

**Livelihood strategies of farmers in Bolivar, Ecuador: asset distribution, activity  
selection and income generation decisions in rural households.**

Robert Santiago Andrade Lopez

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University  
in partial fulfillment of the requirements for the degree of

Master of Science

Agricultural and Applied Economics

Jeffrey R. Alwang

George W. Norton

Nicolai V. Kuminoff

June 20, 2008

Blacksburg, Virginia

Keywords: livelihood strategies, well-being, welfare, Bolivar, Ecuador

Livelihood strategies of farmers in Bolivar, Ecuador: asset distribution, activity selection and income generation decisions in rural households.

Robert Santiago Andrade Lopez

ABSTRACT

Households in rural Ecuador face several challenges. One of them is the severe deprivation that reaches alarming percentages in the countryside. Unequal distribution and limited assets constrain households from improving their economic conditions. These factors induce households to overexploit natural resources. Poor households engage in a variety of livelihood strategies. Livelihood strategies are characterized by the allocation of assets (natural, physical, financial, public, social and human), income-earning activities (on farm, off farm), and outcomes (food, income, security). Together these determine the well-being attained by an individual or households. We used data collected by INIAP as part of the SANREM-CRSP project to identify livelihood strategies, their determinants, and well-being implications of adopting a particular livelihood. These data were from a comprehensive survey of 286 households collected during September and November, 2006. Livelihood strategies for the Chimbo watershed were identified using qualitative and quantitative methods. The methods provide similar results and identified four main livelihoods: households engaged in diversified activities, agricultural markets, non-farm activities, and agricultural wage work. Most households are engaged in agricultural markets followed by households in diversified activities. Households engaged in agricultural markets own higher amounts of natural and physical resources, while households engaged in non-farm activities have, on average, more human capital. 100 Households participating in agricultural wage work are mainly from the down-stream watershed and possess less natural, physical and human assets. Factors influencing the selection of livelihood strategies were examined using a multinomial logit model. Variables such as access to irrigation, amount of farm surface and value of physical assets were statistically significant determinants of livelihood selection. Households with higher endowments of natural and physical assets are more likely to engage in agricultural markets and less likely to participate in non-farm activities. Secondary education tends to decrease participation in the agricultural sector while increasing engagement in non-farm activities. Several geographic variables like watershed location, altitude, and distance to rivers and cities are statistically significant determinants of livelihood strategies. The well-being associated with each livelihood strategy was estimated using least squares corrected for selection bias. Since participation in each livelihood is endogenously selected it was necessary to correct for selection. We use the Dubin- McFadden (1984) correction, based on the multinomial logit model. In our models of well-being few variables were statistically significant; this may be due to data limitations. Credit is statistically significant and has a positive effect on wellbeing. A similar positive effect is shown by education but the variable is not statistically significant. An odd result was found in the coefficient of irrigation access. This coefficient appears to decrease household well-being for those engaged in agricultural markets. This result is hard to explain, as we would expect that irrigation would be positively associated with well-being. The lack of access to water in irrigation systems in

the region (noted by many respondents) might explain this negative effect. Most 101 households that access irrigation do not have enough water, and access to irrigation does not provide the advantages that it might otherwise. The selection models were used to estimate the amount of well-being that households currently engaged in other livelihoods might receive if they selected a different livelihood. For example, what level of wellbeing would be attained by households currently engaged in agricultural markets if they instead engaged in non-farm activities. Results indicate that most households might achieve higher well-being if they engaged in non-farm activities. However households that want to engage in this sector require special skills or assets that are not easy to obtain; thus there are constraining barriers to diversification in the watershed. Several policy changes were simulated to determine their impacts on livelihood choice and household well-being. First a policy change that provides wider education to households in the region was assumed, with more education livelihood strategy selection moves towards the non-farm sector and away from agricultural wage work. These changes generate positive effects on household well-being. The second policy change was creating wider access to irrigation. This change moves livelihood strategies towards agricultural production and away from diversification and non-farm activities, and it had the effect of decreasing household well-being. This was unexpected but it is explained by the negative coefficient of irrigation access in the well-being model. These two policy changes were made to variables that are not statistically significant determinants in the well-being models but were highly significant determinants of livelihood strategies. 102 The third and final policy was wider access to formal credit. Although credit is not a variable that affects the selection of livelihood strategies, it has an important effect on well-being. This policy change generates the highest increment in average well-being. However even though credit is available, if it is not used for productive purposes, it might represent an unnecessary cost for the households instead of being beneficial.

## GENERAL INDEX

|   | <b>Pages</b> |
|---|--------------|
| <b>1. INTRODUCTION</b> .....  | 1            |
| 1.1. Problem Statement.....   | 1            |
| 1.2. Objectives.....  | 5            |
| 1.3. Methods.....   | 5            |
| 1.4. Thesis Outline.....  | 7            |
| <b>2. CONCEPTUAL FRAMEWORK</b> .....  | 9            |
| 2.1. Introduction.....  | 9            |
| 2.2. Livelihood strategy concepts.....  | 9            |
| 2.3. Livelihood strategy diversification.....                                     | 10           |
| 2.4. Livelihood strategy determinants.....  | 13           |
| 2.5. Livelihood activities .....  | 15           |
| 2.6. Outcomes.....  | 17           |
| 2.7. Livelihood strategy synthesis.....   | 18           |
| <b>3. DESCRIPTION OF THE STUDY AREA</b> .....                                     | 20           |
| 3.1. Introduction.....  | 20           |
| 3.2. Geographic and Economic Description of the Area.....                         | 20           |
| 3.3. Description of the Chimbo Watershed.....                                     | 23           |
| 3.4. Summary Statistics for Households Surveyed.....                              | 27           |
| 3.4.1. Income activities and well-being.....                                      | 28           |
| 3.4.2. Household productivity and productive assets.....                          | 32           |
| 3.4.3. Other problems faced by households .....                                   | 41           |
| <b>4. METHODS</b> .....   | 43           |
| 4.1. Introduction.....  | 43           |
| 4.2. Livelihood identification.....   | 43           |
| 4.2.1. Qualitative Cluster Protocol.....  | 44           |
| 4.2.2. Quantitative Cluster Method .....  | 46           |
| 4.3. Econometric models and simulation.....                                       | 49           |
| 4.3.1. Livelihood selection.....  | 49           |
| 4.3.2. Impacts of livelihood choice on household well-being.....                  | 53           |
| 4.3.3. Impacts policy changes on household well-being.....                        | 58           |
| <b>5. RESULTS</b> .....   | 62           |
| 5.1. Introduction.....  | 62           |
| 5.2. Livelihood strategies identification.....                                    | 62           |
| 5.2.1. Diversified Household (Livelihood A).....                                  | 63           |
| 5.2.2. Engaged in Agricultural markets (Livelihood B).....                        | 66           |
| 5.2.3. Rural Non-farm Economy (livelihood C).....                                 | 68           |
| 5.2.4. Agricultural consumption and wage work (livelihood D).....                 | 70           |
| 5.2.5. Identified livelihood strategies synthesis .....                           | 72           |
| 5.2.6. Livelihood strategies tests.....   | 73           |
| 5.3. Livelihood strategies and their characteristics influencing participation... | 73           |
| 5.3.1. Livelihood strategy selection .....  | 79           |
| 5.3.2. Livelihood strategy synthesis .....  | 79           |

|  |     |
|--|-----|
| 5.4. Livelihood strategies and well-being.....   | 80  |
| 5.4.1. Characteristics influencing well-being level under different<br>livelihood strategies ..... | 81  |
| 5.4.2. Estimated well-being level under different livelihood strategies....                        | 85  |
| 5.5. Policy changes, livelihood strategy selection and estimated well-being...                     | 87  |
| 5.5.1. Education policy change.....  | 88  |
| 5.5.2. Irrigation policy changes.....  | 92  |
| 5.5.3. Credit policy changes.....  | 95  |
| 6. <b>CONCLUSIONS</b> .....  | 99  |
| 6.1. Summary.....  | 99  |
| 6.2. Conclusions.....  | 101 |
| 6.3. Weakness and Further research.....  | 103 |
| <b>REFERENCES</b> .....  | 105 |
| Appendix 1: Sample Methodology and Questionnaire.....  | 110 |
| Appendix 2 Livelihood Strategies Summary Statistics.....   | 129 |
| Appendix 3 Marginal Effects Multinomial Logit Model .....  | 133 |
| Appendix 4 Alternate Household Well-being Equation.....  | 136 |

## FIGURE INDEX

|  | <b>Pages</b> |
|--|--------------|
| Figure 2.1. Households Livelihood Strategy Components  | 10           |
| Figure 3.1. Guaranda Province  | 21           |
| Figure 3.2. Chimbo watershed and households surveyed   | 25           |
| Figure 3.3. Illangama sub-watershed and households surveyed                                  | 26           |
| Figure 3.4. Alumbre sub-watershed and households surveyed                                    | 27           |
| Figure 3.5. Income share activity  | 29           |
| Figure 3.6. Total consumption expenditure share by categories                                | 31           |
| Figure 5.1. Income share by activities for diversified households (A)                        | 64           |
| Figure 5.2. Income share by activities of households engaged in agricultural markets (B)     | 67           |
| Figure 5.3. Income share by activities of households engaged in rural non-farm economies (C) | 69           |
| Figure 5.4. Income share by activities of households engaged in agricultural wage work (D)   | 70           |

## TABLE INDEX

|              |   | <b>Pages</b> |
|--------------|---|--------------|
| Table 3.1.   | Bolivar province summary statistic  | 23           |
| Table 3.2.   | Household expenditures and income activities                                    | 30           |
| Table 3.3.   | Natural assets  | 34           |
| Table 3.4.   | Physical assets   | 35           |
| Table 3.5.   | Financial and Public assets   | 37           |
| Table 3.6.   | Social capital  | 39           |
| Table 3.7.   | Human capital   | 41           |
| Table 4.1.   | Income-generating activities  | 45           |
| Table 4.2.   | Livelihood strategy selection criteria  | 46           |
| Table 4.3.   | Variables used in the multinomial logit model                                   | 51           |
| Table 4.4.   | Variables affecting household well-being  | 57           |
| Table 4.5.   | Variables used in the education logit model                                     | 59           |
| Table 4.6.   | Variables used in irrigation logit model  | 61           |
| Table 4.7.   | Variables used in the credit logit model  | 61           |
| Table 5.1.   | Livelihood strategies selection   | 63           |
| Table 5.2.   | Analysis of variance results for the variables used to define the livelihoods   | 63           |
| Table 5.3.   | Summary statistics for main variables   | 63           |
| Table 5.4.   | Comparison of qualitative cluster protocol and quantitative hierarchical method | 73           |
| Table 5.5.   | Multinomial logit coefficients: determinants of livelihood strategies           | 74           |
| Table 5.6.   | Marginal effects  | 75           |
| Table 5.7.   | Percentage of households predicted correctly                                    | 79           |
| Table 5.8.   | Determinants of household well-being conditioned on livelihood selection        | 82           |
| Table 5.9.   | Average estimated well-being within each livelihood strategy                    | 86           |
| Table 5.10.  | Determinants of education attainment  | 89           |
| Table 5.11.  | Percentage of households engaged among livelihood strategies                    | 90           |
| Table 5.12.  | Welfare change after education policy change                                    | 91           |
| Table 5.13.  | Determinants of irrigation access   | 92           |
| Table 5.14.  | Percentage of households engaged among livelihood strategies                    | 93           |
| Table 5.15.  | Welfare change after irrigation access change                                   | 94           |
| Table 5.16.  | Determinants of formal credit access  | 96           |
| Table 5.17.  | Percentage of households engaged among livelihood strategies                    | 97           |
| Table 5.18.  | Welfare change after credit policy change                                       | 98           |
| Table A 2.1. | Natural assets by livelihood strategy   | 129          |
| Table A 2.2. | Physical assets by livelihood strategy  | 129          |
| Table A 2.3. | Financial and Public assets by livelihood strategy                              | 130          |
| Table A 2.4. | Social assets by livelihood strategy  | 130          |
| Table A 2.5. | Human capital by livelihood strategy  | 131          |

|              |   |     |
|--------------|---|-----|
| Table A 2.6. | Income activities participation and outcomes gained by livelihood strategy        | 131 |
| Table A 2.7. | Expenditures level by livelihood strategies                                       | 132 |
| Table A 3.1. | Marginal effects for typical household engaging in agriculture markets            | 133 |
| Table A 3.2. | Marginal effects for typical household engaging in non-farm activities            | 134 |
| Table A 3.3. | Marginal effects for typical household engaging in agricultural wage work         | 135 |
| Table A 4.1. | Determinants of household well-being (income) conditioned on livelihood selection | 136 |

# 1. Introduction

## 1.1. Problem Statement

Eradication of extreme poverty represents one of the largest challenges in the world. This objective is part of the Millennium Development Goals pursued by the United Nations (UN). In their most recent report, the UN show that 28% of the developing world's population lived in extreme poverty in 1990, but in 2002 the proportion had been reduced to 19%. Although the international trend is toward a lower share of poor people, success is being achieved unequally across regions. For example, in Asia there has been an impressive reduction in the poverty rate due to rapid economic growth, but in other regions such as Africa, Latin America and the Caribbean reduction in poverty rates has progressed at a slower pace (UN, 2007).

Poverty can be measured in various ways, such as failure to attain basic needs, access to employment, empowerment, the strength of community relations, secure legal and human rights, political freedoms, and levels of income. This multidimensional nature of poverty provides the opportunity to alleviate it in different ways, rather than simply targeting income levels (World Bank, 2000). There exists a clear relationship between poverty and security, opportunity, and empowerment so that efforts to improve well-being should include means of reducing risk exposure, and managing the multiple risks faced by rural households (Alwang, *et al.* 2001).

In Ecuador, a lower middle income country (\$3,270 GDP per capita, BCE, 2007), around 56% of the rural population was below the poverty line in 1995 (World Bank, 2001). Moreover around 61% of the population lack basic needs according to the most

recent census, reflecting a continued alarming extent of poverty (INEC, 2001). While the share of poor people has been rising in urban areas, the highest incidence of poverty is generally found in the countryside (Lanjouw, 1999). Bolivar Province, located in the Andean Highland region of Ecuador, clearly reflects this reality. Bolivar is relatively rural, 78% of households lack basic needs, and it has the highest percentage of people in poverty in the country (INEC, 2001; Barrera, *et al.* 2007).

Bolivar is part of the Chimbo Watershed, which provides between 30% and 40% of the water to the Guayas River, one of the main rivers in Ecuador. Water quality in the Chimbo watershed is being seriously degraded. Cities dump solid wastes and garbage into the rivers indiscriminately, endangering natural resources and compromising human health. Around 8 million metric tons of sediment are generated annually in this watershed due to deforestation, cropping on steep slopes, use of intensive farming practices, and limited use of soil conservation practices (Barrera, *et al.* 2007). This runoff is reducing water flow and water availability in general, lowering productivity and damaging the natural balance of the ecosystem. These events are worsening as farmers who continue to farm their land intensively encroach onto more fragile higher-elevation areas, unaware of future consequences.

Households in this region depend mainly on agricultural production, and are vulnerable to price and income uncertainty due to incomplete and unequal access to markets, overproduction in certain seasons, unimproved public infrastructure, lack of production alternatives, and the dominant presence of intermediaries. As a result, many farmers behave conservatively making it more difficult to achieve high levels of income from on-farm production. Also, farmers face low crop yields due to inadequate training,

use of traditional technology, and degradation of natural resources. Households try to increase their income by mining natural resources such as soil, expanding crops to fragile areas not appropriate for agricultural activities, and allocating assets across non-farm activities. Diversification of income sources and bundling activities into livelihood strategies is a natural response in risky environments. Adoption of a livelihood strategy depends on available assets and conditions faced (Ellis, *et al.* 2003). Livelihood strategies are defined as the assets (natural, physical, financial, public, social and human), the activities (on farm, off farm), the outcomes (food, income, security) and the access to them that together determine the living gained by an individual or household (Chambers, 1995; Winters *et al.* 2002, Ellis *et al.* 2003).

When farmers lack assets, they can be proscribed from participating in activities that might improve their well-being. Because assets bases are narrow in Chimbo, diversification is limited. For example, the average education of the head of the household in the Chimbo watershed is five years (Barrera, *et al.* 2007), while evidence shows that returns from one additional year of schooling are quantitatively and statistically significant in rural areas of Latin America (Taylor, *et al.* 2000). Lack of education in Chimbo may slow diversification and contribute to poverty.

Limited bases of other assets may similarly contribute to slow levels of well-being. Natural and physical assets are unequally distributed in the Chimbo watershed. For instance, some households own extensive land, while others do not. Most households do not own heavy machinery, only small tools like machetes and plows. Only around one fifth of the farms have access to irrigation, and, those that do frequently have problems

gaining access to adequate irrigation water. There have been no recent improvements in infrastructure such as roads, transportation or adequate irrigation systems.

Accumulation of financial assets is slowed by high transaction costs and incomplete formal financial markets. Limited credit impedes opportunities for investment and access to more profitable activities. Different types of social organizations exist throughout the watershed, but participation in, and acceptance of, these organizations varies. Although in certain areas, social organizations are accepted and almost everyone participates, but in other areas most farmers are not willing to participate in social organizations due to a lack of trust. One example of social organizations in the upper sub-watershed is the COCDIAG<sup>1</sup> entity that was created with the aim of improving prospects for sustainable development (Barrera, *et al.* 2007).

By providing a window into household decisions about livelihood options, a study of diversification behavior will offer important insights for policy design. For example, investing in sustainable rural financial systems, increasing investments in education, health, physical and institutional infrastructure, and reducing entry costs can help farmers diversify and promote higher and more stable income (Lanjouw, 2001; Barret, *et al.* 2001). Authors like Ellis, Bebbington and Winters encourage the enhancement of household asset position in order to promote diversification towards non-farm activities. They also emphasize the importance of strengthening social assets, like strategic alliances among actors (society-market-farmers), social participation and empowerment in policy design, and long term relationships in sustainable projects. However, little information is available to help prioritize such interventions in the Chimbo watershed. As a response of this need projects like the Sustainable Agriculture and Natural Resource Management

---

<sup>1</sup> Corporación de Organizaciones Campesinas para el Desarrollo Integral del Sector Alto Guanujo

Collaborative Research Support Program (SANREM-CRSP) are trying to enhance the capacity to make better decisions, in order to improve livelihood strategies through stakeholder empowerment, enhanced resource management, strengthened local institutions, improved market access for smallholders and communities, and sustainable and environmentally development, increasing household's well-being.

A better understanding of diversification behavior will help in the design of policies that alleviate poverty, reduce vulnerability, and improve household wellbeing. Being able to predict the effects and impacts of new policies on households will reduce risk exposure, decrease household vulnerability, and aid in pursuing better conditions for households in the region.

## **1.2. Objectives**

The main goal of this study is to identify successful livelihood strategies and understand the factors affecting adoption of such strategies in Bolivar. To achieve this goal it is necessary to address the following sub objectives:

- Describe and characterize the available livelihood strategies.
- Identify the determinants of adoption of these strategies.
- Establish the relationship between livelihood choices and household well-being.
- Determine how policy change will affect household's well-being.

## **1.3. Methods**

The study begins by gathering secondary information on livelihood strategies, poverty alleviation, and the extent of on and off-farm activities. Information related to

Ecuador and its socio-economic situation is collected from national institutions like the National Institute of Agricultural Research (INIAP), the Ministry of Agriculture and Livestock (MAG), the National Institute of Trends and Census (INEC), Municipality of Bolivar, and others. The main source of primary data for the analysis is a survey of 286 households fielded by the INIAP in the Chimbo Watershed during 2006.

In order to identify differences among the livelihood strategies that farmers in Bolivar use, it is necessary to classify strategies. A useful tool for classifying data into groups is cluster analysis, an exploratory procedure for data analysis for nonhomogeneous groups. A cluster analysis is a multivariate statistical procedure that requires a data set describing a sample of cases or variables, and attempts to organize these cases or variables into relatively homogeneous groups (Aldenderfer and Blashfield, 1984). This analysis will be used to identify the livelihood strategies chosen by the farmers in the Chimbo Watershed.

Once the livelihood clusters are identified, a multinomial logit model will be used to identify the main variables that influence the household decision to adopt each strategy. The multinomial logit model offers a strategy to predict the behavior of categorical dependent variables as a function of a set of explanatory variables (Demaris, 1992). The results allow us to estimate the probability that a household adopts a particular livelihood strategy, given its asset base and other factors. The model will provide estimations of the marginal effects produced by a change in the characteristics of the household in the probability of belonging to the livelihood cluster. Finally, the model will allow us to identify the positive or negative effect that characteristics have on the probability of farmers' decisions (Liao, 1994).

In order to develop poverty alleviation strategies, it is important to understand how each livelihood strategy is associated with household well-being, conditional on the choice of the strategy. The proxy used to measure well-being is expenditures consumption level due to its advantage over income measures. It is necessary to use a two step model that corrects for selectivity bias because unobservable factors may affect both the selection of a livelihood strategy and the relationship between household and community assets and household well-being (Bourguignon *et al.* 2007). The results will allow us to identify how variations in households' characteristics influence well-being and identify the relationship between livelihood strategy choices and household well-being. The model will allow us to determine which livelihood strategy provides relatively higher levels of well-being among the households.

Finally, the change in well-being from policy changes in education, irrigation and credit access will be estimated. We examine how the probabilities of belonging to each livelihood strategy will change and how these changes affect household well-being. After estimating changes in well-being that each household with irrigation, higher education, or credit access could achieve, we can compare with the actual amount of well-being of that target population and see which ones improve irrigation access, education or credit for the households.

#### **1.4. Thesis outline**

An extensive literature review about livelihood concepts, determinants, and activity diversification is presented in chapter 2. The subsequent chapter describes the study area and its social and economic conditions. A complete overview of the econometric models

and procedures used to attain the objectives of the research is presented in chapter 4. Findings and a discussion of results are presented in chapter 5, and policy suggestions and conclusions are found in chapter 6.

## **2. Conceptual Framework**

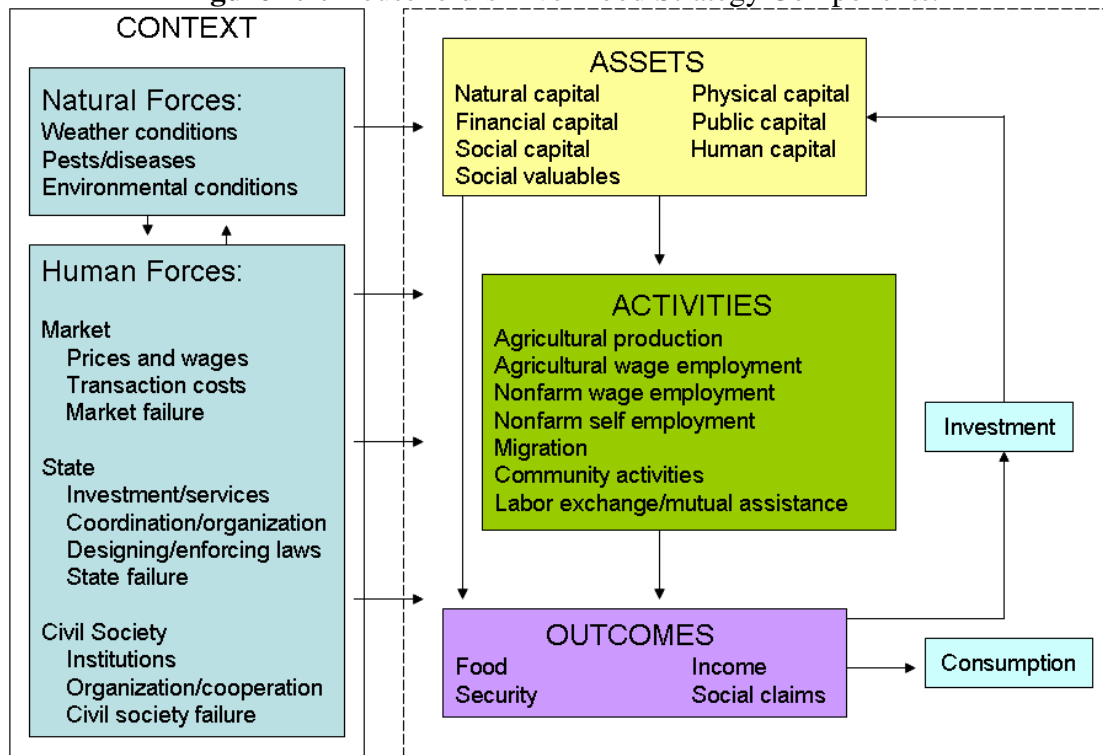
### **2.1. Introduction**

This chapter develops the concept of livelihood strategies. It describes attributes of a livelihood and the factors affecting livelihood diversification. It describes the main determinants in the selection of livelihood strategies and possible outcomes from livelihood choice.

### **2.2. Livelihood strategy concept**

Livelihood strategies are the activities realized by household members (farm production, off farm activities, migration, etc.), resulting in outcomes such as food or income security (Ellis *et al.* 2003). These activities are characterized by different allocations of natural (land area, irrigation, soil productivity), physical (working tools, tractors, livestock), financial (access to credit), public (roads, schools, public services), social (civil organizations, migration networks) and human (education, household size, training) assets (Winters *et al.* 2002). A livelihood refers to the means of gaining a living, including employing skills, tangible assets and intangible assets (Chambers, 1995). The activities engaged by the households help to identify the different livelihood strategies. Figure 2.1 details the components of a typical rural household livelihood strategy in Latin America

**Figure 2.1. Household's Livelihood Strategy Components.**



Source: Winters P, Corral L and Gordillo G, 2001.

### 2.3. Livelihood strategy diversification

Most poor rural households base their livelihood strategies on multiple activities to manage risky events, and achieve a sustainable stream of income over time. For example, poor rural Malawians confront several constraints that can only be addressed by some combination of raising agricultural productivity, diversifying farm output to shift toward higher value outputs and include high profitable activities like non-farm enterprises in order to improve wellbeing (Ellis *et al.* 2003). In other parts of rural Africa the same situation exists and diversification is the norm. Household reliance on non-farm income diversification is widespread, although not all households enjoy equal access to non-farm opportunities (Barrett *et al.* 2001).

In Latin America, most poor farmers manage risk and avoid adverse economic impacts by diversifying their income-earning activities. Livelihood diversification is the process by which households construct a portfolio of activities and assets allocation to manage risk and improve their standard of living. Historically government and non governmental institutions have focused their policies and efforts to improve specific sectors of the rural economy like production of specific crops. However, evidence shows that rural development policies and projects should consider the multiple factors that play a part in household livelihoods, and focus on a broad scope of activities rather than single sectors (Winters *et al.* 2002).

Many factors induce diversification out of farming. Sometimes diversification is born of desperation, sometimes of opportunity or risk management (Barret and Reardon, 2000). Multiple motives encourage diversification of assets, incomes, and activities. The first set of motives includes *push factors*, which are a response to diminishing factor returns in any given use. The second set of motives is known as *pull factors*, which are a set of factors that appear because of the strategic complementarities between activities, like crop-livestock integration, specialization according to comparative advantages by superior technology, or skills. Diversification due to push factors is driven by limited risk bearing capacity in the presence of incomplete or weak financial systems, constraints in labor and land markets, and climatic uncertainty. From the pull factors perspective, diversification results from reduction of barriers to participation in profitable activities, infrastructure improvements that will facilitate the access to local engines of growth such as commercial agriculture, or proximity to urban areas which creates opportunities for income diversification (Barret *et al.* 2001).

Some of the push factors faced by farmers in the province of Bolivar are seasonal droughts, lack of irrigation, missing financial markets, unequal land access, and lack of labor (Barrera V, *et al.* 2007). Farmers in Bolivar do not identify pull factors, and their pessimism, lack of faith in social organizations, and apathy against governmental institutions is a concern<sup>2</sup>.

Assets like natural (land), physical (livestock), or human (labor) capital will provide different returns for households. Assets returns vary among households and within communities (Barret and Reardon, 2000). For example, in the Chimbo watershed men and women access different labor markets due to cultural reasons; men allocate more of their time to off-farm activities, while women use more of their time on-farm. Seasonal variability in time availability explains a good part of diversification. For instance in the Alumbre downstream sub-watershed some farmers allocate all their labor to own-farm production during the rainy season and allocate their labor to off-farm agricultural activities during the dry season by migrating to plantations in the coast to harvest coffee and bananas.

Diversification is partly explained as a response to incomplete or absent markets. De Janvry (2000) defines absent markets as the risk premia, transport and search costs, etc. that would make it irrational to participate in the market even if it existed. Incomplete markets can induce or reduce rural diversification. For example, in the Chimbo watershed financial markets are incomplete and this incompleteness reduces access to formal credit or insurance, therefore limiting opportunities to invest in risky or high entry cost activities. However households in the Chimbo's Illangama sub-watershed can access

---

<sup>2</sup> These set of conclusions were defined by Participatory Appraisal Workshop realized during 2005 by several scientist from Virginia Tech, INIAP and PROINPA under the project SANREM-CRSP in several communities from the Chimbo watershed.

informal credit only if they participate in livestock activities like cheese production. This potential access to credit may encourage diversification away from crop agriculture. Also it has been argued that high entry costs limit diversification into non-farm activities (Winters *et al.* 2001). For example, the initial investment needed to establish a business includes buying materials, installing shelves, renting space, etc. Entry costs limit and incomplete credit markets diminish diversification.

According to Barrett (2001) economies of scope in production also help explain diversification. Economies of scope exist when the same inputs generate greater per unit profits when spread across multiple outputs than when dedicated to any single output. For example, some households allocate all their land to produce one crop, while others diversify the land across different crops and this diversification might provide them with higher profits than just producing one crop.

#### **2.4. Livelihood strategy determinants**

Decisions about a livelihood strategy depend on household assets. Assets are stocks of productive factors that produce a stream of cash or in kind returns, and they have significant importance at the moment of choosing a livelihood strategy. For example, in Mexico the asset position of rural households has a significant effect on household participation in income-generating activities and returns to those activities. Increasing schooling of the household head discourages participation in staple production, while encouraging participation in wage work and international migration (Taylor and Yunez, 2000). Household assets can be expanded by investment, and this expansion can influence household decisions in future livelihood strategies. Asset value depends on ownership

status and transferability (de Janvry and Sadoulet, 2000). For example, land is often a clear<sup>3</sup> and transferable<sup>4</sup> asset (Winters *et al.* 2002). In certain areas of Ecuador, however, land is not clear or transferable due to lack of markets and property rights (Samaniego, 2006). On the other hand human capital is clearly owned by the household but not transferable. The lack of transferable assets could inhibit selection or continuance of certain livelihood strategies. For example, households that own extensive amounts of land might engage in agricultural production, but if they have the option to transfer land and access financial capital they might diversify their strategy.

Several assets have received attention as main factors in the livelihood decision process. Human capital is directly linked to education, and the probability of participating in non-farm wage employment increases if the individual attains secondary education (Corral and Reardon, 2001). The average years of schooling of adults is an important determinant of rural household income from non-farm sources in rural Nicaragua (Corral and Reardon, 2001). Similarly, educated people are more likely to find employment in the non-farm sector than are the uneducated in rural Ecuador (Lanjouw, 1999). Quichua and Shuar speakers in Ecuador are just as likely to participate in the non-farm sector as Spanish speakers, but indigenous ethnics are at disadvantage in accessing more remunerative off-farm activities (Lanjouw, 1999).

Public assets like electrification, access to roads and potable water have been shown to be significant in adoption of livelihood strategies and establishment of small enterprises in rural Ecuador (Lanjouw, 1999). Similar results were found in Nicaragua, where access to paved roads increases participation in non-farm wage employment

---

<sup>3</sup> “Clear” meaning that can be identified or seen easily as assets.

<sup>4</sup> “Transferable” meaning that the property rights are clearly defined and the assets can be transfer to others for their use.

(Corral and Reardon, 2001). Infrastructure services appear to have significant influence in the probability of finding non-farm employment in rural El Salvador (Lanjouw, 2001).

A number of specific social capital variables have significant influence in income generation from farm and non farm activities in rural Mexico (Winters, *et al.* 2002). Migration networks, whether national or international have been shown to increase seasonal migration and overcome costs of entry into certain activities (De Janvry and Sadoulet, 2000).

## **2.5. Livelihood activities**

Based on the asset base, a household must decide the intensity of involvement in each activity. Activities require one or a combination of assets with the purpose of obtaining outcomes (Barret and Reardon, 2000). For example, agricultural production, or an own business income strategy may use natural, human, financial, or physical capital, while agricultural wage employment, off-farm employment, or migration will use only human capital like education, or social network access and not physical or natural capital.

Recent studies in several Latin America countries show the relevance of the broad scope of activities that integrate a livelihood strategy. For example 40% of rural household income in Nicaragua is generated by non-farm activities (Reardon *et al.* 2001). In Latin America as much as 47% of the labor force and 79% of women in rural locations are employed in non-farm activities (Lanjouw, 2001). These non-farm activities have played a key role in absorbing the rural work force and generating income (Winters *et al.* 2001). This changing context highlights the importance of considering the different

activities as a whole and emphasizes the necessity to improve and support livelihood strategies to help households.

Elbers (2001) reports that in Ecuador, non-farm activities constitute a significant portion of rural employment, 36% in 1994 with a growing rate. Also the share of income by activities shows that own farm employment represents 46% and non-farm self-employment around 32% in rural Ecuador. That, compared with other countries, represents the biggest share of income (Peru 30%, Mexico 9%, Nicaragua 11%). Lanjouw (1999) also found an important role of nonagricultural activities in rural Ecuador. The importance of nonagricultural income as a route out of poverty is again suggested because the share of total income from nonagricultural sources rises sharply with total income. The poorest quintile receives 22% of their total income from nonagricultural sources, compared to 37% for the second quintile and 64% to the top quintile (Lanjouw, 1999).

