2004

Financial viability of eco-labeled cacao in the Santander Mountains (Columbia)

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**FINANCIAL VIABILITY OF ECO-LABELED CACAO IN THE SANTANDER
MOUNTAINS (COLOMBIA)**

**A Thesis
Presented to
The Department of Environmental Studies
San José State University**

**In Partial Fulfillment
of the Requirements for the Degree
Master of Sciences**

**by
Marcela Villegas
December 2004**

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A handwritten signature in dark ink, appearing to read "Rachel O'Malley", written over a horizontal line.

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ABSTRACT
FINANCIAL VIABILITY OF ECO-LABELED CACAO IN THE SANTANDER
MOUNTAINS (COLOMBIA)

By Marcela Villegas

Cacao may be a valuable market-based conservation initiative in Colombia as this cash crop is more beneficial for biodiversity than are other crop alternatives, and Colombian cacao production is dominated by small “organic by default” shaded farms. This research assessed the magnitude and risk of the investment needed by cacao growers in Santander to be certified by Rainforest Alliance, and the premiums that make certification profitable. I characterized 14 cacao farms and defined changes required for certification, calculated Net Present Values (NVP) for farms with and without certification, and performed a risk analysis for certified farms obtaining a premium.

Results show that certification without a premium causes substantial income decrements for farmers, and that even when obtaining a premium, income increments are not certain for certified farms. This underscores the need to support farmers seeking certification financially and organizationally, and to link certification to commercialization strategies offering premiums.

ACKNOWLEDGMENTS

I am especially grateful to my committee members Dr. Rachel O'Malley, Dr. Karen Holl, and Dr. Douglas Greer for their valuable comments and advice through the development of this work, and to my husband Sergio Gómez for his help in designing the risk model. A grant from San José Research Foundation supported the field phase of this study. Finally, this research would not have been possible without the assistance from the personnel at the Federación de Cacaoteros in San Vicente de Chucurí, and the cooperation from the farmers and their families, who generously allowed me to study their farms.

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INTRODUCTION

Conservation of biodiversity in the tropics faces the challenge of preserving unique biological values amid extremely poor people whose survival depends on living from the natural environment. Very often, agricultural activities yielding economic revenue generate few social benefits, and profits are obtained at the expense of damage to ecosystems. Historically, cultivation of agricultural commodities has had strong negative effects in natural ecosystems in the tropics (Tucker 1990, Prance 1990, Nestel 1995, Ruf and Zadi 1998). However, research suggests that cacao agroforests are comparatively more beneficial for biodiversity than are other tropical crops (Rice and Greenberg 2000, Reitsma, Parrish and McLearnay 2001). The demonstrated contributions to biodiversity of these agroecosystems, in conjunction with the increasing demand for chocolate in the developed world, present a great opportunity for linking conservation and improving living conditions for poor people in the tropics (Rice and Greenberg 2000). Mechanisms to make shade-grown cacao an applicable market based conservation initiative have not been studied. Some studies have investigated the commercialization chain of cacao in Africa and evaluated the socioeconomic impacts of fair-trade cacao (Robins and Fox 2000, Robins and Roberts 2000). The financial viability of certifying cacao under comprehensive social and biological criteria such as the ones proposed by Rainforest Alliance/Sustainable Agriculture Network (RA/SAN) has not been addressed in Colombia or in any other tropical countries.

Agricultural commodities and their environmental and human impacts

As with most environmental problems, impacts to the environment from agriculture involve complex socioeconomic aspects. In Colombia, nearly 40% of the population depends on agriculture as their primary source of income. The contribution of agriculture to the Colombian GDP (Gross Domestic Product) is calculated to be as much as 14.6% (Ministerio de Agricultura Colombiano and IICA 2001). Export commodities, including coffee, cacao, flowers and bananas, account for 75% of the total agricultural exports of the country (Orozco 2000).

Because it is such a pervasive global enterprise, agriculture has been identified as one of the primary causes of biodiversity loss (Wilson 1988, Raven 1988, Noss and Cooperrider 1994, Lovejoy 1997, Myers 1997). In Colombia, almost entire ecosystems such as the dry and deciduous tropical forests in the low lands, the clouded forests in the Andes, and the *páramos*, have disappeared as a result of agricultural expansion (Andrade 1993, Etter 1993 and 1998, Gentry 1993, Van der Hammen 1998). Deforestation associated with coffee and cacao cultivation alone has destroyed vast forest areas in Brazil, Colombia, and Central America (Tucker 1990, Prance 1990, Nestel 1995, Ruf and Zadi 1998). Most of the expansion of cacao cultivation in Colombia during the 1970-1990 period is attributable to the colonization of tropical forest areas in Uraba, Arauca, Magdalena Medio Santandereano, Catatumbo and along the Ariari river (Ministerio de Agricultura Colombiano and IICA 2001).

Cacao and coffee experience significant price instability; volatility of prices, speculation, and the insignificant percent of the retailer price that goes to the producers

are characteristics of this market (Robins and Roberts 2000, Gresser and Tickell 2002).

A socioeconomic crisis occurred in 1980 in the cacao producing countries when the ICCO (International Cocoa Organization) pact on fixed export quotas fell and cacao prices plummeted due to an enormous global surplus (Maes and Trio 2002). For instance, because of the decline in cocoa prices between 1986 and 1996, Ghana exported nearly 80% more cocoa, but received just 2% greater income. The low cacao value caused abandonment of farms, unemployment and emigration (Boon 2000). In the Bahia area of Brazil, approximately 250,000 jobs were lost because of the decline of the cocoa sector (Maes and Trio 2002).

Like coffee, cacao relates to market behavior in a cyclic way. When prices are high, producers improve their plantations and/or expand the cultivated area. This leads to an increase in the supply that prompts a fall in prices. The fall in prices discourages production, causing abandonment of the plantations leading to a shortage in supply that generates high prices. Then the cycle begins again (Maes and Trio 2002).

World cocoa production is carried out predominantly by smallholders, who have proved more productive and efficient than large-scale growers despite the fact that government policies have historically favored the latter (Clarence-Smith 1997).

Cacao (*Theobroma cacao*): Natural history

Cacao --also called cocoa-- (*Theobroma cacao*) originated in the Amazon forest and was domesticated by people living in the Amazon's northern basin and Mesoamerica (Young 1994). Soon after Spaniards arrived to Aztec and Maya territories in the

sixteenth century, cultivation of cacao spread to the Spanish-dominated places in the Caribbean basin. Later, in the seventeenth and eighteenth centuries, cacao cultivation moved to the Pacific, Ceylon, and Brazil, from whence it finally passed to Africa in the nineteenth century (Wood and Lass 1975). Almost 7,000,000 hectares are cultivated in cacao in the world. In 2002, more than 40% of the global production of cacao came from Ivory Coast. Ghana, Indonesia and Nigeria produced the 33%, while Brazil accounted for 5% of the production (Rice and Greenberg 2003). Because of its origins as an understory tree, the cultivated forms of cacao thrive under shade, and cacao has co-evolved with a wide range of forest organisms (Young 1994). When shade trees are removed, the cacao tree responds by flowering profusely, and the production of pods increases. However, the life span of the tree is reduced because of water stress, excessive evapotranspiration and diseases (Adomako 1983, cited by Evans 1998). The main diseases affecting cacao cultivation in Latin America are monilia pod rot (*Moniliophthora rorerii*) and witches' broom. Preliminary studies by Evans in Ecuador (1998) suggest that shade inhibits the spread of both diseases. Somarriba and Beer (1998), however, found that in Costa Rica selection and management of the shade species did not have an effect on crop losses due to fungal pathogens.

