivity of sheep*) for information on improved sheep at SJL;

(5) Household reliance on indigenous animal production technology for income generation and food production. The converse of (4) above was estimated by the number of Criollo sheep owned per household. Criollo sheep reflect access to unimproved, rain-fed grazing resources;

(6) Household reliance on novel animal production technology for income generation, market integration and capital asset accumulation. The number of improved dairy cattle owned by each household was used as an indicator for this component. Improved dairy cattle reflect access to cultivated forages. See Section 4.3.3. (*Household production system*) for reviews of the role of smallholder dairying in stimulating income generation and market integration;

(7) Household reliance on indigenous animal production technology for capital asset accumulation. The number of Criollo cattle owned by each household was used as an indicator for this component. Criollo cattle reflect access to unimproved, rain-fed grazing resources;

(8) Off-farm income for households. Off-farm income can help smooth the income stream and be a risk-mitigating component for households (Low 1986; Norman 1992; Reardon et al 1992). Off-farm income can also reflect demand for cash and thus market integration. Annual wages derived from off-farm employment were used for each household as an indicator of reliance on off-farm income;

(9) Level of consumption by households. Level of household consumption of goods and services can reflect wealth (Morduch 1995). Total per capita sum of in-kind and cash income per household was used as an indicator for consumption and household wealth. See Section 4.3.3.2: *Household income synopsis* for a review of income sources for households at SJL; and

(10) Ability of households to capitalize and reinvest. The ability of households to capitalize and reinvest is important (Kusterer 1989). Households at SJL accumulate capital mostly in the form of cattle. Reinvestment can occur when households buy land to build homes in local towns (Dr. C. Valdivia, IBTA/SR-CRSP, unpubl. data). Net income from sales of live cattle was used as a proxy for this characteristic.

Cluster analysis was carried out using the Pearson correlation method in SYSTAT (1992). This matrix-based procedure organised households into groups based on common characteristics. The analysis routine attempts to minimise variation within groups and maximise variation among groups.

Cluster analysis was performed on data for 39 households collected in 1993 and 1995. It was expected that there would be high repeatability between years in that clusters and household membership within clusters would not change.

6.2.2.2 Effects of socioeconomic group and rainfall years on household economy

The Inverse Simpson Diversity Index (Hill 1973) was used to measure the degree of household income diversification (Valdivia et al 1996). The index incorporates the number of distinct, income-generating activities (i.e., cash and in-kind) as well as the relative contribution of each activity to total household income. The index becomes larger when the number of income-generating activities increases and when the relative contributions from each activity become more equitable. The formula for the index is as follows:

$$D = 1/ \ p_i^2$$

where D is the diversity index value and p is the proportion of the i^{th} income-generating activity. The value for D has a lower limit of 1.0 for a household engaged in only one income-generating activity and an infinite upper limit.

Variation in resources across socioeconomic groups was assessed using t-tests for paired comparisons or with a one-way Analysis of Variance (ANOVA) for multiple comparisons. For the ANOVA, means separation was provided using the Least Significant Difference (LSD) test.

Effect of rainfall year and socioeconomic group on household income sources, total value of production (TVP) and per capita change in consumption were analysed using a split-plot, repeated measures, two-way ANOVA where households were the experimental unit for group and repeated measures were the experimental unit for years. The LSD test was used for means separation. Raw data were log-transformed prior to conducting the ANOVA so they would conform to assumptions of normality and homogeneous variability (SPSS 1998). The main reason for selecting the two-way ANOVA was to examine possible year x group interactions. The basic hypotheses are based on such interactions. One key hypothesis, for example, was that groups more dependent on income from livestock and/or off-farm employment would have income less affected by a drought year compared to that for households with more reliance on income from food crops. Such results would illustrate the effects of group on consumption smoothing across years. Response variables included cash plus in-kind income derived from off-farm wages, food crops, sheep production, cattle production, handicrafts and remittances. These collectively added to total income. The response variable TVP was defined as total income plus the value of cultivated forage production. Cultivated forage production was estimated using figures for forage yield per household along with market prices per unit air-dried weight. Forage yield considered acreage devoted to cultivated forage as well as production per unit area. The rationale for using TVP and thus including forage value was to look at the effect of production capacity from agriculture. Per capita consumption was defined as cash and in-kind income derived from sheep, food crops, wages, handicrafts and remittances. These sources of income provided for important welfare expenditures such as food, clothing, health care and entertainment; consumption expenditures are thus synonymous with household welfare expenditures (see Section 4.3.3*: Household produc-*

tion system). Income from cattle, in contrast, was used for investing in cattle or property and was not a component of household welfare expenditures (Valdivia et al 1995). "Per capita" here refers to an adult equivalent unit (above) and not per head.