The context in which the household operates also affects livelihoods and outcomes. Usually two main forces are identified as part of the context: human and natural. Included among human forces are markets, state and civil societies. Each of these forces is independent of household decisions (Winters, *et al.* 2001). In Ecuador factors like markets can be affected by state policies. Effectiveness of state policies will depend on the action of civil societies and how strong their relations are with state entities. The acceptance of state policies will also depend on civil trust. The norms that govern interactions of individuals in formal and informal contracts can shape market transactions. Natural forces also shape the use of assets. For example, in the Chimbo watershed, weather patterns, deforestation, erosion and agricultural pests or diseases

create uncertainty in yields and prices. This uncertainty influences decisions and the ability to maintain or improve a livelihood strategy. Markets influence activities mainly through input and output prices but access to markets may affect activity adoption. The state influences activities through a variety of past and present actions. For example, investing in infrastructure (roads, schools, health centers), providing services (electricity, water), designing, implementing and enforcing laws, helping to reduce transaction costs or harming certain groups and thus altering the choice of activities. Civil societies shape activities because institutions determine acceptability and returns of activities (Winters *et al.* 2001)

## **2.6. Outcomes**

Activities lead to outcomes, and outcomes might be immediately obvious or only obvious over time. Activities such as agricultural production can lead to immediate increases in income and access to food; activities like communal work do not lead to immediate income but can lead to future social claims. Outcomes are the result of activities or direct use of assets. Diversifying activities is a way to manage variability in outcomes (Winters *et al.* 2001). Income is the main outcome of analysis for most studies, due to household motivations to diversify such as income maximization, income stabilization or both.

However, income is a flawed measure of well-being for a number of reasons. First, it tends to be underestimated because households tend to underreport it for strategic reasons. Second income, particularly in rural areas, is irregular and subject to shocks. It can be a misleading indicator of economic status and earnings are susceptible to

temporary fluctuations due to transitory events. Finally, income may fail to capture disparities in consumption that result from differences across families in the accumulation of assets or savings. For households that face poverty and high extent of material deprivation, income is a poor measure and it is not reliable (Meyer and Sullivan, 2003). Most researchers suggest the use of expenditures as a measure of well-being due to the ability to smooth over short term fluctuations, its relative ease of measurement, and clear interpretation as a well-being outcome (Barret *et al.* 2001). According to the World Bank (2001), consumption is conventionally viewed as the preferred well-being indicator for practical reasons of reliability because consumption is thought to capture long-run well-being levels. Consumption is less vulnerable to under reporting bias and ethnographic effects for poor households with low resources (Meyer and Sullivan, 2003; Ravallion, 2003). Our well-being measure is, then household consumption expenditures on final goods per capita, where expenditures are broadly defined to include the value of home produced and consumed goods, as well as outflows of money used in consumption. That total value is used as a well-being measure of the households in the Chimbo watershed. It is necessary to clarify that only consumption goods were included in the measure. For example, pesticide or fertilizer expenses were not included.

## **2.7. Livelihood strategy synthesis**

A livelihood strategy represents the composition of activities engaged in by members of the households resulting in outcomes that provide well-being. Household well-being is directly related to livelihood selections. For example, households might engage in agricultural production or non-farm activities as a livelihood strategy and achieve higher

or smaller amounts of well-being as a result of their decision. Poor households diversify their livelihood strategies through multiple activities, in order to cope with risky events and achieve a sustainable income stream over time. An important factor to livelihood adoption is the asset base. Households decide the activities that combine into a livelihood strategy and the intensity devoted to each activity based on the household asset base. The asset base might be affected by policy changes that redistribute assets and therefore affect livelihood selection. Wider access to education or natural assets might have a strong effect on the selection of livelihood strategies and therefore in the amount of well-being gain by livelihood. The aim to improve asset access is to adopt better livelihoods that provide higher amounts of well-being and sustainable development for households reducing their risk exposure.

### **3. Description of the Study Area**

#### **3.1. Introduction**

This chapter presents a description of the study area. It briefly describes Bolivar Province. It describes social and economic conditions, levels of education, and basic infrastructure. Descriptive statistics of the watershed are presented. It describes the context, including natural and human forces within the watershed. Finally it briefly describes the main assets owned by households, the different activities realized, income gained and levels of expenditures.

#### **3.2. Geographic and Economic Description of the Area**

The area of interest is located in the province<sup>5</sup> of Bolivar (Figure 3.1), in the central part of the Andean (Sierra) region of Ecuador. The province was founded in April 23, 1884 and it receives its name in honor of the great liberator of South-America, Simon Bolivar. Bolivar Province has an approximate surface of 3,254 square kilometers or 1,256 square miles, making it one of the smallest provinces in Ecuador.

Bolivar is divided into seven cantons<sup>6</sup> (Caluma, Chillanes, Chimbo, Echandia, Guaranda, Las Naves, and San Miguel), and each of these is divided into several parishes<sup>7</sup>. The province has a total of twenty seven parishes and ten of them are part of the capital, Guaranda.

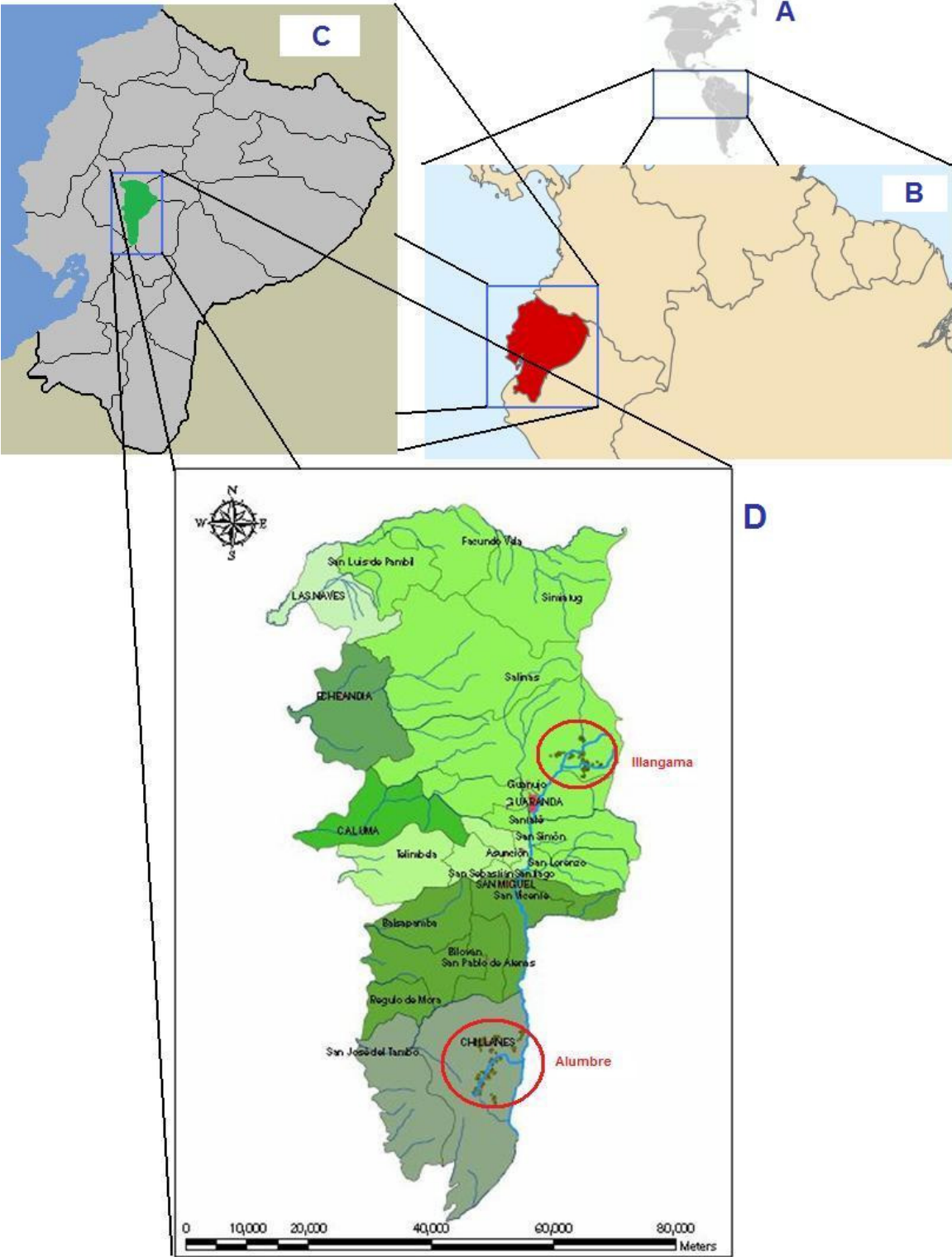
---

<sup>5</sup> A political subdivision of Ecuador; the country is divided in twenty three provinces

<sup>6</sup> A political subdivision of provinces in Ecuador, in Spanish “cantones”

<sup>7</sup> A political subdivision of cantons in Ecuador, in Spanish “parroquias”

Figure 3.1. Guaranda Province.



Source: SIGAGRO-MAG.

Bolivar has a total population of 169,370 inhabitants (INEC, 2001) with approximately 135 inhabitants per square mile. About 51% of the population is female. Approximately 72% lives in rural areas, and 29% are indigenous. The cantons with larger populations are Guaranda (48% of the total), San Miguel (16%) and Chillanes (11%). Around 70% of the total population of work age (above 15 years old) participates in the labor market but only 52% of them are actually employed in the formal labor market (INEC, 2001). No official reports exist about informal employment in the province, although a high percentage of the population participates in the informal market.

The average years of education completed by the population over 18 years old is around 5 years, and the illiteracy rate of people older than 15 years old is 18%. Only 48% of the population above 12 years old have completed primary school, and just 13% above 18 years old have finished high school. The difference in years of education completed between males and females is only one year; however the illiteracy rate for female adults is 21%, almost double the illiteracy rate for males. The Guaranda canton has the highest illiteracy. For females it reaches 29% mostly due to a high indigenous population (INEC, 2001); see table 3.1.

In Bolivar an estimated 77% of the households lack basic needs, and the province has the highest index of poverty in Ecuador. About 68% of the population lives in housing lacking minimum services like sewage systems, water, telephone lines, and electricity. 78% of households own their properties, 77% have electricity, 64% sewage systems, 29% garbage removal, and 12% telephone lines, although increasingly households have access to cell-phones, reducing the importance of this indicator. The cantons of Chillanes and Guaranda have the highest poverty in Bolivar (85% and 78% respectively). In Chillanes,

78% of houses lack minimum infrastructure services, 64% have electricity, 52% sewage systems, 20% waste management, and 7% telephone lines. See table 3.1.

**Table 3.1.** Bolivar province summary statistics.

|                           | <i>Guaranda</i> | <i>Chillanes</i> | <i>Chimbo</i> | <i>Echandia</i> | <i>San Miguel</i> | <i>Caluma</i> | <i>Las Naves</i> |
|---------------------------|-----------------|------------------|---------------|-----------------|-------------------|---------------|------------------|
| Population % of total     | 0.48            | 0.11             | 0.09          | 0.06            | 0.16              | 0.07          | 0.03             |
| Working population %      | 0.38            | 0.35             | 0.36          | 0.35            | 0.35              | 0.35          | 0.35             |
| Poverty by basic needs %  | 0.78            | 0.85             | 0.73          | 0.74            | 0.72              | 0.67          | 0.84             |
| Illiteracy %              | 0.23            | 0.18             | 0.11          | 0.13            | 0.11              | 0.09          | 0.12             |
| Males                     | 0.17            | 0.14             | 0.09          | 0.10            | 0.09              | 0.07          | 0.12             |
| Females                   | 0.29            | 0.22             | 0.13          | 0.15            | 0.13              | 0.10          | 0.13             |
| Education level (years)   | 5.0             | 4.7              | 5.7           | 5.8             | 6.0               | 6.1           | 5.5              |
| Males                     | 5.5             | 5.0              | 5.9           | 6.0             | 6.1               | 6.1           | 5.5              |
| Females                   | 4.6             | 4.4              | 5.6           | 5.5             | 5.9               | 6.1           | 5.5              |
| Female population %       | 0.52            | 0.49             | 0.51          | 0.49            | 0.51              | 0.50          | 0.47             |
| Homeowners (% households) | 0.79            | 0.74             | 0.78          | 0.73            | 0.76              | 0.71          | 0.68             |
| Electricity access %      | 0.74            | 0.64             | 0.84          | 0.84            | 0.86              | 0.81          | 0.71             |
| Telephone access %        | 0.13            | 0.07             | 0.17          | 0.10            | 0.08              | 0.18          | 0.02             |
| Waste management %        | 0.29            | 0.20             | 0.30          | 0.45            | 0.26              | 0.39          | 0.36             |

Source: INEC, 2001.

### 3.3. Description of the Chimbo Watershed

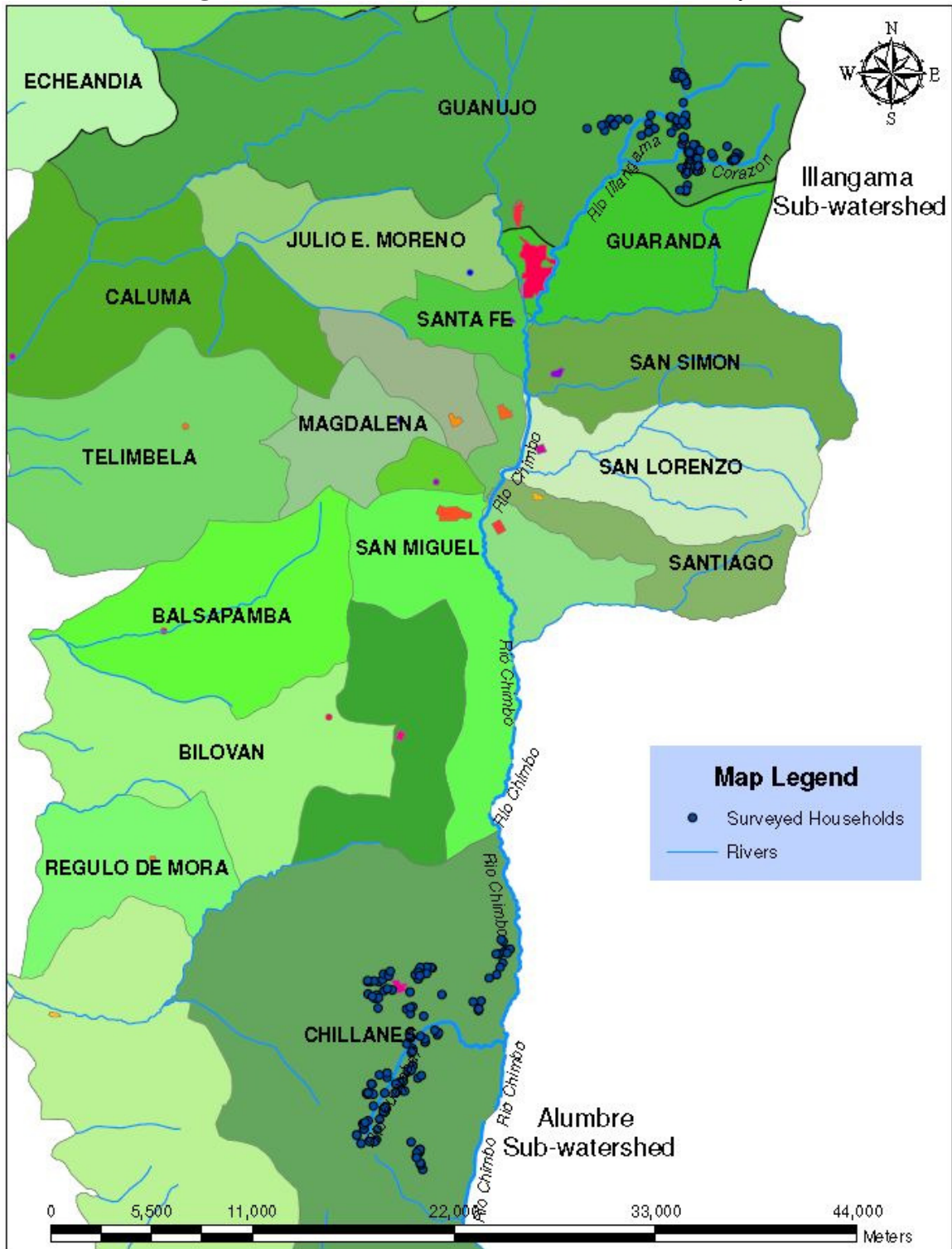
The Chimbo watershed runs through Bolivar province through Guaranda, Chimbo, San Miguel and Chillanes cantons. This watershed provides between 30% and 40% of the total water flow to the Guayas River, which flows by Guayaquil, the most populous city in Ecuador. The watershed is affected by several problems. The flow of the river has been reduced by an escalating degradation of natural resources due to the expansion of farming areas and depleted forest buffers along the river. Also the increasing processes of erosion along the watershed, compounded by lack of soil protection practices, contribute to around 8 million metric tons of sediment in the river per year (Barrera *et al.* 2007). The most populated cities in the Bolivar province dump their sewage directly into the rivers that are part of the Chimbo watershed without any treatment. Garbage dumps for these

cities are located on the banks of the rivers, directly polluting the water, endangering human health and reducing environmental quality (Barrera *et al.* 2007).

With the aim of finding a solution to these problems, participatory appraisal workshops were realized in several communities by INIAP, PROINPA and Virginia Tech scientists during 2005. These workshops helped identify common problems in the watershed and delimited the subsequent study area. This study area was the focus of a household survey used to generate baseline information for the SANREM project.

INIAP was in charge to gather the baseline information, gathering 286 surveys within the Chimbo watershed. The two sub-watersheds characterized were: the downstream Alumbre sub-watershed and the upstream Illangama sub-watershed. Figure 3.2 shows the location of the sub-watersheds and the households that were surveyed by INIAP during 2006.

**Figure 3.2.** Chimbo watershed and households surveyed.

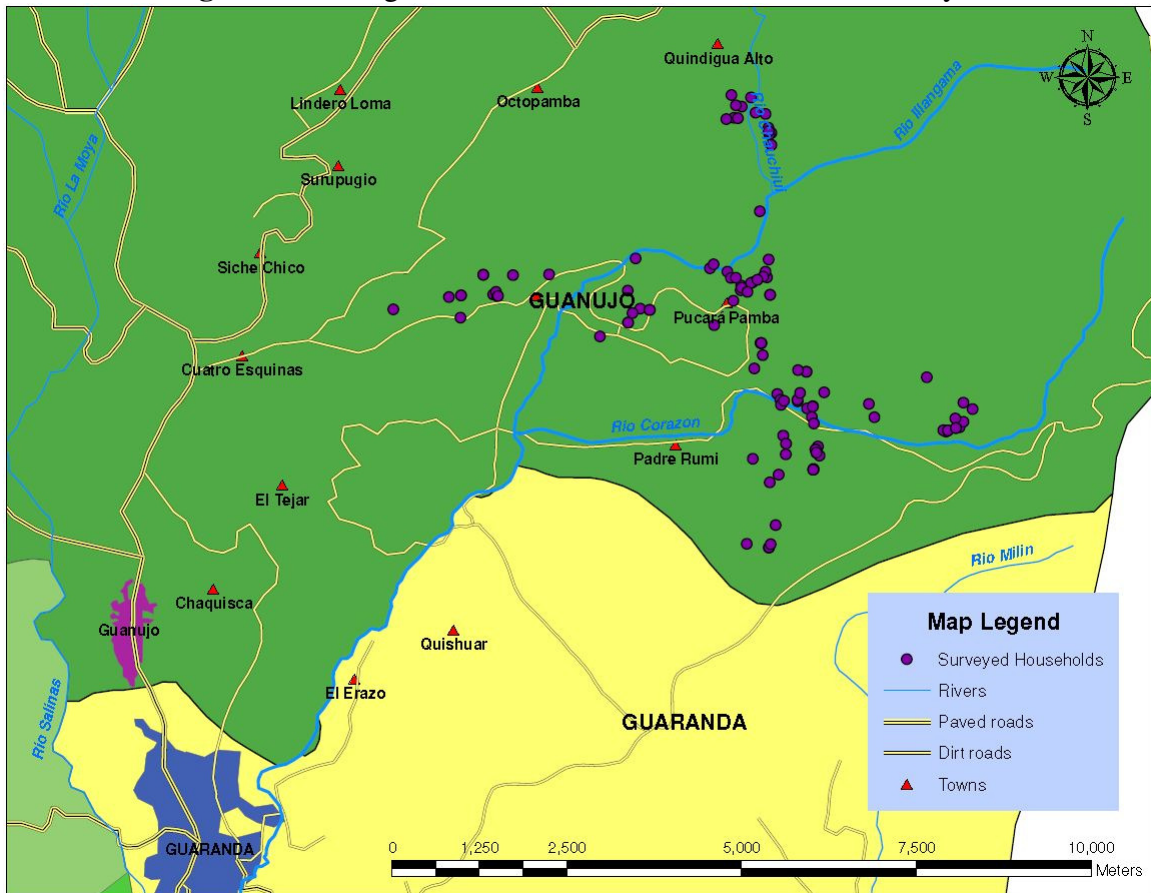


Source: SIGAGRO-MAG.

The Illangama sub-watershed (figure 3.3) has an approximate area of 50 square miles (12,829 ha) and is mainly within the Guaranda canton, Guanujo parish at the upstream

part of the Chimbo watershed. The average temperature during the year in Guaranda is between 7° to 13° Celsius and average precipitation is 51 inches per year. The Illangama sub-watershed ranges from 9,200 to 16,400 feet above the sea, but cropping activities are only found below 11,800 feet (Barrera *et al.* 2007).

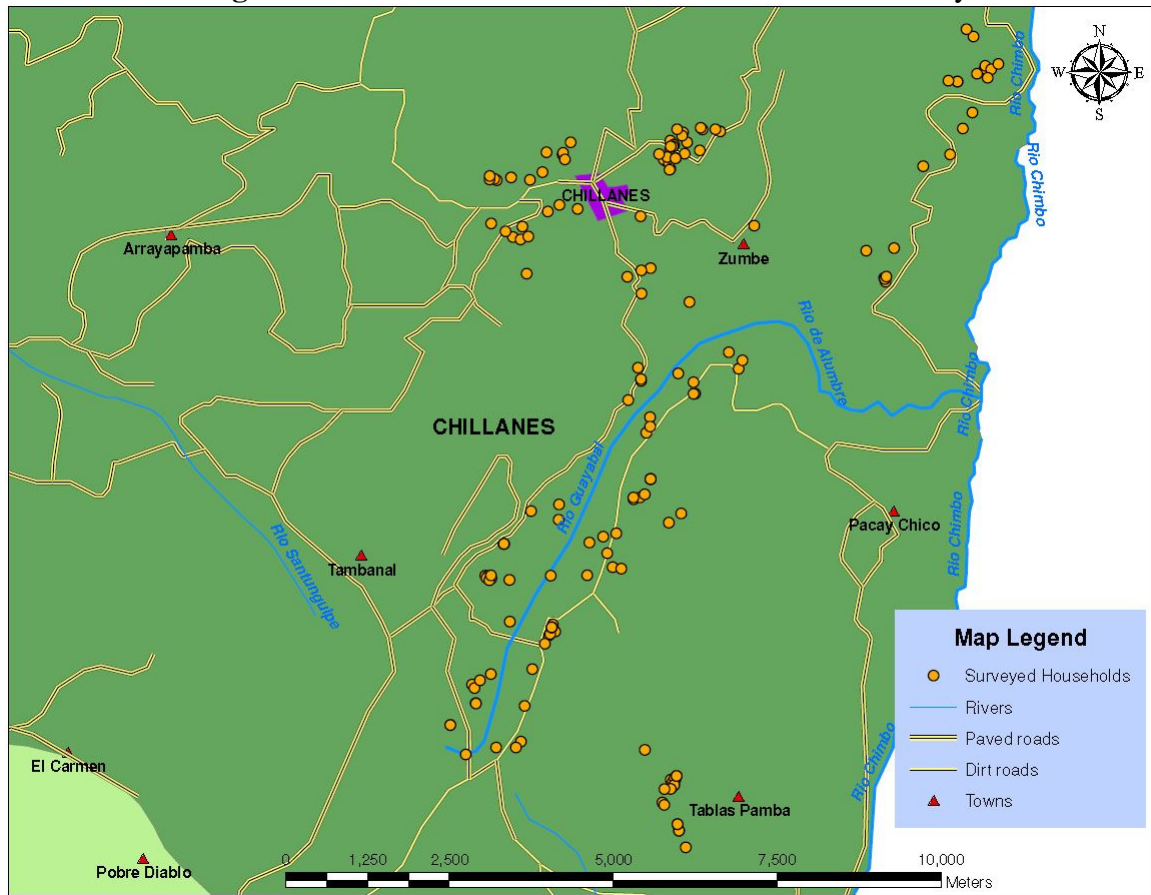
**Figure 3.3.** Illangama Sub-watershed, and households surveyed



Source: SIGAGRO-MAG.

The Alumbre sub-watershed (figure 3.4) has an approximate area of 25 square miles (6,556 ha) and it is mainly located in Chillanes canton in the downstream area of the Chimbo watershed. The average temperature during the year in Chillanes is between 15° to 19° Celsius and average precipitation is 59 inches per year. The altitude ranges from 6,500 to 9,200 feet above sea level (Barrera *et al.* 2007).

**Figure 3.4.** Alumbre Sub-watershed and households surveyed.



Source: SIGAGRO-MAG.

### 3.4. Summary Statistics for Households Surveyed

After identifying the study area, household surveys were collected by INIAP technicians and undergraduate students from Bolivar University (UEB) during September and November, 2006 with the aim of characterizing the households and their livelihood strategies. The surveys contain information from around 1,500 persons from 286 households. Seventeen communities were characterized from the Alumbre sub-watershed and ten communities from the Illangama sub-watershed. The original questionnaire used to survey households and the sampling procedures are presented in appendix 1.

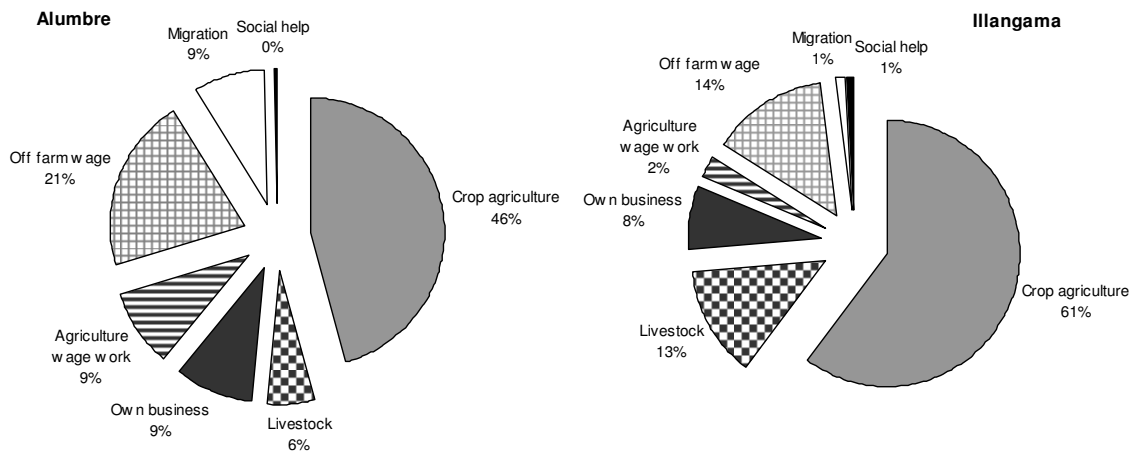
The productive activities of the households and their incomes are described together with consumption expenditures (well-being) of the families. Also the amount of productive assets and household productivity are described, together with problems faced by the households.

#### **3.4.1. Income activities and well-being**

One way that households in the Chimbo watershed cope with risk is by diversifying their income over several activities. The total amount of income per year differs across sub-watersheds, and the difference in the mean values is statistically significant but only at 10% level (See table 3.2). Even when the downstream area has the lowest total average annual income, it is the upstream area that has the lowest annual average income per capita. However the annual income per capita is not statistically different between sub-watersheds (See table 3.2). Households in both sub-watersheds diversify their income source among two to four activities.

In both watersheds, households depend on agricultural production, which represents the highest income share. Therefore if a risky event affects the agricultural sector in general, all households of the region suffer an important shortage of income. The remaining income share is provided by rural non-farm activities which are an important source of income to reduce risk exposure (See figure 3.5).

**Figure 3.5. Income share activity**



Source: SANREM-CRSP survey.

In the Alumbre sub-watershed, agricultural wage work is particularly important, as are off-farm wage earning activities. Households from this sub-watershed can easily engage in agriculture wage work on other farms from the coastal region due to its proximity. It is also common for these households to migrate due to their location. Households in the Illangama sub-watershed participate more in crop and livestock production and off-farm activities such as their own business and rural non-farm work such as construction or services. However just a few households engage in agricultural wage work or migration. Livestock activities are more common in the upper sub-watershed. For instance, one of the most successful communal enterprises of cheese production in Ecuador is located close to the upper sub-watershed and provides an example of a possible development pathway. The altitude limits diversification of crops in the upper sub-watershed, so producers complement their agricultural activities by livestock production (See table 3.2 and Figure 3.5).

The quality of life or degree of well-being of the households in the Chimbo watershed is low. We use annual consumption expenditures level per capita to measure household well-being. This measure does not differ across the sub-watersheds. Households in the

downstream sub-watershed are in the same conditions as those in Illangama. Households in both sub-watersheds have low levels of consumption and face basic needs deprivation.

Table 3.2 presents the annual average amount of income and expenditures per capita in each sub-watershed and the percentage of households engaged in each productive activity. Also a t-test or pr-test is performed in order to test the statistical significance of the hypothesis that mean values between sub-watersheds do not differ.

**Table 3.2.** Household expenditures and income activities.

| <i>Variables</i>                             | <i>Alumbre</i> | <i>Illangama</i> | <i>t-test or pr-test</i> |
|--|----------------|------------------|--------------------------|
| Total Annual Average Expenditures \$         | 964.61         | 1286.59          | 0.00***                  |
| Annual Expenditures per capita \$            | 240.56         | 239.39           | 0.95                     |
| Average food expenditures share %            | 0.47           | 0.53             | 0.00***                  |
| Total Annual Average Income \$               | 2752.93        | 3443.27          | 0.06*                    |
| Annual Income per capita \$                  | 682.44         | 643.23           | 0.65                     |
| Income diversity index %                     | 0.40           | 0.42             | 0.34                     |
| Crop agricultural Activities participation % | 1.00           | 1.00             | Nt                       |
| Total Annual Average income \$               | 1261.83        | 2076.76          | 0.00***                  |
| Livestock Activities participation %         | 0.41           | 0.85             | 0.00***                  |
| Total Annual Average income \$               | 367.63         | 544.51           | 0.00***                  |
| Own business Activities participation %      | 0.20           | 0.21             | 0.80                     |
| Total Annual Average income \$               | 1298.53        | 1229.04          | 0.85                     |
| Agricultural wage employment participation % | 0.51           | 0.16             | 0.00***                  |
| Total Annual Average income \$               | 507.91         | 521.58           | 0.87                     |
| Off farm wage Activities participation %     | 0.40           | 0.51             | 0.07*                    |
| Total Annual Average income \$               | 1425.21        | 956.50           | 0.09*                    |
| Migration Activities participation %         | 0.24           | 0.08             | 0.00***                  |
| Total Annual Average income \$               | 993.75         | 563.33           | 0.02**                   |
| Social help Activities participation %       | 0.04           | 0.14             | 0.00***                  |
| Total Annual Average income \$               | 180.00         | 180.00           | Nt                       |

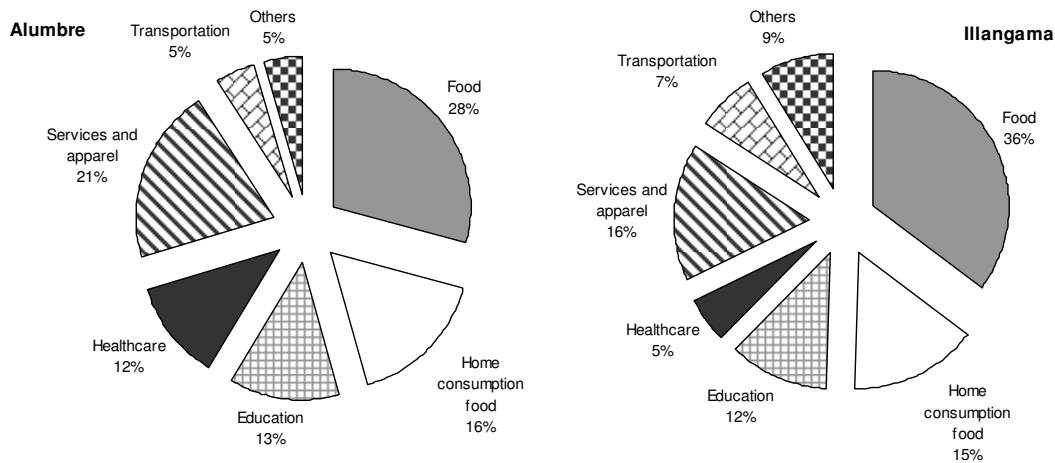
Nt = no test was performed because the variable do not differ among watershed.

\* significant at 10% - \*\* significant at 5% - \*\*\* significant at less than 1%

Source: SANREM-CRSP survey.

The largest shares of expenditures are dedicated to food consumption and home consumption. Almost half of the total amount of consumption expenditures is dedicated to food consumption from households own farm production or from external sources. Agricultural production represents an important activity because it provides products for home consumption which ensures food security. The other categories of consumption are services and apparel, education, and health care expenditures (See figure 3.6).

**Figure 3.6.** Total consumption expenditure share by categories



Source: SANREM-CRSP survey.

Data on income and consumption expenditures present some limitations as variables due to how they were recorded. Expenditures has some limitations because it does not record carefully all the goods consumed by the family. For instance, it does not measure the home consumption of livestock products like milk, eggs, cheese, guinea-pigs or chickens, which in many cases represent an important source of food. Also many of the expenditures were just projected for one year and not recorded in extensive detail. Due to this reduced expenditure level it appears that income is extremely high, being almost three times bigger than expenditures. The reason why income is so high is because the variable was also projected for twelve months assuming that each of the income activities is steady during the year without considering income seasonality, especially for activities like migration or agricultural wage work, even agricultural production, where prices fluctuate greatly during the year and can not be easily projected. An improved survey is needed.

### **3.4.2. Household productivity and productive assets**

Households own limited productive assets. In Illangama the average farm size is 3.5 hectares and around 81% of the total surface is owned with title, while in Alumbre the average farm size is 5.8 hectares. The differences between land sizes in the watersheds are statistically significant. Although households in the downstream area possess more land, households in the upstream watershed have better access to irrigation. This difference is also statistically significant. Another major difference between the watersheds is the allocation of land among crops. Households in Alumbre dedicate a higher percentage of land for crops (grains and legumes), while those in Illangama dedicate a higher percentage to pasture and roots (table 3.3).