Traditional cacao and coffee agroforests and biodiversity conservation

Some farmers in the developing world produce coffee and cacao in agroforests, which consist of growing the coffee and cacao bushes inside natural secondary forests or planted forests. Traditional agroforests are now regarded as important places for

biodiversity conservation (Altieri 1988, Pimentel 1992, Perfecto *et al.* 1996, Greenberg, Bichier and Sterleing 1997, Rice and Greenberg 2000). Cacao plantations are considered as important for maintaining the diversity of birds (Reitsma, Parrish and McLearnay 2001), ants (Roth, Perfecto and Rathcke 1994) and threatened bryophytes (Kautz and Gradstein 2001). Cacao in agroforestry systems is also one of the best alternatives to slash-and-burn agriculture from the standpoint of carbon dynamics (Kotto *et al.* 1997), and one of the land management strategies offering best resource protection in areas where forest is converted to agricultural uses (Zapfack *et al.* 2002).

There is a tight relationship between biological and structural complexity of the shade canopy and the diversity of organisms harbored by cacao and coffee plantations (Perfecto *et al.* 1996, Greenberg, Bichier and Sterleing 1997). As shown in coffee by Moguel and Toledo (1999), shade management in cacao ranges from planting cacao trees under old-growth forest, through systems where one or several species are planted for shade, to cultivation to full sun exposure (Alves 1990, Rice and Greenberg 2000). Research suggests that cacao systems in proximity to natural forest are more biodiverse than are isolated crops (Alves 1990, Parrish, Reitsma and Greenberg 1998, Young 1994). However, Rice and Greenberg (2000) affirm that the implications of this proximity effect are unclear, and cacao farms may be population sinks, unable to support populations of sensitive forest organisms in the long term. Cacao farms are being promoted as habitat corridors for the movement of forest organisms in Talamanca Costa Rica (Parrish, Reitsma and Greenberg 1998, Rice and Greenberg 2000).

Certification, sustainability, and alternative markets for coffee and cacao

Traditional agroforests are among the best agricultural alternatives conciliating conservation of biodiversity and use of natural resources (Thiollay 1995). Several authors agree on that a market-based conservation initiative based on certification could be an effective way for preserving these biodiversity-friendly agroecosystems (Rice and Ward 1996, Parrish *et al.* 1998, Perfecto *et al.* 1999, Rice and Greenberg 2000, Rice and Greenberg 2003). Market-based conservation initiatives are built upon the growing awareness in developed countries on how purchase decisions impact the economic welfare of people in developing countries, the environment, and biodiversity. Certification assures these consumers that the products purchased comply with their ecological and/or social expectations, and rewards the effort of the producers usually through economic incentives. Sustainable coffee (shade and organic) is probably the agricultural commodity with the longest trajectory as a conservation-oriented market product, and, as such, it has been the most widely studied.

Key research findings on conservation-oriented coffee are: Increases in income for farmers participating in a sustainable coffee program in Nicaragua were attributable to obtainment of premiums and reductions of marketing costs by obviating middlemen. The same study found that sustainable production represented a decrease in costs for farms using intensive technology, and an increase in total costs for low-input operations (Sorby 2002). Organization has been fundamental for programs promoting organic coffee, which is an economically viable and sustainable alternative. However, these programs seem to be mainly reaching middle sized farms because entry costs are too high for the

smallest producers (Bray, Sánchez and Murphy 2002). Programs seeking transition to more ecologically friendly coffee management require intensive training of participating farmers and subsidies (Gobbi 2000).

Meeting certification guidelines may be costly and the rewards uncertain because financial mechanisms for recognition remain scarce. Also, several authors have voiced concerns about equity and certification of sustainable goods. Questions such as who sets standards, prices, and environmental and social dimensions, and who are the beneficiaries of the certification process are particularly daunting in the field of environmentally driven products (Abott and Robins 2000, Robins and Fox 2000, Boon 2000). Other doubts relate to how accurately indicators used in certification reflect ecological and social dynamics, to the variety of conceptual approaches on what “sustainable” means, and the sufficiency of ecological, technical, and social information on which certification programs are based (Putz and Viana 1996).

Usually, mechanisms called premiums are used to compensate the producers of organic, eco-friendly or “fair trade” certified cacao. However, because these are emerging markets, premiums are not always guaranteed, except for Fair Trade certified cacao. Fair Trade organizations obviate middlemen in the commercialization process, and offer the producers prices that allow covering production costs and obtaining a minimum wage. According to ICCO (2003) the Fair Trade premium for standard quality cocoa is US\$150 per tonne (1000 kg), and the minimum price for fair trade standard quality cocoa, including premium, is US\$1,750 per tonne. Cacao producers under a fair trade scheme in Ecuador receive premiums between 8 and 15% over the selling cacao

price in the conventional market (Collinson and Leon 2000). For organic fair trade cacao, the premium is of 350 US\$/ton over the minimum price \$1600 US\$/ton (MAX HAVELLAR 2002). Because fair trade sets a minimum price, the premium for fair trade organic cacao may increase up to 100% or more of the market price, when international prices drop under the \$1600 US\$/ton level. Although financial benefits of Fair Trade certified cacao seem clear, benefits related to farmer organization and empowerment seem to be even more important than the improvements in the standard of life yielded by better prices (Maes and Trio 2001, Bowen 2002).

The Rainforest Alliance is an international conservation organization seeking to protect ecosystems and people depending on them through market-based initiatives. The Rainforest Alliance label is an agricultural certification program managed jointly by the Rainforest Alliance and a network of Latin American partner organizations (Sustainable Agriculture Network, SAN). Fundación Natura, a non-profit organization devoted to conservation, is the partner organization in Colombia. Rainforest Alliance certification standards promote conservation of wildlife, reforestation, and healthy work conditions. Since June 2001, the program has certified 218 farms and cooperatives, and 51.650 hectares of bananas, coffee, cocoa, oranges, sugar cane and other export crops in Costa Rica, Colombia, Ecuador, Guatemala, Honduras, Panamá, Hawaii, México, and El Salvador. Of the total certified area, 4,650 hectares correspond to cacao in Ecuador (Rainforest Alliance 2004).

Cacao cultivation in Colombia

Most of the cacao in Colombia is produced by small farmers in traditional agroecosystems under shade, with no external fertilizers or pesticides. However, the potential to market cacao certified as socially and ecologically friendly in the environmentally-conscious markets of the developed world remains mainly unexplored. This research examines the magnitude, profitability, and risk of the investments that cacao farmers in the main cacao-producing region of Santander would have to make to be certified as sustainable under the Rainforest Alliance label. This study also estimates the price premiums that the farmers would need for their investment in certification to be profitable.