Effects of socioeconomic group and key household enterprises on change in annual per capita consumption by households between 1993 and 1995 were also analysed using a multiple regression model to complement the two-way ANOVA approach. In contrast to the ANOVA, where socioeconomic group could obscure effects of individual enterprises, the multiple regression allowed for an analysis whereby effects of specific enterprises could be evaluated. For example, another multiple regression conducted on data collected from 45 households during the near-average rainfall year of 1993 indicated that per capita consumption in SJL households was positively influenced ($P<0.01$, $R^2 = 0.38$, df = 41) by total sheep held, diversity of the economic portfolio (i.e., Inverse Simpson Index) and income transfers or remittances (Valdivia and Jetté 1998). The dependent variable of change in per capita consumption was calculated as 1995 values minus 1993 values for the same 39 households. These were the households that remained in the sample of 1995, as the other families (13%) migrated to other regions such as Villazón, Cochabamba and Argentina. Consumption was constructed from the in-kind and cash income of food crops, the products from livestock consumed by the family, the income from wages which are used for welfare expenditures, and the income from the sales of sheep and milk, which are also reported as being used for consumption. Change in per capita consumption was postulated to be a function of up to six key, independent household variables. These variables included: (1) Change in total income between 1993 and 1995; (2) value of total sheep assets in 1993; (3) value of improved sheep assets in 1995; (4) income transfers in 1995; (5) diversity of the economic portfolio in 1993; and (6) change in the area planted to irrigated forages between 1993 and 1995. The rationale was that consumption change should be positively related to income change (Deaton 1996), sheep assets in 1995, income transfers (Rosensweig and Wolpin 1985; Morduch 1995) and economic diversity (Reardon et al 1992), but negatively related to sheep assets in 1993 and change in forage area. Sheep assets in 1993 were used as an indicator of savings behaviour—anticipation of using sheep sales to cope with future shocks [see the "permanent income hypothesis" in Deaton (1996)]. Households having a smaller change in consumption over the period 1993-5 would have larger sheep flocks, hence the proposed negative relationship. Sheep assets in 1995 would reflect contemporary household emphasis on expendable income in a stressful production year. The reason that value of "total sheep" assets was used in 1993 and "improved" sheep assets in 1995 was to reduce problems of co-linearity among independent variables in the multiple regression. The thought behind the forage component was as follows: If irrigated forage area was increased, risk from drought should be reduced and a smaller change in per capita consumption should result. The model that was constructed was an ordinary, least-squares regression (Deaton 1996). In addition to variables representing enterprises or diversity, dummy variables were also included to incorporate socioeconomic groups.

6.3 Results and discussion

6.3.1 Socioeconomic groups

6.3.1.1 Primary categories

Cluster analysis revealed two primary categories of households, largely defined by the age of household heads and access to labour (Valdivia and Jetté 1996; Valdivia et al 1996). For this presentation we have labeled these groups as: (1) Activos or active (i.e., productive households at a "mid-career" stage in terms of the life cycle); and (2) Pasivos or passive (i.e., less-productive households with elderly household heads in a "retirement" stage of the life cycle). Active households were twice as abundant in the sample of 45 households as passive households were. Statistics contrasting the two groups in terms of livestock holdings, access to irrigated forage, income and economic diversity are displayed in Table 6.1.

Differences between the two groups were marked. Active households held more productive resources and were considerably wealthier than passive households in nearly every category shown in Table 6.1. Compared to passive households, active households had: (1) Heads of household who averaged 20 years younger; (2) more than twice the labour pool; (3) four-times more Criollo sheep; (4) 17-times more improved sheep; (5) 15-times more improved cattle; (6) over 30-times more net income from cattle; (7) over five-times more acreage devoted to irrigated forages; (8) around five-times the cash and total (i.e., cash plus in-kind)

Table 6.1. *Distinguishing features between active ("mid-career") and passive ("elderly") groups of households at San José Llanga in 1993 as identified using cluster analysis.* Source: Adapted from Valdivia and Jetté (1996).[1]

Variable	Household Group	
	Active (n=29)	Passive (n=16)
Age of household head (years)	44 a[2]	65 b
Size of household labour pool (index)[3]	3.4 a	1.5 b
Criollo sheep (no.)	12 a	3 b
Improved sheep (no.)	17 a	1 b
Criollo cattle (no.)	1.3 a	0.7 a
Improved cattle (no.)	3.0 a	0.2 b
Irrigated forage (ha)[4]	3.3 a	0.6 b
Annual total household income (Bolivianos)[5]	8193 a	1720 b
Annual total cash household income (Bolivianos)	662 a	120 a
Annual per capita consumption (Bolivianos)[6]	1167 a	1145 a
Annual cattle net income (Bolivianos)[7]	1474 a	48 b
Inverse Simpson Diversity Index[8]	3.40 a	2.26 b

[1]See text for a description of the cluster methodology and details for socioeconomic groups. USD 1.0 = 4.05 Bolivianos.

[2]Entries within the same row accompanied by the same letter (a,b) were not significantly different according to a *t*-test at $P \leq 0.05$.

[3]Labour index was based on age and gender of family members as in Deere and de Janvry (1981).

[4]Typically alfalfa and barley.

[5]Includes cash and in-kind income.

[6]Considers cash and in-kind income from sheep, food crops, wages, handicrafts and remittances. This income typically represented welfare expenditures and was spent on clothing, food, health and entertainment.

[7]Proxy for capitalisation and investment potential. Net income from cattle was typically reinvested in cattle or property.

[8]Diversity index as in Hill (1973).

level of income; (9) about twice the level of consumption per capita; and (10) half again the level of economic diversity. That age of household heads, and thus stage of the life cycle, was a key discriminatory variable was not surprising. As reviewed in Section 4.3.4: *Non-market factors in resource access*, as household heads age they gradually redistribute their controlled land and livestock resources to their maturing off-spring, through a process of inheritance that starts when the children marry (see Section 4.3.1.2: *Living standards, household structure and human population dynamics*).

Several passive households reported very low as well as high total annual incomes, ranging from 150 to 6232 Bolivianos per year (USD 37 to 1537 per year). Remittances and other transfers from relatives typically appeared to be low, though in the case of the pasivos it was important (60% of them received remittances), especially when food crop income was low, as in 1995. Transfers represented from 6 to 61% of total income, enough to play a smoothing role in consumption (Dr. C. Valdivia, IBTA/SR-CRSP, personal observation). While it is possible that we underestimated income from social reciprocity relationships, the general impression was that a number of passive households were indeed extremely poor (Valdivia and Jetté 1996).