According to the Ministry of Agriculture (2006) the national yield of potatoes is 9.6 metric tons per hectare, while the yield in Bolivar province is 7.6 metric tons per hectare. Similar yields were found in Illangama in the survey, around 8.3 metric tons per hectare, while in the downstream region the yield was only 3.9 metric tons per hectare. It is not surprising that the yield of potatoes in the downstream area is smaller since the main crops in that area are corn and beans. According to the Ministry of Agriculture (2006) the national yield of corn is 3.42 and beans 1.31 metric tons per hectare. However in the downstream area the yield of corn is only 0.44 and beans 0.40 metric tons per hectare far lower than the national average. These low yields reflect the productivity problems faced by the households in both sub-watersheds. Although potato yield is close to the national average and surpasses the province average, the price received for the product varies widely during the year, increasing the exposure to unstable income from agricultural production.

Most households feel like they have productive soils and recognize the importance of them. However, incomes are generally low and few farmers have implemented soil conservation practices (30%). The use of productive inputs is more intense in the upper watershed where a higher percentage of households uses pesticides (50%) and applies fertilizer (89%). Part of the difference in input intensity is due to the different type of crops; those in Illangama such as potatoes demand higher amount of inputs. Usually farms in both sub-watersheds are divided into at least two parcels and the topography in both areas is steeply sloped with few flat areas.

Table 3.3 shows the natural assets and differences in assets between the two watersheds. Similar t-tests and pr-tests are used to test the null hypothesis that the mean values in both sub-watersheds are the same. The percentage of households that have irrigation is higher in the upstream sub-watershed Illangama, while downstream the percentage of households having irrigation is reduced. In the downstream area the sources of irrigation are reduced and polluted from the upstream area.

**Table 3.3.** Natural assets.

| <i>Variables</i>              | <i>Alumbre</i> | <i>Illangama</i> | <i>t-test or pr-test</i> |
|-------------------------------|----------------|------------------|--------------------------|
| Altitude (km)                 | 2.35           | 3.42             | 0.00***                  |
| Land size (ha)                | 5.77           | 3.50             | 0.01**                   |
| Own with title %              | 0.85           | 0.81             | 0.07*                    |
| Own surface (ha)              | 6.35           | 3.50             | 0.00***                  |
| Pasture surface %             | 0.39           | 0.63             | Nt                       |
| Pasture surface (ha)          | 4.79           | 2.29             | 0.00***                  |
| Cropped surface %             | 0.61           | 0.37             | Nt                       |
| Cropped surface (ha)          | 3.50           | 1.31             | 0.00***                  |
| Legumes %                     | 0.20           | 0.06             | Nt                       |
| Grains %                      | 0.42           | 0.07             | Nt                       |
| Grains and legumes %          | 0.34           | 0.00             | Nt                       |
| Tubers or roots %             | 0.01           | 0.84             | Nt                       |
| Andean Fruits %               | 0.03           | 0.00             | Nt                       |
| Others %                      | 0.00           | 0.02             | Nt                       |
| Productive soils %            | 0.42           | 0.58             | 0.01**                   |
| Irrigation access %           | 0.09           | 0.38             | 0.00***                  |
| Enough access to water %      | 0.31           | 0.38             | Nt                       |
| Water reservoirs access %     | 0.02           | 0.01             | 0.52                     |
| Soil conservation practices % | 0.32           | 0.26             | 0.32                     |
| Use of fertilizer %           | 0.67           | 0.89             | 0.00***                  |
| Use of pesticides %           | 0.37           | 0.50             | 0.02**                   |

Nt = no test was performed because variables do not differ among watershed or they are not suit for a t-test or pr-test.

Note: The legume crops are peas, beans, chochos, fababeans and lentils. The grain crops are corn, wheat, barley and quinoa, while in root or tuber crops are potatoes, mashua, melloco, and oca. Andean fruits are tamarillo (tree tomato) and blackberry, while others are onions, sugarcane, carrots, tomatoes, sambo and zapallo. The variable irrigation access shows the percentage of households that have some kind of irrigation infrastructure within their land such as rivers, springs, or wells, the original question was “do you have irrigation infrastructure? What kind?”

Source: SANREM-CRSP survey.

The amount of physical capital owned by households in both sub-watersheds is minimal. Households do not own large trucks or expensive machinery. They mainly have some small tools and livestock. In both sub-watersheds, farmers own small work tools, such as backpack sprayers, hoes, and machetes. But in the downstream sub-watershed only a small percentage of producers own these implements. Although the amount of productive assets is similar between sub-watersheds, the amount of livestock owned differs greatly. Households in the Illangama sub-watershed own more cattle and small

livestock, because pasture is one of the only options beside potatoes<sup>8</sup>. On average, the values for cattle and small livestock in the upstream region are estimated at \$2,800 per household, while in the downstream region they are \$1,100. The small livestock owned by the farmers include hens, sheep, horses, mules, donkeys, rabbits, llamas, pigs, and guinea pigs. For more detail see table 3.4.

**Table 3.4.** Physical assets.

| <i>Variables</i>           | <i>Alumbre</i> | <i>Illangama</i> | <i>t-test or pr-test</i> |
|----------------------------|----------------|------------------|--------------------------|
| Own Physical assets %      | 0.88           | 1.00             | 0.00***                  |
| Value Physical assets \$   | 759.58         | 2698.86          | 0.00***                  |
| Own Small livestock %      | 0.79           | 0.99             | 0.00***                  |
| Value Small livestock \$   | 347.04         | 767.99           | 0.00***                  |
| Own Cattle %               | 0.59           | 0.95             | 0.00***                  |
| Value Cattle \$            | 804.88         | 2087.74          | 0.00***                  |
| Number of cattle           | 2.64           | 7.13             | 0.00***                  |
| Own productive assets %    | 0.66           | 0.98             | 0.00***                  |
| Value productive assets \$ | 136.24         | 149.67           | 0.91                     |
| Steel hand plow %          | 0.02           | 0.00             | 0.15                     |
| Irrigation equipment %     | 0.02           | 0.07             | 0.03**                   |
| Backpack sprayers %        | 0.26           | 0.41             | 0.01**                   |
| Small work tools %         | 0.23           | 0.34             | 0.04**                   |
| Vehicles %                 | 0.01           | 0.01             | 0.79                     |
| Chainsaws %                | 0.00           | 0.01             | 0.23                     |
| Hoes %                     | 0.43           | 0.79             | 0.00***                  |
| Machetes %                 | 0.32           | 0.36             | 0.49                     |

Source: SANREM-CRSP survey.

Access to financial capital is limited, as only 5% of the producers in both sub-watersheds report having access to financial capital through the formal financial system. It is important to mention that the original question from the survey does not represent exactly financial access, since almost all the farmers could access to credit from friends, neighbors, rural grocery stores, intermediaries, or micro-financial institutions<sup>9</sup>. For example, producers of cheese in the upper watershed access small amounts of credit as a payment in advance for their product, but access to credit is limited overall.

<sup>8</sup> Also fits in rotation with potatoes

<sup>9</sup> All the financial institutions that are not a Bank.

Access to public capital is also constrained due to remoteness and lack of larger cities in Bolivar. Most households have access only to dirt roads that are easily degraded during the winter season. In the Alumbre area, access to paved roads is better but those roads get easily destroyed due to lack of maintenance. In addition to the bad condition of the roads, access to clean potable water is a major concern in the area. On average in both watersheds only 20% of the households access water from a public company that has previously treated the water with chlorine, and the remainder use untreated water from springs or natural sources. Of the households that use natural sources of water, they feel like they are using clean water even when statistics from the Ministry of Health show that the higher percentage of diseases in the area is due to bad quality of water (MSP, 2005). Water sources are often contaminated by non-point source pollutants like livestock waste, which increase the risk of diseases. Access to electricity is in general good for all the households. Distance to cities could give us an insight into how close the farmers are to markets. However it is very difficult for them to sell products in the markets if they are not organized (Weeks and Slusher, 2007). Also in this particular area, schools are mostly located in the main towns; therefore the distance to closest town could be used as a comparable measure of access to schools. Small towns are places where farmers tend to gather after the work day to share experiences, play sports and socialize increasing their social network and strengthening personal bonds. For more detail see table 3.5 that shows the percentage of households that access credit and public assets.

**Table 3.5.** Financial and Public assets.

| <i>Variables</i>                    | <i>Alumbre</i> | <i>Illangama</i> | <i>t-test or<br/>pr-test</i> |
|-------------------------------------|----------------|------------------|------------------------------|
| Credit %                            | 0.05           | 0.06             | 0.64                         |
| Amount borrowed \$                  | 600.00         | 1600.00          | 0.11                         |
| Access public water system %        | 0.28           | 0.10             | 0.00***                      |
| Access pipe water %                 | 0.40           | 0.38             | 0.76                         |
| Use natural water sources %         | 0.32           | 0.51             | 0.00***                      |
| Access electricity %                | 0.93           | 0.93             | 0.93                         |
| Distance to closest paved road (km) | 0.63           | 4.77             | 0.00***                      |
| Closest to a highway %              | 0.22           | 0.11             | 0.01**                       |
| Closest to a paved road %           | 0.37           | 0.00             | 0.00***                      |
| Closest to a dirt road %            | 0.41           | 0.89             | 0.00***                      |
| Distance to closest river (km)      | 1.72           | 0.62             | 0.00***                      |
| Closest to Alumbre river %          | 0.01           | 0.00             | 0.41                         |
| Closest to Chimbo river %           | 0.12           | 0.00             | 0.00***                      |
| Closest to Guayabal river %         | 0.88           | 0.00             | 0.00***                      |
| Closest to Corazon river %          | 0.00           | 0.88             | 0.00***                      |
| Closest to Illangama river %        | 0.00           | 0.50             | 0.00***                      |
| Distance to closest town (km)       | 2.57           | 1.51             | 0.00***                      |
| Distance to closest city (km)       | 4.16           | 9.49             | 0.00***                      |

Note: The variable credit access represents more like households that could undertake credit. The original question asked in the survey was "have you ever receive a financial credit? Which source did provide the credit?"

Source: SANREM-CRSP survey.

Social capital is more difficult to measure than other assets. Social capital can be defined as the rules, norms, obligations, reciprocity and trust embedded in social relations, and social structures, which enable people to achieve their individual and community objectives (Narayan and Pritchett, 1999). As a relational concept, it can not be measured and assessment relies on proxy indicators (Rakodi, 1999). Thus in practical terms, in this study, it is defined to include unity and spirit of participation in civil organizations, election of authorities, and association with external groups by migration networks.

Based on these perceptions we can appreciate two different realities between the sub-watersheds. In the lower sub-watershed just one quarter of the households participate in civil organizations, while in the upper watershed almost four fifths of the households actively participate. This large difference between the watersheds is an important factor. Households in the lower sub-watershed likely lack organization and trust. They are not

willing to participate in social organizations that intend to help them, limiting their ability to improve their conditions. In the upstream watershed, more than half of the households that participate in civil organizations are participating in the COCDIAG (Corporación de Organizaciones Campesinas para el Desarrollo Integral del Sector Alto Guanujo) is the main social-political organization in the area. It was created with the aim of improving prospects for sustainable development of the upper watershed. Leaders of this organization help implement new policies since they are known and trusted by almost everybody in the area.

It is additionally evident that in the upstream watershed females are restrained from social participation. This might be due to cultural factors, since for indigenous communities females have fewer opportunities to be leaders or decision makers. Even when they are heavily engaged in administrating the farm and executing a wide range of productive activities in the downstream area, the percentage of females participating in communal organizations is higher but still it is the males who elect authorities and participate in most meetings. In general terms, participation in communal meetings and election of authorities in the downstream sub-watershed is still lower compared to the upper region, showing lack of interest in social organizations.

The family members that migrate might be considered as a proxy indicator of social capital because households with members that migrate to other cities are more likely to access a larger social network. Those households with relatives who migrate do not necessarily receive income from migration activities. Around half the households in both sub-watersheds have relatives who have migrated, mainly to Quito (Capital of Ecuador) if they are from the upper watershed, or to the coast region looking for seasonal jobs if

they are from the lower sub-watershed. For more detail of proxy indicators of social capital see table 3.6.

**Table 3.6.** Social capital.

| <i>Variables</i>                         | <i>Alumbre</i> | <i>Illangama</i> | <i>t-test or pr-test</i> |
|--|----------------|------------------|--------------------------|
| Participation in civil societies %       | 0.23           | 0.85             | 0.00***                  |
| Election of communal authorities %       | 0.38           | 0.62             | 0.00***                  |
| Female that elect communal authorities % | 0.25           | 0.08             | Nt                       |
| Participation as communal authorities %  | 0.32           | 0.47             | 0.00***                  |
| Female communal authorities %            | 0.26           | 0.13             | Nt                       |
| Participation in communal meetings %     | 0.57           | 0.89             | 0.00***                  |
| Females participating in meetings %      | 0.25           | 0.12             | Nt                       |
| Family members that migrate %            | 0.40           | 0.53             | 0.03**                   |
| To Quito %                               | 0.68           | 0.87             | Nt                       |
| To other cities on Ecuador %             | 0.13           | 0.13             | Nt                       |
| To out of the country %                  | 0.19           | 0.00             | Nt                       |

Nt = no test was performed because variables are not suit for a t-test or pr-test  
Source: SANREM-CRSP survey.

Human capital is limited in the watershed, and there are minimal differences between the sub-watersheds. Educational attainment of the household member that has achieved the highest level is about equal. Although this educational level is high, the number of years achieved by the household head and his or her spouse is smaller, around four years. The only significant difference in education across sub-watersheds is the level attained by the spouse; for instance, in the downstream region wives attain higher levels of education and in the upstream area almost one third of the wives do not have education. These differences are explained due to gender differences because females have constrained access to several assets. In both sub-watersheds, the education level of males is similar and again the only difference is shown in the education level of females, where those in the upstream area are less educated by almost two years.

Another great difference is the percentage of households that have participated in training. This difference could be attributed to the differences in social organizations that participate in the areas. Households from the upper watershed exhibit more participation

in civil organizations, which allow them to engage easily in seminars organized by the civil organizations and be aware of them. It is also important to mention that the National Institute of Agriculture Research in Ecuador (INIAP) has been an active participant in the upper area. This has led to excellent trust relations between community leaders and research scientists. Also the issues taught during the seminars differ between sub-watersheds. Households from the downstream sub-watershed show more interest in issues like organic farming, community and leadership, while households from the upper area have attended workshops on improving the potato crop, environmental management, raising guinea pigs, leadership, livestock management, reforestation, and tourism. The main difference is that upstream households have already built strong social capital and now are interested in economic activities, while the downstream households are in the process of building strong social community capital.

Most households are composed of five or six members, with no difference between sub-watersheds. The dependency ratio is larger in the upstream area<sup>10</sup>. Also households in the upstream area are mainly indigenous while in the lower sub-watershed only around one third of the households are indigenous. This difference is due to a traditional location of indigenous communities in the Andean region, and groups of mestizos<sup>11</sup> in the lower areas (See table 3.7).

---

<sup>10</sup> The dependency ratio is the percentage of family members that are below 18 years old or above 71 years old.

<sup>11</sup> It is a Spanish term used formally for Spanish empire to designate people of mixed European (Spaniard) and Amerindian ancestry origins.

**Table 3.7. Human capital.**

| <i>Variables</i>                          | <i>Alumbre</i> | <i>Illangama</i> | <i>t-test or<br/>pr-test</i> |
|---|----------------|------------------|------------------------------|
| Household highest level of education (yr) | 12.51          | 12.08            | 0.60                         |
| No education %                            | 0.03           | 0.02             | 0.50                         |
| Primary education %                       | 0.36           | 0.36             | 0.97                         |
| Secondary education %                     | 0.53           | 0.57             | 0.44                         |
| Secondary plus education %                | 0.08           | 0.05             | 0.30                         |
| Households that have receive training %   | 0.08           | 0.41             | 0.00***                      |
| Household head education level (yr)       | 4.32           | 4.45             | 0.80                         |
| No education %                            | 0.25           | 0.32             | 0.25                         |
| Primary education %                       | 0.62           | 0.41             | 0.00***                      |
| Secondary education %                     | 0.11           | 0.24             | 0.00***                      |
| Secondary plus education %                | 0.02           | 0.03             | 0.60                         |
| Spouse's education level (yr)             | 4.17           | 3.17             | 0.04**                       |
| No education %                            | 0.26           | 0.32             | 0.32                         |
| Primary education %                       | 0.65           | 0.62             | 0.58                         |
| Secondary education %                     | 0.07           | 0.05             | 0.56                         |
| Secondary plus education %                | 0.02           | 0.01             | 0.73                         |
| Average education females (yr)            | 7.95           | 6.57             | 0.04**                       |
| Average education males (yr)              | 8.48           | 9.04             | 0.45                         |
| Household head female %                   | 0.17           | 0.13             | 0.32                         |
| Households with wife %                    | 0.73           | 0.80             | 0.17                         |
| Household head age (yr)                   | 54.81          | 43.25            | 0.00***                      |
| Household wife age (yr)                   | 49.19          | 38.83            | 0.00***                      |
| Household members                         | 4.70           | 5.75             | 0.00***                      |
| Dependency ratio %                        | 0.29           | 0.44             | 0.00***                      |
| Female ratio %                            | 0.52           | 0.50             | 0.46                         |
| Indigenous households %                   | 0.35           | 1.00             | 0.00***                      |

Source: SANREM-CRSP survey.

### 3.4.3. Other Problems Faced by Households

Farmers in both sub-watersheds face other challenges. These problems include poor transportation infrastructure, low and unstable prices, and the presence of intermediaries who may exploit small-scale farmers, absorbing more of the gains from higher prices in the markets and limiting the access of producers to higher gains from their agricultural products. In Illangama, 56% of producers feel they have commercialization problems due to overproduction. The goods produced by the farmers in this watershed are mainly sold in Guaranda's market (58%), and smaller percentages are sold at the farm (21%) and in

the local Guanujo market (20%). The main goods sold in Illangama are cheese and potatoes. Cheese prices can vary widely between seasons but on average, producers receive 72 cents per kilogram. Average prices for potato are 24 and 21 cents per kilogram for Gabriela and Fripapa varieties respectively during November, 2006 (MAG, 2007).

In Alumbre, 30% of the households believe they have problems related to lack of organization among producers, and low local capture of value added. Around 94% of the commodities produced by the households are sold in Chillanes and around 4% are sold in Riobamba, a bigger market with better prices, but far away. Farmers note that they sell their products to intermediaries and not directly to consumers, even when they go to the markets. The main products sold in Alumbre are white corn and beans, at an average price of 26 and 81 cents per kilogram, respectively.

## **4. Methods**

### **4.1. Introduction**

This chapter presents an overview of methods needed to fulfill the objectives of this research. First the cluster analysis is described; this analysis is used to identify the different livelihood strategies. The second part describes the multinomial logit model and its use to understand factors that influence the choice of livelihood strategies. Next is described a generalization of Heckman's selection model which is used to specify the welfare gains that each livelihood strategy provides to the households. Finally the models are used to simulate different policy effects within the watershed.

### **4.2. Livelihood identification**

This section describes the methods used to identify differences between the livelihood strategies of farmers in the Chimbo watershed. In order to achieve this, it is necessary to use a classification method. Initially a qualitative cluster protocol is used to define the livelihood strategies and later a quantitative hierarchical cluster method is used to corroborate the information obtained from the first procedure.

Cluster analysis has been used in other studies to classify farming systems in China (Hardiman, *et al.* 1990), swine management systems in Ontario (Rosenberg and Turvey, 1991), farms as conventional or alternative systems (Bernhardt, *et al.* 1996), small scale dairy farming in the highlands Mexico (Espinoza, *et al.* 2007), and to relate household characteristics into clusters of sheep keepers in West Africa (Siegmond-Schultze and Rischfowsky, 2001).

#### **4.2.1. Qualitative Cluster Protocol**

Rural households usually engage in several activities such as farming, agricultural wage work, non-farm labor, migration, and others, but one or a combination of these activities usually dominates as a source of income. This main activity or the combination of them will be examined in order to identify the livelihood strategy that each household adopts.

It is essential to select the right variables to form the groupings; while it might be ideal to include a large number of variables, it is not feasible. Thus, it is important to carefully select the variables that guide livelihood identification (Aldenderfer and Blashfield, 1984; Bernhardt, *et al.* 1996). This represents a challenge since the concept of livelihood includes a wide range of dimensions (assets, activities realized and outcomes). The main means of reducing the number of variables was subjective categorization (Rosenberg and Turvey, 1991) based on the primary information collected from farmers and experts in the region.

Households were classified by activities devoted to agricultural production, agricultural wage work, and rural non-farm income earnings. The survey provides information on several activities related to the three main categories mentioned above. Table 4.1 shows the different activities identified and how they were narrow into three categories.

**Table 4.1. Income-generating activities**

| <i>Main Category</i>    | <i>Primary subcategory</i> | <i>Secondary subcategory of activities</i>  |
|-------------------------|----------------------------|---|
| Agricultural production | Crop production            | Crops, nursery, wood, medicinal plants, sugarcane bricks                            |
|                         | Livestock production       | Eggs, cheese, wool, milk, honey bee, cattle, small and large livestock              |
| Agricultural wage work  | Agricultural wage work     | Loggers, peasant worker, share hands working on other farms                         |
|                         | Off-farm activities        | Chef, driver, carpenter, musician, washer, made, doctor, building worker, worker    |
| Rural non-farm income   | Own business               | Handicrafts, small grocery store, agrochemical products, mills, vehicle rent, loans |
|                         | Migration                  | Remittances from workers outside and within the country                             |
|                         | Social help                | Development bonus provided by the government  |

The variables used to identify if the household is engaged in agricultural activities are dummy variables indicating whether or not the household received income from participating in livestock or crop activities. The variables used to identify if the household is engaged in agriculture wage work was a dummy variable indicating whether or not members from the household receive income from agricultural activities on farms other than their own. Dummy variables also indicated whether the household owned a business, participated in off farm activities, received remittances from members that have migrated, or from government transfers.

It is also necessary to examine the intensity or time devoted to each activity. Some useful variables for this purpose are the number of members from each household that engage in the activities. However we use the share of income from each activity because we lack other variables that help identify the intensity of engagement in livelihoods. After identifying the percentage share from agricultural production, agricultural wage work, and off farm activities, the main livelihood strategies are identified.

Some households derive most of their income from actively engaging in agricultural markets. These farm-oriented households might receive more than 70% of their income

from agricultural production to belong to this livelihood. Others could primarily depend on agricultural wage work and use their farming production mainly for home consumption. These households must receive more than 70% of their income from agricultural wage work and agricultural production and less than 30% from rural non-farm activities in order to be categorized within this livelihood. Others derive the larger part of their income from rural non-farm activities such as own business, off farm wage work, and remittances from migration and government plus wage work in agriculture. Households must receive more than 70% of their income from rural non-farm activities and agricultural wage work and less than 30% from agricultural production to belong to this livelihood. Finally diversified households combine income from farming, off-farm activities, and agricultural wage work. For these households neither farming, off-farm or agricultural wage income source contributes more than 70% of total income. These are the parameters used to classify the households into the four, mutually exclusive, livelihood strategies. (See table 4.2)

**Table 4.2.** Livelihood strategy selection criteria

| <i>Livelihoods</i>                                | <i>Income Share Criteria</i>   |
|---|--|
| <i>(A) Diversified Activities:</i>                | Neither agriculture production, agriculture wage work or non-farm activities contributes more than 70%           |
| <i>(B) Engaged in Agriculture Production:</i>     | Agriculture production contributes more than 70% and non-farm activities or agriculture wage work less than 30%  |
| <i>(C) Rural Non-farm Economy:</i>                | Non-farm activities contributes more than 70% and agriculture production less than 30% of income                 |
| <i>(D) Agriculture Consumption and Wage Work:</i> | Agriculture wage work and agriculture production contributes more than 70% and non-farm activities less than 30% |

#### **4.2.2. Quantitative Cluster Method**

We examine the livelihood strategies using a statistical tool to further validate the results from our qualitative clustering. This quantitative analysis is a multivariate statistical procedure that organizes cases into relatively homogeneous groups. It is an

exploratory data analysis procedure for nonhomogeneous groups (Aldenderfer and Blashfield, 1984).

There are several crucial steps in the quantitative cluster analysis. Livelihood strategies are categorized into groups using the same variables as in the qualitative cluster protocol. The clustering procedure requires standardization in the form of Z-scores, with a mean of 0 and standard deviation of 1 for all variables (Romesburg, 1990). The formula used for standardization was:

$$z_{ir} = \frac{x_{ir} - \mu_r}{\sigma_r} \quad (4.1)$$

where  $z_{ir}$  represent the unitless values,  $x_{ir}$  represent the actual variable,  $\mu_r$  and  $\sigma_r$  represent the mean and standard deviation ( $i=1,\dots,286$  households) of the ( $r=1,\dots,15$ ) variables.

After the variables are converted into z-scores, they are plotted into fifteen-dimensional space, where each axis represents one of the variables. Squared Euclidean Distance<sup>12</sup> coefficients are calculated between each pair of households, removing the effect (positive or negative) on the direction of the distance coefficient. The magnitude of each of these coefficients measures how similar or dissimilar each pair is in Euclidean space. Households will be more alike when they have low Euclidean distance coefficients and less alike when they have high Euclidean coefficients (Bernhardt, *et al.* 1996; Romesburg, 1990).

---

<sup>12</sup> Squared Euclidean Distance: It is the sum of the squared distances over all the variables in standardized units and it is used as a distance measure for clustering cases.

Finally Ward's method is used as the agglomerative linkage<sup>13</sup> method. This algorithm begins by locating each household as an individual cluster, then continues with a series of successive combinations between households or groups of households that are the most similar. It ends when all households are grouped into a unique cluster based in the Squared Euclidean Distance (Everitt, 1993). During this process, two households, one household and one group, or two groups can be linked together according to the criteria specified. Once they are linked, the households will remain together until the final solution is formed. Ward's method is used because it minimizes the variance within clusters (Aldenderfer and Blashfield, 1984) and links together the households or group of households with the lowest increase in the error sum of squares along each stage of the agglomerative process (Ward, 1963). The formula used to calculate the error sum of squares was:

$$\sum e^2 = \sum_{i=1}^I (z_{ir} - \mu_r)^2 \quad (4.2)$$

where  $\mu_r$  represents the mean of each group across the  $r$ th variable, and  $I$  is the number of households in each cluster. When the groups are formed with a single household or several households with identical values for all  $z_{ir}$ , the group error sum of squares is equal to zero, which is the most desirable value for homogeneous cluster formation (Ward, 1963).

We compare the final cluster solutions using both qualitative and quantitative methods because of obvious inexactness in clustering methods. A one-way analysis of variance is conducted across the variables used to create the clusters and on some other

---

<sup>13</sup> The computed distance between two clusters, the distance between the two closest elements in the two clusters (Ward, 1963)

variables of interest (income and expenditures level, natural, physical, public, social and human assets) to test if the differences among the means of the defined clusters are statistically significant (Bernhardt, 1996).

### **4.3. Econometric models and simulation**

This section describes the methods used to examine the determinants of choice of livelihood strategies, the relation between welfare and livelihood choice and the changes generated by implementing policy changes in education and irrigation.

#### **4.3.1. Livelihood selection**

Once the different livelihood strategies are identified using the cluster analysis, a multinomial logit model will be used to examine determinants that influence choice of livelihood strategy. The multinomial logit model offers efficient ways to predict the behavior of categorical dependent variables as a function of a set of explanatory variables (Demaris, 1992).

Multinomial logit models have been used in other studies to analyze remarriage and welfare choices of divorced and separated women (Hoffman and Duncan, 1988); the determinants of academic performance (Park and Kerr, 1990); consumer choice behavior (Gonul and Kannan, 1993); and to predict travel behavior responses of San Francisco Bay Bridge users to changes in travel conditions (Bhat and Castelar, 2003).

The multinomial logit model is expressed as:

$$Y^* = \sum_{r=1}^R \beta_{jr} X_r + \varepsilon_j$$

$$Y = 1 \quad \text{if} \quad Y^* \leq \mu_1,$$

$$Y = 2 \quad \text{if} \quad \mu_1 \leq Y^* \leq \mu_2,$$

$$\vdots$$

$$Y = m \quad \text{if} \quad \mu_{j-1} < Y^*$$
(4.3)

where  $Y^*$  represents an unobserved latent outcome (which might be a level of utility or income),  $Y$  represents the livelihood strategy selected,  $\beta_{jr}$  are the estimated parameters ( $r=1, \dots, R$ ),  $j$  represents the livelihood alternatives ( $j=1, \dots, m$ ),  $X_r$  are the variables that represent household characteristics that influence the decision process,  $\varepsilon_j$  represent error terms (which might be skills needed to engage into livelihoods) and  $\mu_j$  the unknown threshold parameter separating livelihood strategies.

The set of variables  $X_r$  affecting livelihood choice includes natural, physical, financial, human, public, and social assets. All the variables are described in more detail in table 4.3:

**Table 4.3.** Variables used in the multinomial logit model

| <i>Variables</i>     | <i>Definitions</i>  | <i>Mean</i> | <i>Std Dev</i> |
|----------------------|---|-------------|----------------|
| Land size            | Amount of land owned or rented by the household in hectares   | 4.84        | 6.83           |
| Irrigation Access    | Dummy whether or not farmers access irrigation  | 0.21        | 0.41           |
| Physical Assets /100 | Estimated monetary value of the productive assets, livestock and cattle in hundred of dollars                                 | 15.53       | 17.64          |
| Secondary Education  | Dummy whether or not the individual in the household with the highest level of education attained secondary education or more | 0.62        | 0.49           |
| Household Head Age   | Years   | 50.08       | 15.24          |
| Household Size       | Number of household members   | 5.13        | 2.34           |
| Dependency Ratio *10 | Percentage of members below 18 years old and above 71 years old   | 3.52        | 2.68           |
| Watershed Alumbre    | Dummy whether or not the household belongs to the Alumbre sub-watershed   | 0.59        | 0.49           |
| Altitude             | Altitude in hundred meters above the sea level  | 27.87       | 5.42           |
| Distance to Rivers   | Distance to the closest river in kilometers   | 1.27        | 1.14           |
| Distance to Towns    | Distance to the closest community in kilometers   | 2.14        | 1.11           |
| Distance to City     | Distance to the closest city in kilometers  | 6.34        | 3.54           |

Sample size = 286

The physical assets, dependency ratio and altitude were modified to avoid scaling problems and also to have a clearer interpretation during computation of the marginal effects. Because only one unit changes are estimated in the marginal effects, it is not the same to analyze how the probability to engage in livelihood strategies might change by one dollar change in physical assets as to estimate the marginal effect of a 100 dollar change in physical assets. For similar reasons the dependency ratio and altitude variables are scaled.

Several assumptions must hold in order to successfully use a multinomial logit model. According to Train (2002) the error term is independently, identically distributed extreme

value (also called Gumbel or type I extreme value distribution). According to Borooah (2002) and Greene (2000), the results of most applications are similar regardless of using a normal distribution or type I extreme value.

A second assumption of the model is that livelihood strategies in the region do not have a specific order or ranking among them. For example, we can not state that a farmer would rather focus his livelihood strategy on only off-farm activities or that he or she would prefer to depend strongly on agriculture activities alone. We can assume that each household is trying to maximize its utility level subject to their assets. It is always better to treat outcomes as if no order exists unless there is a good reason for imposing ranking among them (Borooah, 2002).

The livelihood strategies are mutually exclusive, which means that farmers can not be part of two livelihood strategies. Also the livelihood strategies are collectively exhaustive, which means the strategies identified by the cluster analysis are the only ones that are available in the region.

This leads to our final assumption in the model. The livelihood strategies are assumed to be independent of irrelevant alternatives. This assumption holds that the ratio of the probabilities of choosing any two livelihood strategies for a particular farmer is not influenced by any other alternatives. This assumption would be violated if the livelihood strategies are not mutually exclusive (Liao, T. 1994).

The multinomial logit model is more appropriate than the conditional logit model because the data include characteristics of the household and not of the livelihoods. The hours one devotes to the livelihood strategy, the level of risk one faces in choosing certain strategies, the physical and technical skills required to be part of the strategy are

examples or variables that are characteristics of livelihoods strategies (Borooah, 2002). The model will allow us to identify how each variable affects the probability of choosing each livelihood.

### 4.3.2. Impacts of livelihood choice on household well-being

One objective of this research is to understand how each livelihood strategy is associated with household well-being, conditional on the choice of strategy. This objective suggests that wellbeing<sup>14</sup> should be regressed on the determinants of household wellbeing, conditional on the choice of a livelihood. Since we are estimating an equation of interest, where the outcome of interest is determined in part by individual choice of whether or not to participate in a livelihood, it is necessary to employ a selectivity bias correction. Unobservable factors may affect both the selection of the livelihood and household well-being, introducing a correlation between the error terms across the equations. The selection bias correction based on the multinomial logit model will be used to establish this relationship between livelihood choices and household well-being (Bourguignon *et al.* 2007). The corrected selection model shows the relation between welfare level and its determinants for each livelihood strategy. The corrected selection model based on the multinomial logit model is:

$$\begin{aligned}
 W_m &= \sum_{r=1}^R (\alpha_{mr} X_{mr}) + u_m + \lambda_m \\
 Y_j^* &= \sum_{r=1}^R \beta_{jr} X_r + \varepsilon_j
 \end{aligned}
 \tag{4.4}$$

---

<sup>14</sup> We use expenditures as measure of well-being because it is smooth over short term fluctuations, captures long-run well-being levels, provides a clear interpretation as a well-being outcome, is reliable and less vulnerable to under-reporting bias and ethnographic effects for poor households with low resources (World Bank, 2001; Barrett *et al.* 2001; Meyer and Sullivan, 2003; and Ravallion, 2003)

where  $W_m$  is the outcome of interest (the natural log of consumption expenditures within livelihood  $m$ ); this is observed only if the household chooses livelihood strategy  $m$ . The  $\alpha_{mr}$  are estimated parameters,  $X_{mr}$  represents the characteristics of each household;  $r$  are the variables of interest, and  $u_m$  represents the error term of the outcome equation. The problem is to estimate the parameter  $\alpha_{mr}$  while taking into account that the error term  $u_m$  may not be independent of all  $(\varepsilon_j)$ s from the selection of livelihood strategies (see model 4.3 the livelihood participation equation).

The presence of sample selection would introduce correlation between the explanatory variables and the error term in the well-being equation creating an endogeneity problem. Because of this, least square estimates of  $\alpha_{mr}$  would not be consistent and we include correction coefficients ( $\lambda_m$ ) (Cameron and Trivedi, 2005). With the selectivity corrections, the estimates are significantly improved, both in terms of reducing bias and root mean squared error of the model (Bourguignon *et al.* 2007).