In the case of Colombia, where cacao cultivation is associated with poverty and social conflict, marketing of certified sustainable cacao could reinforce the achievement of conservationist, social, and economic goals. Exploring the impact that certification will have in the finances of cacao farmers and their families is an essential step to permit the cacao sector to achieve all these goals.

Since certification programs are usually designed in developed countries for application in developing nations, it is important to clarify how scale-dependent certification processes and standards are. Therefore, this research looks into the financial impact that the adoption of eco-labeling would have on farmers with different income levels in Santander, Colombia.

This study provides valuable information for decision-making in the cacao sector in Colombia, both to the farm and institutional levels. Its findings can be used to design

eco-labeling programs for discouraging the conversion to less ecologically friendly cacao management and/or to other crops, including illegal coca crops. Some of the results of this research can be applied to other cacao producing countries in the Caribbean, Central America, and Africa, with similar products or market-based conservation initiatives.

OBJECTIVES

This thesis will address the following questions for cacao farms located in the Santander Mountains (Colombia):

1. For cacao farms located in the Santander Mountains (Colombia),
 - a) What are the certification costs under the Rainforest Alliance label?
 - b) What premiums over the market price are needed to make certification profitable?
 - c) How profitable would it be to certify the farms under current economic conditions?
2. For farms grouped into three income categories (High, Middle, and Low)
 - a) Do certification costs differ among income categories?
 - b) Do premiums required to make certification profitable differ among High, Middle and Low-income farms?
 - c) Does certification-related financial risk differ among High, Middle and Low-income farms?

METHODS

Study system

The Santander Mountains

The study area (known as Santander Mountains) sits between 6°45' - 7°07' Lat. N and 73°15' - 73°30' Long, in the municipalities of San Vicente de Chucurí, El Carmen de Chucurí, and Betulia (Fig. 1). Santander is the main cacao-producing region in Colombia (Fig. 2), providing 49% of the national production (FEDECACAO 2004a). The farms studied are between 500 and 1000 meters above sea level in the steep slopes of the Cordillera de la Paz and the Cordillera de los Cobardes, where precipitation ranges from 1,500 to 2,000 mm/year. Although this region has supported agriculture and livestock for more than one century, fragments of natural forests remain in the area. Illegal logging of precious timber has been identified as causing ecological deterioration in these forest areas (Alcaldía de San Vicente de Chucurí 2001). Eighteen vertebrate species --some of them being hunted-- are reported as present in cacao farms or their proximities by farmers participating in this study (Table 1).

Coca (*Erythroxylon coca*) cultivation is spreading to the study region from other areas of Santander. According to the Colombian government, the coca cultivated area in Santander increased by 37 % between the years of 2002 (463 ha) and 2003 (632 ha) (Gobierno de Colombia and UNODOC 2004).

Cacao production in the Santander Mountains

In the region, the cacao materials cultivated are *Criollos* (traditional materials), *Híbridos* (artificial hybrids), and recently *Clones* (clones). The most common planting density in the area is approximately 1,000 plants/ha, but in old plantations it is possible to find 600 plants/ha. Cacao is commonly cultivated under the shade of plantain and fruit or timber trees (see Table 2). Cacao trees are pruned once a year, and mechanical weed control is performed every six months. Prevalently, there is no chemical fertilization and pesticide application on cacao. Management of the diseases monilia (*Moniliophthora rorerii*) and witches' broom (*Crinipellis perniciosa*) is incipient and ill-timed, done by physically removing the infected plant parts. According to Ministerio de Agricultura Colombiano and IICA (2001), is estimated that monilia causes production losses of 30-40% in farms although proper cultural control may reduce the losses to 5-10%.

After collecting the pods, and extracting, fermenting, and drying the cacao beans, farmers sell their production to local middlemen in the towns, where they sell it to collection agents from the two main Colombian chocolate factories: Casa Luker and Nacional de Chocolates. From there, cacao is transported to Medellín or Bogotá, where the factories are located. Some farmers sell their crop to local chocolate factories in San Vicente de Chucurí. A technical standard for purchasing cacao beans is issued by ICONTEC (National Institute of Technical Standards), aiming to standardize quality. However, this rule is rarely, if ever, applied.

Social aspects of cacao production in the Santander Mountains

Typically, farm owners live and work on the farms full-time. Permanent hired labor is common in large farms, while for middle and small-sized farms the farmers themselves are the main source of labor, hiring on a temporary basis. Commonly, children and women are in charge of the final steps in cacao post-harvest.

FEDECACAO (Federación de Cacaoteros) is the main institution giving technical assistance to the farmers in the area; FEDECACAO technicians visit most of the farms in the study area sporadically. Several farmers' organizations also exist in the region, of which ECOCACAO and APROCAFRUM are the most important. In general, these farmers' organizations aim to improve productivity and marketing conditions.

Basic cacao economics

Colombia is the eighth largest cacao-producing country in the world (Table 3). Internal consumption of cacao is substantial, and the country imports cacao products. In the period 1991-2002, export balances were positive for all years but 2000 (Table 4). The Agriculture Ministry establishes the minimal internal cacao price to the producer each semester based on the cacao markets in London and New York. An official quality premium of 5% over the market price is intended to award producers of extra high quality cacao. In the study region, though, purchasers do not award such premiums even to qualified producers, because there is not a mechanism to oversee purchasers' operations.

National chocolate factories dictate factory prices and purchase prices (prices effectively paid to middlemen and farmers, respectively). These prices are determined by

several factors, including stocks of cacao beans, presence of exporters/importers, and international prices. A global overstock of cacao beans (rooted in the accumulation of seven consecutive surplus periods) recently caused an international crisis in cocoa prices. During 1998-2001 the average price per tonne (1,000 kg) of cacao beans paid in the national market to the producers exceeded the international price, meaning that it was cheaper for Colombian industries to import cacao beans than to buy Colombian cacao. As a consequence, during this three-year period, the price paid to the cacao growers did not increase (Ministerio de Agricultura Colombiano and IICA, 2001). International prices have recovered since 2000, when cacao prices were at their lowest since 1972 (Table 5), and so have internal cacao prices in Colombia.

During the field phase of this study in July 2004, purchase and factory prices were \$3,400/kg and \$3,800 (Colombian pesos. At that time, the exchange rate was 1 US\$ = \$2,600 pesos), respectively. However, the price effectively paid to farmers in the study region was \$3,500. By September 2004, purchase and factory prices were \$4,234 and \$4,314, respectively.