6.3.1.2 Secondary categories

Active households. A major clustering variable which discriminated among households within the active category was whether or not households relied on improved or Criollo livestock breeds. Active households were thus divided into two additional subgroups: (1) Active/improved; and (2) active/Criollo. Household statistics contrasting these two subgroups are displayed in Table 6.2. Compared to active/Criollo, the active/improved households had: (1) Nearly four-times more improved sheep; (2) nearly four-times more improved cattle; (3) about three-times more acreage devoted to irrigated forage; (4) about three-times the cash income, although highly variable; (5) about twice the level of household consumption per capita; and (6) half again the level of net income from cattle. The degree of diversification of economic portfolios was similar between the two subgroups; however, net returns from portfolios differed (Table 6.2). This illustrates that diversification was common regardless of income level.

The active/Criollo subgroup was further divided into two more sub-subgroups based on the quality of land accessed for animal production. One of these sub-subgroups I called active/Criollo/range while the other I called active/Criollo/PIL. In general, these two sub-subgroups were distinguished by location of residence, which in turn influenced quality of forage resources that were accessed, and the distance to the PIL collection centre. Households in the active/Criollo/range category were located nearer to the settlement of *Espíritu Willq'i* where unimproved, native rangeland dominated forage resources (see Figure 3.5 and Section 3.3.2.4: *Land cover*). These households were consequently less able to adopt improved livestock breeds unless they gained access to improved forages through rentals or non-market means. This constraint and the distance to the milk collection building may have undermined the ability of these households to maintain themselves at SJL, as three were in the process of emigrating by 1995 (Dr. C. Valdivia, IBTA/SR-CRSP, unpublished data).

Households of the sub-subgroup called active/Criollo/PIL resided closer to the main *Barrio* and had more routine access to improved pastures, cultivated fodder and a milk market. While this differential access to higher-quality forage did not markedly affect livestock breed composition or numbers for either cattle or sheep between sub-subgroups, it appeared to influence the ability of the active/Criollo/PIL households to sell milk to the local dairy cooperative called PIL [Programa de Industrialización Lechera (Valdivia and Jetté 1996); see Section 2.4.2: *Local society*]. Households in the active/Criollo/PIL sub-subgroup also had slightly younger household heads (i.e., with a mean age of 36 years versus a mean age of 47 years for active/Criollo/range; $P<0.05$) and a slightly larger labour pool (i.e., with an average of 4 labour units versus an average of 2.6 units for active/Criollo/range; $P<0.05$). The level of economic diversity was 2.8 for the active/Criollo/range and 3.6 for the active/Criollo/PIL. Households in the active/Criollo/PIL appeared to be in a transition of increasing their volume of dairy sales by intensifying milk production (Valdivia and Jetté 1996).

Passive households. The passive group was also divided into two subgroups-- these were distinguished ($P<0.05$) according to number of adult labourers per household. We called these either: (1) Passive/couples; or (2) passive/singles. The passive/couples were households where both the MHH and FHH were present. The average labour

Table 6.2. *Distinguishing features between active/improved and active/criollo subgroups of households at San José Llanga in 1993 as identified using cluster analysis.* Source: Adapted from Nolan and Valdivia (1995, 138)[1].

Variable[1]	Active Subgroup	
	Improved (n=15)	Criollo (n=14)
Age of household head (years)	46 a[2]	42 a
Size of household labour pool (index)[3]	3.4 a	3.3 a
Criollo sheep (no.)	4 a	20 b
Improved sheep (no.)	27 a	7 b
Criollo cattle (no.)	0.3 a	2.5 b
Improved cattle (no.)	4.8 a	1.3 b
Irrigated forage (ha)[4]	4.9 a	1.6 b
Annual total household income (Bolivianos)[5]	2561 a	1226 b
Annual total cash household income (Bolivianos)	1000 a	299 a
Annual per capita consumption (Bolivianos)[6]	1561 a	616 b
Annual cattle net income (Bolivianos)[7]	1784 a	1143 a
Inverse Simpson Diversity Index[8]	3.57 a	3.24 a

[1]See text for a description of the cluster methodology and details for socioeconomic groups. USD 1.0 = 4.05 Bolivianos.

[2]Entries within the same row accompanied by the same letter (a,b) were not significantly different according to a *t*-test at $P \leq 0.05$.

[3]Labour index was based on age and gender of family members as in Deere and de Janvry (1981).

[4]Typically alfalfa and barley.

[5]Includes cash and in-kind income.

[6]Considers cash and in-kind income from sheep, food crops, wages, handicrafts and remittances. This income typically represented welfare expenditures and was spent on clothing, food, health and entertainment.

[7]Proxy for capitalisation and investment potential. Net income from cattle was typically reinvested in cattle or property.

[8]Diversity index as in Hill (1973).

pool for passive/couples was two. The passive/singles were households where typically the MHH had died and the FHH was widowed and alone. The average labour pool for passive/singles was one. The dominant types of sheep or cattle held by both subgroups was Criollo which reflected their uniform access to marginal forage resources.

In summary, the cluster analysis for 1992-3 revealed two primary household groups and each of these was broken out into two subgroups. One of the active subgroups was then broken out into two more sub-subgroups. This classification was highly repeatable in 1994-5, indicating robustness (Dr. C. Valdivia, IBTA/SR-CRSP, unpublished data; Aldenderfer and Blashfield 1984). The discriminatory variables also appear very meaningful in relation to factors affecting household productivity, welfare and sustainability. Figure 6.1 depicts the summarised cluster results. Table 6.3 displays variability in other land resources for subgroups. Active subgroups typically had larger land holdings than passive subgroups—particularly in the case of comparisons between active/improved versus passive/singles, which is the result of the latter group bequeathing land to descendants. Compared to passive/singles, the active/improved households had three-times more land devoted to food crops, 11-times more land devoted to alfalfa, and almost twice the area of privately accessed rangeland (Table 6.3).