There are several methods suggested for selection bias correction in the case of a multinomial outcome. Two approaches were developed by Lee (1983) and Dubin-McFadden (1984), and there is a recent semi-parametric approach proposed by Dahl (2002). Lee's correction is easier to implement than the other methods and it requires only one correction term parameter to be estimated. However the cost of this simplicity is a restrictive assumption that unobservable determinants of the choice of livelihood strategy should always be correlated in the same direction with unobservable determinants in the well-being outcome. This is a very strong hypothesis (Bourguignon, *et al.* 2007). For example, considering skills as an unobserved variable, if the household

head attains an advanced level of mechanic skills, he might be more likely to decrease the probability of engaging in agriculture production, while this advanced skill might have positive effects on well-being received from engaging in agricultural activities. The household head can improve his machinery performance and achieve higher levels of income from agriculture production. Therefore the correlation effect between an unobserved variable and the livelihood selection are negative while the correlation effect between the same unobserved factor and well-being are positive, violating this basic assumption.

Dahl's correction restricts the set of probabilities of engaging in each livelihood strategy  $\varepsilon_j(P_1, \dots, P_j)$  to a chosen subset ( $S$ ) of particular interest, making the hypothesis that this subset exhausts all the relevant information. However this reduced subset is defined at the cost of a restrictive assumption on the correlation structure of the error terms. Also it is not possible to test if this probabilities subset ( $S$ ) really exhausts all relevant information about the original set of probabilities  $\varepsilon_j(P_1, \dots, P_j)$ . Dahl's correction also loses efficiency with small sample sizes, which causes problems in our case (Bourguignon, *et al.* 2007).

Dubin-McFadden's correction is preferred on theoretical grounds. Also the Dubin-McFadden method, without imposing (4.8 see below), guarantees unbiased estimators and performs better than the other methods for small samples (Bourguignon, *et al.* 2007). Therefore to correct selection bias, we use the correlation coefficient between  $u_m$  and  $(\varepsilon_j)$ s defined by Dubin-McFadden. The main assumption imposed by Dubin-McFadden is the linearity assumption:

$$E(u_m | \varepsilon_1 \dots \varepsilon_M) = \sigma \frac{\sqrt{6}}{\pi} \sum_{j=1}^m cc_j (\varepsilon_j - E(\varepsilon_j)) \quad (4.5)$$

where  $cc_j$  is the correlation coefficient between error terms. With the multinomial logit model Dubin-McFadden defines:

$$\begin{aligned} E(\varepsilon_m - E(\varepsilon_m) | Y_m^* > \max_{j \neq 1} (Y_j^*), \Gamma) &= -\ln(P_m) \\ E(\varepsilon_j - E(\varepsilon_j) | Y_m^* > \max_{j \neq 1} (Y_j^*), \Gamma) &= \frac{P_j \ln(P_j)}{1 - P_j}, \forall j > 1 \end{aligned} \quad (4.6)$$

where  $\Gamma = \{\beta_1 X_1, \beta_2 X_2, \dots, \beta_m X_m\}$  from the multinomial logit model (4.3) and  $P_j$  represents the household-specific probability of engaging in each livelihood strategy ( $j=1, \dots, m$ ).

Given assumptions (4.5) and (4.6), the selection model (4.4) can be estimated by least squares in the form of equation (4.7). For more detail see Bourguignon (2007).

$$W_m = \sum_{r=1}^R (\alpha_{mr} \dot{X}_r) + u_m + \sigma \frac{\sqrt{6}}{\pi} \left[ \sum_{j=1}^m cc_j \left( \frac{P_j \ln(P_j)}{1 - P_j} \right) - cc_m \ln(P_m) \right] \quad (4.7)$$

Also in the original paper by Dubin-McFadden the following restriction was introduced:

$$\sum_{j=1}^m cc_j = 0 \quad (4.8)$$

However, according to Bourguignon (2007), this assumption can be easily relaxed and it can be a source of bias when incorrectly imposed. Using a different version of Dubin-McFadden (excluding assumption 4.8) estimators will generate only relatively little efficiency loss.

Since the Dubin-McFadden method requires a correlation coefficient for each livelihood in the multinomial logit model, it is necessary have same amount of

instruments in the multinomial logit model. In absence of these instrumental variables, identification in the second stage will rely entirely on parametric hypothesis and the multinomial logit model would not be robust (Bourguignon *et al.* 2007). The four instrumental variables used are geographic features from our Geographic Information System (GIS): altitude, distance to rivers, towns and cities. The assumption that these geographic features influence the selection of livelihood strategies but not the amount of wellbeing must hold in order to have a consistent estimator. For example, households in both sub-watersheds have similar economic conditions. The amount of consumption expenditures and income per capita is similar between sub-watersheds and it is not statistically different (see table 3.2).

Many of the  $X_{mr}$  from equation (4.7) are the same as the variables used in the multinomial logit model, but not all. Some variables affected only well-being, not the probability of being in a livelihood (table 4.4 shows our regressors).

**Table 4.4.** Variables affecting household well-being

| <i>Variables</i>    | <i>Definitions</i>  | <i>Mean</i> | <i>Std Dev</i> |
|---------------------|---|-------------|----------------|
| Ln land size        | Natural log of the amount of land owned or rented by the household in hectares  | 1.03        | 1.02           |
| Irrigation Access   | Dummy whether or not farmers access irrigation  | 0.21        | 0.41           |
| Ln physical assets  | Natural log of the estimated monetary value of the productive assets, livestock and cattle in dollars                         | 6.25        | 2.23           |
| Secondary Education | Dummy whether or not the individual in the household with the highest level of education attained secondary education or more | 0.62        | 0.49           |
| Credit              | Dummy whether or not farmers access formal credit   | 0.05        | 0.22           |
| Household gender    | Dummy whether or not the household head is male   | 0.85        | 0.36           |
| Ln household size   | Natural log of the number of household members  | 1.52        | 0.50           |
| Watershed Alumbre   | Dummy whether or not the household belongs to the Alumbre sub-watershed   | 0.59        | 0.49           |

Sample size = 286

The model allows us to examine estimated welfare levels of the households in each livelihood strategy and compare, using 4.7, the results with how much welfare they would have received if they participated in the other livelihoods.

### 4.3.3. Impacts of policy changes on household well-being

One use of the selectivity correction model is to examine the impact on household's wellbeing of policy changes in education, irrigation and credit access. To examine how education might affect wellbeing, we begin by identifying which households are most likely to increase their education level as education becomes more widely available. We use a logit model to identify those households with the highest probability of achieving secondary education. The logit model is:

$$\begin{aligned}
 E^* &= \sum_{r=1}^R \delta_r S_r + v \\
 E &= 1 \quad \text{if} \quad E^* > 0 \\
 E &= 0 \quad \text{otherwise}
 \end{aligned}
 \tag{4.9}$$

where  $E^*$  represents whether or not the individual in the household with the highest level of education attained secondary education or more,  $\delta_r$  represents the parameters,  $S_r$  represents the  $R$  characteristics affecting the level of education attained, and  $\varepsilon_i$  represents the error term. The variables  $S_r$  are shown in table 4.5.

**Table 4.5.** Variables used in the education logit model

| <i>Variables</i>     | <i>Definitions</i>  | <i>Mean</i> | <i>Std. Dev.</i> |
|----------------------|---|-------------|------------------|
| Watershed Alumbre    | Whether or not the household belongs to the Alumbre sub-watershed | 0.59        | 0.49             |
| Household Size       | Number of households members                                      | 5.13        | 2.34             |
| Young children       | Household members below 5 years old                               | 0.51        | 0.77             |
| Older children       | Household members between 5 and 15 years old                      | 1.33        | 1.48             |
| Adults               | Household members between 17 and 70 years old                     | 2.69        | 1.43             |
| Elders               | Household members above 71 years old                              | 0.17        | 0.47             |
| Education level      | Education years attained by household head                        | 4.30        | 4.07             |
| Education wife       | Education years attained by wife                                  | 2.85        | 3.35             |
| Household Head Age   | Household head age in years                                       | 50.08       | 15.24            |
| Square age           | Square amount of household head years                             | 2739.36     | 1579.61          |
| Spouse age           | Spouse age in years   | 34.09       | 23.02            |
| Square age spouse    | Square amount of spouse years                                     | 1690.22     | 1550.47          |
| Distance university  | Distance to Guaranda where the closest university is located (km) | 28.19       | 15.81            |
| Distance market      | Distance to the main cities (km)                                  | 6.34        | 3.54             |
| Distance towns       | Distance to the closest town (km)                                 | 2.14        | 1.11             |
| Distance paved roads | Distance to the closest paved road (km)                           | 2.32        | 2.38             |
| Farm surface         | Total farm size in hectares                                       | 4.84        | 6.83             |

Sample size = 286

Base category: household members between 16 and 18 years of age

After identifying those households most likely to attain higher levels of education, the change in the probability associated with belonging in each livelihood strategy will be estimated for the target population using the coefficients estimated in equation (4.3):

$$\hat{Y}_j^* = \sum_{r=1}^R \hat{\beta}_{jr} X_r^* \quad (4.10)$$

where  $\hat{Y}_j^*$  represents the new estimated probability of engaging in each livelihood strategy,  $\hat{\beta}_{jr}$  are estimated parameters (from equation 4.3) and  $X_r^*$  is  $X_r$  with the new higher level of education included only for those households that are most likely to attain higher education.

Once the new probabilities set are estimated  $(\hat{P}_1, \hat{P}_2, \dots, \hat{P}_j)$  for the target population and their new livelihood strategy is identified, we estimate the well-being they should receive under each new livelihood strategy using the estimated parameters from (4.7).

$$\hat{W}_m = \sum_{r=1}^R (\hat{\alpha}_{mr} \dot{X}_r^*) + \sigma \frac{\sqrt{6}}{\pi} \left[ \sum_{j=1}^m \hat{c}c_j \left( \frac{\hat{P}_j \ln(\hat{P}_j)}{1 - \hat{P}_j} \right) - \hat{c}c_m \ln(\hat{P}_m) \right] \quad (4.11)$$

where  $\hat{W}_m$  represents the estimated well-being after adjusting for selection into each livelihood, conditioned on the increase on education,  $\hat{\alpha}_{mr}$  are estimated parameters,  $\hat{c}c_j$  are the estimated correction coefficients (from our original equation 4.7). The  $\hat{P}_j$  are the estimated probabilities of engaging in each livelihood strategy.

Next the percentage change between current welfare and the estimated welfare caused by the new education policy will be computed using (4.12)

$$\Delta \bar{W}_m = \frac{\sum_{i=1}^I (W_{im} - \hat{W}_{im})}{I} \quad (4.12)$$

Where  $\Delta \bar{W}_m$  represents the average percentage change of well-being of households engaged in livelihood  $m$ ,  $W_{im}$  represents actual household well-being,  $\hat{W}_{im}$  represents the estimated amount of well-being following the change in education policy, and  $i=1 \dots I$  indexes the households in each livelihood strategy.

Using the same procedure we can examine welfare changes associated with improved access to irrigation or credit. We use a similar logit model for irrigation and credit access. The variables used for the logit model for irrigation are described in table 4.6 and the variables used for the logit model for credit access are described in table 4.7.

**Table 4.6.** Variables used in irrigation logit model

| <i>Variables coefficients</i> | <i>Definitions</i>  | <i>Mean</i> | <i>Std. Dev.</i> |
|-------------------------------|---|-------------|------------------|
| Watershed Alumbre             | Whether or not the household belongs to the Alumbre sub-watershed | 0.59        | 0.49             |
| Farm size                     | Total farm size in hectares                                       | 4.84        | 6.83             |
| Distance closest river        | Distance to the closest river (km)                                | 1.27        | 1.14             |
| Cattle value                  | Estimated value of cattle (\$)                                    | 1092        | 1288             |
| Livestock value               | Estimated value of livestock (\$)                                 | 348         | 577              |
| Productive assets             | Estimated value of productive assets (\$)                         | 114         | 761              |

**Table 4.7.** Variables used in credit logit model

| <i>Variable coefficients</i> | <i>Definitions</i>  | <i>Mean</i> | <i>Std. Dev.</i> |
|------------------------------|---|-------------|------------------|
| Alumbre watershed            | Whether or not the household belongs to the Alumbre sub-watershed   | 0.59        | 0.49             |
| Cattle value                 | Estimated value of cattle (\$)  | 1092        | 1288             |
| Livestock value              | Estimated value of livestock (\$)   | 348         | 577              |
| Productive assets value      | Estimated value of productive assets (\$)   | 114         | 761              |
| Farm size owned with title   | Total farm size owned with title in hectares  | 4.24        | 6.86             |
| Social participation         | Whether or not the household participates in social organizations   | 0.48        | 0.50             |
| Household gender             | Whether or not the household head is male   | 0.85        | 0.36             |
| Household size               |   | 5.13        | 2.34             |
| Distance closest city        | Distance to closest city (km)   | 6.34        | 3.54             |
| Distance closest capital     | Distance to the capital (km)  | 28.19       | 15.81            |
| Household head age           | Years   | 50.08       | 15.24            |
| Square age                   | Years   | 2739.36     | 1579.61          |
| Education                    | Dummy whether or not the individual in the household with the highest level of education attained secondary education or more | 0.62        | 0.49             |

After identifying the target population (that is, those households most likely to benefit from the change), the change in a household's probabilities to choose a livelihood strategy will be estimated. Since the livelihood strategies are changing, the welfare level will also change. After estimating the change in well-being that each household could attain with irrigation and credit access, we can compare the current amount of welfare of that target population and see how much irrigation and credit access is improving the actual conditions of the households using the formulas (4.10), (4.11) and (4.12).

## **5. Results**

### **5.1. Introduction.**

This chapter describes the livelihood strategies adopted by households in the Chimbo watershed, and then presents summary statistics for households adopting each of the strategies. The determinants of choosing each strategy are then estimated using the multinomial logit model. We next estimate the welfare received in each livelihood strategy, and the marginal contribution of assets to household well-being. Finally changes in policy to improve education, irrigation access and credit will be considered, and their impact on monetary well-being will be measured.

### **5.2. Livelihood strategies identification.**

Four main livelihood strategies were identified in the Chimbo watershed: diversified households (livelihood A), those engaged in agricultural markets (livelihood B), rural non-farm economy participants (livelihood C), and agricultural own-consumption and agricultural wage work (livelihood D). The distribution of households among these livelihoods is shown in table 5.1 and summary statistics are shown in table 5.2 and 5.3<sup>15</sup>. Each of these livelihood strategies has different characteristics and attributes of households selecting each one different.

---

<sup>15</sup> A complete set of tables is presented in appendix 2, these include the amount of assets, income, and well-being levels of the households within each livelihood strategy.

**Table 5.1.** Livelihood strategies selection.

| <i>Livelihoods</i>                         | <i>Percentage</i> | <i>Households</i> | <i>Members</i> |
|--|-------------------|-------------------|----------------|
| Diversified households (A)                 | 27                | 78                | 432            |
| Engaged in agricultural markets (B)        | 37                | 105               | 576            |
| Rural non-farm economy (C)                 | 17                | 50                | 218            |
| Agricultural consumption and wage work (D) | 19                | 53                | 241            |
| Total                                      | 100               | 286               | 1467           |

Source: SANREM-CRSP survey

**Table 5.2.** Analysis of Variance results for the variables used to define the livelihoods

| <i>Qualitative Cluster variables</i>      | <i>Livelihood A</i> | <i>Livelihood B</i> | <i>Livelihood C</i> | <i>Livelihood D</i> | <i>ANOVA Sig.</i> |
|---|---------------------|---------------------|---------------------|---------------------|-------------------|
| Agricultural income share                 | 0.45                | 0.87                | 0.12                | 0.39                | 0.00***           |
| Agricultural wage share                   | 0.02                | 0.03                | 0.14                | 0.57                | 0.00***           |
| Off farm income share                     | 0.53                | 0.10                | 0.74                | 0.05                | 0.00***           |
| Agricultural wage and agricultural income | 0.47                | 0.90                | 0.26                | 0.95                | 0.00***           |
| Agricultural wage and off farm income     | 0.55                | 0.13                | 0.88                | 0.61                | 0.00***           |

\*\*\* Significant at less than 1%

**Table 5.3.** Summary statistics for main variables

| <i>Variables</i>                    | <i>Livelihood A</i> | <i>Livelihood B</i> | <i>Livelihood C</i> | <i>Livelihood D</i> | <i>ANOVA Sig.</i> |
|-------------------------------------|---------------------|---------------------|---------------------|---------------------|-------------------|
| Watershed Alumbre %                 | 46                  | 37                  | 98                  | 85                  | 0.00***           |
| Land size (ha)                      | 3.82                | 6.79                | 3.59                | 3.64                | 0.00***           |
| Irrigation access %                 | 23                  | 33                  | 6                   | 9                   | 0.00***           |
| Value physical assets \$            | 2008                | 2348                | 856                 | 496                 | 0.00***           |
| Distance to closest river (km)      | 1.12                | 0.86                | 2.05                | 1.58                | 0.00***           |
| Distance to closest city (km)       | 7.21                | 7.58                | 3.61                | 5.17                | 0.00***           |
| Participation in civil societies %  | 60                  | 55                  | 26                  | 38                  | 0.00***           |
| Family members that migrate %       | 71                  | 39                  | 54                  | 13                  | 0.00***           |
| Mestizo households %                | 31                  | 25                  | 64                  | 53                  | 0.00***           |
| Household size                      | 5.54                | 5.49                | 4.36                | 4.55                | 0.00***           |
| Household head male %               | 88                  | 90                  | 82                  | 72                  | 0.02**            |
| Secondary education or plus %       | 65                  | 65                  | 66                  | 45                  | 0.09*             |
| Income per capita annually \$       | 653                 | 785                 | 839                 | 288                 | 0.00***           |
| Expenditures per capita annually \$ | 254                 | 252                 | 252                 | 184                 | 0.03**            |

\*\*\* Significant at less than 1% level

\*\* Significant at less than 5% level

\* Significant at less than 10% level

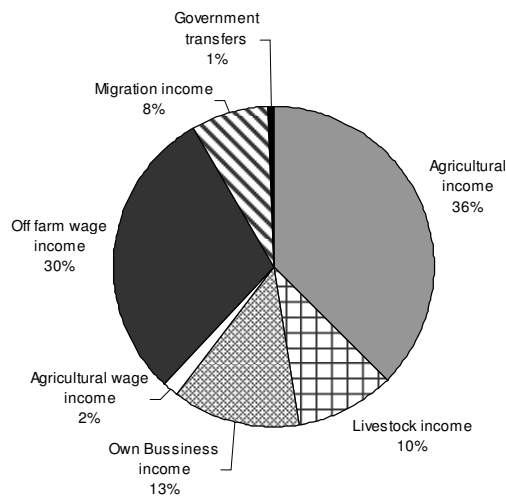
Note: An analysis of variance (ANOVA) shows statistically significance of differences in variables across the livelihoods

### 5.2.1. Diversified Households (Livelihood A).

This is the second most common livelihood in the watershed and it represents almost one third of the watershed households. Households that engage in this livelihood receive

income from a combination of agricultural production and rural non-farm activities, but neither of these activities provides more than 70% of total income. The average annual per capita income is low in this strategy compared with the others. Of this income, on average 47% comes from agriculture production (crops and livestock) and 53% from non-farm activities (such as own business, off-farm wage, agriculture wage and migration) (see, figure 5.1). The households in livelihood A expend, on average, less than one dollar per day per capita. Although they have the highest consumption compared to the other livelihoods, the differences between households in livelihood strategy A, B, and C are minor (see table 5.3). Around one half of household expenditure<sup>16</sup> is dedicated to food consumption.

**Figure 5.1.** Income share by activities for diversified households (A)



Source: SANREM-CRSP survey

Households in this livelihood are from both watersheds, and almost equally distributed (50% from each sub-watershed, see table 5.3). For this reason, the range of productive activities in which they engage varies. For example, people from the upper

<sup>16</sup> Note that expenditure measure from our survey is probably an under estimate of actual expenditure. The recall period (1 year) is relatively long and several expenditure categories are missing from the questionnaire, such as livestock home consumption.

watershed that diversify activities tend to do it between non-farm activities and production of potatoes and livestock products, while households from the downstream area tend to combine migration, agricultural wage work and agricultural production of grains and legumes. Although they diversify across different activities the livelihood strategy is still the same, diversification is the norm.

The amount of natural assets controlled by households in this livelihood is small compared to other livelihoods, but the amount of physical assets is around \$ 2,000 (see table 5.3), mainly in the form of cattle and productive tools. Almost one quarter of the households within this livelihood have access to irrigation and use soil conservation practices. However this good access to natural and physical assets is not enough to boost their income from agriculture. As a result, they diversify. Diversification might also be a response to reduce risk exposure.

Households in this livelihood are relatively close to rivers, roads and cities (see table 5.3). They are closest to small towns in the region of all the livelihood clusters. Proximity apparently facilitates diversification. Since they are not so far from rivers they can engage in agriculture production and since access to towns and cities is fairly good they can also migrate and engage in non-farm activities.

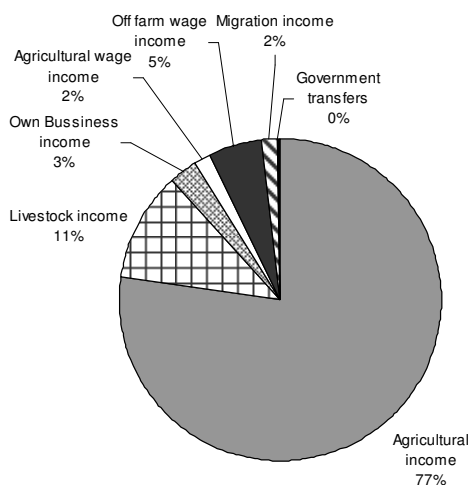
A high percentage of households within this livelihood participate actively in social organizations. The highest rates of migration are also found in this cluster. Active participation in social organizations and migration networks also contributes to diversification. Migration income is not, however, the main source of income for households in this livelihood.

Almost two thirds of these households are indigenous. It is likely that larger household size helps the household diversify their activities, since some labor can be dedicated to non-farm activities while others can take care of agricultural production. This livelihood class also tends to be the youngest and has the highest average years of education. Most of the households have achieved secondary education (see table 5.3) and one quarter of them have received extra agricultural.

### **5.2.2. Engaged in Agriculture Markets (Livelihood B).**

This is the most common livelihood in the Chimbo watershed. Households in this livelihood mainly receive income from agriculture and dedicate their effort to success in agricultural production (table 5.3). Agricultural production provides at least 70% of income, and more than half their production is sold in markets. The average annual amount of per capita income is the second highest compared to the other livelihood strategies and of this total 88% comes from agricultural production (crops and livestock) and the remainder from non-farm activities (see figure 5.2). These households have a consumption level close to the one attained by diversified households but, on average, this is barely more than one dollar per day. These households dedicate half their expenditures to food consumption.

**Figure 5.2.** Income share by activities of households engaged in agricultural markets (B)



Source: SANREM-CRSP survey

Around two thirds of the households in this livelihood are from Illangama. Almost all land for households adopting this livelihood is owned with title. Most land is dedicated to commercial crops (roots, grains and legumes) (see appendix 2). This group has the highest percentage of households with irrigation access (almost one third), the highest value of physical assets, and cattle represent the largest share of this value of physical assets.

On average households in cluster B are less than one kilometer from the nearest river and since they dedicate their effort to agricultural production (using land and productive inputs like pesticides and fertilizer) they can threaten the environmental quality. Also, compared to the other livelihoods these households are located farther from main cities (see table 5.3), but they still depend on selling their products in cities. The necessity to transport products to markets is satisfied by numerous intermediaries, who absorb part of the benefits production. From the fact that they are far away from cities might be a barrier to engaging in non-farm activities. Almost one third of the households had participated in training seminars.

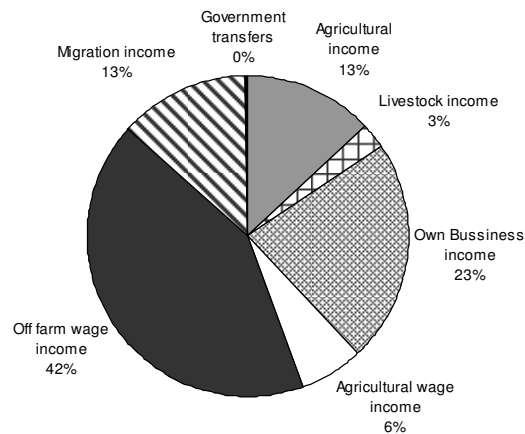
Almost three quarters are indigenous and household size is around five. Having enough members in the family allow them to focus their labor on agricultural production without resorting to hiring labor. Most households have achieved secondary education, similar to the other livelihoods.

### **5.2.3. Rural Non-farm Economy (Livelihood C).**

Livelihood C is the least common livelihood strategy in the Chimbo watershed. In theory, non-farm activities should provide higher amounts of income, and indeed this strategy provides the highest income per capita, however the amount of consumption expenditures is rather small.

Households in this livelihood receive at least 70% of their income from non-farm activities, and allocating all their labor to work outside of agriculture. Members migrate, own businesses, and engage in off-farm wage work like construction or services. About 78% of income comes from migration, off-farm or own-business activities, with the rest coming from agricultural wage work and production (Figure 5.3).

**Figure 5.3.** Income share by activities of households engaged in rural non-farm economies (C)



Source: SANREM-CRSP survey

Almost all households within this cluster are from Alumbre, the lower sub-watershed (see table 5.3), which may indicate that geographic difference may affect the ability to access non-farm activities. Several households from Illangama engage in non-farm activities; however the share of income from these activities is minimal. On average, households engaged in livelihood C have the least access to natural resources and most of their land is dedicated to pasture (see appendix 2). Few households have access to irrigation; these households are generally far from rivers and other water sources. The amount of physical assets owned is small compared to the other livelihoods (see table 5.3). These are reasons why these households prefer to engage in activities not related to agriculture, since this level of natural and physical assets is limited.

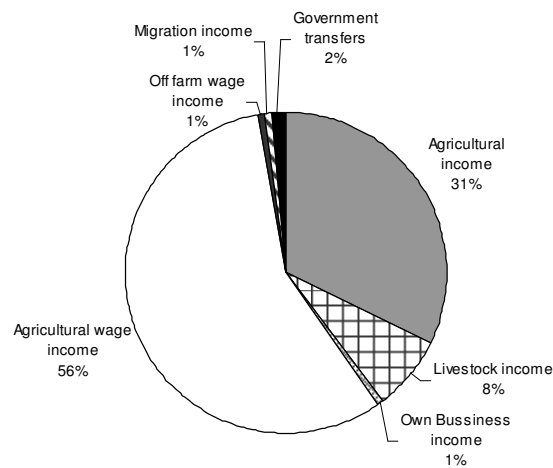
Households in this livelihood strategy have ample access to public assets. They are closest to cities and have better access to potable water compared to those in other livelihoods. Also they are closest to paved roads (less than one kilometer, on average). More than half are closer to a paved road than a dirt road. Because of the fact that almost

all these households are from Alumbre, they are generally farther from Guaranda the capital of Bolivar. Also because more households in this livelihood are located in Alumbre, they do not participate in civil organizations, but almost half of the households have some relatives that have migrated to other cities in and out of Ecuador (see table 5.3). Almost two thirds of these households are mestizos and education level is similar to the other livelihoods.

#### 5.2.4. Agricultural Consumption and Wage Work (Livelihood D).

This livelihood strategy is adopted by one fifth of the households in the Chimbo watershed, and almost 250 persons depend on it. All the households receive at least 70% of their income from agricultural wage work and agricultural production is mainly used for own consumption (See figure 5.4).

**Figure 5.4.** Income share by activities of households engaged in agricultural wage work (D)



Source: SANREM-CRSP survey

All households engaged in this livelihood receive less annual income per capita and have fewer consumption expenditures compared to the other three livelihoods. This group

of households is strongly dependent on agriculture. It is also highly exposed to risky events affecting the agriculture sector. Almost two thirds of income for this livelihood comes from agriculture wage work, and one third from agriculture production (see figure 5.4), but this income represents less than one dollar per day per person.

Similar to livelihood C most of the households engaging in these activities are from the Alumbre sub-watershed (see table 5.3). The reason is clear: in the upper watershed, farm size is smaller and farmers do not need extra labor to take care of the production. In contrast downstream farms tend to be larger and require extra labor. The downstream watershed is also closest to the coastal region where farms are bigger and require extra labor during harvest. These conditions allow downstream households to engage in agricultural wage work.

The amount of natural resources is limited in livelihood cluster D. Land holding sizes are relatively small compared to the other livelihoods. The estimated value of physical assets is the smallest of the entire livelihood clusters.

None of these households has access to formal credit. Also access to public goods is relatively limited. They are farther away from rivers and from the main cities. Not surprising, few households engage in civil societies (see table 5.3).

The ethnic composition of these households is almost equally distributed between indigenous and mestizos. The high percentage of households headed by women (almost one quarter of the total) might explain limited amount of assets owned by this group, due to gender exclusion and reduced access to opportunities. In addition, households within this group have low levels of education; only 45% have attained secondary education and more than half only primary (see table 5.3).

### **5.2.5. Identified livelihood strategies synthesis**

The four livelihood strategies identified are quite different. In the first place, the group that engages in agricultural markets (livelihood B) needs a large amount of natural and physical resources in order to engage in this activity; when holdings are smaller production is dedicated mainly to home consumption. When production is limited, households also diversify income sources and reduce exposure to risk. In the face of agricultural risk, households that diversify out of agriculture will likely be better off, because they still have a source of income from non-farm activities. Therefore there is a trade off between income gain from specialization and exposure to risky events. Households engaged mainly in non-farm activities do not require large amounts of natural resources, but benefit from more education and better access to public goods. An important factor distinguishing the livelihood is location relative to population centers. Households that dedicate their time to non-farm activities are more likely to be close to cities than those engaged in agricultural activities. Households closest to rivers are more likely to engage in agriculture activities while households farther are more likely to engage in agricultural wage work or non-farm activities, because water sources represent an important input in agricultural production.

Finally the main difference between diversified households and agricultural consumption-wage work is that for diversified households a higher percentage of income is from activities that are not related to agriculture, while households in agriculture wage work still depend on their own production and the work that they can access in other

farms which is clearly related to the agriculture sector. There are obvious differences, then, in exposure to risk.

### 5.2.6. Livelihood strategies tests

In addition to the qualitative cluster protocol used and the results explained above, a quantitative hierarchical cluster method was used to corroborate the results from the qualitative procedure. The quantitative cluster method provides similar results to the ones defined by the qualitative cluster protocol. Both methods cluster similar numbers of households into each livelihood strategy. Using quantitative hierarchical method lead to clusters with 92% of the original households under the same livelihood strategies defined initially by the qualitative protocol cluster, which is expected because both methods should provide similar results (see table 5.4).

**Table. 5.4.** Comparison of qualitative cluster protocol and quantitative hierarchical method

|                              |  | Quantitative Hierarchical Clusters |                             |                           |                           | Total |
|------------------------------|--|------------------------------------|-----------------------------|---------------------------|---------------------------|-------|
|                              |  | Livelihood (A)                     | Livelihood (B)              | Livelihood (C)            | Livelihood (D)            |       |
| Qualitative Cluster Protocol | Diversified households (A)                 | <b>68</b><br><b>(87%)</b>          | 5<br>(6%)                   | 0<br>(0%)                 | 5<br>(6%)                 | 78    |
|                              | Engaged in agriculture markets (B)         | 0<br>(0%)                          | <b>105</b><br><b>(100%)</b> | 0<br>(0%)                 | 0<br>(0%)                 | 105   |
|                              | Rural non-farm economy (C)                 | 9<br>(18%)                         | 0<br>(0%)                   | <b>41</b><br><b>(82%)</b> | 0<br>(0%)                 | 50    |
|                              | Agricultural consumption and wage work (D) | 0<br>(0%)                          | 1<br>(2%)                   | 2<br>(4%)                 | <b>50</b><br><b>(94%)</b> | 53    |
|                              | Total                                      | 77                                 | 111                         | 43                        | 55                        | 286   |

### 5.3. Livelihood strategies and their characteristics influencing participation.

We now turn to investigating the determinants of livelihood choice. We use a multinomial logit model to explain these choices assuming that each household is free to choose among the livelihood options.

The multinomial logit model contains all social and economic characteristics of the producers that influence livelihood strategy selection. The model also includes geographic variables to capture how these characteristics affect the household decision process (see table 5.5).

**Table 5.5.** Multinomial logit coefficients: determinants of livelihood strategies.

| <i>Variables Coefficients</i> | <i>Livelihood</i> | <i>Livelihood</i> | <i>Livelihood</i> |
|-------------------------------|-------------------|-------------------|-------------------|
|                               | <i>A</i>          | <i>C</i>          | <i>D</i>          |
| Farm surface                  | -0.09             | -0.15             | -0.06             |
| <i>p-value</i>                | (0.01)***         | (0.33)            | (0.28)            |
| Irrigation access             | -0.58             | -0.92             | -0.32             |
| <i>p-value</i>                | (0.17)            | (0.17)            | (0.60)            |
| Physical assets /100          | 0.01              | 0.01              | -0.12             |
| <i>p-value</i>                | (0.20)            | (0.58)            | (0.00)***         |
| Household head age            | -0.15             | -0.10             | -0.07             |
| <i>p-value</i>                | (0.03)**          | (0.35)            | (0.44)            |
| Age square                    | 0.00              | 0.00              | 0.00              |
| <i>p-value</i>                | (0.06)*           | (0.31)            | (0.53)            |
| Household size                | 0.06              | -0.08             | -0.02             |
| <i>p-value</i>                | (0.49)            | (0.60)            | (0.83)            |
| Dependency ratio *10          | 0.01              | 0.12              | 0.09              |
| <i>p-value</i>                | (0.87)            | (0.32)            | (0.45)            |
| Secondary education           | 0.16              | 0.41              | -0.69             |
| <i>p-value</i>                | (0.65)            | (0.37)            | (0.10)*           |
| Alumbre watershed             | -2.08             | 2.94              | 0.71              |
| <i>p-value</i>                | (0.17)            | (0.30)            | (0.74)            |
| Altitude in kilometers *10    | -0.34             | -0.16             | -0.13             |
| <i>p-value</i>                | (0.01)***         | (0.52)            | (0.50)            |
| Distance to river             | 0.42              | 0.56              | 0.27              |
| <i>p-value</i>                | (0.07)*           | (0.02)**          | (0.27)            |
| Distance to town              | -0.08             | -0.05             | -0.07             |
| <i>p-value</i>                | (0.70)            | (0.83)            | (0.76)            |
| Distance to city              | 0.14              | 0.03              | 0.13              |
| <i>p-value</i>                | (0.11)            | (0.71)            | (0.15)            |
| Constant                      | 13.32             | 2.88              | 5.27              |
| <i>p-value</i>                | (0.01)***         | (0.74)            | (0.42)            |

N=286; Pseudo R<sup>2</sup>=0.23; Goodness of fit=0.50

Note: Households engaging in agricultural markets (livelihood B) is comparison group.