Certification process

The certification process begins with a preliminary (voluntary) visit to the farm to determine changes needed for certification. Next, Fundación Natura (Colombian partner of Rainforest Alliance/Sustainable Agriculture Network) technicians audit farm operations (see Appendix A for evaluation criteria), prepare a report on the farm, and decide if the farm is entitled to certification. The producer is responsible for costs related to transportation of auditors to the farm and auditors wages. After this, Rainforest

Alliance and the producer sign a contract ruling the use of the label and product marketing. The producer agrees to have his/her certified farm subject to annual supervision, and to pay an annual certification fee (Rainforest Alliance 2004). Rainforest Alliance and its partners do not participate in the commercialization process of the products. Producers may use the certification to get a premium over the market price between 5 to 20%. Other benefits of the certification process are reducing inputs and improving farm management (Rainforest Alliance 2004). Costs for individual producers generally include the costs of the changes needed for the farm to be certified (investments and changes in the production system), and certification processing costs (certification audit(s) plus an annual certification fee). In the case of associated producers, costs also include organization related expenditures.

Data collection

I conducted semi-structured interviews with three agricultural technicians in the San Vicente de Chucurí FEDECACAO Technical unit during June, 2004, in order to locate fourteen farms where I carried out the field studies. I asked the agronomists to introduce me with respondents located in their assigned work areas. I also asked the agronomists about agroecological characteristics of the regions under their influence, as well as aspects of the opportunity cost of labor in the region, such as wages, and demand for labor (See Appendix B. Agronomists Survey).

In July, 2004, I conducted fieldwork (direct observation and measurements) and interviews with farmers to determine production factors, use of hired labor, culture

practices, and, weed, pest, and disease management practices for each farm (Appendix B. Farmers Survey and Field Guide). I evaluated farms from the standpoint of compliance with RA/SAN standards (Appendix A), which included practices for conservation and restoration of natural ecosystems; composition of shade; firewood consumption; soil protection; plant nutrition; weed management; integrated pest management; safe management of agrochemicals; harvest and post-harvest practices; fair treatment of workers; waste management; and, water management. I established changes to implement in each farm to achieve these standards, and produced a set of technical recommendations for each farm.

I also analyzed archival documentation from FEDECACAO and Casa LUKER. Some of these documents included technical recommendations for cacao cultivation in the region (which I used for modeling each farm's production conditions), and information regarding costs for cacao production in the region (used to refine farm budgets during the financial analysis phase). I performed other informal inquiries during this research: prices for agricultural inputs from local stores; cacao prices paid to producers by middlemen; categories used in the region to classify cacao quality; and prices for transportation and building materials in the region. I used this information to construct farm budgets during the analysis phase.

Analytic Methods

Modeling the farms

I constructed farm models spanning 10 years, both under current production conditions (Alternative A) and under a certification agreement with RA/SAN (Alternative B), for each farm. Farm models included estimates of production --calculated based on yield reported by farmer; area cultivated in cacao (ha); planting density (number of trees/ha); genetic material; age of the plants; and rate of replacement of lost productive sites-- and labor and material requirements derived from cultural practices used in the farm. I only considered hired labor to estimate labor requirements because this research focused on the analysis of cash flows in the farms. Farm models for Alternative B included changes in the production system needed to achieve RA/SAN standards.

Financial analysis

I used farm models to calculate budgets for alternatives A and B following Gittinger (1982) and Brown (1979).

I only took into account income and expenditures derived from cacao sales and cultivation. I did not include the cost of land for both alternatives A and B, since the farmers already own the land. I assumed that there were no property taxes, income taxes, or financial costs, such as mortgages. I also assumed that cacao prices and exchange rates would be constant and a no-inflation scenario. These assumptions allow the analysis to focus on the certification issue under the familiar *ceteris paribus* (all other factors remaining equal) conditions of economics.

In the budgets for Alternative A, all costs correspond to variable costs. This is the baseline case or current situation of the farm operations, requiring no special investments.

For Alternative B, variable costs were affected by increments to production costs attributable to paying benefits to permanently hired workers (which under Alternative A: current conditions, are not being awarded) and increases in organic fertilization as required by the certification program. Additionally, I considered the following certification-related fixed costs:

- 1) The investment done in the first year to adapt the farm to RA/SAN requirements, which were typically: constructing a waste water treatment system; planting shade trees; pruning existing shade trees; recycling non-organic waste; and constructing a device for cacao fermentation.
- 2) Administrative costs of belonging to an association created for the purpose of obtaining certification
- 3) Costs of certification auditing
- 4) Per-hectare annual certification fee

Fixed costs for subsequent years are:

- 1) Maintenance of the wastewater treatment system, fertilization of shade trees, pruning existing shade trees, and, recycling non-organic waste
- 2) Administrative costs of belonging to an association created for the purpose of obtaining the certification
- 3) Per-hectare annual certification fee

I used budgets to build 10-year cash flows for each farm under Alternatives A and

B. Cacao selling price remained constant by assumption.

Since the main factors affecting yield did not change for Alternative B under adoption of RA/SAN requirements, the impact of adopting the biodiversity certification on the annual production (expressed as a penalty coefficient) was set to zero.

I generated Net Present Values (NPV's) with a ten-year horizon for each alternative, without and with certification. I used NPV's without certification to group farms into three income categories. Six farms with an average NPV of \$22,192,438 (Colombian pesos) composed the low-income category; five farms with an average NPV of \$75,159,929 made up the middle-income category; and three farms with an average NPV of \$267,424,882 were included in the high-income category. The discount rate was 5.8% (interest rate applied for Colombian banks to loans for cacao production minus inflation). I compared the two computed Net Present Values for each farm (NPV without certification and NPV with certification) to evaluate the financial viability of certification, and calculated the minimum selling price for certified cacao for each farm. This value is the selling price at which the net income in the certified farm equals the net income under current conditions. Therefore, this minimum price allows determination of the base premium, or the increment in the selling price over which certification represents a financial advantage for the farmer. I also calculated an incentive premium for certification, which is the increment over the selling price that allows the farmer to cover certification costs and obtain a 10% income increase (compared to the farm without certification).

Risk analysis of the investment

I completed a risk analysis for individual farms and farms grouped by income. This analysis focused on main variables affecting NPV's in certified cacao farms, namely, yield, internal price of cacao, and annual production and certification costs, taking into account the expected values of these variables and the dispersion around these expected values. I modeled each variable as follows:

Internal price of cocoa: I created a model not for the price itself, but for the change in price; I assumed the change in price has a mean equal to zero (that is, the average price remains constant) and a standard deviation equal to 16.55%. The standard deviation was derived from the historical behavior of the internal price of cocoa during the last 15 years. I used a normal probability distribution to model the price changes.

Annual production of each farm: Based on the expected annual production of each farm, I used a triangular probability distribution (minimum, most likely, maximum) to model this variable. I set the most likely value to the expected value of the production and assumed a range of variation of +/-20%; that is, the minimum and maximum values were equal to 80% and 120% of the expected annual production of each farm.

Production and Certification costs: I modeled this third variable in the same manner as the annual production, using a triangular probability distribution and assuming a variation of +/- 20%.

Parameters for which I did not model variability include:

Inflation rate: For the whole financial analysis I assumed there was not inflation throughout the 10-year time span.

U.S. Dollar / Colombian Peso exchange rate: I modeled the entire study using Colombian Pesos, because this is the relevant monetary unit for the farmers' decision making.