Overall, we believe that the cluster approach revealed meaningful socioeconomic groups, and this validated the conceptual framework proposed for prioritising variables. Clustering has been used elsewhere to segregate groups within target populations and identify recommendation domains for development interventions (Jamtgaard 1989; Coppock and Birkenfeld 1999). The primary organising factor that discriminated among different groups of households was age of household heads or stage of the life cycle. This supports contentions of Deere and de Janvry (1981) that life cycle is a crucial variable. Our secondary organising factor, namely reliance on improved or traditional breeds of livestock, really was a proxy for resource base. The importance of this factor supports perspectives of Hopkins and Barrantes (1987) and Montes de Oca (1989) that resource base fundamentally conditions and shapes the configuration of the household economic portfolio.

6.3.2. Coping with a drought year

Previously we introduced some general hypotheses regarding variation among socioeconomic groups in term of their ability to mitigate drought. Now that the cantón community has been stratified in terms of socioeconomic features of groups and subgroups, detail can be added to the hypotheses.

Our analysis proceeded at the level of the four subgroups (i.e., active/improved, active/Criollo, passive/singles, and passive/couples). The number of observations per subgroup averaged about 10 with a range of eight to 15. We were interested in the variability among these subgroups in terms of how they mitigated negative effects of a drought year. We were unable to conduct any analyses at a higher level of resolution (i.e., sub-subgroups) because of problems concerning small sample sizes for the two-way ANOVA.

One hypothesis was that all subgroups would exhibit a similar relative decline in the contribution of food-crop income in a drought year compared to an average rainfall year. We expected that contributions of income related to livestock production, off-farm employment, and remittances would increase in a drought year compared to an average year, and that this would mitigate loss of food-crop income to a different degree depending on subgroup. The active subgroups having more livestock, forages and labour were therefore expected to show less of an overall decline in TVP in a drought year compared to passive subgroups. Households at a higher stage in the accumulation process would have less need to deplete their livestock assets (Kusterer 1989). Households in a lower stage of accumulation (Criollo group) would have to increase their sales of livestock products, hence income from this enterprise would increase. Sheep should thus have the most important mitigating role for those households with intermediate to low levels of crop production—in other words, those who would likely have a food deficit. The wealthiest households could conceivably sustain themselves in a drought year by being able to subsist on home-grown crops production and not need to increase sheep sales to buy food.

6.3.2.1 Year effect on income sources for socioeconomic groups

Overall—and somewhat of a surprise—average TVP per household and average total income per household significantly increased on the order of

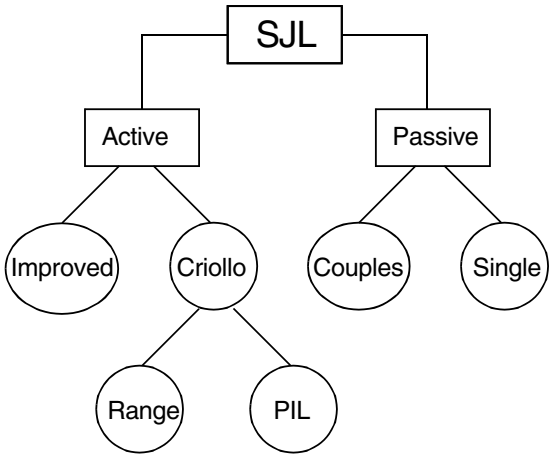

Figure 6.1. *Depiction of socioeconomic groups and subgroups revealed from a cluster analysis of 45 households at San José Llanga for 1993 and 1995.* Source: Dr. C. Valdivia (IBTA/SR-CRSP, unpublished analysis)

60% in the drought year of 1995 compared to the average rainfall year of 1993. The major contributors to this pattern were significant increases in the value of cultivated forage and cattle production in the drought year (Table 6.4) as well as the positive price effect for most crops (see Section 6.2.1: *Data collection*). In contrast, there was no significant effect of year ($P>0.05$) on the mean household value of off-farm wages, sheep production, food crops, or "other" sources such as handicraft production and remittances. High variability among households, in concert with relatively modest sample sizes, contributed to a lack of significant year effects in wages and sheep income despite apparent marked increases in their mean values between years. High price changes in crops were compensated with low yields which probably was the main factor explaining no effect of year. In aggregate, however, income from sheep plus cattle significantly increased in 1995 compared to 1993 (Table 6.4).

On a relative scale only, the most notable increases in the drought-year household economy compared to the average-year were observed for off-farm wages when all socioeconomic groups were combined (Figure 6.2a,b). The most notable relative decrease between 1993 and 1995 was observed for food crops. Some added descriptive detail on a relative basis was provided by breaking out households into active versus passive subgroups (Figure 6.3a-d). These pie charts illustrate the decrease in the proportion of income generated from food crops. The cause is two fold, first because households had less actual quantity of food produced that they could consume, and second because they had to sell more livestock products, or labour, in order to purchase the food at higher prices.

Main effects of subgroup on income features are shown in Table 6.5. There was statistically significant variation between active and passive subgroups in terms of value of forage, food crops, sheep production, cattle production, total livestock production, total income and TVP.

Year x subgroup interactions were significant ($P<0.05$) for TVP and forage value. Inspection of patterns indicated that, relative to the average year, active households in the drought year had a greater relative increase in TVP than passive households, the source was forage value (Figure 6.4 a,b). Overall, the average area devoted to irrigated forage production per household increased by 48% from 2.5 to 3.7 ha in 1993 to 1995, respectively (Valdivia and Jetté 1997). The substitution of income from wages and livestock and shift on the crops side to forages are strategies that reduce the vulnerability of the household to climate risks.