In order to estimate the marginal effect that a one unit change will have in the probability of engaging in a livelihood strategy, it is necessary to hold the variables at representative values (see table 5.6). Initially all dummy variables are held at 0 and all the continuous variables are held at their mean value. Under these conditions the multinomial

logit model estimates that this household is more likely to engage in diversified activities (70% probability).

**Table 5.6. Marginal effects**

|                         | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> |                              |
|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|------------------------------|
| Probability to engage % | 0.70                    | 0.24                    | 0.01                    | 0.06                    |                              |
| <i>Variables</i>        | <i>dy/dx</i>            | <i>dy/dx</i>            | <i>dy/dx</i>            | <i>dy/dx</i>            | <i>Variables<br/>hold at</i> |
| Alumbre watershed       | -0.55                   | 0.17                    | 0.24                    | 0.14                    | 0                            |
| <i>p&gt; z </i>         | <i>(0.02)**</i>         | <i>(0.60)</i>           | <i>(0.26)</i>           | <i>(0.42)</i>           |                              |
| Altitude *10            | -0.07                   | 0.06                    | 0.00                    | 0.01                    | 27.87                        |
| <i>p&gt; z </i>         | <i>(0.00)***</i>        | <i>(0.00)***</i>        | <i>(0.50)</i>           | <i>(0.17)</i>           |                              |
| Farm surface            | -0.02                   | 0.02                    | 0.00                    | 0.00                    | 4.84                         |
| <i>p&gt; z </i>         | <i>(0.07)*</i>          | <i>(0.08)*</i>          | <i>(0.69)</i>           | <i>(0.97)</i>           |                              |
| Irrigation access       | -0.12                   | 0.11                    | 0.00                    | 0.00                    | 0                            |
| <i>p&gt; z </i>         | <i>(0.25)</i>           | <i>(0.26)</i>           | <i>(0.62)</i>           | <i>(0.89)</i>           |                              |
| Physical assets /100    | 0.01                    | 0.00                    | 0.00                    | -0.01                   | 15.53                        |
| <i>p&gt; z </i>         | <i>(0.17)</i>           | <i>(0.85)</i>           | <i>(0.77)</i>           | <i>(0.30)</i>           |                              |
| Age                     | -0.03                   | 0.03                    | 0.00                    | 0.00                    | 50.08                        |
| <i>p&gt; z </i>         | <i>(0.09)*</i>          | <i>(0.14)</i>           | <i>(0.90)</i>           | <i>(0.69)</i>           |                              |
| Square age              | 0.00                    | 0.00                    | 0.00                    | 0.00                    | 2739.36                      |
| <i>p&gt; z </i>         | <i>(0.11)</i>           | <i>(0.17)</i>           | <i>(0.94)</i>           | <i>(0.68)</i>           |                              |
| Household size          | 0.01                    | -0.01                   | 0.00                    | 0.00                    | 5.13                         |
| <i>p&gt; z </i>         | <i>(0.41)</i>           | <i>(0.56)</i>           | <i>(0.63)</i>           | <i>(0.54)</i>           |                              |
| Dependency ratio *10    | 0.00                    | 0.00                    | 0.00                    | 0.00                    | 3.52                         |
| <i>p&gt; z </i>         | <i>(0.93)</i>           | <i>(0.80)</i>           | <i>(0.63)</i>           | <i>(0.56)</i>           |                              |
| Education               | 0.05                    | -0.02                   | 0.00                    | -0.03                   | 0                            |
| <i>p&gt; z </i>         | <i>(0.47)</i>           | <i>(0.74)</i>           | <i>(0.68)</i>           | <i>(0.34)</i>           |                              |
| Distance to river       | 0.08                    | -0.07                   | 0.00                    | 0.00                    | 1.27                         |
| <i>p&gt; z </i>         | <i>(0.11)</i>           | <i>(0.10)*</i>          | <i>(0.64)</i>           | <i>(0.83)</i>           |                              |
| Distance to town        | -0.01                   | 0.01                    | 0.00                    | 0.00                    | 2.14                         |
| <i>p&gt; z </i>         | <i>(0.74)</i>           | <i>(0.72)</i>           | <i>(0.97)</i>           | <i>(0.95)</i>           |                              |
| Distance to city        | 0.02                    | -0.02                   | 0.00                    | 0.00                    | 6.34                         |
| <i>p&gt; z </i>         | <i>(0.21)</i>           | <i>(0.18)</i>           | <i>(0.64)</i>           | <i>(0.77)</i>           |                              |

Note: From livelihood selection model with dummy variables held at zero and continuous variables at mean values

In general, access to natural assets has an important impact on the choice of livelihood strategy (see table 5.5). Increasing the amount of land reduces the probability of engaging in non-farm activities, agricultural wage work and diversification of activities, while increasing the probability of engaging in agricultural markets. However this negative effect is only statistically significant when we compare the diversified households and the comparison group (livelihood B).

Irrigation access has a negative effect on selection of other livelihoods relative to livelihood B (see table 5.5), reducing the probability of engaging in rural non-farm activities, agricultural wage work, and diversification while increasing the probability of engaging in agricultural markets. These results are reasonable since better resource endowments allow households to engage in agricultural markets.

Households do not require as many natural resources to engage in agricultural wage work and to diversify, while households with more natural resources will engage primarily in agricultural production.

The value of physical assets owned by the household also has a negative effect on the probability of engaging in agricultural wage work while increasing the probability of engaging in agricultural markets (see table 5.5). Accumulation of physical assets increases the probability of diversifying and engaging in non-farm activities, but the coefficients are not statistically significant.

Increasing farm surface and irrigation have a positive marginal impact on the probability of engaging in agriculture markets, the same for physical assets (see table 5.6). Providing irrigation will increase the probability of engaging in agricultural market by 11%, while increasing the amount of physical assets by \$100 will only increase the probability by less than 1%. The probability of diversifying activities will be reduced by increasing farm size and accessing irrigation but it will become higher by increasing physical assets. Irrigation access reduces the probability of engaging in the diversified livelihood (livelihood A) by almost 12%.

Households require more human capital to engage in non-farm livelihoods. Education moves households out of agriculture, and encourage adoption of non-farm livelihoods

(see table 5.5). Changing the education level from primary or no education to the secondary level will increase the probability of engaging in rural non-farm activities and diversification. The marginal effect in the probability to engage in rural non-farm activities will increase by less than 1% and diversification will increase by 5%. The probability of engaging in agricultural markets and agricultural wage work will decrease. The marginal effect in the probability of engaging in agriculture wage work and agriculture production will be reduced by almost 2% and 3% respectively (see table 5.6). Increasing the level attained by the households in education is a factor to disengage agriculture while encouraging the participation in non-farm activities.

Older age reduces the probability of adopting a diversified livelihood while increasing probability of engaging in agricultural markets. Household size and dependency ratio are not significant.

Several geographic variables are statistically significant and important determinants of livelihood strategy selection. For instance, the watershed location's marginal effect is statistically significant (see table 5.6). If the household is located in the Alumbre sub-watershed the probability of diversifying will fall by about 55%, while the probability of engaging in agricultural production will increase. The probability of engaging in non-farm activities and agricultural wage work (livelihood C and D, respectively) increases by 24% and 14% respectively (see table 5.5). Those results agree with empirical evidence where it is more common for households in the downstream area to access agricultural wage work or non-farm activities.

The altitude variable has similar effects. Households located in higher altitudes are more likely to engage in agricultural markets while households in lower altitudes are

more likely to engage in non-farm activities, agricultural wage work and diversified activities (see table 5.5). Increasing the altitude by 100 meters will reduce the probability of engaging in the diversified livelihood by 7%, while increasing the probability of engaging in agricultural markets by 6% (see table 5.6). Households at higher altitudes are more likely to engage in agricultural production and not in activities off the farm.

As the distance to rivers increases, the probability of engaging in diversified activities and rural non-farm activities grows while the probability of engaging in agricultural production decreases. Households that engage in agricultural production need to be close to water sources. The effects shown by the distance to rivers confirm the results shown by irrigation access since they are similar. Households that are far away from rivers have increased probability of engaging in diverse activities while the probability to engage in agriculture markets will be reduced by 7% if we increase the distance from the river by one kilometer (see table 5.6).

Increased distance from markets means that households are more likely to diversify their activities, and less likely to engage in agricultural markets (see table 5.5). It was expected that households that are closest to cities are more likely to engage in non-farm activities, but the coefficients in the model show the opposite result. As we increase the distance to cities, the probability of engaging in non-farm activities and agricultural wage work increases, while the probability of engaging in agriculture markets diminishes, which is expected. On the other hand increasing distance to towns reduces the probability of engaging in rural non-farm activities while increasing the probability of engaging in agricultural production (see table 5.5).

### 5.3.1. Livelihood strategy selection

The multinomial logit model accurately predicts the selected livelihood strategy almost half the times. The households that engage in non-farm and diversified activities are predicted with the most accuracy, while households that engage in agricultural wage work are predicted less accurately (see table 5.7). The percentage of households predicted accurately was determined using the predicted probabilities from the selection model (multinomial logit) and the current livelihood engaged. The highest probability predicted was compared to the current livelihood. For example, if a household has a predicted probability of engaging in diversified activities (52%), and currently is engaged in diversified activities, it is considered as a correct prediction. The percentage of households predicted accurately is actually quite good (see table 5.7).

**Table 5.7.** Percentage of households predicted correctly

|                                       | <i>Sample<br/>size</i> | <i>Correct<br/>prediction<br/>%</i> |
|---------------------------------------|------------------------|-------------------------------------|
| Sample population                     | 286                    | 0.50                                |
| Diversified households                | 78                     | 0.33                                |
| Engaged in agriculture markets        | 105                    | 0.67                                |
| Rural non-farm economy                | 50                     | 0.52                                |
| Agriculture consumption and wage work | 53                     | 0.38                                |

### 5.3.2. Livelihood strategy synthesis

As we can see access to natural and physical assets are important determinants of household livelihood strategies. Even though education is not statistically significant, it increases the probability of engaging in non-farm activities, while reducing the probability of participating in the agricultural sector in either production or wage work.

This result was expected and it shows that returns to education are higher outside of agriculture than inside and that increased education may help conserve natural resources by inducing movement into diversified and non-agricultural livelihoods.

Natural and physical assets increase the probability of engaging in agricultural markets, and reduce the probability of engaging in non-farm activities and agricultural wage work. As distance to rivers increases, the probability of engaging in agricultural markets falls and engagement in non-farm activities increase. Under the current conditions it might be harmful to improve access to water sources, since this may encourage overuse of natural resources in agricultural production, increasing erosion, depleting forest and contaminating the environment. If we improve access to water sources, it is necessary to improve farming practices in order to protect the watershed and reduce contamination.

Lastly, it is possible to analyze marginal effects of different types of households. The statistical significance and the magnitude of the coefficients differ among different scenarios (for more examples see Appendix 3).

#### **5.4. Livelihood strategies and well-being.**

We now analyze the relationship between livelihood strategy and well-being. Initially this section will describe the main characteristics influencing well-being<sup>17</sup> received under each livelihood strategy. Then the amount of well-being under each livelihood will be compared with the amount of well-being that might be achieved if the farmers selected

---

<sup>17</sup> Household consumption expenditure is used as a well-being measure. Because it is smooth over short term fluctuations, capture long-run well-being levels, reliable and less vulnerable to under reporting bias for poor households with low resources (World Bank, 2001; Barret *et al.* 2001; Meyer and Sullivan, 2003; and Ravallion, 2003). However several consumption categories were excluded during the data collection process, like livestock home consumption.

different livelihoods. Note that we only observe well-being levels for households in the livelihood they select. We do not observe the well-being that a diversified household would have received had it engaged instead in agricultural markets. This is the selection problem.

#### **5.4.1. Characteristics influencing well-being level under different livelihood strategies.**

The well-being selection models include all the social and economic variables that might affect the amount of well-being achieved under each livelihood strategy (see table 5.8). Another complementary selection model, estimated using income as the well-being measure is presented in appendix 4. The coefficients estimated using income (appendix 4) are similar to the ones estimated in table 5.8 using expenditures. The only difference is that watershed becomes statistically significant when we use income as the measure of well-being (appendix 4).

**Table 5.8.** Determinants of household well-being conditioned on livelihood selection

| <i>Variables</i>          | <i>Livelihood</i>    | <i>Livelihood</i>    | <i>Livelihood</i>    | <i>Livelihood</i>    |
|---------------------------|----------------------|----------------------|----------------------|----------------------|
|                           | <i>A</i>             | <i>B</i>             | <i>C</i>             | <i>D</i>             |
| Alumbre watershed         | 0.45                 | -0.02                | -0.24                | -0.04                |
| <i>P&gt; t </i>           | (0.26)               | (0.93)               | (0.69)               | (0.88)               |
| Ln farm surface           | 0.07                 | 0.19                 | 0.14                 | -0.01                |
| <i>P&gt; t </i>           | (0.37)               | (0.01)***            | (0.02)**             | (0.85)               |
| Irrigation                | 0.03                 | -0.15                | -0.46                | 0.22                 |
| <i>P&gt; t </i>           | (0.81)               | (0.12)               | (0.11)               | (0.29)               |
| Ln physical assets        | 0.00                 | -0.08                | -0.06                | -0.03                |
| <i>P&gt; t </i>           | (1.00)               | (0.04)**             | (0.08)*              | (0.50)               |
| Credit                    | 0.42                 | 0.70                 | 0.42                 | (dropped)            |
| <i>P&gt; t </i>           | (0.04)**             | (0.00)***            | (0.02)**             | --                   |
| Household gender          | -0.43                | 0.13                 | 0.09                 | 0.00                 |
| <i>P&gt; t </i>           | (0.01)***            | (0.32)               | (0.51)               | (0.98)               |
| Ln household size         | -0.85                | -0.64                | -0.87                | -0.79                |
| <i>P&gt; t </i>           | (0.00)***            | (0.00)***            | (0.00)***            | (0.00)***            |
| Education                 | 0.11                 | 0.10                 | 0.02                 | 0.09                 |
| <i>P&gt; t </i>           | (0.39)               | (0.35)               | (0.91)               | (0.60)               |
| Correction coefficients 1 | -0.05                | -0.59                | -1.61                | -1.40                |
| <i>P&gt; t </i>           | (0.85)               | (0.24)               | (0.01)***            | (0.16)               |
| Correction coefficients 2 | 0.07                 | -0.07                | -1.34                | -1.45                |
| <i>P&gt; t </i>           | (0.92)               | (0.75)               | (0.02)**             | (0.09)***            |
| Correction coefficients 3 | 0.50                 | 0.26                 | -0.03                | -0.72                |
| <i>P&gt; t </i>           | (0.56)               | (0.63)               | (0.81)               | (0.40)               |
| Correction coefficients 4 | 1.68                 | 0.92                 | 0.35                 | -0.35                |
| <i>P&gt; t </i>           | (0.01)***            | (0.07)*              | (0.54)               | (0.10)*              |
| Constant                  | 7.39                 | 6.58                 | 5.96                 | 5.32                 |
| <i>P&gt; t </i>           | (0.00)***            | (0.00)***            | (0.00)***            | (0.00)***            |
|                           | N=78                 | N=105                | N=50                 | N=53                 |
|                           | R <sup>2</sup> =0.62 | R <sup>2</sup> =0.46 | R <sup>2</sup> =0.76 | R <sup>2</sup> =0.62 |

Note: dependent variable natural log of annual well-being per capita as consumption expenditures.

Several variables in the well-being selection regressions are important and several of the correction coefficients are statistically significant (see table 5.8), confirming the necessity to correct for selection bias. For instance well-being in each of the livelihood strategies increases by increasing the farm size, and this variable is highly significant in the agricultural market (livelihood B) and rural non-farm livelihoods (livelihood C). Households engaged in agriculture markets increase their well-being by almost 1.9% if they increase the farm size by 10%, similarly well-being will be increased by a smaller

percentage for households engaged in non-farm activities, if the farm size increases (see table 5.8).

Irrigation access does not statistically affect well-being, although for households that diversify activities and engage in agricultural wage work it has positive effects on well-being. It is odd that irrigation access has a negative coefficient for the agricultural markets livelihood B (see table 5.8). It was expected that accessing irrigation might increase well-being, especially within this livelihood. Households complained about lack of access to water, even though they had irrigation, they consider it is not enough water. Also since the amount of water is not enough, it might happen that even when households have irrigation access they do not harvest during the dry season and do not receive extra benefits for accessing irrigation. On the other hand, households that engage in rural non-farm activities have a negative coefficient for irrigation access. This negative coefficient was expected since this household group gains more of their income from off-farm activities and accessing irrigation might not help to improve their conditions off-farm. Irrigation access might represent an unnecessary cost for this group of households.

Similar negative effects are seen in the amount of physical assets. One explanation might be that since the biggest share of the value of physical assets is represented by livestock, as households own more livestock they will consume fewer livestock products from the market and more from their own farm, reducing the amount of expenditures. Unfortunately our expenditure variable does not include home consumption from livestock products and (only from crop production). However for the other two livelihood strategies these coefficients are not statistically significant therefore the hypothesis that the coefficient is different to zero can not be rejected (see table 5.8).

We expected education to have a positive impact on well-being. However this variable is not statistically significant for any of the households engaged in any livelihood strategy (see table 5.8).

Another interesting factor is access to formal credit or households that undertake credit from the formal financial sector, since almost all households could access some kind of informal credit from neighbors, friends or relatives in small amounts. Accessing formal credit has a positive effect on the amount of well-being for all livelihoods. Providing credit to households engaged in agricultural markets increases their wellbeing by almost 70% and around 42% for households that diversify and engage in non-farm activities (see table 5.8). The large increase in well-being by credit access is due to the nature of the well-being variable (consumption expenditures), since most household use their credit to buy consumption goods and improve productive activities achieving higher income levels and consuming more.

Also for those engaged in agricultural markets, having a male household head will increase well-being by 13%. For households engaged in diversified activities having male heads will reduce their well-being by 43% (see table 5.8).

As was expected, increasing the number of household members results in smaller amounts of well-being per capita. If households engaged in agricultural markets increased their size by 10%, their welfare would be reduced by an estimated 6.4%. A similar effect is seen for households diversifying activities, but with a higher magnitude (see table 5.8). This effect is expected since having larger families reduces the amount of income per capita and therefore well-being.

At least one of the correction coefficients appears statistically significant in each of the livelihood strategy regressions (see table 5.8). For households engaged in agricultural markets (livelihood B) and diverse activities (livelihood A), one of the correction coefficients is significant, and for households in non-farm activities (livelihood C) and agricultural wage work (livelihood D), two of the coefficients are significant.

The adjusted R-squares for the models range from 0.40 to 0.70. Variables like farm size and education increase the amount of current well-being, while irrigation and physical assets decrease it. The reason why the model has only a few variables is because initially including more social and economic characteristics did not improve our results, and the added variables were not statistically significant.

#### **5.4.2. Estimated well-being level under different livelihood strategies.**

Using these results we can estimate the average amount of welfare received by households when they engage in a certain livelihood. Also we can estimate the average amount of well-being that the same households would receive if they were engaged in other livelihood strategies.

The estimated annual welfare per capita in alternative livelihoods differs from the actual amount (see table 5.9). For instance, households engaged in diversified activities (livelihood A) might have the option of specializing in only one activity. According to the model, these households might be better off only if they engage in non-farm activities (livelihood C). However, access to the non-farm sector is constrained to households that possess special labor skills to engage in sectors other than agriculture. According to the model, these households might increase their welfare by 22% if they engage in non-farm

activities, while if they engage in agricultural markets (livelihood B) their welfare would remain almost the same. For this particular group, engaging in agricultural wage work (livelihood D) would reduce their welfare by almost half (see table 5.9).

**Table 5.9.** Average estimated well-being within each livelihood strategy.

| <i>Variable</i>                           | <i>Livelihood A</i> |                   | <i>Livelihood B</i> |                   | <i>Livelihood C</i> |                   | <i>Livelihood D</i> |                   |
|---|---------------------|-------------------|---------------------|-------------------|---------------------|-------------------|---------------------|-------------------|
|   | <i>Mean</i>         |                   | <i>Mean</i>         |                   | <i>Mean</i>         |                   | <i>Mean</i>         |                   |
| Current welfare                           | 253.88              |                   | 252.46              |                   | 251.96              |                   | 184.04              |                   |
| Estimated welfare if households belong to | <i>Mean</i>         | <i>Std. Error</i> | <i>Mean</i>         | <i>Std. Error</i> | <i>Mean</i>         | <i>Std. Error</i> | <i>Mean</i>         | <i>Std. Error</i> |
| Livelihood A                              | <b>231.85</b>       | <b>131.18</b>     | 254.05              | 125.54            | 246.41              | 127.80            | 202.83              | 94.10             |
| % change                                  | <b>(-0.09)</b>      |                   | <i>(0.01)</i>       |                   | <i>(-0.02)</i>      |                   | <i>(0.10)</i>       |                   |
| Livelihood B                              | 214.40              | 169.76            | <b>236.09</b>       | <b>97.53</b>      | 202.35              | 126.70            | 169.58              | 82.65             |
| % change                                  | <i>(-0.16)</i>      |                   | <b>(-0.06)</b>      |                   | <i>(-0.20)</i>      |                   | <i>(-0.08)</i>      |                   |
| Livelihood C                              | 309.20              | 191.30            | 343.74              | 182.52            | <b>241.95</b>       | <b>86.98</b>      | 235.21              | 112.03            |
| % change                                  | <i>(0.22)</i>       |                   | <i>(0.36)</i>       |                   | <b>(-0.04)</b>      |                   | <i>(0.28)</i>       |                   |
| Livelihood D                              | 123.02              | 241.03            | 113.37              | 206.09            | 162.97              | 157.51            | <b>176.66</b>       | <b>62.37</b>      |
| % change                                  | <i>(-0.52)</i>      |                   | <i>(-0.55)</i>      |                   | <i>(-0.35)</i>      |                   | <b>(-0.04)</b>      |                   |

Similar results are seen in the other three livelihoods. For example, households engaged in agricultural markets (livelihood B) might be better off if they engaged in non-farm activities (livelihood C) increasing their annual average welfare by almost 36% (see table 5.9). These households might be worst off by almost 55%, if they try to change their current livelihood strategy to agricultural wage work (see table 5.9).

Households engaged in agricultural wage work (livelihood D) might improve by engaging in any other livelihood strategy except agricultural markets (livelihood B). Under their actual conditions (low assets endowment) engaging in agricultural markets (livelihood B) might reduce well-being by almost 8% and they do not have enough skills or assets to engage in the non-farm sector (see table 5.9).

It is clear that engaging in agricultural wage work (livelihood D) for all households results in a reduction in well-being. For households that are engaged in agricultural wage work (livelihood D), agricultural markets (livelihood B), and diversified livelihoods

(livelihood A), changing their livelihood strategy to non-farm activities might be beneficial for them. However in order for these households to access the activities within the rural non-farm sector, they might need attributes or assets that we have not identified. Engaging the non-farm sector appears to be an important option to improve well-being. Households engaged in rural non-farm activities (livelihood C) might not be better off changing livelihood strategies under their current conditions. For households in livelihood A it might be attractive to specialize their efforts and engage in only non-farm activities (livelihood C). However, they are less likely to be affected by risky events that might affect the rural non-farm sector or the agriculture sector if they engage in both.

#### **5.5. Policy changes, livelihood strategy selection and estimated well-being.**

We now examine the impacts on livelihood choice and well-being due to three prospective policy changes: increased expenditure on education, more access to irrigation, and wider access to credit. The first policy change assumes that education becomes more widely available for households and this increased education is simulated for those households most likely to attain higher levels of education given a total expenditure on education. The second policy assumes that irrigation might become more widely available. Those households most likely to access irrigation are identified and their changes in livelihood strategies are estimated, and subsequently, the well-being change associated with increase irrigation. The third policy change assumes that formal credit becomes more widely available. Changes in livelihood selection and well-being are estimated for those households more likely to access formal credit. Both of the first policies (education and irrigation) affect variables that are not statistically significant in

the well-being selection model, but are important determinants of livelihood strategies and affect well-being through the choice of livelihood. The credit policy does not affect livelihood selection, but it is an important determinant of well-being.

#### **5.5.1. Education policy changes.**

We begin by asking which households would be most likely to receive benefits. Initially a logit model is used to identify those households most likely to attain secondary education. Variables affecting the probability of achieving higher levels of education include: watershed location, household size, household members that are teenagers, household head and spouse education, and household head age (see table 5.10). Some geographic variables are also statistically significant, such as distance to cities and paved roads. Around 80% of the observations are correctly predicted.

**Table 5.10. Determinants of education attainment**

| <i>Variables</i>            | <i>Coefficients</i> |
|-----------------------------|---------------------|
| Alumbre                     | -9.91               |
| <i>p&gt; z </i>             | (0.00)***           |
| Household size              | 1.74                |
| <i>p&gt; z </i>             | (0.00)***           |
| Young children              | -1.74               |
| <i>p&gt; z </i>             | (0.00)***           |
| Older children              | -1.68               |
| <i>p&gt; z </i>             | (0.00)***           |
| Adults                      | -0.99               |
| <i>p&gt; z </i>             | (0.01)***           |
| Elders                      | -1.56               |
| <i>p&gt; z </i>             | (0.02)**            |
| Household head education    | 0.31                |
| <i>p&gt; z </i>             | (0.00)***           |
| Household head age          | 0.16                |
| <i>p&gt; z </i>             | (0.07)*             |
| Age squared                 | 0.00                |
| <i>p&gt; z </i>             | (0.15)              |
| Wife education              | 0.31                |
| <i>p&gt; z </i>             | (0.00)***           |
| Wife age                    | -0.03               |
| <i>p&gt; z </i>             | (0.35)              |
| Age squared wife            | 0.00                |
| <i>p&gt; z </i>             | (0.46)              |
| Distance closest University | 0.22                |
| <i>p&gt; z </i>             | (0.01)***           |
| Distance closest market     | -0.19               |
| <i>p&gt; z </i>             | (0.09)*             |
| Distance closest school     | 0.18                |
| <i>p&gt; z </i>             | (0.35)              |
| Distance closest paved road | -0.29               |
| <i>p&gt; z </i>             | (0.05)**            |
| Farm surface                | 0.02                |
| <i>p&gt; z </i>             | (0.58)              |
| Constant                    | -7.22               |
| <i>p&gt; z </i>             | (0.00)***           |

Dependent variable: dummy whether a household member has attained secondary education or not.

Pseudo-R<sup>2</sup> 0.35 and 286 observations.

Note: Between the variables young and older children, adults, and elder, teenager is the comparison group.

In order to define the target population affected by the policy change, it is assumed that an annual expenditure of \$100,000 will be invested in increased education. The

estimated annual cost for one year of secondary studies was estimated at \$450<sup>18</sup>. The total cost to complete high school is \$2,700 since in Ecuador it is necessary to complete six years. The percentage of households, most likely to attain secondary education, is 13%. From those households who are most likely to benefit from higher educational expenditures, almost one third is engaged in agricultural wage work (livelihood D) similar amounts are engaged in agricultural markets (livelihood B) and diversified activities (livelihood A). Only 14% are engaged in non-farm activities (livelihood C) (see table 5.11). After changing the education level of the target population from primary to secondary, the number of households in livelihood D (agricultural wage work), falls to only 8% and the remaining households are distributed almost equally among the other three livelihoods (see table 5.11).

**Table 5.11.** Percentage of households engaged among livelihood strategies

| <i>Current livelihood</i> | <i>Predicted livelihood</i> |                     |                     |                     | <i>Households</i> |
|---------------------------|-----------------------------|---------------------|---------------------|---------------------|-------------------|
|                           | <i>Livelihood A</i>         | <i>Livelihood B</i> | <i>Livelihood C</i> | <i>Livelihood D</i> |                   |
| <b>Livelihood A</b>       | 7                           | 2                   | 1                   | 1                   | <b>11</b>         |
| <i>% change</i>           | (0.64)                      | (0.18)              | (0.09)              | (0.09)              | (0.30)            |
| <b>Livelihood B</b>       | 2                           | 8                   | 1                   | 0                   | <b>11</b>         |
| <i>% change</i>           | (0.18)                      | (0.73)              | (0.09)              | (0.00)              | (0.30)            |
| <b>Livelihood C</b>       | 0                           | 2                   | 2                   | 1                   | <b>5</b>          |
| <i>% change</i>           | (0.00)                      | (0.40)              | (0.40)              | (0.20)              | (0.14)            |
| <b>Livelihood D</b>       | 2                           | 1                   | 6                   | 1                   | <b>10</b>         |
| <i>% change</i>           | (0.20)                      | (0.10)              | (0.60)              | (0.10)              | (0.27)            |
| <b>Households</b>         | <b>11</b>                   | <b>13</b>           | <b>10</b>           | <b>3</b>            | <b>37</b>         |
| <i>% change</i>           | (0.30)                      | (0.35)              | (0.27)              | (0.08)              | (1.00)            |

Note: The table present in the final column the households and their current livelihood and in the last column the predicted livelihood selection after change education. The matrix shows the households remaining in the same livelihood or changing their livelihood after change education.

For households engaged in diversified activities (livelihood A), 64% preserve their current livelihood after attaining a higher education, while 18% change their livelihood strategy to agricultural activities (livelihood B) and 9% to non-farm activities (livelihood

<sup>18</sup> Inscription cost was estimated up to \$50 in public high-schools, study material and transportation up to \$350 and several expenses up to \$50 during one year.

C). Only 10% of the households engaged in agricultural wage work (livelihood D) continue in this livelihood, while almost 60% move into non-farm activities (livelihood C) (see table 5.11). Higher education levels encourage households to select non-farm livelihoods.

On average, the well-being increases result from higher levels of education. Under current conditions, those households most likely to attain higher education have an annual average well-being per capita of \$195 (see table 5.12), while after the increase in education, their well-being grows to \$229 or by 17% (see table 5.12). All the households affected by wider access to education improve their well-being conditions significantly as a result of the policy.

**Table 5.12.** Welfare change after education policy change

|                   | <i>Current Welfare Mean</i> | <i>Predicted Welfare Mean</i> | <i>Std. Error</i> | <i>Average % Change Mean</i> |
|-------------------|-----------------------------|-------------------------------|-------------------|------------------------------|
| Target population | 195.19                      | 228.77                        | 92.22             | 0.39                         |
| <i>% Change</i>   |                             | <i>(0.17)</i>                 |                   |                              |
| Livelihood A      | 214.73                      | 278.92                        | 123.90            | 0.59                         |
| <i>% Change</i>   |                             | <i>(0.30)</i>                 |                   |                              |
| Livelihood B      | 217.27                      | 232.00                        | 83.11             | 0.19                         |
| <i>% Change</i>   |                             | <i>(0.07)</i>                 |                   |                              |
| Livelihood C      | 196.80                      | 222.67                        | 73.12             | 0.20                         |
| <i>% Change</i>   |                             | <i>(0.13)</i>                 |                   |                              |
| Livelihood D      | 148.60                      | 173.09                        | 29.22             | 0.49                         |
| <i>% Change</i>   |                             | <i>(0.16)</i>                 |                   |                              |

Households engaged in diversified activities (livelihood A) receive the highest percentage increase in well-being, and see it grow by almost 30% (see table 5.12). Also the group of households currently engaged in agricultural wage work (livelihood D) will benefit significantly.

Providing wider access to education will affect livelihood strategies selection, mainly for households already engaged in agricultural wage work. Increasing education also increases well-being for beneficiary households.

### 5.5.2. Irrigation policy changes.

We begin by identifying those households most likely to receive benefits from more widely spread access to irrigation using a logit model. The most important significant variables in this logit model were: watershed location and estimated cattle value (see table 5.13). Around 80% of the observations are correctly predicted.

**Table 5.13. Determinants of irrigation access**

| <i>Variables</i>                 | <i>Coefficients</i> |
|----------------------------------|---------------------|
| Alumbre sub-watershed            | -1.01               |
| <i>p&gt; z </i>                  | (0.03)**            |
| Farm surface                     | 0.01                |
| <i>p&gt; z </i>                  | (0.70)              |
| Distance to river                | -0.21               |
| <i>p&gt; z </i>                  | (0.24)              |
| Monetary value of cattle         | 0.00                |
| <i>p&gt; z </i>                  | (0.01)***           |
| Monetary value of livestock      | 0.00                |
| <i>p&gt; z </i>                  | (0.58)              |
| Monetary value productive assets | 0.00                |
| <i>p&gt; z </i>                  | (0.31)              |
| Constant                         | -1.27               |
| <i>p&gt; z </i>                  | (0.00)***           |

Dependent variable: dummy whether a household has access to irrigation or not

Pseudo-R<sup>2</sup> = 0.17 and 286 observations.

The cost to irrigate one hectare in the area was estimated from information gathered by INIAP and SANREM-CRSP during this study. The average annual cost to irrigate one hectare in Illangama is estimated at almost \$3,200 while in Alumbre is estimated at \$5,000. Assuming an investment of \$100,000 by the government to improve access to irrigation, only 5% households will be benefited as the most likely to access irrigation.

The total cost per farm to implement irrigation was estimated by the crop surface times the irrigation cost per hectare. From those households most likely to benefit from wider irrigation access, almost half are currently engaged in agricultural markets (livelihood B), around 38% are in diversified activities (livelihood A) and only 8% are engaged in non-farm activities (livelihood C) (table 5.14). After accessing irrigation, those households engage mainly in agricultural markets 92% (livelihood B) (table 5.14).