Interest rate of discount: As mentioned before, I used a real discount rate of 5.8% in the financial analysis. This value remains constant throughout the 10 years time span.

Statistical analysis

I used a single factor ANOVA ($\alpha=0.05$) to compare means for Costs of Certification, Relative income decrement when certifying without a premium, Base Premiums, and Incentive Premiums, among farms grouped into three income categories: Low, Middle and High income. For the ANOVA comparing risk of producing eco-labeled cacao between groups I used the samples' coefficients of variation for the NPV's yielded by the risk analyses. The hypotheses tested were of the type:

$$H_0: \mu_1 = \mu_2 = \mu_3$$

$$H_1: \mu_1 \neq \mu_2 \neq \mu_3$$

I also used a two factor without replication ANOVA ($\alpha=0.05$) to compare the three cost categories compounding total costs of certification (Increment in production costs, Cost of investments, and Costs of certification processing) between years (First year and subsequent years under certification) and among income levels (Low, Middle and High). The hypothesis tested were of the type:

Costs first year versus costs subsequent years

$HA_0: \mu_1 = \mu_2$

$HA_1: \mu_1 \neq \mu_2$

Costs among High, Middle and Low income groups

$HB_0: \mu_1 = \mu_2 = \mu_3$

$HB_1: \mu_1 \neq \mu_2 \neq \mu_3$

Finally, I found the probability of certified farms receiving a premium earning less income than under current conditions (no certified) using the sets of 10.000 NPV generated by the risk model.

RESULTS AND DISCUSSION

Twelve out of 14 farmers considered their cacao farms as profitable, and reported earnings derived from cacao. All the farmers in the study were aware of practices of ecological agriculture, and used them to different degrees. Only one out of fourteen farmers used external inputs (pesticides) on his farm, and all the farmers did organic fertilization. At the moment of this study, the farmers were already informed about the generalities of eco-certification. All of them would undergo a certification process if premiums were guaranteed, and conditions such as financial and technical external support were present. Regarding social organization, most of the farmers in the study (8) were members of APROCAFRUM, and two of them were members of a smaller farmers' group called ASOFRUTAS (See *Social aspects of cacao production* in this document).

I evaluated the financial impact that certification by Rainforest Alliance would have on the finances of cacao farmers and their families by estimating certification costs, premiums required, and financial risk of the investment in certification. I compared the

financial impact of the certification process among three income categories, which I defined using current income (NPVa) in the farm operations (Fig. 3). I calculated group means and standard deviation for area, productivity and production costs (Table 6).

Productivity for low-income farmers is 284 kg-ha/year, 119 kg-ha/year less than the Colombian national average of 403 kg-ha/year (FEDECACAO 2004b), and costs for kilogram of cacao produced (current production costs/ha over kg cacao/ha, without considering family labor) of this income group are higher than for middle and high-income farmers. Currently these farmers are earning an average of \$174,415 Colombian pesos a month (US\$ 69 at the exchange rate for October 2004, approximately), less than half of the monthly legal minimum salary in Colombia. Monthly income for middle and high categories was \$656,085 and \$1,911,337 respectively (US\$262 and US\$765 approximately). Income in the farms depends on cacao selling price and farm production, which is on its time a function of productivity (kg cacao/ha year) and area of the farm. Marked differences on income among groups are explained by differences in farm productivity and farm size (Table 6).

Costs of certification

I calculated means and standard deviations of total certification costs/hectare (10 year horizon) for each income category. I clustered certification costs in three categories (Increment in production, Investments, Certification processing) to detect differences in type of certification related expenses for the three income groups studied. I compared the

magnitude of these cost categories between the first year and subsequent years (an average of the subsequent nine years) of certification.

There was no statistically significant difference for total certification costs per hectare for a ten years horizon among low, high and middle-income farms (Appendix C, a) Certification costs). However, although certification costs/ha are statistically similar (Fig. 4), there is a significance trend ($p = 0.0627$, ANOVA single factor $\alpha = 0.05$, Appendix C, b) for differences in income decrements between Low, Middle and High income farms when certifying without a premium (Fig. 5), suggesting a dissimilar financial impact from investing in certification among the three groups analyzed. Research on organic coffee in Mexico has shown that the smallest farms are being left out of certification programs because of their inability to cover certification costs (Bray, Sánchez and Murphy 2002). This could happen as well with small cacao farmers in the Santander Mountains because of their extreme poverty.

When comparing the three different components of total certification costs by income category (Fig. 6, 7 and 8), results were:

Increment in production costs per hectare/year

For the first and subsequent years under certification, this increment was mainly attributable to paying benefits to permanently hired workers (which are not being awarded currently), increases in organic fertilization, and pruning of existing shade trees. A p value of 0.0581 (Appendix C, c) implies a significance trend for differences among income groups. The high-income group experiences a larger increment in the cost category production costs during the first and subsequent years (Fig. 6) than the middle

and low-income group do. In the farms sampled, production costs are variable costs, directly dependent from yield (Table 6). When yield is translated into productivity (yield/area) larger costs are seen for more productive operations, which is the case for the high-income group (Fig. 9). Another factor affecting production costs is the origin of labor. Most work in the high-income farms is done by permanent hired labor, while for the middle and low-income farms the farmers themselves are the main workers and permanent hired labor is not prevalent. The RA eco-label requires paying workers legal benefits, which represents an increase in the cost of labor mainly affecting high-income operations heavily dependant on hired labor. It is noteworthy to say that although this certification label addresses health care and labor benefits for hired workers in the farms, the need for health care and labor benefits that farm owners and their families currently have would continue unresolved under a certification program.

Cost of investments per hectare/year

The statistical analysis shows a trend ($p = 0.0720$, Appendix C, d) for differences in investment costs among first and subsequent years (Fig. 7). This difference is explained by the fact that for the first year under certification, investment costs were due to activities with more intensive labor and materials requirements (planting of new shade trees, installation of a wastewater treatment system, and installation of devices for cacao fermentation), than those needed during the subsequent years under certification (annual pruning and fertilization of the shade trees, and annual maintenance of the wastewater treatment system).

Costs of certification processing per hectare/year

These costs were due to expenses from belonging to a farmers organization, auditors travel expenses, auditors fees, and certification annual fees. The statistical analysis yielded significant differences in the average cost of certification processing among income groups ($p = 0.0454$, Appendix C, e), and a trend ($p = 0.0772$ Appendix C, e) for significant differences in certification processing costs between years. Farmers in low-income farms have higher certification processing costs/ ha than middle and high-income operations (Fig. 8). Certification processing costs tend to remain constant for all farms independently of their size; when expressed by hectare, these costs are relatively higher for low- income farmers with small farms than for middle and high-income farmers with larger farms.

Certification costs represented substantial increments in costs for all the income groups analyzed in at least two of three cost categories analyzed (Fig. 6, Fig. 7 and Fig. 8). Given that all the farms had no or very low dependence on external inputs, this result coincides with Sorby's (2002) findings of low-input technology coffee farms experiencing increases in costs when certifying. Consequently, income decrements with certification without obtaining a premium were large for all the income groups (Fig. 5), making investment in certification for the present scenario financially unviable.