Year x subgroup interactions approached significance ($0.05<P>0.10$) for value of total livestock production, total income and sheep production. These are shown in Figure 6.5 (a-c) for illustrative purposes—patterns suggested that, compared to other subgroups, the active/Criollo subgroup increased total income relatively more in the drought year largely due to increased livestock income derived from sheep, which indicated a strategy to use sheep sales as an income-smoothing mechanism. Year x subgroup interactions were clearly not significant ($P>0.230$) for all other response variables.

An ANOVA on per capita changes in consumption between 1993 and 1995 showed no significant differences due to socioeconomic group or year, hence patterns are not illustrated. Per capita consumption ranged from a mean of 2295 Bolivianos per year for the active/improved group to 1186 Bolivianos per year for passive groups. While the apparent statistical similarity among groups may be indicative of opportunistic behaviour and a common ability to smooth consumption regardless of wealth or agricultural enterprises, sample sizes may have been inadequate to detect differences given high variability among households.

Table 6.3. *Land resources accessed by various socioeconomic subgroups of households at San José Llanga in 1993.* Source: Valdivia and Jetté (1997).[1]

	Active Subgroup		Passive Subgroup	
Land Resource	Improved (n=15)	Criollo (n=14)	Couples (n=8)	Singles (n=8)
Potato cultivation (ha)	1.1 a[2]	0.7 b	0.6 b	0.6 b
Quinoa cultivation (ha)	0.9 a	0.8 ab	0.4 ab	0.3 b
Barley cultivation (ha)	1.0 a	0.7 ab	0.6 ab	0.1 b
Wheat cultivation (ha)	0.1 ab	0.3 a	0.0 b	<0.1 b
Total food crop cultivation (ha)	3.3 a	2.6 ab	1.5 b	1.1 b
Total food crop plots (no.)	6.3 a	5.2 a	4.5 b	2.8 b
Alfalfa cultivation (ha)	3.4 a	1.0 b	0.6 b	0.3 b
Forage barley cultivation (ha)	1.6 a	1.0 ab	0.1 b	0.2 b
Total forage cultivation (ha)	5.0 a	1.9 b	0.7 b	0.5 b
Total irrigated crop production (ha)	1.4 a	0.3 b	0.4 ab	0.9 ab
Total land rentals for food/forage crops (ha)	1.4 a	1.9 a	0.5 a	0.6 a
Private access range (ha)	4.2 ab	7.7 a	0.8 b	3.1 ab
Fallowed cropland (ha)	9.6 a	5.9 ab	1.3 b	5.9 ab
Total grazing access (ha)	13.9 a	13.6 a	2.0 a	9.0 ab

[1]See text for a description of the cluster methodology and details for socioeconomic groups. Households from various subgroups were unevenly distributed within the Cantón of SJL. Six of 15 active/improved were located in *T'olatia*, five of 14 active/Criollo were located in *Espiritu Will'qi*, and seven of passive/couples and passive/singles combined lived in *Savilani*. This affected access to land resources.

[2]Entries in the same row accompanied by the same letter (a,b) were not significantly different according to an LSD test at $P \leq 0.05$.

6.3.2.2 Factors affecting consumption smoothing during a drought

Table 6.6 illustrates results from the multiple regression analysis on determinants of change in per capita consumption between 1993 and 1995. The overall model was significant ($P<0.01$, adjusted $R^2 = 0.71$, df = 32). Hypotheses were supported regarding effects of income, sheep assets and income transfers in reducing variation in consumption (all at $P<0.05$). Economic diversity approached significance, while change in area planted to irrigated forage was not significant.

The multiple regression was more illuminating than the ANOVA in revealing sources of change

Table 6.4. *Main effects of rainfall year on various household income components (in Bolivianos) for 39 campesino households at San José Llanga during 1993 and 1995*[1].

	Rainfall Year		
Income Category[2]	1993 (Average)	1995 (Drought)	P
Off-farm wages	509	1598	0.21
Cultivated forage	1699	3163	<0.01
Cultivated food crops	1402	1313	0.98
Sheep production	763	1315	0.29
Cattle production	1282	2073	<0.01
Total livestock production[3]	2045	3388	<0.01
Other[4]	233	234	0.22
Total income[5]	4189	6533	<0.01
TVP[6]	5889	9696	<0.01
Per capita consumption[7]	1159	2396	0.95

[1]Where USD 1.0 = 4.05 Bolivianos. Tabulated P values are based on ANOVA using log-transformed data.

[2]Categories include cash and in-kind components.

[3]Sheep production plus cattle production.

[4]Value of handicrafts plus remittances.

[5]Includes all categories except cultivated forage (i.e., wages, crops, sheep, cattle and other).

[6]Includes all categories (i.e., wages, forage, crops, sheep, cattle and other).

[7]Includes income from sheep, food crops, wages and other. This income was typically used for welfare expenditures (i.e., clothing, food, health, etc.)

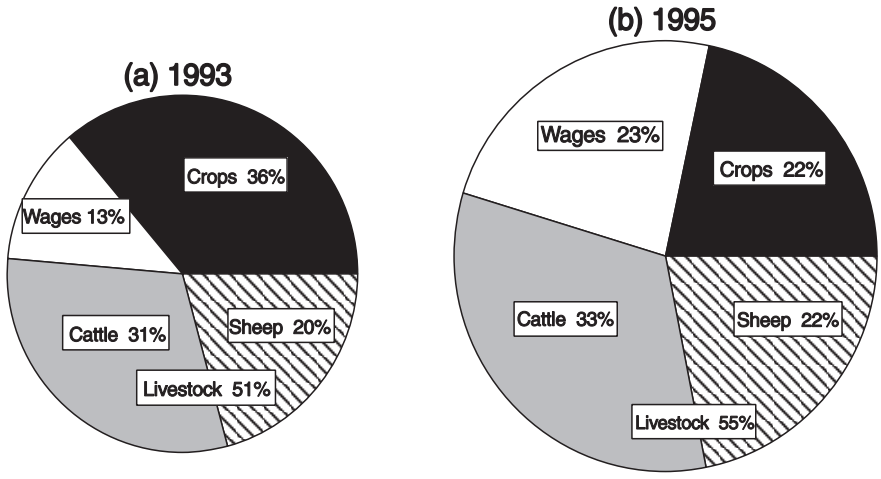

Figure 6.2 (a,b). *Distribution of total income from crops, livestock, wages and other sources for 39 campesino households at San José Llanga in: (a) 1993, a year of near-average precipitation; and (b) 1995, a drought year. Total income increased overall in the drought year by 64% compared to near-average 1993.* Source: Dr. C. Valdivia (IBTA/SR-CRSP, unpublished data)