**Table 5.14.** Percentage of households engaged among livelihood strategies

| <i>Current livelihood</i> | Predicted livelihood |                     |                     |                     | <i>Households</i> |
|---------------------------|----------------------|---------------------|---------------------|---------------------|-------------------|
|                           | <i>Livelihood A</i>  | <i>Livelihood B</i> | <i>Livelihood C</i> | <i>Livelihood D</i> |                   |
| <i>Livelihood A</i>       | 1                    | 4                   | 0                   | 0                   | <b>5</b>          |
| <i>% change</i>           | (0.20)               | (0.80)              | (0.00)              | (0.00)              | <b>(0.38)</b>     |
| <i>Livelihood B</i>       | 0                    | 7                   | 0                   | 0                   | <b>7</b>          |
| <i>% change</i>           | (0.00)               | (1.00)              | (0.00)              | (0.00)              | <b>(0.54)</b>     |
| <i>Livelihood C</i>       | 0                    | 1                   | 0                   | 0                   | <b>1</b>          |
| <i>% change</i>           | (0.00)               | (1.00)              | (0.00)              | (0.00)              | <b>(0.08)</b>     |
| <i>Livelihood D</i>       | 0                    | 0                   | 0                   | 0                   | <b>0</b>          |
| <i>% change</i>           | (0.00)               | (0.00)              | (0.00)              | (0.00)              | <b>(0.00)</b>     |
| <i>Households</i>         | <b>1</b>             | <b>12</b>           | <b>0</b>            | <b>0</b>            | <b>13</b>         |
| <i>% change</i>           | <b>(0.08)</b>        | <b>(0.92)</b>       | <b>(0.00)</b>       | <b>(0.00)</b>       | <b>(1.00)</b>     |

Note: The predicted livelihood selection is defined using the multinomial logit model

Only 20% of the households currently engaged in diversified activities (livelihood A) preserve their current livelihood after accessing irrigation, while 80% is predicted to change their livelihood strategy to one dedicated to agricultural activities (livelihood B) (see table 5.14). The same effect is seen for households currently engaged in non-farm activities. Irrigation is an important factor in the selection of livelihood strategies, mainly because it encourages selection of livelihood strategies related to agriculture production while reducing the ones related to the non-agricultural activities (see table 5.14).

On average, household well-being decreases following access to irrigation<sup>19</sup>. The main reason is the negative coefficient defined by the well-being selection model that decreases well-being by almost 15% for households engaged in agricultural markets (livelihood B) (table 5.8). Households that have irrigation access complain that the conditions of the infrastructure are bad and that they do not have enough water, factors which might explain the negative coefficient. If we want the irrigation policy to be positive we need to improve the infrastructure conditions and the quantity of water available. Under current conditions, those households most likely to access irrigation have an annual average well-being per capita of \$367 (see table 5.15), while after providing irrigation, their well-being decreases to \$258 or by 30% (see table 5.15). This fall is mainly because diversified households (livelihood A) will engage in agricultural markets (livelihood B) without having enough assets to get benefits from only agricultural production.

**Table 5.15.** Welfare change after irrigation policy change

|                   | <i>Current Welfare</i> | <i>Predicted Welfare</i> |                   | <i>Average % Change</i> |
|-------------------|------------------------|--------------------------|-------------------|-------------------------|
|                   | <i>Mean</i>            | <i>Mean</i>              | <i>Std. Error</i> | <i>Mean</i>             |
| Target population | 367.23                 | 257.92                   | 144.47            | -0.25                   |
| <i>% Change</i>   |                        | <i>(-0.30)</i>           |                   |                         |
| Livelihood A      | 467.00                 | 280.88                   | 257.37            | -0.38                   |
| <i>% Change</i>   |                        | <i>(-0.40)</i>           |                   |                         |
| Livelihood B      | 272.86                 | 216.87                   | 130.73            | -0.17                   |
| <i>% Change</i>   |                        | <i>(-0.21)</i>           |                   |                         |
| Livelihood C      | 529.00                 | 430.43                   | N.E.              | -0.19                   |
| <i>% Change</i>   |                        | <i>(-0.19)</i>           |                   |                         |
| Livelihood D      | 0.00                   | 0.00                     | N.E.              | 0.00                    |
| <i>% Change</i>   |                        | <i>(0.00)</i>            |                   |                         |

Note: N.E. means not estimation was performed, after changing irrigation, households only engage in livelihoods A and B therefore the standard error is estimated only for them.

<sup>19</sup> This effect is due to weakness in the well-being model. The well-being and irrigation variables need more information that ensures their comprehensiveness. For instance the well-being variable does not include certain categories like own consumption and households that access irrigation do not have enough water or the technology to use this input in beneficial ways, therefore it looks like well-being decreases.

Providing a wider access to irrigation without improving quantity of water, infrastructure or training producers to use irrigation might result in a reduction of well-being. Mainly for households already engaged in diversified activities. Also they increase their exposure to risk by depending in only one source of income (agriculture).

### **5.5.3. Credit policy changes.**

We assume that those households with the highest probability of undertaking credit will be those who receive it when more become available. We begin identifying households most likely to gain access formal credit. A logit model is used to measure the household-specific probability of receiving credit. The dependent variable is whether households have received credit in the past or not. Variables affecting the probability of receiving formal credit are: watershed location and the value of productive assets (see table 5.16). Some geographic variables are also statistically significant like distance to cities and capital. Around 95% of the observations are correctly predicted.

**Table 5.16.** Determinants of formal credit access

| <i>Variable</i>            | <i>Coefficient</i> |
|----------------------------|--------------------|
| Alumbre watershed          | 10.97              |
| <i>p&gt; z </i>            | (0.02)**           |
| Cattle value               | 0.00               |
| <i>p&gt; z </i>            | (0.75)             |
| Livestock value            | 0.00               |
| <i>p&gt; z </i>            | (0.67)             |
| Productive assets value    | 0.00               |
| <i>p&gt; z </i>            | (0.04)**           |
| Farm size owned with title | -0.07              |
| <i>p&gt; z </i>            | (0.11)             |
| Social participation       | -0.41              |
| <i>p&gt; z </i>            | (0.71)             |
| Household gender           | 0.52               |
| <i>p&gt; z </i>            | (0.62)             |
| Household size             | 0.13               |
| <i>p&gt; z </i>            | (0.30)             |
| Distance closest city      | 0.59               |
| <i>p&gt; z </i>            | (0.00)***          |
| Distance capital           | -0.26              |
| <i>p&gt; z </i>            | (0.04)**           |
| Household head age         | 0.46               |
| <i>p&gt; z </i>            | (0.10)*            |
| Square age                 | -0.01              |
| <i>p&gt; z </i>            | (0.09)*            |
| Education                  | 0.01               |
| <i>p&gt; z </i>            | (0.99)             |
| Constant                   | -16.30             |
| <i>p&gt; z </i>            | (0.00)***          |

Dependent variable: dummy whether a household undertake formal credit or not.

Pseudo-R<sup>2</sup> = 0.20 and 286 observations.

Under the assumption that international non-governmental organizations donate \$100,000 annually to provide wider credit access, the 17% of households will benefit. Micro credits of \$1,500 to improve production will be distributed among the households most likely to undertake formal credit and \$500 is administrative cost annually. From those households most likely to benefit from wider credit access, almost one third are currently engaged in diversified activities (livelihood A), 42% are engaged in agricultural markets (livelihood B), 10% in non-farm activities and the remaining are in agricultural wage work (livelihood D) (see table 5.17). After undertaking the formal credit, livelihood

selection should not change since credit does not significantly influence livelihood selection. However, since the multinomial logit model used to predict household selection of livelihood strategies can not predict perfectly the livelihood strategies selected (only predicts 50% of the times correctly), it appears like livelihood strategy will change, but it is not a result of increased credit access, it is a result of the predicted power of the multinomial logit model (see table 5.17).

**Table 5.17. Percentage of households engaged among livelihood strategies**

| <i>Current livelihood</i> | <i>Predicted livelihood</i> |                     |                     |                     | <i>Households</i> |
|---------------------------|-----------------------------|---------------------|---------------------|---------------------|-------------------|
|                           | <i>Livelihood A</i>         | <i>Livelihood B</i> | <i>Livelihood C</i> | <i>Livelihood D</i> |                   |
| <i>Livelihood A</i>       | 8                           | 5                   | 0                   | 2                   | <b>15</b>         |
| <i>% change</i>           | (0.53)                      | (0.33)              | (0.00)              | (0.13)              | (0.30)            |
| <i>Livelihood B</i>       | 6                           | 14                  | 1                   | 0                   | <b>21</b>         |
| <i>% change</i>           | (0.29)                      | (0.67)              | (0.05)              | (0.00)              | (0.42)            |
| <i>Livelihood C</i>       | 2                           | 0                   | 0                   | 3                   | <b>5</b>          |
| <i>% change</i>           | (0.40)                      | (0.00)              | (0.00)              | (0.60)              | (0.10)            |
| <i>Livelihood D</i>       | 2                           | 1                   | 2                   | 4                   | <b>9</b>          |
| <i>% change</i>           | (0.22)                      | (0.11)              | (0.22)              | (0.44)              | (0.18)            |
| <i>Households</i>         | <b>18</b>                   | <b>20</b>           | <b>3</b>            | <b>9</b>            | <b>50</b>         |
| <i>% change</i>           | (0.36)                      | (0.40)              | (0.06)              | (0.18)              | (1.00)            |

Note: It appears like livelihood selection will change but indeed is because the multinomial logit model used to predict livelihood strategies selection can not predict perfectly the current reality only can predict 50% of the times accurately the livelihood strategy engaged.

However accessing credit will affect well-being. On average, well-being increases significantly after increased access to formal credit. Under current conditions, those households most likely to access credit have an annual average well-being per capita of \$190 (see table 5.18), while after accessing formal credit, their well-being grows to \$283 or by 48%. All the households affected by wider access to formal credit improve their well-being conditions significantly as a result of the policy.

**Table 5.18.** Welfare change after credit policy change

|                   | <i>Current<br/>Welfare<br/>Mean</i> | <i>Predicted<br/>Welfare<br/>Mean</i> | <i>Std. Error</i> | <i>Average %<br/>Change<br/>Mean</i> |
|-------------------|-------------------------------------|---------------------------------------|-------------------|--------------------------------------|
| Target population | 190.64                              | 282.82                                | 161.22            | 0.82                                 |
| <i>% Change</i>   |                                     | <i>(0.48)</i>                         |                   |                                      |
| Livelihood A      | 230.07                              | 293.61                                | 150.81            | 0.70                                 |
| <i>% Change</i>   |                                     | <i>(0.28)</i>                         |                   |                                      |
| Livelihood B      | 187.71                              | 325.54                                | 205.11            | 0.96                                 |
| <i>% Change</i>   |                                     | <i>(0.73)</i>                         |                   |                                      |
| Livelihood C      | 184.60                              | 212.45                                | 80.19             | 0.21                                 |
| <i>% Change</i>   |                                     | <i>(0.15)</i>                         |                   |                                      |
| Livelihood D      | 135.11                              | 204.26                                | 57.22             | 1.06                                 |
| <i>% Change</i>   |                                     | <i>(0.51)</i>                         |                   |                                      |

Note: It is assumed that the benefited households will undertake credit in order to improve their amount of well-being.

Households engaged in agricultural markets (livelihood B) receive the highest percentage increase in well-being, almost 73% (see table 5.18). Also, the group of households engaged in agricultural wage work (livelihood D) will benefit significantly by almost 51% (see table 5.18). Providing a wider access to credit will affect positively well-being for all beneficiary households.

## **6. Conclusions**

### **6.1. Summary**

Households in rural Ecuador face several challenges. One of them is the severe deprivation that reaches alarming percentages in the countryside. Unequal distribution and limited assets constrain households from improving their economic conditions. These factors induce households to overexploit natural resources. Poor households engage in a variety of livelihood strategies. Livelihood strategies are characterized by the allocation of assets (natural, physical, financial, public, social and human), income-earning activities (on farm, off farm), and outcomes (food, income, security). Together these determine the well-being attained by an individual or households.

We used data collected by INIAP as part of the SANREM-CRSP project to identify livelihood strategies, their determinants, and well-being implications of adopting a particular livelihood. These data were from a comprehensive survey of 286 households collected during September and November, 2006.

Livelihood strategies for the Chimbo watershed were identified using qualitative and quantitative methods. The methods provide similar results and identified four main livelihoods: households engaged in diversified activities, agricultural markets, non-farm activities, and agricultural wage work. Most households are engaged in agricultural markets followed by households in diversified activities. Households engaged in agricultural markets own higher amounts of natural and physical resources, while households engaged in non-farm activities have, on average, more human capital.

Households participating in agricultural wage work are mainly from the down-stream watershed and possess less natural, physical and human assets.

Factors influencing the selection of livelihood strategies were examined using a multinomial logit model. Variables such as access to irrigation, amount of farm surface and value of physical assets were statistically significant determinants of livelihood selection. Households with higher endowments of natural and physical assets are more likely to engage in agricultural markets and less likely to participate in non-farm activities. Secondary education tends to decrease participation in the agricultural sector while increasing engagement in non-farm activities. Several geographic variables like watershed location, altitude, and distance to rivers and cities are statistically significant determinants of livelihood strategies.

The well-being associated with each livelihood strategy was estimated using least squares corrected for selection bias. Since participation in each livelihood is endogenously selected it was necessary to correct for selection. We use the Dubin-McFadden (1984) correction, based on the multinomial logit model.

In our models of well-being few variables were statistically significant; this may be due to data limitations. Credit is statistically significant and has a positive effect on well-being. A similar positive effect is shown by education but the variable is not statistically significant. An odd result was found in the coefficient of irrigation access. This coefficient appears to decrease household well-being for those engaged in agricultural markets. This result is hard to explain, as we would expect that irrigation would be positively associated with well-being. The lack of access to water in irrigation systems in the region (noted by many respondents) might explain this negative effect. Most

households that access irrigation do not have enough water, and access to irrigation does not provide the advantages that it might otherwise.

The selection models were used to estimate the amount of well-being that households currently engaged in other livelihoods might receive if they selected a different livelihood. For example, what level of wellbeing would be attained by households currently engaged in agricultural markets if they instead engaged in non-farm activities. Results indicate that most households might achieve higher well-being if they engaged in non-farm activities. However households that want to engage in this sector require special skills or assets that are not easy to obtain; thus there are constraining barriers to diversification in the watershed.

## **6.2. Conclusions**

Several policy changes were simulated to determine their impacts on livelihood choice and household well-being. First a policy change that provides wider education to households in the region was assumed, with more education livelihood strategy selection moves towards the non-farm sector and away from agricultural wage work. These changes generate positive effects on household well-being. The second policy change was creating wider access to irrigation. This change moves livelihood strategies towards agricultural production and away from diversification and non-farm activities, and it had the effect of decreasing household well-being. This was unexpected but it is explained by the negative coefficient of irrigation access in the well-being model. These two policy changes were made to variables that are not statistically significant determinants in the well-being models but were highly significant determinants of livelihood strategies.

The third and final policy was wider access to formal credit. Although credit is not a variable that affects the selection of livelihood strategies, it has an important effect on well-being. This policy change generates the highest increment in average well-being. However even though credit is available, if it is not used for productive purposes, it might represent an unnecessary cost for the households instead of being beneficial.

The policy makers should consider implementing the distribution of micro-loans among households in the watershed. This policy change generated the highest amount of economic benefits for the households. For instance, the total benefit for all households is \$4,600, which does not seem like much if we invest \$100,000. Also, wider access to formal credit will not reduce the harmful impact of agricultural activities on the environment, since credit does not affect the selection of livelihood strategies. Thus credit should be coupled with technical assistance that provides information about soil conservation, low-impact agriculture, or other strategies that improve the agriculture/environment relationship.

Wider access to education might increase the total benefits for all households in a total of \$1,300 approximately. Although the monetary benefit is smaller than credit, increasing access to education might reduce environmental problems. Better access to education will move households from agriculture towards non-farm activities. This might reduce erosion problems and pressure on fragile areas. Also, changing education is a long term policy, rather than small productive loans which is short term. Increasing education for households is more sustainable in time and could provide more benefits than the ones identified by this study.

It is important to reduce the barriers faced in engaging in non-farm activities. Households that want to participate in the non-farm sector require higher amounts of human capital such special skills (carpenter, blacksmith, etc.). In addition, they need big amounts of financial capital as initial investment. However, there are not enough financial sources that provide big amounts of credit in the rural sector.

### **6.3. Weakness and further research**

The multinomial logit model correctly predicts half of the livelihood strategies, which indicates a reasonable model. The model might be improved if we had access to variables that measure social capital in more detail, variables describing the characteristics of each livelihood, like skills needed or effort devoted, which might be used to run a mixed logit combining the conditional and multinomial logit. Better measures of financial assets might also improve our results since access to formal credit did not appear to be significant in livelihood selection. We wonder about the veracity of this result. The role that females have in the participation and selection of livelihood strategies must be captured better, as well as information about migration networks and trust relations.

The well-being measure was consumption expenditures. However the data set exhibited several weaknesses. For example, several consumption categories were excluded during the data collection process, like livestock home consumption. It is critically important that the measure contains as much information on consumption expenditures possible. Also it is necessary to consider more variables that determine well-being such as access to public assets, social characteristics, and human capital like especial skills.

Finally, it is important to improve the estimation of education, irrigation and credit costs in order to define better the benefited population and find better results in the simulation of policy changes. We can also combine several policy changes to achieve the highest well-being benefit for households.

## References

- Aldenderfer, M., and R. Blashfield (1984), *Cluster Analysis; Series: Quantitative Applications in the Social Science*. Beverly Hills: SAGE University Paper.
- Alwang, J., P. Siegel, and S. Jorgensen (2001) "Vulnerability: A View From Different Disciplines," *Social Protection Discussion Paper*, World Bank, 0115.
- Barrera, V., F. Cardenas, L. Escudero, and J. Alwang (2007), "Manejo de Recursos Naturales Basado en Cuencas Hidrográficas en Agricultura de Pequeña Escala: El Caso de la Subcuenca del Río Chimbo," *mimeo*, Guaranda, Ecuador.
- Barrett, C., and T. Reardon (2000), "Asset, Activity, and Income Diversification Among African Agriculturists: Some Practical Issues," *Project Report to USAID BASIS CRSP*.
- Barrett, C., T. Reardon, and P. Webb (2001), "Nonfarm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications," *Food Policy* 26, 315-331.
- Bebbington, A. (1999), "Capitals and Capabilities: A Framework for Analyzing Peasant Viability, Rural Livelihoods and Poverty," *World Development* 27, 12, 2021-2044.
- Bebbington, A. (1997), "Social Capital and Rural Intensification: Local Organizations and Islands of Sustainability in the Rural Andes," *The Geographical Journal Environmental Transformation in Developing Countries* 163, 2, 189-197.
- Bernhardt, K., J. Allen, and G. Helmers (1996), "Using Cluster Analysis to classify farms for conventional/alternative systems research," *Review of Agricultural Economics* 18, 4, 599-611.
- Bhat, Ch., and S. Castelar (2003), "A Unified Mixed Logit Framework From Modeling Revealed and Stated Preferences: Formulation and Application to Congestion Pricing Analysis in the San Francisco Bay Area," *Research Report* 167220-1. Austin: University of Texas.
- Borooah, V. (2001), *Logit and Probit, Ordered and Multinomial models*. Thousand Oaks: Sage University Papers Series on Quantitative Applications in the Social Sciences.

- Bourguignon, F., M. Fournier, and M. Gurgand (2007), "Selection Bias Corrections Based on the Multinomial Logit Model: Monte Carlo Comparisons," *Journal of Economic Surveys* 21, 1.
- Cameron, A., and P. Trivedi (2005), *Microeconometrics: Methods and Applications*. New York: Cambridge University Press.
- Chambers, R. (1995), "Poverty and Livelihoods: Whose Reality Counts?" *Environment and Urbanization* 7, 173.
- Corral, L., and T. Reardon (2001), "Rural Nonfarm Incomes in Nicaragua," *World Development* 29, 3, 427-442.
- Cramer, J. (2003), *Logit Models From Economics and Other Fields*. United Kingdom: Cambridge University Press.
- Cramer, J. (1991), *The Logit Model: An Introduction for Economists*. New York: Edward Arnold a division of Hodder & Stoughton.
- De Janvry, A., and E. Sadoulet (2000), "Rural Poverty in Latin America Determinants and Exit Paths," *Food Policy* 25, 389-409.
- Demaris, A. (1992), *Logit Modeling: Practical Applications*. Newbury Park: Sage University Papers Series on Quantitative Applications in the Social Sciences.
- Dunteman, G. (1989), *Principal Component Analysis*. Quantitative applications in the social science: SAGE University Paper.
- Elbers, C. and P. Lanjouw (2001), "Intersectoral Transfer, Growth, and Inequality in Rural Ecuador," *World Development* 29, 3, 481-496.
- Ellis, F., M. Kutengule, and A. Nyasulu (2003), "Livelihoods and Rural Poverty Reduction in Malawi," *World Development* 31, 19, 1495-1510.
- Espinoza, A., E. Espinoza, J. Bastidas, T. Castanieda, and C. Arriaga (2007), "Small-Scale Dairy Farming in the Highlands of Central Mexico: Technical, Economic and Social Aspects and Their Impact on Poverty," *Experimental Agriculture* 43, 241-256.
- Everitt, B. (1993), *Cluster Analysis*. New York: Edward Arnold A Division of Hodder & Stoughton, Third Edition.

- Gonul, F., and S. Kannan (1993), "Modeling Multiple Sources of Heterogeneity in Multinomial Logit Models: Methodological and Managerial Issues," *Marketing Science* 12, 3, 213-229.
- Hardiman, R., R. Lacey, Y. Mu Yi (1990), "Use of Cluster Analysis for Identification and Classification of Farming Systems in Qingyang County, Central North China," *Agricultural Systems* 33, 115-125.
- Hoffman, S., and G. Duncan (1998), "Multinomial and Conditional Logit Discrete-Choice Models in Demography," *Demography* 25, 3, 415-427.
- Instituto Nacional de Estadísticas y Censos del Ecuador (2001), *VI Censo de Población y V de Vivienda*. Quito, Ecuador: INEC.
- Lanjouw, P. (2001), "Nonfarm Employment and Poverty in Rural El Salvador," *World Development* 29, 3, 529-547.
- Lanjouw, P. (1999), "Rural Nonagricultural Employment and Poverty in Ecuador," *Economic Development and Cultural Change* 48, 1, 91-122.
- Liao, T. (1994), *Interpreting Probability Models: Logit, Probit, and other Generalized Linear Models*. Thousand Oaks: Sage University Papers Series on Quantitative Applications in the Social Sciences.
- Meyer, B., and J. Sullivan (2003), "Measuring the Well-Being of the Poor Using Income and Consumption," *The Journal of Human Resources Special Issue on Income Volatility and Implications for Food Assistance Programs* 38, 1180-1220.
- Ministerio de Agricultura y Ganadería, Servicio de Información y Censo Agropecuario, Instituto Nacional de Estadísticas y Censos (2002), *III Censo Nacional Agropecuario*. Quito, Ecuador: MAG-SICA-INEC.
- Ministerio de Agricultura y Ganadería, Servicio de Información y Censo Agropecuario, Instituto Nacional de Estadísticas y Censos (2007), *Información Nacional de Precios*. Quito, Ecuador: MAG-SICA.
- Ministerio de Salud Pública del Ecuador, Aguilar E. (2005), *Enfermedades Epidemiología*. Quito, Ecuador: MSP.
- Narayan, D., and L. Pritchett (1999), "Cents and Sociability: Household Income and Social Capital in Rural Tanzania," *Economic Development and Cultural Change* 47, 4, 871.

- Park, K., and P. Kerr (1990), "Determinants of academic performance: A multinomial logit approach," *The Journal of Economic Education* 21, 2, 101-111.
- Rakodi, C. (1999), "A Capital Assets Framework for Analyzing Household Livelihood Strategies: Implications for Policy," *Development Policy Review* 17, 315-342.
- Ravallion, M. (2003), "Measuring Aggregate Welfare in Developing Countries: How Well Do National Accounts and Survey Agree?" *The Review of Economics and Statistics* 85, 3, 645-652: MIT Press.
- Reardon, T., J. Berdegue, and G. Escobar (2001), "Rural Nonfarm Employment and Incomes in Latin America: Overview and Policy Implications," *World Development* 29, 3, 395-409.
- Romesburg, C. (1990), *Cluster Analysis for Researchers*. Malabar: Robert E Kieger Publishing Company.
- Rosenberg, A., and C. Turvey (1991), "Identifying Management Profiles of Ontario Swine Producers Through Cluster Analysis," *Review of Agricultural Economics* 13, 2, 201-213.
- Samaniego, J. (2006), *Informe Conferencia Internacional Sobre Reforma Agraria y Desarrollo Rural*. Porto Alegre, Brasil: Ministerio de Agricultura y Ganadería.
- Siegmund, M., and B. Rischfowsky (2001), "Relating Household Characteristics to Urban Sheep Keeping in West Africa," *Agricultural Systems* 67, 139-152.
- Slusher, W., and H. Weeks (2007), "Analysis of the Dairy Market in Upper Guanujo, Ecuador," *mimeo*, Virginia Tech, Virginia.
- Taylor, E., and A. Yunez-Naude (2000), "The Returns From Schooling in a Diversified Rural Economy," *American Journal of Agricultural Economics* 82, 287-297.
- United Nations Development Programme (2000), "Sustainable Livelihoods Concept Paper", *UNDP*.
- United Nations (2006), "The millennium development goals report", New York: DESA UN.
- Ward, H (1963), "Hierarchical Grouping to Optimize and Objective Function," *Journal of the American Statistical Association* 58, 301, 236-244.
- Winters, P., L. Corral, and G. Gordillo (2001), "Rural livelihood strategies and social capital in Latin America: Implications for rural development projects" *University*

- of New England: Graduate School of Agricultural and Resource Economics and School of Economics* 2001, 6.
- Winters, P., B. Davis, L. Corral (2002), "Assets, activities and income generation in rural Mexico: factoring in social and public capital," *Agricultural Economics* 27, 139-156.
- Wooldridge, J. (2006), *Introductory Econometrics a Modern Approach*. Mason: Thompson South Western, Third Edition.
- World Bank (2000), "Agriculture and Achieving the Millennium Development Goals," *The World Bank Agriculture and Rural Development*, Washington D.C.
- World Bank (2001), "World Bank Report 2000/2001 Attacking Poverty: Opportunity, Empowerment and Security," *The World Bank*, Washington D.C.

## **Appendix 1 Sample Methodology and Questionnaire**

Original information is from Barrera, V., F. Cardenas, L. Escudero, and J. Alwang (2007), "Manejo de Recursos Naturales Basado en Cuencas Hidrográficas en Agricultura de Pequeña Escala: El Caso de la Subcuenca del Río Chimbo," *mimeo*, Guaranda, Ecuador.

### **SAMPLE METHODOLOGY AND QUESTIONNAIRE**

#### **1.1. Procedimiento**

Se recolectó información secundaria de censos, mapas, registros y formularios en instituciones tales como: Sistema de Información Geográfica Agropecuaria del Ministerio de Agricultura y Ganadería (SIGAGRO-MAG), Instituto Nacional de Estadísticas y Censos (INEC), Instituto Geográfico Militar (IGM), Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Gobierno Provincial de Bolívar, Universidad Estatal de Bolívar, entre otros.

En el mes de junio del 2006 se realizó un sondeo en la subcuenca del río Chimbo, con él se logró establecer las microcuencas de los ríos Illangama y Alumbre, como sitios de implementación del proyecto, así como también se logró verificar las características de los sistemas de producción prevalentes en las dos microcuencas y levantar información cualitativa y cuantitativa de base, interactuando con los productores de la zona en forma dinámica.

Con los datos del sondeo sumados a la información secundaria, se diseñó un cuestionario de 14 páginas (Anexo 1), el cual fue posteriormente probado en campo. De esta manera se demostró operatividad a través de las siguientes ventajas: a) el cuestionario respondió a la información que se deseaba generar; b) el entrevistado fue capaz de responder la totalidad de preguntas del cuestionario; c) permitió estimar el tiempo promedio de la entrevista, que fue de una hora con cuarenta y cinco minutos, lo cual ayudó a estimar el tiempo a consumir en el campo; d) permitió estimar la eficiencia de la organización del muestreo y estimar el costo real del mismo; y e) permitió obtener estimaciones de varianza sobre variables desconocidas para los investigadores. El cuestionario fue el instrumento de comunicación entre el productor y/o su familia y los cuadros estadísticos que se completaron.

Para el trabajo de campo, se eligió un coordinador, el cual recopiló todas las encuestas que levantaron el personal técnico y egresados, con el fin de realizar una revisión y depuración de la información en las encuestas. El personal que realizó las encuestas, estuvo conformado por técnicos del INIAP, ECOPAR, MAG y egresados de la UEB. La toma de datos tuvo una duración de 30 días laborables, realizando 10 encuestas por día como promedio general, comenzando a partir del lunes 25 de septiembre del 2006 hasta el 30 de noviembre del 2006.

Los cuestionarios con la información recopilada fueron procesados en la Unidad de Transferencia y Capacitación del INIAP, localizada en la ciudad de Guaranda, en donde a las preguntas de los formatos establecidos se les asignó nombres de variables, las cuales contienen las respuestas en forma numérica.

Para su procesamiento, la información recopilada en campo, se transcribió a una base de datos utilizando el programa SPSS para Windows versión 13.0, cuya información se interpretó y analizó. El análisis estadístico utilizado para caracterizar los sistemas de producción de la zona en estudio, se basó principalmente en estadísticas descriptivas de tendencia central como la media y de variación como la desviación estándar, así como frecuencias y/o porcentajes. Finalmente, se procedió a documentar los resultados que se describen en este documento.

## **1.2. Etapas del muestreo**

Se consideró como base el Muestreo Aleatorio Irrestricto, por ser adecuado para este estudio, dado que el universo o población objetivo era heterogéneo, como es el caso del muestreo de tipo agrícola ganadero.

**Definición del objetivo.-** Con el objetivo de realizar la formación de base de datos y el posterior análisis estadístico para la identificación de modelos de hogares y su posterior caracterización, se incluyó el análisis de las relaciones entre las variables estadísticas registradas en la encuesta.

**Definición de la Población Objetivo.-** Para efectos del estudio la población objetivo comprendió todas aquellas Unidades Productivas Agropecuarias (UPAs), de las microcuencas de los ríos Illangama y Alumbre que forman parte de la subcuenca del río Chimbo, localizadas principalmente en la provincia de Bolívar, con extensiones que van desde 1 ha hasta 40 ha. En base a esta información se elaboró el Padrón de Productores, comprendido dentro de la subcuenca, constituyéndose dicho padrón en el marco de unidades primarias de muestreo dentro del diseño previsto para la selección de la muestra.

**Precisión y Confiabilidad del Muestreo.-** El muestreo probabilístico ayudó a prediseñar el muestreo bajo precisión y confiabilidad conocidos. La confiabilidad, que fue el grado de seguridad de que la precisión se cumpla y que se midió en términos de probabilidad, fue del 95%. Se estimó el valor de la población con una precisión específica del 95%, la cual se expresó en términos de margen de error permisible del 10% en la estimación y el coeficiente de confianza, con lo que se aseguró que la estimación se encuentre dentro del margen de error.

**Marco de Muestreo.-** El diseño de la muestra y la definición del Marco Muestral de productores que fueron encuestados fue una de las fases de mayor importancia en la presente metodología. La muestra elegida cumplió los requisitos de una muestra probabilística. La ventaja de esta radicó en que fue posible estimar el error de muestreo, esto es, el grado de precisión de los principales indicadores estadísticos a ser calculados.

La selección de la muestra se hizo en una etapa, en donde una vez elaborados los padrones de las dos microcuencas, se seleccionó en forma aleatoria a los productores agropecuarios y/o sus familias a quienes se aplicó la encuesta estática. Al 20 de septiembre del 2006, los datos proporcionados por la Agencia de Servicios Agropecuarios (ASA-MAG) del cantón Chillanes de la provincia de Bolívar, constituyeron un recurso técnico importante para el diseño de muestras probabilísticas referidas a la microcuenca del río Alumbre, dada su actualidad y cobertura disponible para todas las comunidades de la zona. El marco de muestreo de la microcuenca del río Alumbre lo constituyó un listado depurado de 700 familias agropecuarias. Para el caso de la microcuenca del río Illangama, los datos proporcionados por el INIAP, el Fondo Ecuatoriano Populorum Progressio (FEPP) y las organizaciones campesinas de la zona, constituyeron el recurso técnico más importante para el diseño de la muestra probabilística. El marco de muestreo de la microcuenca del río Illangama lo constituyó un listado depurado de 500 familias agropecuarias.

**Tamaño de la Muestra.-** Al utilizar el Muestreo Aleatorio Irrestricto cada UPA tuvo igual probabilidad de ser tomada en cuenta para conformar la muestra en la que se tomó los datos. Para la determinación del tamaño de la muestra se utilizó la variable continua "Superficie de la UPA en hectáreas", que constituyó el marco de muestreo. La fórmula utilizada para estimar el tamaño de la muestra fue la siguiente:

$$n = \frac{\frac{t^2(\alpha)}{\epsilon^2} \times \frac{S^2}{\tilde{X} N^2}}{1 + \frac{1}{N} \times \frac{t^2(\alpha)}{\epsilon^2} \times \frac{S^2}{\tilde{X} N^2}}$$

Donde:

- t = valor tabular de "t" de Student al 95%
- ε = error permisible al 10% = 0,10
- S<sup>2</sup> = cuadrado medio de la población
- $\tilde{X} N$  = media de la población
- N = número de UPAs por estrato
- n = tamaño de la muestra por estrato

El tamaño de la muestra para las microcuencas de los ríos Illangama y Alumbre, se muestra en el siguiente Cuadro.

**Cuadro 1. Tamaño de muestra estratificado por Microcuencas. Provincia de Bolívar, Ecuador, 2006.**

| Microcuenca Río Alumbre |            |              | Microcuenca Río Illangama |            |              |
|-------------------------|------------|--------------|---------------------------|------------|--------------|
| Comunidades             | UPAs       | Porcentaje   | Comunidades               | UPAs       | Porcentaje   |
| El Ensilado             | 6          | 3.6          | Culebrillas               | 12         | 10.3         |
| Bola de Oro             | 12         | 7.1          | Marcopamba                | 12         | 10.3         |
| San Pedro Guayabal      | 16         | 9.5          | Corazón                   | 25         | 21.4         |
| San José Comuna         | 9          | 5.3          | Pachacutik                | 5          | 4.3          |
| San José de Guayabal    | 12         | 7.1          | Totoras                   | 6          | 5.1          |
| Loma de Pacay           | 7          | 4.1          | Quindigua Central         | 16         | 13.7         |
| Pacay Grande            | 3          | 1.8          | Illangama                 | 8          | 6.8          |
| Loma de Guacalgoto      | 6          | 3.6          | Pucarapamba               | 20         | 17.1         |
| Tablaspamba             | 20         | 11.8         | Carbón                    | 8          | 6.8          |
| San Juan Pamba          | 31         | 18.3         | Chinipamba                | 5          | 4.3          |
| La Vaquería             | 3          | 1.8          | Quilitagua                |            |              |
| Rumipamba               | 4          | 2.4          |                           |            |              |
| Alagoto                 | 4          | 2.4          |                           |            |              |
| Tiguindala              | 4          | 2.4          |                           |            |              |
| Sigsipamba              | 22         | 13.0         |                           |            |              |
| Gualapamba              | 5          | 3.0          |                           |            |              |
| Guayabal Naranjal       | 5          | 3.0          |                           |            |              |
| <b>Total</b>            | <b>169</b> | <b>100.0</b> |                           | <b>117</b> | <b>100.0</b> |

Fuente: Proyecto INIAP-SANREMCRSP-ECOPAR-ECOCIENCIA-SIGAGRO, 2006.