Premiums

I calculated price premiums based on NPV's under three certification scenarios (Fig.10): no certified farm operations (current conditions, NPVa), farm operations

certified without obtaining a premium (NPVb), and farm operations certified obtaining a premium allowing them to increase current income --NPVa-- by ten percent (NPVi). Premiums were based on the cacao selling price in July 2004 (\$3500 approximately). I calculated two types of premiums (Fig. 11): (1) Base premium, understood as the increase in selling price sufficient to cover certification costs, or to equal NPVa (current operation selling at market price) and NPVb (certified operation selling at market price); and, (2) Incentive premium, which is the increment in selling price required to cover certification costs and to obtain 10% more income than under current conditions.

Base premiums

There were not significant differences for base premiums (Fig. 11 and Appendix C, f) Base premium), however the p value of 0.1090 from the ANOVA indicates a dissimilarity trend. This trend may be explained by looking at relative income decrements in low, middle and high-income farms (Fig. 5). The higher the relative income decrement caused by certifying the farm --(NPVa-NPVb)/ NPVa--, the larger the base premium that is needed to cover such decrement (Fig. 12).

Incentive premiums

Incentive premiums were significantly different statistically among income groups (Appendix C, g) Incentive premium). The fact that Incentive premium is the increase in the selling price required to cover certification costs and to increase current income by 10% implies a relationship between farm income (NPV) previous to certification and the magnitude of Incentive premium -- the premium required to make

investment in certification financially viable--. NPV's and productivity (Fig. 9) are correlated, to more productivity higher NPV. When comparing productivity against premiums (both, base and incentive premiums), there is an inverse correlation (Fig. 13); low-income farms with lower productivity require higher premiums than more productive middle and high-income farms.

Taking into account that RA/SAN certification criteria consider social and ecological aspects of cacao production, incentive premiums needed to make certification profitable for middle and high-income groups (23.43%, and 20.34%, respectively) in the farms studied in Santander seem viable; Rainforest Alliance reports that farmers certified under this label may obtain premiums between 5 and 20% over the market price (Rainforest Alliance 2004). It is unlikely that Rainforest Alliance certified low-income farmers could obtain the calculated price premium of 48.1%, unless a partnership with a fair trade organization is established. Also, when looking at the premiums calculated in this study, it is important to have in mind that such premiums were calculated at a moment when the monthly international price of cacao (Table 5) was at one of its highest points (almost equaling mean + 1 SD) for the last 73 months. Consequently, premiums to make certification profitable will have to increase when a highly likely fall in cacao international price occurs.

Risk analysis

The term “risk” makes reference to the volatility of the Net Present Values (NPVs) of the future cash flows of farms cultivating cacao under certified operations, denoting the dispersion of the NPVs around their corresponding expected values.

I did individual assessments of the risk (Appendix D) of producing cacao under certification for each farm, considering yield, production costs under certification, and incentive price (price that allows the farmer to cover certification costs and to obtain a 10% income increment taking current income as a base). Ten thousand simulations yielded a coefficient of variation for the NPV of each farm in an “under certification” scenario.

Statistical analysis (Appendix C, h) Risk) determined no differences in the means of Coefficients of Variation among income groups (Fig. 14). When analyzing risk data -- dispersion values -- by income group to find the probability of obtaining a lesser NPV under certification than in current conditions, results are very similar among groups (Fig. 15), fluctuating between 47% a 48%, which means that for all income groups, farmers may or may not loose money under a scenario of certification obtaining a premium.

CONCLUSIONS AND RECOMMENDATIONS

The income decrements for farms under a certification without a premium scenario make it highly unlikely that farmers will decide to certify their farms with Rainforest Alliance/Sustainable Agriculture Network, which currently does not participate in the commercialization of certified products. An alliance between the

certification organization, FEDECACAO, and chocolate processing companies --like the one currently taking place between RA/SAN, KRAFT, and Federación Nacional de Cafeteros for Colombian certified coffee --would allow linking certification and commercialization to effectively reward farmers through premiums. The uncertainty of obtaining premiums underscores the need to support groups of farmers undergoing the certification process financially and organizationally. Government institutions could subsidize or cover the cost of systems for wastewater treatment, one of the requirements for certification, since wastewater management is such a basic aspect of environmental health. The costs of increasing shade in the farms can be covered through incentives for reforestation. An institution such as FEDECACAO could help by decreasing the costs of association, which included technical assistance. Experiences with sustainable coffee demonstrate that consolidated farmers' organizations --which require years of coordinated inter-institutional effort and resource allocations-- are key factors to the success of certification programs.

Credit is a very important factor to consider when establishing a scheme for buying cacao to the producers out of the conventional channels. Prevalently, farmers depend on money lent to them by the same middlemen buying their cacao. Such money is used to pay for production costs and for household expenses, and is paid during the harvest season when the farmers take their cacao production to the middlemen. The middlemen pay the farmers the difference between the amount borrowed plus an interest, and the value of the cacao produced. This mechanism is highly advantageous for the middlemen, because allows them to keep captive as much cacao production as they can

afford, and to manipulate prices. Hence, a program for commercialization of certified cacao must be based in a credit system supplying the financial needs of participating farmers.

Even if low-income cacao farmers can obtain premiums like the ones calculated in this research, they would not represent considerable improvements in their financial well being given that these farmers and their families have currently a monthly income that is half of the Colombian minimum salary. Whether a certification program happens or not, is imperative to help low-income farmers to improve their productivity, before they are compelled to abandon the cacao farms or to switch to much less environmentally and sociable desirable, profitable alternatives, such as coca cultivation, a phenomenon that is presently taking place in the proximities of the study region.

There is no certainty about the financial benefits of certification in the long- term, fluctuating scenario of cacao. Certification programs can achieve risk reduction through mechanisms to decrease variability in the factors affecting income. Technical assistance can help to improve productivity and increase cost-efficiency in farms, while offering a minimum price such as the one guaranteed under fair trade schemes can minimize the income fluctuations due to decrements in price.

On a scenario with similar certification costs for all income groups, poor farmers face a disproportionately higher financial burden that makes certification prohibitive for them, while middle-income farmers probably will need credit to pay for certification related expenses. Certification programs attempting to reach a broad base of farmers must consider that production and financial conditions of the farms are very

heterogeneous, and that productivity and income level determine the feasibility of certification for the farmers and the benefits they experience in the process.