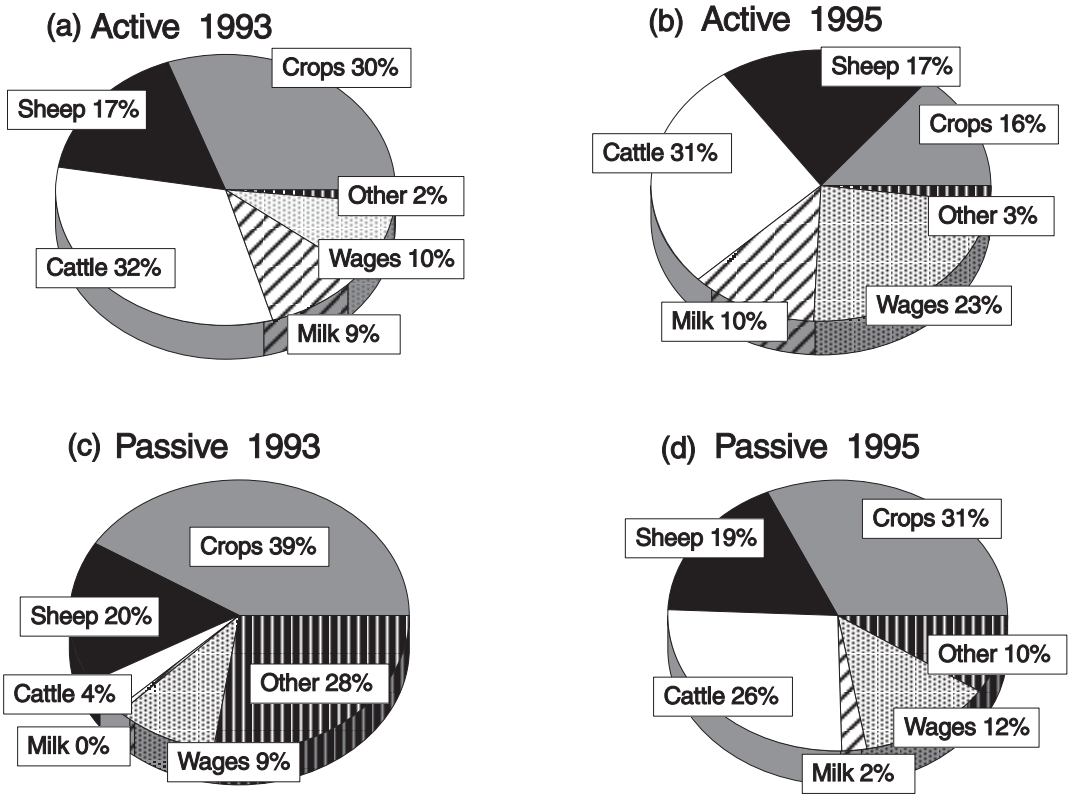

Figure 6.3 (a-d). *Distribution of total income from crops, livestock, wages and other sources for 39 campesino households at San José Llanga that were in: (a) The active group in 1993; (b) the active group in 1995; (c) the passive group in 1993; and (d) the passive group in 1995.* Source: Dr. C. Valdivia (IBTA/SR-CRSP, unpublished data)

Table 6.5. *Main effects of socioeconomic subgroup on various household income components (in Bolivianos) for 39 campesino households at San José Langa during 1993 and 1995.*[1]

	Subgroup				
	Active		Passive		
Income Category[2]	Improved	Criollo	Couples	Singles	P
Off-farm wages	2262a[3]	584a	302a	167a	0.57
Cultivated forage	4843a	1819ab	331c	881bc	<0.01
Cultivated food crops	2265a	1223ab	692b	495b	<0.01
Sheep production	1438a	1505a	345b	367b	<0.01
Cattle production	3042a	1740a	506b	194b	<0.01
Total livestock production	4481a	3247a	851b	561b	<0.01
Other[5]	224a	198a	446a	60a	0.77
Total income[6]	9232a	5252a	2292b	1282b	<0.01
TVP[7]	14 076a	7072a	2623b	2163b	<0.01
Per capita consumption[8]	2829	1102	1756	666	

[1]Where USD 1.0 = 4.05 Bolivianos. Tabulated P values are based on ANOVA using log-transformed data.

[2]Categories include cash and in-kind components.

[3]Entries in the same row followed by the same letter (a,b,c) were not significantly different (P<0.05) according to overlap of 95% confidence limits on log-transformed means.

[4]Sheep production plus cattle production.

[5]Value of handicrafts plus remittances.

[6]Includes all categories except cultivated forage (i.e., wages, crops, sheep, cattle and other).

[7]Total value of production includes all categories (i.e., wages, forage, crops, sheep, cattle and other).