**Selección de productores.-** Como resultado del diseño de la muestra y como punto de partida para el trabajo de campo a realizar, se seleccionaron los productores a entrevistar, los cuales resultaron ser 169 para la microcuenca del río Alumbre y 117 para la microcuenca del río Illangama. La selección del tamaño de muestra se la hizo mediante un procedimiento aleatorio o al azar. En primer lugar se numeraron los productores, luego se incluyó el nombre del productor y el número de hectáreas que poseía cada uno de ellos. El procedimiento de selección al azar fue bastante simple, y se encuentra descrito en Reinoso *et al.* (1993).

### 1.3. Técnicas de obtención de información

Tres técnicas de obtención de datos se utilizaron para cumplir con el establecimiento del estudio de Línea Base: Sondeo, Encuesta Formal, y Diagnóstico Rural Rápido y/o Diagnóstico Participativo.

**Sondeo.**- Se ejecutó en el mes de junio del 2006, en donde se pudo interactuar con todos los actores del proyecto: grupos de productores, tomadores de decisiones políticas, representantes de instituciones que trabajan en la zona, y los técnicos responsables del proyecto. A través de esta técnica se pudo establecer, en una forma muy rápida, las principales características de los sistemas de producción prevalentes en las microcuencas. Esta información sirvió de base para formular el cuestionario con el cual se estableció la Encuesta Formal.

**Encuesta Formal.**- Se ejecutó entre el 25 de septiembre del 2006 y el 30 de noviembre del 2006. Esta se implementó en base a un cuestionario orientado específicamente para los productores y sus familias (Cuadro 1). Este combinó preguntas cerradas y abiertas sobre los sistemas de producción prevalentes en las microcuencas. Los agricultores de las localidades en estudio entrevistados, comentaron sobre aspectos relacionados a las siguientes temáticas: composición familiar, tenencia y uso de la tierra, producción agrícola de la última y forestal, proceso tecnológico de los principales cultivos, insumos y materiales del cultivo, uso de equipos, herramientas o servicios, controles fitosanitarios, establecimiento de pasturas, mantenimiento de pasturas, producción animal, producción de leche y quesos, mano de obra para producción animal, préstamos, medios de producción, comercialización agrícola, forestal y pecuaria, ingresos y egresos familiares, migración, manejo de recursos hídricos, manejo de los bosques y páramos, manejo del recurso suelo, conocimiento tradicional sobre biodiversidad, problemas ambientales, división del trabajo por género, acceso y control de recursos y beneficios por género, necesidades prácticas y estrategias según género, capacitación y difusión, y organizaciones locales.

**Diagnóstico Rural Rápido (DRR) y/o Diagnóstico Participativo.**- Se implementó en cada una de las microcuencas y permitió recopilar información sobre la situación y los problemas de la colectividad y los cambios que se han producido con el tiempo. El DRR en este estudio en particular no experimentó problemas de representatividad, ya que los que participaron en las consultas colectivas y de dinámica de grupo, fueron grupos representativos de los sistemas de producción localizados en las microcuencas. Esta técnica se utilizó para establecer los costos de producción de los principales cultivos establecidos en los sistemas de producción. Para el caso de la microcuenca del río Illangama se establecieron los costos de los cultivos de papa y pastos, y para la microcuenca del río Alumbre se establecieron los costos de los cultivos de maíz y fréjol.

**Proyecto: "Manejo de recursos naturales con base a cuencas hidrográficas para agricultura de pequeña escala: Subcuenca del río Chimbo, Ecuador  
SANREM CRSP: INIAP - CIP - ECOCIENCIA - ECOPAR - SIGAGRO - HCPB - UEB - VIRGINIA TECH**

**I. IDENTIFICACION:**

Nombre del/a responsable del hogar: ..... Etnia: Mestiza ..... Indígena ..... Afrodescendiente ..... Otra .....  
 Dirección: .....  
 Cantón: ..... Parroquia: ..... Comunidad: ..... Coordenadas SIG: .....

**MODULO 1: COMPOSICION FAMILIAR** Quién o quienes respondieron a este módulo. Poner código familiar: /.../ /.../ /.../ /.../ /.../

Anote los datos de las personas que han vivido con Ud. los últimos 12 meses aunque no PASEN todo el tiempo aquí (cada línea del cuadro es un miembro del hogar).

| MIEMBROS DEL HOGAR   | SEXO                  | EDAD   | PARENTESCO  | NIVEL EDUCATIVO   | APROBACION  | ACTIVIDAD  |            |
|--|-----------------------|--|---|---|---|--|------------|
|  |                       |  |   |   |   | Principal  | Secundaria |
| Registre los nombres de todas las personas que forman parte de este hogar. Empiece por el/la responsable del hogar | 1. Hombre<br>2. Mujer | ¿Cuántos años cumplidos tiene?<br><br>Cuando tiene menor de 1 año anote 1. | ¿Cuál es el parentesco con el/la responsable del hogar?<br><br>Responsable<br>Esposo/a<br>Hijo<br>Hija<br>Yerno<br>Nuera<br>Nieto<br>Nieta<br>Padres<br>Suegros<br>Hermano<br>Hermana<br>Sobrino<br>Sobrino<br>Otros: | ¿Cuál es el nivel más alto que llegó de educación?<br><br>1. Ninguno<br>2. Alfabetización<br>3. Pre-primario<br>4. Primario<br>5. Secundario<br>6. Superior<br>7. No aplica | ¿Cuál fue el último año, grado o curso que aprobó?<br><br>(poner el número del grado, curso o año aprobado) | ¿Cuál es la actividad principal que realiza y otra actividad que considere secundaria?<br><br>- No olvide preguntar por recolección, artesanía, servicio doméstico.<br>- Incluye todas las actividades aunque no reciba ingresos monetarios. |            |
| <b>1</b>   | <b>2</b>              | <b>3</b>   | <b>4</b>  | <b>5</b>  | <b>6</b>  | <b>7</b>   | <b>8</b>   |
| 1  |                       |  |   |   |   |  |            |
| 2  |                       |  |   |   |   |  |            |
| 3  |                       |  |   |   |   |  |            |
| 4  |                       |  |   |   |   |  |            |
| 5  |                       |  |   |   |   |  |            |
| 6  |                       |  |   |   |   |  |            |
| 7  |                       |  |   |   |   |  |            |
| 8  |                       |  |   |   |   |  |            |
| 9  |                       |  |   |   |   |  |            |
| 10   |                       |  |   |   |   |  |            |
| 11   |                       |  |   |   |   |  |            |
| 12   |                       |  |   |   |   |  |            |
| 13   |                       |  |   |   |   |  |            |
| 14   |                       |  |   |   |   |  |            |











**Proyecto: "Manejo de recursos naturales con base a cuencas hidrográficas para agricultura de pequeña escala: Subcuenca del río Chimbo, Ecuador  
SANREM CRSP: INIAP - CIP - ECOCIENCIA - ECOPAR - SIGAGRO - HCPB - UEB - VIRGINIA TECH**

**MODULO 12. MANO DE OBRA PRODUCCION ANIMAL**

| MANO DE OBRA CONTRATADA |                  |                 |                |
|-------------------------|------------------|-----------------|----------------|
| Rubro                   | Unidad de medida | Número de meses | Valor unitario |
| 1                       | 2                | 3               | 4              |
| Vaquero                 |                  |                 |                |
| Vaquera                 |                  |                 |                |
| Ordeñador               |                  |                 |                |
| Ordeñadora              |                  |                 |                |
| Peones                  |                  |                 |                |
| Veterinario/a           |                  |                 |                |

| MANO DE OBRA FAMILIAR |                 |        |                  |
|-----------------------|-----------------|--------|------------------|
| Familiar/Sexo         | Labor/actividad | Unidad | Cantidad por año |
| 1                     | 2               | 3      | 4                |
|                       |                 |        |                  |
|                       |                 |        |                  |
|                       |                 |        |                  |
|                       |                 |        |                  |

**MODULO 13. PRESTAMOS**

| Prestamos                         | Deudor                                    | Prestamista  | Monto recibido          | Plazo                             | Monto a pagar más interés                | Destino                     |
|-----------------------------------|---|--|-------------------------|-----------------------------------|--|-----------------------------|
| En qué fecha recibió el préstamo? | ¿Quién recibió el préstamo?               | ¿Quién prestó el dinero?   | ¿Cuánto dinero recibió? | ¿A qué plazo recibió el préstamo? | ¿Cuánto dinero tiene que pagar en total? | ¿Qué uso le dio al crédito? |
| 1                                 | 2   | 3  | 4                       | 5                                 | 6  | 7                           |
|                                   | Poner el familiar que recibió el préstamo | 1. Banco<br>2. Prestamista<br>3. Familiar<br>4. Intermediario<br>5. Otro |                         |                                   |  |                             |
|                                   |   |  |                         |                                   |  |                             |
|                                   |   |  |                         |                                   |  |                             |

**MODULO 14. MEDIOS DE PRODUCCIÓN**

| Equipo                           | Número que posee | Cuántos años de uso tiene | En cuánto lo vendería (\$/equipo) |
|----------------------------------|------------------|---------------------------|-----------------------------------|
| 1                                | 2                | 3                         | 4                                 |
| Tractor                          |                  |                           |                                   |
| Arado                            |                  |                           |                                   |
| Rastra                           |                  |                           |                                   |
| Sembradora                       |                  |                           |                                   |
| Equipo de riego                  |                  |                           |                                   |
| Bomba de fumigar manual          |                  |                           |                                   |
| Bomba de fumigar a motor         |                  |                           |                                   |
| Herramientas manuales de trabajo |                  |                           |                                   |
| Vehículo                         |                  |                           |                                   |
| Motosierra                       |                  |                           |                                   |
| Otro:                            |                  |                           |                                   |

**MODULO 15. COMERCIALIZACION AGRICOLA, FORESTAL Y PECUARIA**

| Producto         | Lugar de venta | A quién vende | Cantidad total en el año | Precio unitario \$ | Costo \$ del flete/unidad |
|------------------|----------------|---------------|--------------------------|--------------------|---------------------------|
| 1                | 2              | 3             | 4                        | 5                  | 6                         |
| <b>Agrícola:</b> |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
| <b>Arboles:</b>  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
| <b>Pecuario:</b> |                |               |                          |                    |                           |
| Leche            |                |               |                          |                    |                           |
| Queso            |                |               |                          |                    |                           |
| Quesillo         |                |               |                          |                    |                           |
| Yogurt           |                |               |                          |                    |                           |
| Mantequilla      |                |               |                          |                    |                           |
| Otros lácteos    |                |               |                          |                    |                           |
|                  |                |               |                          |                    |                           |
| Vacas descarte   |                |               |                          |                    |                           |
| Toro             |                |               |                          |                    |                           |
| Toretas          |                |               |                          |                    |                           |
| Terneros         |                |               |                          |                    |                           |
| Cerdos           |                |               |                          |                    |                           |
| Aves             |                |               |                          |                    |                           |
| Ovejas           |                |               |                          |                    |                           |
| Cabras           |                |               |                          |                    |                           |
| Cuyes            |                |               |                          |                    |                           |
| Caballos         |                |               |                          |                    |                           |
| Mulas            |                |               |                          |                    |                           |
| Asnos            |                |               |                          |                    |                           |
| Otros:           |                |               |                          |                    |                           |

15.1. ¿Tiene problemas con la comercialización de los productos?  
 1. SI /...../ Cuáles? : .....  
 .....  
 .....  
 2. NO /...../

**MODULO 16. INGRESOS Y EGRESOS FAMILIARES, Y MIGRACION**

Cuáles han sido los ingresos totales de su hogar en el año pasado? No olvide: es el ingreso total, sumado todos los miembros del hogar.

| INGRESOS DEL HOGAR                         |   |   |
|--|---|---|
| RUBROS                                     | Cuánto fue su ingreso en el mes pasado? | Cuánto fue su ingreso en el año pasado? |
| 1  | 2                                       | 3                                       |
| Venta de cultivos                          |   |   |
| Venta de especies forestales               |   |   |
| Venta de leña                              |   |   |
| Venta de animales mayores                  |   |   |
| Venta de animales menores                  |   |   |
| Venta de huevos                            |   |   |
| Venta de especies piscícolas               |   |   |
| Venta de lana                              |   |   |
| Venta de abonos orgánicos                  |   |   |
| Venta de artesanía                         |   |   |
| Venta de plantas medicinales               |   |   |
| Comercio por tienda de abarrotes           |   |   |
| Comercio por venta de comidas              |   |   |
| Comercio por venta productos agropecuarios |   |   |
| Comercio por bazar                         |   |   |
| Comercio por botiquines                    |   |   |
| Comercio por panadería                     |   |   |
| Comercio por viveros de plantas            |   |   |
| Jornales agrícolas en el sitio             |   |   |
| Jornales agrícolas en otros sitios         |   |   |
| Jornales de construcción en el sitio       |   |   |
| Jornales de construcción en otros sitios   |   |   |
| Salario empleo fijo                        |   |   |
| Salario a contrato                         |   |   |

| GASTOS DEL HOGAR                               |                             |                             |
|--|-----------------------------|-----------------------------|
| RUBROS   | Cuánto gastó el mes pasado? | Cuánto gastó el año pasado? |
| 1  | 2                           | 3                           |
| Ayudas o pensiones que da a familiares, amigos |                             |                             |
| Pago de préstamos (capital +intereses)         |                             |                             |
| Alimentación de la familia                     |                             |                             |
| Arriendo/vivienda                              |                             |                             |
| Educación                                      |                             |                             |
| Salud  |                             |                             |
| Agua   |                             |                             |
| Gas  |                             |                             |
| Electricidad                                   |                             |                             |
| Vestimenta                                     |                             |                             |
| Diversión, fiestas, priostazgos                |                             |                             |
| Transporte                                     |                             |                             |
| Leña   |                             |                             |
| Otros:   |                             |                             |
|  |                             |                             |
|  |                             |                             |

16.1. Migra Usted o algún miembro de la familia? 1. Sí ..... 2. No .....

16.2. A dónde migra usualmente? .....

16.3. En qué meses de año migra?.....

16.4. Por cuánto tiempo migra?.....

| <b>MODULO 17: MANEJO DE RECURSOS HIDRICOS</b>   |  |   |  |   |  |  |
|---|--|---|--|---|--|--|
| <p>1. De dónde obtiene la familia agua para consumo doméstico?</p> <p>1. Red pública .....<br/> 2. Agua lluvia .....<br/> 3. Pozo .....<br/> 4. Vertiente .....<br/> 5. Llave pública .....<br/> 6. Entubada .....<br/> 7. Otro:.....</p> | <p>2. El agua que recibe, llega tratada?</p> <p>1. Si ..... 2. No .....</p>  | <p>3. ¿Se han presentado enfermedades por el consumo directo del agua?</p> <p>1. Si ..... 2. No .....</p> <p>Cuáles son?.....</p>   | <p>4. Llega el agua hasta su domicilio?</p> <p>1. Si ..... 2. No .....</p> <p>¿Cree Usted que es de buena calidad</p> <p>1. Si ..... 2. No .....</p> | <p>5. Conoce Usted dónde se realiza la captación del agua?</p> <p>1. Si ..... 2. No .....</p> <p>En dónde? .....</p>                            | <p>6. De dónde obtiene agua para bebedero de animales?</p> <p>1. Acequia .....<br/> 2. Vertiente .....<br/> 3. Ciénega .....<br/> 4. Río .....<br/> 5. Pozo .....<br/> 6. Canal .....<br/> 7. Otro:.....</p> | <p>7. Tiene agua de riego?</p> <p>1. Si ..... 2 No .....</p> <p>1. Acequia .....<br/> 2. Vertiente .....<br/> 3. Ciénega .....<br/> 4. Río .....<br/> 5. Pozo .....<br/> 6. Canal .....<br/> 7. Otro:.....</p> |
| <p>8. Conoce el nombre de la o las acequias que le abastecen de agua de riego?</p> <p>1. Si ..... 2. No .....</p> <p>Cuál es el nombre?</p>   | <p>9. Usted sabe dónde está la bocatoma y el origen de la acequia?</p> <p>1. Si ..... 2. No .....</p> <p>Dónde?</p>  | <p>10. De acuerdo a las necesidades de sus cultivos. Usted siente que el agua es:</p> <p>1. Suficiente .....<br/> 2. Insuficiente .....</p>   | <p>11. Por qué es suficiente o insuficiente?</p>   | <p>12. En los últimos tres meses, algún miembro de la familia ha asistido a la reunión de la Junta de Aguas?</p> <p>1. Si ..... 2. No .....</p> | <p>13. En los últimos tres meses algún miembro de la familia participó del mantenimiento de acequias?</p> <p>1. Si ..... 2. No .....</p>   | <p>14. Cree usted que las condiciones del sistema de riego son:</p> <p>1. Buenas .....<br/> 2. Regulares .....<br/> 3. Malas .....</p> <p>Por qué?.....</p>  |
| <p>15. Tiene reservorio en su propiedad?</p> <p>1. Si ..... 2. No .....</p>   | <p>16. Cómo realiza Usted el riego?</p> <p>0. No riega .....<br/> 1. Inundación .....<br/> 2. Aspersión .....<br/> 3. Gravedad .....<br/> 4. Otro: .....</p> | <p>17. A quién cree Usted que corresponde generar acciones para mejorar las condiciones de las acequias?</p> <p>1. Comunidad .....<br/> 2. Municipio .....<br/> 3. CNRH .....<br/> 4. Consejo Provincial .....<br/> 5. Otro:.....</p> | <p>18. Está de acuerdo en aportar con dinero para mejorar la infraestructura de riego?</p> <p>1. Si ..... 2. No .....</p>                            | <p>19. Cada qué tiempo realiza mantenimiento de las acequias?</p> <p>A qué se debe tal suceso?</p>  | <p>20. De acuerdo a su percepción, cómo ha variado la cantidad de agua en ríos y acequias?</p>   | <p>21. ¿Cómo piensa cuidar las vertientes de agua en el futuro?</p>  |

| <b>MODULO 18. MANEJO DE LOS RECURSOS: BOSQUES Y PÁRAMOS. ABASTECIMIENTO Y CONSUMO DE LEÑA.</b>   |  |   |  |  |   |  |
|--|--|---|--|--|---|--|
| <p>1. De acuerdo a su percepción, cómo ha variado la extensión de páramos, cerros y bosques en su entorno:</p> <p>Por qué?.....</p>  | <p>2. ¿Cómo utiliza el páramo o el bosque en su comunidad?</p>   | <p>3. ¿Sabía Usted que la permanencia del páramo y bosque en las fuentes de agua garantiza la existencia de buenos caudales de agua?</p> <p>1. Si ..... 2. No .....</p> | <p>4. ¿Conoce en su entorno zonas de páramo o bosque bien conservada?</p> <p>1. Si ..... 2. No .....</p> <p>Cuáles?.....</p> | <p>5. Que plantas o animales encuentra en el páramo o bosque en buen estado?</p> | <p>6. Qué tipo de combustible utiliza para cocinar?</p> <p>1. Gas .....<br/> 2. Leña .....<br/> 3. Carbón .....<br/> 4. Otro: .....</p>   | <p>7. De dónde obtiene la leña?</p> <p>1. Plantación forestal .....<br/> 2. Bosque natural .....<br/> 3. Compra .....<br/> 4. Otro:.....</p> |
| <p>8. Qué tipo de leña prefiere utilizar la familia?</p> <p>1. Eucalipto .....<br/> 2. Aliso .....<br/> 3. Chilca .....<br/> 4. Pino .....<br/> 5. Ciprés .....<br/> 6. Otro:.....</p> | <p>9. Por qué prefiere este tipo de leña?</p> <p>1. Mejor combustión .....<br/> 2. Fácil de conseguir .....<br/> 3. No tiene costo .....<br/> 4. Otro: .....</p> | <p>10. Cuánto de leña utiliza por semana?</p>   | <p>11. Cuáles personas de la familia son los responsables de conseguir la leña?</p>  | <p>12. Qué tiempo y con qué frecuencia se demora en conseguir la leña?</p>       | <p>13. Si comparamos hace cinco años atrás, la cantidad de chaparos y montes en la actualidad han:</p> <p>1. Aumentado .....<br/> 2. Disminuido .....<br/> 3. Sigue igual .....</p> | <p>14. Por qué ha aumentado, disminuido, o sigue igual. Explique su respuesta?</p>   |

**MODULO 19. MANEJO DEL RECURSO SUELO**

|  |   |   |  |  |  |  |
|--|---|---|--|--|--|--|
| 1. De acuerdo a su criterio, cómo califica la calidad de los suelos de su finca?.....<br>Por qué?<br>..... | 2. ¿Qué tipo de suelos predominan en su finca<br>Arcillosos .....<br>Arenosos .....<br>Limosos .....<br>Otros:..... | 3. ¿De acuerdo a su criterio cuál es la topografía que predomina en su finca?<br>1. Plana .....<br>2. Ondulada .....<br>3. Quebrada ..... | 4. ¿Qué malezas crecen en forma espontánea en el suelo de su finca?<br>.....   | 5. ¿Qué tipos de prácticas realiza para conservar el suelo?<br>..... | 6. ¿De acuerdo a su percepción, sus suelos están erosionados?<br>1. Si ..... 2. No ..... | 7. ¿Cuáles serían las causas de esa erosión?<br>.....<br>.....<br>.....<br>..... |
| 8. ¿Qué tipo de fertilizantes utiliza mayormente en sus suelos?<br>.....<br>.....<br>.....<br>.....        | 9. ¿Tienen importancia para Usted los suelos de su finca?<br>1. Si ..... 2. No .....<br>Por qué?<br>.....<br>.....  | 10. ¿Cree que las actividades que realiza en su finca afectan a sus suelos?<br>1. Si ..... 2. No .....<br>Por qué?<br>.....<br>.....      | 11. ¿El disponer de suelos de buena calidad le dan bienestar económico?<br>1. Si ..... 2. No .....<br>Por qué?<br>.....<br>..... |  |  |  |

**MÓDULO 20. CONOCIMIENTO TRADICIONAL SOBRE BIODIVERSIDAD**

|   |   |   |   |   |  |  |
|---|---|---|---|---|--|--|
| 1. ¿Qué plantas medicinales usa en hogar?<br>.....<br>.....<br>.....<br>..... | 2. ¿Para qué las utiliza?<br>.....<br>.....<br>.....<br>..... | 3. ¿Quién las utiliza?<br>.....<br>.....<br>.....<br>.....                        | 4. ¿Qué árboles maderables nativos de la finca utiliza?<br>.....<br>.....<br>.....<br>..... | 5. ¿Cómo las utiliza?<br>.....<br>.....<br>.....<br>.....   | 6. ¿Quién las utiliza?<br>.....<br>.....<br>.....<br>.....               | 7. ¿Qué árboles maderables introducidos utiliza de la finca?<br>.....<br>.....<br>.....<br>..... |
| 8. ¿Cómo las utiliza?<br>.....<br>.....<br>.....<br>.....                     | 9. ¿Quién las utiliza?<br>.....<br>.....<br>.....<br>.....    | 10. ¿Qué plantas nativas consume en el hogar?<br>.....<br>.....<br>.....<br>..... | 11. ¿Para qué las utiliza?<br>.....<br>.....<br>.....<br>.....                              | 12. ¿Quién las utiliza?<br>.....<br>.....<br>.....<br>..... | 13. ¿Practica la caza de animales o la pesca?<br>1. Si ..... 2. No ..... | 14. ¿Qué animales caza y/o pesca y utiliza?<br>.....<br>.....<br>.....<br>.....                  |
| 15. ¿Cómo las utiliza?<br>.....<br>.....<br>.....<br>.....                    | ¿Quién las utiliza?<br>.....<br>.....<br>.....<br>.....       |   |   |   |  |  |

**MODULO 21. MODULO DE PROBLEMAS AMBIENTALES**

| Problemas ambientales                                    | Importancia* | Deterioro ** | Por qué considera un problema | Cómo puede evitarlo |
|--|--------------|--------------|-------------------------------|---------------------|
| 1  | 2            | 3            | 4                             | 5                   |
| Degradación de la tierra agrícola/ desertificación       |              |              |                               |                     |
| Deforestación  |              |              |                               |                     |
| Pérdida de la biodiversidad                              |              |              |                               |                     |
| Contaminación del aire                                   |              |              |                               |                     |
| Agravación del estrés hídrico                            |              |              |                               |                     |
| Contaminación de ríos y vertientes                       |              |              |                               |                     |
| Vulnerabilidad ante eventos naturales extremos (sequías) |              |              |                               |                     |
| Pérdida de identidad cultural                            |              |              |                               |                     |
| Pobreza de acuerdo a etnia                               |              |              |                               |                     |
|  |              |              |                               |                     |
|  |              |              |                               |                     |
|  |              |              |                               |                     |
|  |              |              |                               |                     |
|  |              |              |                               |                     |
|  |              |              |                               |                     |
|  |              |              |                               |                     |
|  |              |              |                               |                     |
|  |              |              |                               |                     |

\* 1=más importante 9=menos importante \*\* xxxx=Avance muy rápido, xxx=Avance rápido, xx=Avance moderado, x= Detención/reversión

21.1. ¿Usted cree que las actividades que realiza en su finca afectan al ambiente natural?

.....

.....

.....

.....

.....

21.2. ¿Cree Usted que ha manejado adecuadamente sus recursos naturales? 1. Si ..... 2. No .....

Si la respuesta es Sí, estos le han dado o no beneficios económicos, Explique por qué?

.....

.....

.....

.....

.....

**MODULO 22. DIVISION DEL TRABAJO POR GENERO: ¿QUIEN HACE QUE?**

- Para todos los miembros de la familia
- No olvide insistir en el caso del trabajo de las mujeres a veces aparece oculto detrás del trabajo de la casa
- Si es necesario explique el contenido de la pregunta al entrevistado

| Actividades                                  | Código familiar |   |   |   |   |   |   |   |
|--|-----------------|---|---|---|---|---|---|---|
|  | 1               | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| <b>Producción agrícola:</b>                  |                 |   |   |   |   |   |   |   |
| Quién compra las semillas                    |                 |   |   |   |   |   |   |   |
| Quién compra los fertilizantes               |                 |   |   |   |   |   |   |   |
| Quién compra los pesticidas                  |                 |   |   |   |   |   |   |   |
| Quién mezcla los productos químicos          |                 |   |   |   |   |   |   |   |
| Quién Preparación de alimentos para jornales |                 |   |   |   |   |   |   |   |
| Quién Venta de productos en el mercado       |                 |   |   |   |   |   |   |   |
| Quién Compra de Herramientas                 |                 |   |   |   |   |   |   |   |
| Preparación del suelos                       |                 |   |   |   |   |   |   |   |
| Tumba de árboles                             |                 |   |   |   |   |   |   |   |
| Rozada                                       |                 |   |   |   |   |   |   |   |
| Palizada                                     |                 |   |   |   |   |   |   |   |
| Huequeada                                    |                 |   |   |   |   |   |   |   |
| Establecimiento de sombra                    |                 |   |   |   |   |   |   |   |
| Establecimientos de árboles forestales       |                 |   |   |   |   |   |   |   |
| Quién cuida a los árboles forestales         |                 |   |   |   |   |   |   |   |
| Establecimiento de cultivos perennes:        |                 |   |   |   |   |   |   |   |
| Transporte plantas                           |                 |   |   |   |   |   |   |   |
| Plantar                                      |                 |   |   |   |   |   |   |   |
| Resembrar                                    |                 |   |   |   |   |   |   |   |
| Establecimiento de cultivos ciclo corto      |                 |   |   |   |   |   |   |   |
| Siembra                                      |                 |   |   |   |   |   |   |   |
| Resiembra                                    |                 |   |   |   |   |   |   |   |
| Deshierbas                                   |                 |   |   |   |   |   |   |   |
| Aporques                                     |                 |   |   |   |   |   |   |   |
| Poda de árboles de sombra                    |                 |   |   |   |   |   |   |   |
| Poda de formación                            |                 |   |   |   |   |   |   |   |

| Actividades                              | Código familiar |   |   |   |   |   |   |   |
|--|-----------------|---|---|---|---|---|---|---|
|  | 1               | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Quién cuida al ternero                   |                 |   |   |   |   |   |   |   |
| Quién realiza la atención sanitaria      |                 |   |   |   |   |   |   |   |
| Quién compra el ganado                   |                 |   |   |   |   |   |   |   |
| Quién vende la leche/ quesos             |                 |   |   |   |   |   |   |   |
| Quién vende las gallinas, cuyes, conejos |                 |   |   |   |   |   |   |   |
| Quién vende los huevos                   |                 |   |   |   |   |   |   |   |
| <b>Trabajo reproductivo doméstico:</b>   |                 |   |   |   |   |   |   |   |
| Preparación de alimentos                 |                 |   |   |   |   |   |   |   |
| Arreglo y limpieza de la casa            |                 |   |   |   |   |   |   |   |
| Cuidado de niños                         |                 |   |   |   |   |   |   |   |
| Ayuda de tareas escolares                |                 |   |   |   |   |   |   |   |
| Quién hace las compras                   |                 |   |   |   |   |   |   |   |
| Acarreo de agua                          |                 |   |   |   |   |   |   |   |
| Lavado de ropa                           |                 |   |   |   |   |   |   |   |
| Construcción o reparación de vivienda    |                 |   |   |   |   |   |   |   |
| Representación en la escuela y colegio   |                 |   |   |   |   |   |   |   |
| Trámites en la ciudad                    |                 |   |   |   |   |   |   |   |
| Confección arreglo de ropa               |                 |   |   |   |   |   |   |   |
| Cuidado de enfermos/as                   |                 |   |   |   |   |   |   |   |
| Cuidado de semillas especies nativas     |                 |   |   |   |   |   |   |   |
| <b>Trabajo comunitario/organizativo:</b> |                 |   |   |   |   |   |   |   |
| Cargos comunales                         |                 |   |   |   |   |   |   |   |
| Comisiones mejoras comunidad             |                 |   |   |   |   |   |   |   |
| Junta de agua                            |                 |   |   |   |   |   |   |   |
| Reuniones mingas                         |                 |   |   |   |   |   |   |   |
| Mingas                                   |                 |   |   |   |   |   |   |   |

1. Mujer adulta (>18 años y < 65 años) 2. Mujer joven (12-18 años) 3. Niña (<12 años) 4. Mujer anciana (>65 años) 5. Hombre adulto (>18 años y <65 años) 6. Hombre joven (12-18 años) 7. Niño (<12 años) 8. Hombre anciano (>65 años).

**MODULO 23. ACCESO Y CONTROL DE RECURSOS Y BENEFICIOS POR GENERO:  
¿QUIEN DECIDE?**

- Para todos los miembros de la familia
- No olvide en insistir en el caso del trabajo de las mujeres a veces aparece oculto detrás del trabajo de la casa
- Si es necesario explique el contenido de la pregunta al entrevistado

**MODULO 24. NECESIDADES PRÁCTICAS Y ESTRATEGIAS SEGÚN GENERO:  
¿QUIEN SIENTE?**

| Actividades   | Código familiar |   |   |   |   |   |   |   |
|---|-----------------|---|---|---|---|---|---|---|
|   | 1               | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| <b>Toma de decisiones internas:</b>                         |                 |   |   |   |   |   |   |   |
| Quién toma las decisiones sobre las actividades productivas |                 |   |   |   |   |   |   |   |
| Quién define el destino de los ingresos                     |                 |   |   |   |   |   |   |   |
| Quién consigue las semillas                                 |                 |   |   |   |   |   |   |   |
| Quién decide que variedad sembrar                           |                 |   |   |   |   |   |   |   |
| Quién decide cuanto sembrar                                 |                 |   |   |   |   |   |   |   |
| Quién dispone del dinero de venta de vacunos                |                 |   |   |   |   |   |   |   |
| Quién dispone de dinero venta otros animales                |                 |   |   |   |   |   |   |   |
| Quién contrata a los jornales                               |                 |   |   |   |   |   |   |   |
| La educación de los hijos                                   |                 |   |   |   |   |   |   |   |
| Cuando y que se vende                                       |                 |   |   |   |   |   |   |   |
| Participación en cursos y talleres                          |                 |   |   |   |   |   |   |   |
| Trabajos fuera de la comunidad                              |                 |   |   |   |   |   |   |   |
| Buscar ayuda médica naturista                               |                 |   |   |   |   |   |   |   |
| Decisión sobre el ahorro                                    |                 |   |   |   |   |   |   |   |
| Responsable de manejo del crédito                           |                 |   |   |   |   |   |   |   |
| Pesticidas a comprar  |                 |   |   |   |   |   |   |   |
| <b>Toma de decisiones externas:</b>                         |                 |   |   |   |   |   |   |   |
| Elección de autoridades barrio                              |                 |   |   |   |   |   |   |   |
| Elección de dignidades padres de familia                    |                 |   |   |   |   |   |   |   |
| Relación con institucional                                  |                 |   |   |   |   |   |   |   |
| Adquirir crédito  |                 |   |   |   |   |   |   |   |
| Administrar dinero en casa                                  |                 |   |   |   |   |   |   |   |
| Realizar obras comunales                                    |                 |   |   |   |   |   |   |   |

| Actividades  | Código familiar |   |   |   |   |   |   |   |
|--|-----------------|---|---|---|---|---|---|---|
|  | 1               | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| <b>Necesidades prácticas:</b>                          |                 |   |   |   |   |   |   |   |
| Alimentación   |                 |   |   |   |   |   |   |   |
| Salud  |                 |   |   |   |   |   |   |   |
| Higiene  |                 |   |   |   |   |   |   |   |
| Agua   |                 |   |   |   |   |   |   |   |
| Luz  |                 |   |   |   |   |   |   |   |
| Educación  |                 |   |   |   |   |   |   |   |
| Vestuario  |                 |   |   |   |   |   |   |   |
| Gas/leña   |                 |   |   |   |   |   |   |   |
| Otras  |                 |   |   |   |   |   |   |   |
| <b>Necesidades o intereses estratégicas:</b>           |                 |   |   |   |   |   |   |   |
| Infraestructura procesamiento de materia prima         |                 |   |   |   |   |   |   |   |
| Capacitación en producción y procesamiento de cultivos |                 |   |   |   |   |   |   |   |
| Organización gremial con enfoque de género             |                 |   |   |   |   |   |   |   |
| Distribución de responsabilidades                      |                 |   |   |   |   |   |   |   |
| <b>Gestión política local y estatal</b>                |                 |   |   |   |   |   |   |   |
| Desarrollo sostenible de la comunidad                  |                 |   |   |   |   |   |   |   |
| Participación comunitaria eficiente                    |                 |   |   |   |   |   |   |   |
| Implementación de un Colegio Agropecuario              |                 |   |   |   |   |   |   |   |
| Tener Universidad a distancia                          |                 |   |   |   |   |   |   |   |
| Vías de comunicación                                   |                 |   |   |   |   |   |   |   |
| Otras  |                 |   |   |   |   |   |   |   |
|  |                 |   |   |   |   |   |   |   |
|  |                 |   |   |   |   |   |   |   |

1. Mujer adulta (>18 años y < 65 años) 2. Mujer joven (12-18 años) 3. Niña (<12 años) 4. Mujer anciana (>65 años) 5. Hombre adulto (>18 años y <65 años) 6. Hombre joven (12-18 años) 7. Niño (<12 años) 8. Hombre anciano (>65 años).