TABLES AND FIGURES

Table 1. Wild fauna species reported as present in cacao farms or their proximities

Local Name	English name	Scientific name
Mammals		
Ñeque	Agouti	<i>Dasyprocta</i> spp.
Armadillo	Armadillo	<i>Dasypus</i> spp.
Zaino	Collared peccary	<i>Tajassu tajacu</i>
Ardilla	Squirrel	<i>Sciurus</i> spp.
Oso hormiguero	Anteater	<i>Myrmecophaga tridactyla</i>
Tigrillo	Ocelot	<i>Felis</i> sp.
Zorrillo	Skunk	<i>Conepatus semistriatus</i>
Oso perezoso.	Sloth	<i>Bradypus variegatus</i>
Oso de anteojos	Spectacled bear	<i>Tremarctos ornatus</i>
Birds		
Tucán	Toucan	<i>Rhamphastos</i> sp.
Gualilo	Wattled guan	<i>Aburria aburri</i>
Tinamú del Magdalena	Tinamou	<i>Crypturellus saltuarius</i>
Churica	Orange-chinned Parakeet	<i>Brotogeris jugularis</i>
Guacharaca	Chachalaca	<i>Ortalis</i> sp.
Snakes		
Talla X, patoco		<i>Bothrops</i> spp.
Coral	Coral	<i>Micrurus</i> sp.
Cazadora negra		<i>Clelia clelia</i>
Sapa		<i>Porthidium</i> sp.

Table 2. Tree species commonly used for shade in the study zone

Used for shade and/or wood		Fruit trees	
Common name	Scientific Name	Common name	Scientific Name
Moncoro	<i>Cordia gerascanthus</i>	Aguacate (avocado)	<i>Persea americana</i>
Nauno	<i>Albizzia guachapele</i>	Platano (plantain)	<i>Musa acuminata</i>
Anaco, bucaro	<i>Erythrina</i> spp.	Naranja (orange)	<i>Citrus</i> spp.
Guamos	<i>Inga</i> spp	Mandarina (tangerine)	<i>Citrus</i> spp.
Ceibas	<i>Pochota</i> spp	Limón (lemon)	<i>Citrus</i> spp.
Cucharo	<i>Rapanea ferruginea</i>	Papaya (papaya)	<i>Carica papaya</i>
Urumo	<i>Cecropia</i> sp	Guayaba (guava)	<i>Psidium guajava</i>
Guacimo	<i>Guazuma ulmifolia</i>	Mango (mango)	<i>Mangifera indica</i>
Balso	<i>Ochroma</i> sp	Guanábana	<i>Annona muricata</i>
Cucharo	<i>Swartzia macrophylla</i>		
Cedro	<i>Cedrela</i> sp.		

Table 3. Main cacao-producing countries (FEDECACAO 2004c)

Country	Production (tonnes)
Cote d' Ivoire	1,175,000
Indonesia	408,000
Ghana	395,000
Nigeria	185,000
Brazil	163,000
Cameroon	125,000
Ecuador	85,000
Colombia	36,070
Malaysia	35,000

Table 4. Colombia cacao imports/exports balance. FOB and CIF in thousands of dollars (Observatorio Agrocadenas 2004, based on DANE/DIAN data)

Year	Exports	Imports	Exp/Imp balance
1991	20,352	673	19,679
1992	14,617	1,902	12,715
1993	18,636	4,531	14,105
1994	21,105	5,952	15,153
1995	23,299	9,989	13,310
1996	26,389	6,794	19,595
1997	22,891	10,266	12,625
1998	17,760	12,463	5,297
1999	17,507	18,068	-561
2000	10,782	15,913	-5,131
2001	28,346	13,357	14,989
2002	31,436	28,738	2,698

Table 5. International monthly cacao prices-US\$ cents/lb (ICCO 2004)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	mean
1999	66.01	63.89	59.57	53.8	48.2	52.7	50.5	47.92	48.14	46.33	41.84	41.67	51.71
2000	41.63	38.97	42.32	41.34	41.23	42.71	42.49	39.82	40.06	39.83	36.33	36.45	40.27
2001	43.84	52.48	51	49.06	48.97	44.1	43.87	46.91	46.26	49.21	56.28	60.64	49.39
2002	62.79	67.67	72.21	71.18	72.82	75.24	84.76	88.93	98.16	100.03	82.29	91.75	80.65
2003	99.1	101.57	90.48	87.44	79.37	71.63	70.78	71.28	74.01	67.22	68.54	73.81	79.6
2004	73.68	71.17	68.24	65.2	64.13	63.86	70.74	78.44					

Table 6. Income level, area, productivity, and production costs for current farm operations

Income group	n	NPV _a (10 years)		Area (hectares)		Productivity (kg/ha)		Current production costs ha/year (pesos)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Low	6	\$ 22,192,438	\$ 12,453,784	4.80	1.35	284	116	\$ 355,998	\$ 138,015
Middle	5	\$ 75,159,929	\$ 5,833,191	8.60	2.19	540	71	\$ 618,026	\$ 278,952
High	3	\$ 267,424,882	\$ 140,423,915	12.67	2.31	1,303.19	552.25	\$ 1,659,887	\$ 821,824

Figure 1. Study area. (Municipio de San vicente de Chucurí 1998)

Figure 2. Main cacao-producing provinces in Colombia. Year 2002
(Map: Instituto Geográfico Agustín Codazzi 2000, Data: FEDECACAO 2004a)

Figure 3. Current income by group. The bars show Net Present Values per farm with a time horizon of 10 years for farms producing cacao under current conditions (without certification). Values are means $\pm$ 1 Standard Deviation.

Figure 4. Certification Costs per hectare by income group. Certification costs/ha are calculated for a time horizon of 10 years. Values are means $\pm$ 1 Standard Deviation.

Figure 5. Relative Income decrements when certifying without a premium. Values are averages $\pm$ Standard Error. P value ($P=0.0627$, ANOVA single factor $\alpha=0.05$) suggests a significance trend for differences among income groups.

Figure 6. Increment in production costs per hectare under certification. Values are averages $\pm$ Standard Error. P value ($P=0.0581$, ANOVA two factors $\alpha=0.05$) suggests a significance trend for differences among income groups. There are no significant differences between years.

Figure 7. Costs of investments per hectare under certification. Values are averages $\pm$ Standard Error. P value ($P=0.0720$, ANOVA two factors $\alpha=0.05$) suggests a significance trend for differences in costs of investments between years. There is no difference among income groups.

Figure 8. Certification processing costs per hectare. Values are averages $\pm$ Standard Error. Significant differences among groups ($P=0.0454$, ANOVA two factors $\alpha=0.05$). There is a trend ($P=0.0772$ ANOVA two factors $\alpha=0.05$) for significant differences between years.

Figure 9. Relationship between income of current farm operations and productivity. The graphic compares the average cacao production of one hectare with the income obtained from one hectare. From left to right, points show productivity and income for low, middle and high-income categories.

Figure 10. Farm income under different certification scenarios. NPVa corresponds to current conditions (no certification, no premium). NPVb is certification without a premium, and NPVbi is certification with a premium to cover costs and increase earnings 10% with respect to NPVa. Values are means $\pm$ 1 Standard Error.

Figure 11. Base and incentive premiums by income group. Base premium is the increase in selling price (approximately \$3500/kg in July 2004) required to cover certification costs in a given income category (dotted bars). Incentive premium is the increase in selling price to cover certification costs and increase current earnings by 10%. Statistical analysis showed a trend ($P=0.1090$) for differences in Base premium, and significant differences ($P=0.0450$) for the magnitude of Incentive premium among income groups. Values are means $\pm$ 1 Standard Error.