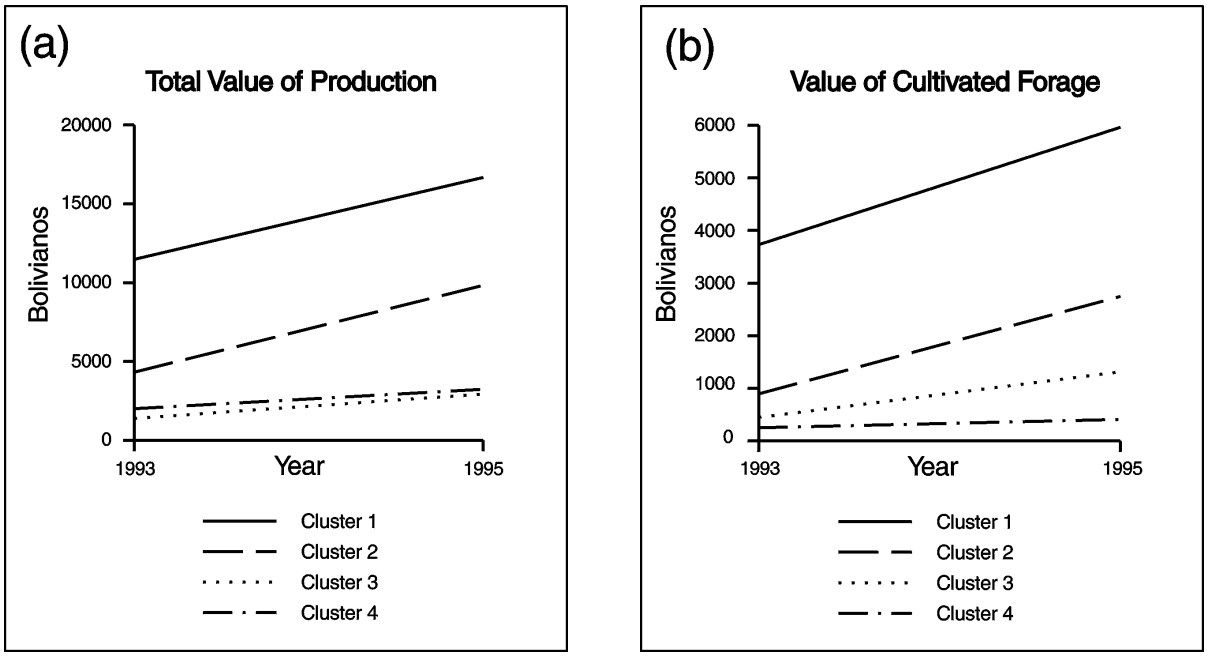

Figure 6.4 (a,b). *Significant year x subgroup ANOVA interactions for: (a) Total value of production (TVP; P=0.017); and (b) value of cultivated forage (P=0.05). Data were based on 39 campesino households from four socioeconomic subgroups. The two active groups tended to have "mid-career" households with larger, more-diverse enterprises, while the two passive groups tended to have "retired" household heads. The year 1993 was near-average in terms of rainfall, while 1995 was a drought year. See text for details including definitions of response variables. Cluster 1 was the active/improved, cluster 2 was the active/Criollo, cluster 3 was the passive/couples and cluster 4 was the passive/singles.* Source: Dr. C. Valdivia (IBTA/SR-CRSP, unpublished analysis)

in per capita consumption. The role of income, sheep assets and income transfers in dampening variation in consumption during a perturbation confirms other findings in the literature (Kusterer 1989; Morduch 1995). Our results highlight the role of small ruminants as a source of cash for household purchases and as a buffer when food shocks take place (Fafchamps et al 1998). The role of diversification was two-fold; maximizing use of resources (Ellis 1993) and as an *ex-ante* strategy to smooth income and consumption (Morduch 1995; Valdivia et al 1996). Unlike von Braun et al (1989) and Bromley and Chavas (1989), we have found diversification to occur at all levels of income, decreasing only at older stages in the life cycle, as in Kusterer (1989).

During our relatively brief period of research from 1991-5, it appeared as though the community of SJL was shifting towards more livestock production, which may be part of a coping response to a drier climatic phase (see Section 3.3.1: *Climate*). There was no collective mechanism to respond to the increased inequality caused by the climatic shock. There were mechanisms to reduce the impact of drought, such as the projects to develop irrigation and access to water. These efforts did not differentially affect active and passive members. Instead, they differentially affected people residing in various locations.

The shifts observed illustrated that household economic portfolios were dynamic and opportunistic, and strategies appeared to maintain a dual nature with regards to production for market as well as for home consumption. Food crop production is not abandoned here with the advent of improved markets (Valdivia and Jetté 1997, 1998). Producers assimilated new technology when appropriate as well as retained indigenous methods (see Chapter 7: *Patterns of technology adoption at San José Llanga*).

6.4 Conclusions

The framework proposed by investigators such as Norman (1992) and Valdivia and Jetté (1996) was validated through use of cluster analysis. We iden-