**MODULO 25. CAPACITACION Y DIFUSION**

Para cada miembro del hogar. Anote los eventos de capacitación y difusión en los que haya participado el año anterior

| Parentesco | Cuál fue el tema del evento? | Quién dio el evento? | Cuánto tiempo duró el evento? | Cuándo se realizó el evento | Le fue útil?<br>1. Si 2. No | Por qué? |
|------------|------------------------------|----------------------|-------------------------------|-----------------------------|-----------------------------|----------|
| 1          | 2                            | 3                    | 4                             | 5                           | 6                           | 7        |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |
|            |                              |                      |                               |                             |                             |          |

**MODULO 26. ORGANIZACIONES LOCALES**

|  |   |   |   |  |  |  |
|--|---|---|---|--|--|--|
| <p>1. Existen organizaciones en su comunidad?</p> <p>1. Si ..... 2. No .....</p> <p>¿Cuáles conoce?</p> <p>.....</p> <p>.....</p> <p>.....</p>   | <p>2. De qué tipo son?</p> <p>1. Cabildo .....<br/>2. Juntas de agua .....<br/>3. Asociaciones .....<br/>4. Cooperativas .....<br/>5. Grupo de mujeres .....<br/>6. Grupo de jóvenes .....<br/>7. Comités .....<br/>8. Clubes .....<br/>9. Otros: Cuáles?</p> | <p>3. Usted es integrante de alguna organización?</p> <p>1. Si ..... 2. No .....</p> <p>A cuántas pertenece?</p> <p>.....</p> <p>En cual participa más?</p> <p>.....</p> <p>.....</p>   | <p>4. Usted es fundador de ésta organización?</p> <p>1. Si ..... 2. No .....</p> <p>En que año se formó?</p> <p>.....</p> <p>.....</p> <p>.....</p> | <p>5. Tiene personería jurídica?</p> <p>1. Si ..... 2. No .....</p> <p>Cuántos socios son en total?</p> <p>.....</p> <p>Cuántos hombres?</p> <p>.....</p> <p>Cuántas mujeres?</p> <p>.....</p> | <p>6. Cada qué tiempo son las reuniones ordinarias?</p> <p>1. Quincenal .....<br/>2. Mensual .....<br/>3. Bimensual .....<br/>4. Trimestral .....<br/>5. Semestral .....<br/>6. Anual .....<br/>7. Otro: .....</p> | <p>7. Recuerda para qué se formó o los objetivos?</p> <p>1. Si ..... 2. No .....</p> <p>Cuales son las actividades principales que realiza?</p> <p>.....</p> <p>.....</p> <p>.....</p>   |
| <p>8. Con qué recursos cuenta su organización?</p> <p>1. Local propio .....<br/>2. Local arrendado .....<br/>3. Local cedido .....<br/>4. Muebles de oficina .....<br/>5. Equipos de oficina .....<br/>6. Empleados .....<br/>7. Equipos de trabajo .....<br/>8. Terrenos .....<br/>9. Otros, cuales?</p> <p>.....</p> <p>.....</p> <p>.....</p> | <p>9. Usted recibe algún servicio de su organización?</p> <p>1. Si ..... 2. No .....</p> <p>Que tipo de servicios?</p> <p>.....</p> <p>.....</p> <p>.....</p>   | <p>10. Alguna vez ha formado parte de la directiva?</p> <p>1. Si ..... 2. No .....</p> <p>Cuántas veces?.....</p> <p>Qué cargos ha ocupado?</p> <p>1. Presidente .....<br/>2. Vicepresidente .....<br/>3. Secretario .....<br/>4. Tesorero .....<br/>5. Comisiones .....<br/>6. Vocal .....</p> | <p>11. Cuáles son los principales problemas que tiene su organización?</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>         | <p>12. Cómo piensa que se pueden solucionar estos problemas?</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>  | <p>13. Su organización ha recibido apoyo o guarda relaciones con otras instituciones?</p> <p>1. Si..... 2. No .....</p> <p>Con cuáles instituciones?</p> <p>.....</p> <p>.....</p> <p>.....</p>                    | <p>14. Qué tipo de apoyo ha recibido?</p> <p>1. Capacitación .....<br/>2. Préstamos .....<br/>3. Infraestructura .....<br/>4. Semillas .....<br/>5. Pies de cría .....<br/>6. Equipos .....<br/>7. Otros: Cuáles? .....</p> <p>.....</p> <p>.....</p> <p>.....</p> |

## Appendix 2 Livelihood Strategies Summary Statistics

**Table A 2.1.** Natural assets by livelihood strategy.

| <i>Variables</i>              | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> | <i>ANOVA<br/>Sig.</i> |
|-------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-----------------------|
| Watershed Alumbre %           | 0.46                    | 0.37                    | 0.98                    | 0.85                    | 0.00***               |
| Altitude (meters)             | 2891.35                 | 3033.58                 | 2396.74                 | 2514.62                 | 0.00***               |
| Land size (ha)                | 3.82                    | 6.79                    | 3.59                    | 3.64                    | 0.00***               |
| Cropped area %                | 0.57                    | 0.52                    | 0.49                    | 0.57                    | Nt                    |
| Cropped surface (ha)          | 2.19                    | 3.58                    | 1.75                    | 2.09                    | 0.01**                |
| Legumes surface %             | 0.21                    | 0.15                    | 0.17                    | 0.16                    | Nt                    |
| Grains surface %              | 0.30                    | 0.18                    | 0.67                    | 0.75                    | Nt                    |
| Grains and legumes surface %  | 0.28                    | 0.38                    | 0.12                    | 0.02                    | Nt                    |
| Tubers or roots surface %     | 0.17                    | 0.26                    | 0.02                    | 0.04                    | Nt                    |
| Andean fruits surface %       | 0.03                    | 0.02                    | 0.02                    | 0.01                    | Nt                    |
| Other crops surface %         | 0.01                    | 0.01                    | 0.00                    | 0.01                    | Nt                    |
| Pasture surface %             | 0.40                    | 0.46                    | 0.51                    | 0.43                    | Nt                    |
| Pasture surface (ha)          | 2.11                    | 3.81                    | 4.20                    | 3.65                    | 0.31                  |
| Own surface with title %      | 0.84                    | 0.87                    | 0.77                    | 0.77                    | Nt                    |
| Own surface (ha)              | 4.11                    | 6.83                    | 3.62                    | 4.22                    | 0.04                  |
| Productive soils %            | 0.62                    | 0.49                    | 0.36                    | 0.42                    | 0.02**                |
| Irrigation access %           | 0.23                    | 0.33                    | 0.06                    | 0.09                    | 0.00***               |
| Water reservoirs access %     | 0.03                    | 0.00                    | 0.02                    | 0.02                    | 0.48                  |
| Soil conservation practices % | 0.28                    | 0.29                    | 0.34                    | 0.30                    | 0.90                  |
| Pesticide use %               | 0.44                    | 0.53                    | 0.28                    | 0.32                    | 0.01**                |
| Fertilizer use %              | 0.79                    | 0.90                    | 0.62                    | 0.58                    | 0.00***               |

\*\*\* Significance level at less than 1%

\*\* Significance level at less than 5%

\* Significance level at less than 10%

Nt. No test could be performed

Source: SANREM-CRSP survey

**Table A 2.2.** Physical assets by livelihood strategy.

| <i>Variables</i>           | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> | <i>ANOVA<br/>Sig.</i> |
|----------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-----------------------|
| Own physical assets %      | 0.95                    | 0.95                    | 0.84                    | 0.94                    | 0.02**                |
| Value physical assets \$   | 2007.80                 | 2348.13                 | 856.24                  | 495.67                  | 0.00***               |
| Own small livestock %      | 0.92                    | 0.91                    | 0.76                    | 0.81                    | 0.01**                |
| Value small livestock \$   | 675.10                  | 688.58                  | 235.40                  | 254.64                  | 0.00***               |
| Own cattle %               | 0.79                    | 0.90                    | 0.58                    | 0.49                    | 0.00***               |
| Value cattle \$            | 1459.71                 | 1959.46                 | 738.26                  | 620.25                  | 0.00***               |
| Number of cattle           | 5.79                    | 7.67                    | 4.03                    | 3.19                    | 0.00***               |
| Diferent livestock         | 3.96                    | 3.49                    | 2.29                    | 2.23                    | 0.00***               |
| Own productive assets %    | 0.85                    | 0.86                    | 0.64                    | 0.74                    | 0.01**                |
| Value productive assets \$ | 266.20                  | 57.53                   | 256.16                  | 39.15                   | 0.33                  |

Source: SANREM-CRSP survey

**Table A 2.3.** Financial and Public assets by livelihood strategy.

| <i>Variables</i>                    | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> | <i>ANOVA</i> |
|-------------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|--------------|
| Credit access %                     | 0.08                    | 0.03                    | 0.12                    | 0.00                    | 0.02**       |
| Amount borrowed \$                  | 1250.00                 | 1466.67                 | 683.33                  | .                       | 0.56         |
| Access public water red %           | 0.19                    | 0.11                    | 0.40                    | 0.23                    | 0.00***      |
| Access pipe water %                 | 0.40                    | 0.43                    | 0.40                    | 0.32                    | 0.63         |
| Use natural water sources %         | 0.41                    | 0.46                    | 0.20                    | 0.45                    | 0.01**       |
| Access electricity %                | 0.90                    | 0.96                    | 0.96                    | 0.89                    | 0.16         |
| Distance to closest paved road (km) | 2.66                    | 3.33                    | 0.72                    | 1.35                    | 0.00***      |
| Closest to a highway %              | 0.22                    | 0.18                    | 0.10                    | 0.19                    | 0.40         |
| Closest to a paved road %           | 0.17                    | 0.11                    | 0.42                    | 0.30                    | 0.00***      |
| Closest to a dirt road %            | 0.62                    | 0.70                    | 0.48                    | 0.51                    | 0.02**       |
| Distance to closest river (km)      | 1.12                    | 0.86                    | 2.05                    | 1.58                    | 0.00***      |
| Closest to Alumbre river %          | 0.00                    | 0.01                    | 0.00                    | 0.00                    | 0.63         |
| Closest to Chimbo river %           | 0.08                    | 0.06                    | 0.04                    | 0.11                    | 0.47         |
| Closest to Guayabal river %         | 0.38                    | 0.30                    | 0.94                    | 0.74                    | 0.00***      |
| Closest to Corazon river %          | 0.24                    | 0.34                    | 0.00                    | 0.08                    | 0.00***      |
| Closest to Illangama river %        | 0.29                    | 0.29                    | 0.02                    | 0.08                    | 0.00***      |
| Distance to closest town (km)       | 1.93                    | 2.03                    | 2.45                    | 2.36                    | 0.02**       |
| Distance to closest city (km)       | 7.21                    | 7.58                    | 3.61                    | 5.17                    | 0.00***      |
| Distance to the capital (km)        | 24.30                   | 21.24                   | 40.04                   | 36.52                   | 0.00***      |

Source: SANREM-CRSP survey

**Table A 2.4.** Social assets by livelihood strategy.

| <i>Variables</i>                   | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> | <i>ANOVA<br/>Sig.</i> |
|------------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-----------------------|
| Participation in civil societies % | 0.60                    | 0.55                    | 0.26                    | 0.38                    | 0.00***               |
| Family members that migrate % to   | 0.71                    | 0.39                    | 0.54                    | 0.13                    | 0.00***               |
| Quito                              | 0.85                    | 0.78                    | 0.70                    | 0.29                    | 0.00***               |
| Other cities                       | 0.09                    | 0.17                    | 0.04                    | 0.57                    | 0.63                  |
| Out of Ecuador                     | 0.05                    | 0.05                    | 0.26                    | 0.14                    | 0.00***               |

Source: SANREM-CRSP survey

**Table A 2.5. Human capital by livelihood strategy.**

| <i>Variables</i>                          | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> | <i>ANOVA<br/>Sig.</i> |
|---|-------------------------|-------------------------|-------------------------|-------------------------|-----------------------|
| Household highest level of education (yr) | 13.01                   | 12.97                   | 12.20                   | 10.21                   | 0.09*                 |
| No education %                            | 0.01                    | 0.02                    | 0.04                    | 0.04                    | 0.69                  |
| Primary education %                       | 0.33                    | 0.33                    | 0.30                    | 0.51                    | 0.09*                 |
| Secondary education %                     | 0.58                    | 0.56                    | 0.58                    | 0.43                    | 0.35                  |
| Secondary plus education %                | 0.08                    | 0.09                    | 0.08                    | 0.02                    | 0.45                  |
| Households that receive training %        | 0.28                    | 0.30                    | 0.10                    | 0.06                    | 0.00***               |
| Household head education level (yr)       | 5.03                    | 4.20                    | 4.66                    | 3.49                    | 0.18                  |
| Household average education males (yr)    | 8.81                    | 9.47                    | 8.70                    | 7.05                    | 0.15                  |
| Household average education females (yr)  | 7.84                    | 7.55                    | 7.75                    | 6.07                    | 0.35                  |
| Mestizo households %                      | 0.31                    | 0.25                    | 0.64                    | 0.53                    | 0.00***               |
| Household size                            | 5.54                    | 5.49                    | 4.36                    | 4.55                    | 0.00***               |
| Dependency ratio %                        | 0.40                    | 0.36                    | 0.30                    | 0.33                    | 0.21                  |
| Female ratio %                            | 0.53                    | 0.48                    | 0.53                    | 0.54                    | 0.22                  |
| Household head male %                     | 0.88                    | 0.90                    | 0.82                    | 0.72                    | 0.02**                |
| Household with wife %                     | 0.83                    | 0.82                    | 0.74                    | 0.57                    | 0.03**                |
| Household head age (yr)                   | 46.35                   | 49.70                   | 55.56                   | 51.15                   | 0.01**                |
| Household wife age (yr)                   | 41.60                   | 44.57                   | 48.57                   | 47.20                   | 0.10*                 |

Source: SANREM-CRSP survey

**Table A 2.6. Income activities participation and outcomes gained by livelihood strategy.**

| <i>Variables</i>                 | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> | <i>ANOVA<br/>Sig.</i> |
|----------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-----------------------|
| Total average income \$          | 3172.49                 | 4022.30                 | 2778.18                 | 1120.81                 | 0.00***               |
| Income per capita \$             | 572.81                  | 733.23                  | 637.20                  | 246.49                  | 0.00***               |
| index of income diversity        | 0.42                    | 0.42                    | 0.39                    | 0.40                    | 0.61                  |
| Crop agriculture participation % | 1.00                    | 1.00                    | 1.00                    | 1.00                    | Nt                    |
| Average income \$                | 1187.54                 | 3108.26                 | 361.32                  | 361.68                  | 0.00***               |
| Livestock participation %        | 0.73                    | 0.73                    | 0.28                    | 0.40                    | 0.00***               |
| Average income \$                | 435.39                  | 606.99                  | 257.93                  | 213.05                  | 0.00***               |
| Own business participation %     | 0.31                    | 0.12                    | 0.40                    | 0.04                    | 0.00***               |
| Average income \$                | 1321.46                 | 888.08                  | 1565.50                 | 153.00                  | 0.37                  |
| Agricultural wage employment %   | 0.14                    | 0.20                    | 0.42                    | 1.00                    | 0.00***               |
| Average income \$                | 389.09                  | 345.81                  | 416.29                  | 638.00                  | 0.00***               |
| Off farm wage participation %    | 0.73                    | 0.35                    | 0.66                    | 0.02                    | 0.00***               |
| Average income \$                | 1283.58                 | 597.84                  | 1779.39                 | 300.00                  | 0.02**                |
| Migration participation %        | 0.24                    | 0.08                    | 0.38                    | 0.06                    | 0.00***               |
| Average income \$                | 1031.05                 | 836.25                  | 952.63                  | 146.67                  | 0.35                  |
| Social help remittances %        | 0.09                    | 0.09                    | 0.04                    | 0.09                    | 0.71                  |
| Average income \$                | 180.00                  | 180.00                  | 180.00                  | 180.00                  | Nt                    |

Source: SANREM-CRSP survey

**Table A 2.7.** Expenditures level by livelihood strategies.

| <i>Variables</i>                          | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> | <i>ANOVA<br/>Sig.</i> |
|---|-------------------------|-------------------------|-------------------------|-------------------------|-----------------------|
| Total average expenditures \$             | 1799.95                 | 2369.86                 | 1221.38                 | 996.70                  | 0.00***               |
| Expenditures per capita \$                | 324.99                  | 432.01                  | 280.13                  | 219.19                  | 0.00***               |
| Ratio of expenditures-income              | 0.68                    | 0.71                    | 0.62                    | 0.93                    | 0.00***               |
| Ratio of food expenditures-income         | 0.17                    | 0.14                    | 0.17                    | 0.22                    | 0.00***               |
| Food expenditures incurred %              | 1.00                    | 1.00                    | 1.00                    | 1.00                    | Nt                    |
| Average expenditures \$                   | 411.77                  | 376.23                  | 315.28                  | 238.83                  | 0.00***               |
| Housing expenditures incurred %           | 0.01                    | 0.02                    | 0.04                    | 0.02                    | 0.76                  |
| Average expenditures \$                   | 300.00                  | 220.00                  | 120.00                  | 48.00                   | 0.03**                |
| Services expenditures incurred %          | 1.00                    | 0.98                    | 0.98                    | 0.98                    | 0.68                  |
| Average expenditures \$                   | 193.24                  | 150.42                  | 170.04                  | 105.73                  | 0.17                  |
| Apparel expenditures incurred %           | 0.87                    | 0.84                    | 0.78                    | 0.74                    | 0.20                  |
| Average expenditures \$                   | 101.74                  | 110.91                  | 94.95                   | 84.46                   | 0.52                  |
| Transportation expenditures incurred %    | 0.94                    | 0.86                    | 0.82                    | 0.83                    | 0.18                  |
| Average expenditures \$                   | 88.85                   | 80.16                   | 48.37                   | 47.75                   | 0.00***               |
| Healthcare expenditures incurred %        | 0.65                    | 0.63                    | 0.86                    | 0.75                    | 0.02**                |
| Average expenditures \$                   | 112.25                  | 140.38                  | 166.88                  | 119.85                  | 0.38                  |
| Education expenditures incurred %         | 0.73                    | 0.69                    | 0.50                    | 0.57                    | 0.03**                |
| Average expenditures \$                   | 257.11                  | 237.22                  | 158.16                  | 106.27                  | 0.09*                 |
| Entertainment expenditures incurred %     | 0.44                    | 0.57                    | 0.48                    | 0.34                    | 0.04**                |
| Average expenditures \$                   | 86.15                   | 77.67                   | 29.42                   | 70.61                   | 0.03**                |
| Production inputs expenditures incurred % | 1.00                    | 1.00                    | 1.00                    | 1.00                    | Nt                    |
| Average expenditures \$                   | 720.41                  | 1384.94                 | 384.22                  | 376.85                  | 0.00***               |

Source: SANREM-CRSP survey

## Appendix 3 Marginal Effects Multinomial Logit Model

### 1. Marginal Effects Example

If we consider the type of households that will engage in agriculture markets with high amounts of natural resources and physical assets, average age, close proximity to rivers and towns but far from the city, the probability of engaging in agricultural markets is 54%.

**Table A 3.1.** Marginal effects for typical household engaging in agriculture markets.

|                         | <i>Livelihood</i> | <i>Livelihood</i> | <i>Livelihood</i> | <i>Livelihood</i> | <i>Variables hold at</i> |
|-------------------------|-------------------|-------------------|-------------------|-------------------|--------------------------|
|                         | <i>A</i>          | <i>B</i>          | <i>C</i>          | <i>D</i>          |                          |
| Probability to engage % | 0.45              | 0.54              | 0.01              | 0.00              |                          |
| <i>Variables</i>        | <i>dy/dx</i>      | <i>Dy/dx</i>      | <i>dy/dx</i>      | <i>dy/dx</i>      |                          |
| Alumbre watershed       | -0.38             | 0.17              | 0.20              | 0.01              | 0                        |
| <i>p&gt; z </i>         | (0.01)***         | (0.70)            | (0.63)            | (0.74)            |                          |
| Altitude *10            | -0.08             | 0.08              | 0.00              | 0.00              | 33.02                    |
| <i>p&gt; z </i>         | (0.02)**          | (0.02)**          | (0.99)            | (0.84)            |                          |
| Farm surface            | -0.02             | 0.02              | 0.00              | 0.00              | 5.64                     |
| <i>p&gt; z </i>         | (0.01)***         | (0.01)***         | (0.56)            | (0.70)            |                          |
| Irrigation access       | -0.13             | 0.14              | 0.00              | 0.00              | 0                        |
| <i>p&gt; z </i>         | (0.16)            | (0.15)            | (0.53)            | (0.88)            |                          |
| Physical assets /100    | 0.00              | 0.00              | 0.00              | 0.00              | 41.71                    |
| <i>p&gt; z </i>         | (0.20)            | (0.25)            | (0.82)            | (0.25)            |                          |
| Age                     | -0.04             | 0.04              | 0.00              | 0.00              | 35.00                    |
| <i>p&gt; z </i>         | (0.03)**          | (0.03)**          | (0.79)            | (0.95)            |                          |
| Square age              | 0.00              | 0.00              | 0.00              | 0.00              | 1225.00                  |
| <i>p&gt; z </i>         | (0.06)*           | (0.06)*           | (0.70)            | (1.00)            |                          |
| Household size          | 0.02              | -0.01             | 0.00              | 0.00              | 3.00                     |
| <i>p&gt; z </i>         | (0.47)            | (0.51)            | (0.67)            | (0.68)            |                          |
| Dependency ratio *10    | 0.00              | 0.00              | 0.00              | 0.00              | 3.33                     |
| <i>p&gt; z </i>         | (0.90)            | (0.85)            | (0.61)            | (0.57)            |                          |
| Education               | 0.04              | -0.04             | 0.00              | 0.00              | 0                        |
| <i>p&gt; z </i>         | (0.66)            | (0.65)            | (0.63)            | (0.39)            |                          |
| Distance to river       | 0.10              | -0.11             | 0.00              | 0.00              | 0.66                     |
| <i>p&gt; z </i>         | (0.08)*           | (0.07)*           | (0.55)            | (0.74)            |                          |
| Distance to town        | -0.02             | 0.02              | 0.00              | 0.00              | 1.23                     |
| <i>p&gt; z </i>         | (0.70)            | (0.70)            | (0.94)            | (0.87)            |                          |
| Distance to city        | 0.03              | -0.03             | 0.00              | 0.00              | 8.12                     |
| <i>p&gt; z </i>         | (0.11)            | (0.12)            | (0.75)            | (0.51)            |                          |

Another example can be a typical household that is engaged in rural non-farm activities with an average amount of natural and physical assets, older and small household size and belongs to the Alumbre sub-watershed will have a probability of 50% of engaging in rural non-farm activities.

**Table A 3.2.** Marginal effects for typical household engaging in non-farm activities.

|                         | <i>Livelihood</i> | <i>Livelihood</i> | <i>Livelihood</i> | <i>Livelihood</i> | <i>Variables hold at</i> |
|-------------------------|-------------------|-------------------|-------------------|-------------------|--------------------------|
|                         | <i>A</i>          | <i>B</i>          | <i>C</i>          | <i>D</i>          |                          |
| Probability to engage % | 0.16              | 0.13              | 0.50              | 0.20              |                          |
| <i>Variables</i>        | <i>dy/dx</i>      | <i>dy/dx</i>      | <i>dy/dx</i>      | <i>dy/dx</i>      |                          |
| Alumbre watershed       | -0.67             | 0.05              | 0.49              | 0.14              | 1                        |
| <i>p&gt; z </i>         | (0.00)***         | (0.71)            | (0.00)***         | (0.26)            |                          |
| Altitude *10            | -0.03             | 0.02              | 0.00              | 0.01              | 23.87                    |
| <i>p&gt; z </i>         | (0.18)            | (0.41)            | (0.99)            | (0.81)            |                          |
| Farm surface            | 0.00              | 0.01              | -0.02             | 0.01              | 4.94                     |
| <i>p&gt; z </i>         | (0.82)            | (0.36)            | (0.49)            | (0.55)            |                          |
| Irrigation access       | 0.00              | 0.10              | -0.15             | 0.06              | 0                        |
| <i>p&gt; z </i>         | (0.97)            | (0.27)            | (0.28)            | (0.63)            |                          |
| Physical assets /100    | 0.00              | 0.00              | 0.01              | -0.02             | 6.68                     |
| <i>p&gt; z </i>         | (0.18)            | (0.41)            | (0.04)**          | (0.01)***         |                          |
| Age                     | -0.01             | 0.01              | 0.00              | 0.00              | 78.00                    |
| <i>p&gt; z </i>         | (0.38)            | (0.13)            | (0.82)            | (0.81)            |                          |
| Square age              | 0.00              | 0.00              | 0.00              | 0.00              | 6084.00                  |
| <i>p&gt; z </i>         | (0.47)            | (0.12)            | (0.64)            | (0.66)            |                          |
| Household size          | 0.02              | 0.00              | -0.02             | 0.00              | 2.00                     |
| <i>p&gt; z </i>         | (0.29)            | (0.72)            | (0.52)            | (0.91)            |                          |
| Dependency ratio *10    | -0.01             | -0.01             | 0.02              | 0.00              | 0.00                     |
| <i>p&gt; z </i>         | (0.39)            | (0.35)            | (0.45)            | (0.95)            |                          |
| Education               | 0.00              | -0.02             | 0.14              | -0.12             | 0                        |
| <i>p&gt; z </i>         | (0.97)            | (0.61)            | (0.16)            | (0.04)**          |                          |
| Distance to river       | 0.00              | -0.05             | 0.08              | -0.03             | 3.12                     |
| <i>p&gt; z </i>         | (0.92)            | (0.06)*           | (0.09)*           | (0.40)            |                          |
| Distance to town        | 0.00              | 0.01              | 0.00              | 0.00              | 1.94                     |
| <i>p&gt; z </i>         | (0.87)            | (0.75)            | (0.99)            | (0.91)            |                          |
| Distance to city        | 0.01              | -0.01             | -0.02             | 0.01              | 1.17                     |
| <i>p&gt; z </i>         | (0.21)            | (0.40)            | (0.37)            | (0.28)            |                          |

Finally, another example can be a household that is engaged in agricultural wage work with limited amount of natural and physical assets. It will have a probability of 46% of engaging in agricultural wage work.

**Table A 3.3.** Marginal effects for typical household engaging in agricultural wage work.

|                         | <i>Livelihood</i> | <i>Livelihood</i> | <i>Livelihood</i> | <i>Livelihood</i> |                          |
|-------------------------|-------------------|-------------------|-------------------|-------------------|--------------------------|
|                         | <i>A</i>          | <i>B</i>          | <i>C</i>          | <i>D</i>          |                          |
| Probability to engage % | 0.25              | 0.29              | 0.01              | 0.46              |                          |
| <i>Variables</i>        | <i>dy/dx</i>      | <i>dy/dx</i>      | <i>dy/dx</i>      | <i>dy/dx</i>      | <i>Variables hold at</i> |
| Alumbre watershed       | -0.22             | -0.08             | 0.08              | 0.22              | 0                        |
| <i>p&gt; z </i>         | (0.02)**          | (0.81)            | (0.64)            | (0.59)            |                          |
| Altitude *10            | -0.05             | 0.04              | 0.00              | 0.01              | 32.62                    |
| <i>p&gt; z </i>         | (0.07)*           | (0.20)            | (0.94)            | (0.83)            |                          |
| Farm surface            | -0.01             | 0.02              | 0.00              | -0.01             | 1.42                     |
| <i>p&gt; z </i>         | (0.26)            | (0.14)            | (0.55)            | (0.69)            |                          |
| Irrigation access       | -0.06             | 0.09              | 0.00              | -0.02             | 0                        |
| <i>p&gt; z </i>         | (0.35)            | (0.43)            | (0.38)            | (0.88)            |                          |
| Physical assets /100    | 0.02              | 0.02              | 0.00              | -0.03             | 1.13                     |
| <i>p&gt; z </i>         | (0.00)***         | (0.01)***         | (0.32)            | (0.00)***         |                          |
| Age                     | -0.02             | 0.02              | 0.00              | 0.00              | 37.00                    |
| <i>p&gt; z </i>         | (0.15)            | (0.22)            | (0.76)            | (0.96)            |                          |
| Square age              | 0.00              | 0.00              | 0.00              | 0.00              | 1369.00                  |
| <i>p&gt; z </i>         | (0.17)            | (0.29)            | (0.60)            | (0.99)            |                          |
| Household size          | 0.01              | 0.00              | 0.00              | -0.01             | 5.00                     |
| <i>p&gt; z </i>         | (0.36)            | (0.96)            | (0.62)            | (0.61)            |                          |
| Dependency ratio *10    | -0.01             | -0.01             | 0.00              | 0.02              | 6.00                     |
| <i>p&gt; z </i>         | (0.63)            | (0.48)            | (0.58)            | (0.46)            |                          |
| Education               | 0.11              | 0.06              | 0.01              | -0.18             | 0                        |
| <i>p&gt; z </i>         | (0.15)            | (0.38)            | (0.37)            | (0.05)**          |                          |
| Distance to river       | 0.05              | -0.07             | 0.00              | 0.02              | 0.75                     |
| <i>p&gt; z </i>         | (0.25)            | (0.14)            | (0.35)            | (0.73)            |                          |
| Distance to town        | -0.01             | 0.02              | 0.00              | -0.01             | 1.36                     |
| <i>p&gt; z </i>         | (0.85)            | (0.71)            | (0.99)            | (0.87)            |                          |
| Distance to city        | 0.01              | -0.03             | 0.00              | 0.02              | 7.86                     |
| <i>p&gt; z </i>         | (0.41)            | (0.12)            | (0.52)            | (0.40)            |                          |

## Appendix 4 Alternate Household Well-being Equation

**Table A 4.1.** Determinants of household well-being (income) conditioned on livelihood selection

| <i>Variables income</i>   | <i>Livelihood<br/>A</i> | <i>Livelihood<br/>B</i> | <i>Livelihood<br/>C</i> | <i>Livelihood<br/>D</i> |
|---------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Alumbre watershed         | 0.81                    | -0.35                   | -0.49                   | -0.54                   |
| <i>P&gt; t </i>           | <i>(0.08)*</i>          | <i>(0.26)</i>           | <i>(0.65)</i>           | <i>(0.02)**</i>         |
| Ln farm surface           | 0.17                    | 0.32                    | 0.49                    | 0.04                    |
| <i>P&gt; t </i>           | <i>(0.05)**</i>         | <i>(0.00)***</i>        | <i>(0.00)***</i>        | <i>(0.55)</i>           |
| Irrigation                | 0.05                    | -0.34                   | -0.09                   | 0.03                    |
| <i>P&gt; t </i>           | <i>(0.77)</i>           | <i>(0.01)***</i>        | <i>(0.85)</i>           | <i>(0.87)</i>           |
| Ln physical assets        | -0.14                   | -0.15                   | -0.16                   | -0.04                   |
| <i>P&gt; t </i>           | <i>(0.04)**</i>         | <i>(0.01)***</i>        | <i>(0.01)***</i>        | <i>(0.22)</i>           |
| Credit                    | 0.39                    | 0.43                    | 0.59                    | (Dropped)               |
| <i>P&gt; t </i>           | <i>(0.10)*</i>          | <i>(0.19)</i>           | <i>(0.06)*</i>          |                         |
| Household gender          | -0.83                   | 0.18                    | -0.28                   | 0.04                    |
| <i>P&gt; t </i>           | <i>(0.00)***</i>        | <i>(0.33)</i>           | <i>(0.25)</i>           | <i>(0.70)</i>           |
| Ln household size         | -0.70                   | -0.67                   | -1.03                   | -0.70                   |
| <i>P&gt; t </i>           | <i>(0.00)***</i>        | <i>(0.00)***</i>        | <i>(0.00)***</i>        | <i>(0.00)***</i>        |
| Education                 | 0.08                    | 0.23                    | -0.06                   | 0.03                    |
| <i>P&gt; t </i>           | <i>(0.60)</i>           | <i>(0.11)</i>           | <i>(0.86)</i>           | <i>(0.85)</i>           |
| Correction coefficients 1 | -0.59                   | -0.56                   | -0.83                   | -1.29                   |
| <i>P&gt; t </i>           | <i>(0.05)**</i>         | <i>(0.42)</i>           | <i>(0.46)</i>           | <i>(0.12)</i>           |
| Correction coefficients 2 | -1.63                   | -0.64                   | 0.98                    | -1.31                   |
| <i>P&gt; t </i>           | <i>(0.08)*</i>          | <i>(0.04)**</i>         | <i>(0.31)</i>           | <i>(0.07)*</i>          |
| Correction coefficients 3 | -0.18                   | -0.39                   | 0.22                    | -0.74                   |
| <i>P&gt; t </i>           | <i>(0.86)</i>           | <i>(0.61)</i>           | <i>(0.29)</i>           | <i>(0.30)</i>           |
| Correction coefficients 4 | 1.91                    | 0.52                    | 1.97                    | -0.21                   |
| <i>P&gt; t </i>           | <i>(0.01)***</i>        | <i>(0.45)</i>           | <i>(0.06)*</i>          | <i>(0.25)</i>           |
| Constant                  | 8.67                    | 8.21                    | 9.43                    | 6.04                    |
| <i>P&gt; t </i>           | <i>(0.00)***</i>        | <i>(0.00)***</i>        | <i>(0.00)***</i>        | <i>(0.00)***</i>        |

Note: dependent variable natural log of annual well-being per capita as income