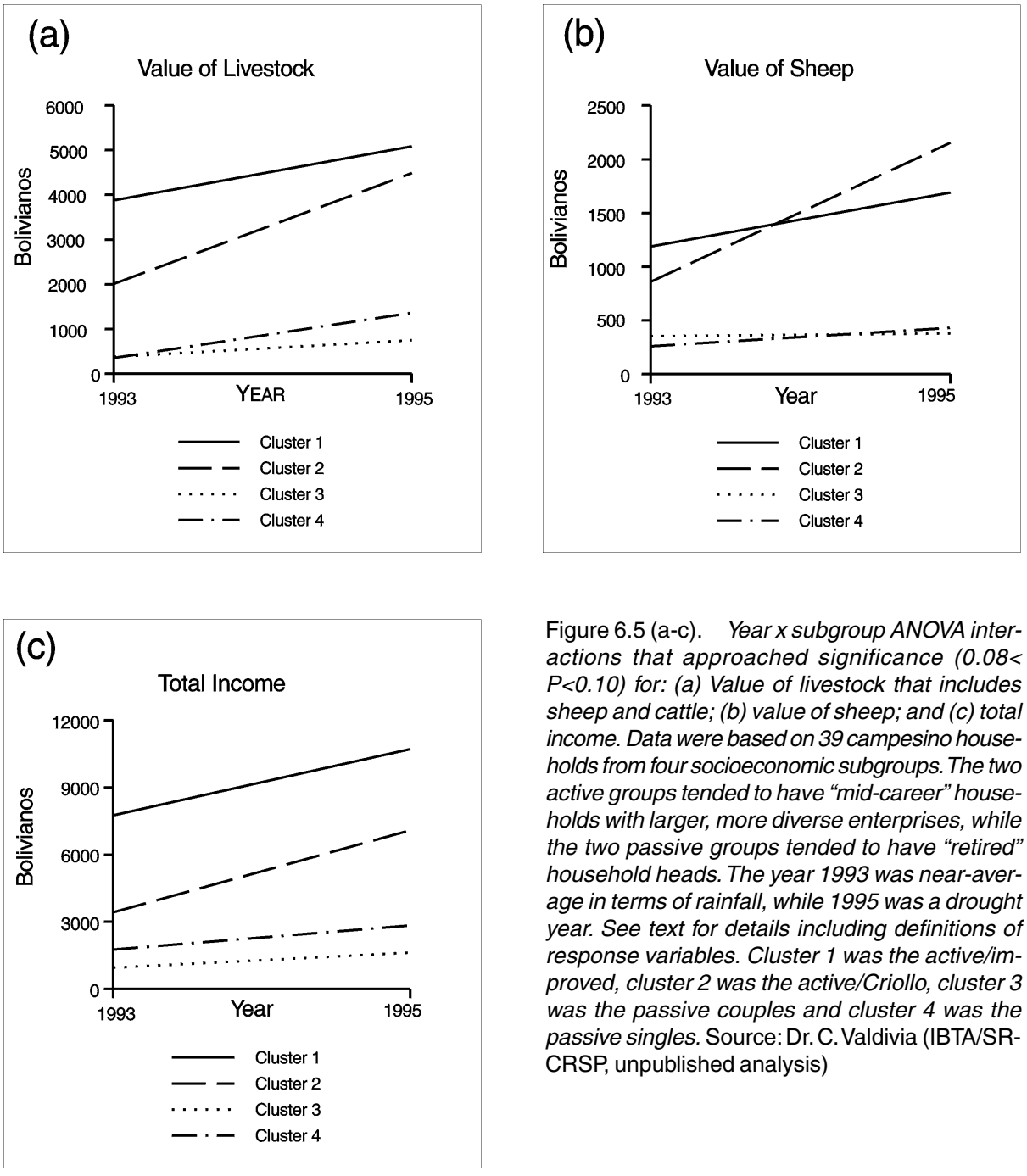

Figure 6.5 (a-c). *Year x subgroup ANOVA interactions that approached significance (0.08< P<0.10) for: (a) Value of livestock that includes sheep and cattle; (b) value of sheep; and (c) total income. Data were based on 39 campesino households from four socioeconomic subgroups. The two active groups tended to have "mid-career" households with larger, more diverse enterprises, while the two passive groups tended to have "retired" household heads. The year 1993 was near-average in terms of rainfall, while 1995 was a drought year. See text for details including definitions of response variables. Cluster 1 was the active/improved, cluster 2 was the active/Criollo, cluster 3 was the passive couples and cluster 4 was the passive singles.* Source: Dr. C. Valdivia (IBTA/SR-CRSP, unpublished analysis)

Table 6.6. *Statistics pertaining to a multiple regression where change in per capita consumption was analysed as a function of income, sheep assets, income transfers, economic diversity, and change in area planted to irrigated forages. Change was measured using the difference between variables in 1993, a near-average year for rainfall, and 1995, a drought year. The overall regression model was significant ($P<0.01$; adjusted $R^2 = 0.71$; $df = 32$).* Source: Dr. C. Valdivia (IBTA/SR-CRSP, unpublished data).

	Statistics			
Variable	Coefficient[1]	SE	*t*	P
Constant	-629.07	436.33	-1.44	0.159
Per Capita Income Change[2]	0.17	0.03	6.54	0.001
Sheep Assets 1993[3]	-23.27	0.61	-2.42	0.021
Improved Sheep Assets 1995[4]	17.37	7.07	2.51	0.017
Transfer of Income 1995[5]	1.32	0.37	3.53	0.001
Diversity Index[6]	259.19	140.96	1.83	0.075
Forage Area Change[7]	-81.04	94.96	-0.85	0.400

[1]Potential bias in coefficients was reduced by using two proxy measures for sheep assets that were not correlated (see below).

[2]Per capita income in 1995 minus per capita income in 1993 for each household.

[3]Indicative of savings behaviour in anticipation of future calamity.

[4]Indicative of current disposable assets in a drought year.

[5]Remittances, etc., from off-farm employment accruing to the household in a drought year.

[6]Inverse diversity index (Hill 1973). See text for details.

[7]Area planted to irrigated forages per household in 1995 minus the same for 1993.

tified various groupings of households that had varied income-generation strategies. These strategies were primarily conditioned by stage in the life cycle (i.e., age of household heads and size of labour pools), secondarily by the type of resources controlled by households, and lastly by access to marketing outlets.

In an economic sense, households at SJL coped with a one-year drought using diverse means including sheep sales, remittances and increased income from food crops that increased in value. This supported the literature on consumption smoothing, and illustrated that sheep, off-farm employment options and viable markets play key roles in promoting food security. Other implications are reviewed in Chapter 8: *Conclusions and recommendations*.

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