Figure 12. Relationship between relative income decrement for certification without a premium and base premium. The dashed line shows the income decrement experienced by an income group when certifying without obtaining a premium, expressed as a percentage of income currently perceived. The solid line shows the percentage in which the cacao selling price has to be increased to avoid this income decrement (Base Premium).

Figure 13. Relationship productivity/premiums. This graphic shows how more productive operations (High and Middle income farms) require smaller premiums (or increases over the selling price) than less productive low-income farms.

Figure 14. Risk analysis for certified operations. The bars show the Coefficient of Variation (Standard deviation/Mean) expressing the dispersion of 10.000 NPV values (obtained in the simulation model) with respect to the mean (expected NPV of certified farms in a given category).

Figure 15. Probability of expected income for certified farms being lesser than current income. The bars show the income farmers are currently earning (left Y axis), while the points show the percentage of NPVs (right Y axis) that were smaller than that income in the simulation.

REFERENCES

- Alcaldía de San Vicente de Chucurí. 2001. Plan de Desarrollo del Municipio de San Vicente de Chucurí. 2001-2003. Photocopied.
- Altieri, M. A., Laura Merrick. 1988. Agroecology and In Situ Conservation of Native Crop Diversity in the Third World. In *Biodiversity: Proceedings of the National Forum on Biodiversity*, Washington D.C, 1986, edited by E. O., Wilson and, Frances M. Peter. Washington D. C: National Academy Press, 361-369.
- Alves, M. C. 1990. The Role of Cacao Plantations in the Conservation of the Atlantic Forest in Southern Bahia, Brazil. Master Thesis, University of Florida.
- Andrade, G. 1993. Biodiversidad y Conservacion en Colombia. In *Nuestra Diversidad Biológica*. Memorias del Primer Seminario Internacional de Biodiversidad, Bogotá, 1992, edited by S. Cárdenas. Bogotá: CEREC, 25-43.
- Boon. E. 2000. Ghana. In *The reality of Sustainable Trade*, edited by Robins, N. and S. Roberts. Documents in Sustainable Trade and Supply Chains. International Institute for Environment and Development: London.
- Bowen, Brid. 2002. Let's go Fair. In *EFTA Yearbook: Challenges of Fair Trade 2001-2003*. EFTA (European Federation of Fair Trade). Available at: <http://www.eftafairtrade.org/document.asp?DocID=229>
- Bray, D., Sánchez, J. L., and Ellen Murphy. 2002. Social Dimensions of Organic Coffee Production in Mexico: Lessons for Eco-labeling initiatives. *Society and Natural Resources*, 15: 429-446.
- Brown, M. 1979. *Farm Budgets: from farm income analysis to agricultural project analysis*. Baltimore: The World Bank/John Hopkins University Press.
- Clarence-Smith, W. G. 1997. Cocoa Plantations in the Third World, 1870's-1914: the political economy of inefficiency. In *The New Institutional Economics and Third World Development*, edited by John Harris, Janet Hunter, and Colin M. Lewis. Routledge: London, 157-171.
- Collinson, C., and Marcelo Leon. 2000. *Economic Viability of Ethical Cocoa Trading in Ecuador*. Natural Resources and Ethical Trade Programme, Natural Resources Institute, University of Greenwich. Report 2519. Available at: <http://www.globalexchange.org/campaigns/fairtrade/cocoa/CocoaEcuadorNRI.pdf>
- Etter, A. 1993. Diversidad Ecosistémica en Colombia Hoy. In *Nuestra Diversidad Biológica*. Memorias del Primer Seminario Internacional de Biodiversidad, Bogotá, 1992, edited by S. Cárdenas. Bogotá: CEREC, 43-62.
- Etter, A. 1998. Ecosistemas Amenazados. In *Cambio: Especial Colombia Ecológica*. Octubre, 54.
- Evans, Harry. 1998. *Disease and Sustainability in the Cocoa Agroecosystem*. Paper presented at the First Sustainable Workshop on Sustainable Cocoa Growing,

- Panamá City, Panamá, March 30-April 2, 1998. Available at:
<http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Cacao/evans.cfm>
- FEDECACAO. 1998. Censo Cacaotero. Photocopied.
- FEDECACAO. 2004a. Principales Departamentos Productores de Cacao en Grano 2001-2002. Departamento de Estadística, FEDECACAO. Available at:
<http://www.fedecacao.com/tablas/entornonacional/departamentos.swf>
- FEDECACAO. 2004b. Area cosechada, producción registrada de cacao en grano y productividad 1991-2001. Departamento de Estadística, FEDECACAO. Available at: <http://www.fedecacao.com/tablas/entornonacional/areayprod.swf>
- FEDECACAO 2004c. Principales países productores de cacao en grano. Departamento de Estadística, FEDECACAO. Available at:
<http://www.fedecacao.com/tablas/entornointernacional/paisesprod.swf>
- Gentry, A. 1993. *El significado de la Biodiversidad*. In *Nuestra Diversidad Biológica*. Memorias del Primer Seminario Internacional de Biodiversidad, Bogotá, 1992, edited by S. Cárdenas. Bogotá: CEREC, 13-25.
- Gobbi, José A. 2000. Is biodiversity-friendly coffee financially viable? An analysis of five different coffee production systems in western El Salvador. *Ecological Economics*, 33:267-281.
- Gittinger, P. 1982. *Economic Analysis of Agricultural Projects*. Baltimore: The World Bank/John Hopkins University Press.
- Gobierno de Colombia-UNODOC 2004. Censo de Cultivos de Coca en Diciembre de 2004. Available at:
<http://www.unodc.org.co/Publicaciones/Informe%20coca%20colombia%202003%20final%20espanol.pdf>
- Greenberg, R., Bichier, P., and John Sterling. 1997. Bird Population in Rustic and Planted Shade Coffee Plantations of Eastern Chiapas, Mexico. *Biotropica* 29, 4:501-514.
- Gresser, Charis and Tickell, Sophia. 2002. *Mugged: Poverty in your Coffee Cup*. Oxfam International. Available at: <http://maketradefair.com>
- Hernández- Camacho, J. A. Hurtado Guerra, R. Ortiz Quijano and Thomas Walschburger. 1992. Unidades biogeográficas de Colombia. In *La diversidad biológica de Iberoamérica*, edited by G. Halffter, Acta Zoológica Mexicana, 1:105-151.
- ICCO. 2003. Fair trade cocoa and chocolate. International Cocoa Organization. Available at: <http://www.icco.org/questions/fairtrade.htm>

- ICCO. 2004. ICCO Monthly and Annual Averages of Daily Prices of Cocoa Beans, 1960 – 2004. International Cocoa Organization. Available at: <http://www.icco.org/prices/pricesave.htm>
- Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. 2003. *Unidades Biogeográficas de Colombia / Biogeographic units of Colombia*. Available at: www.humboldt.org.co/biota/Mapas/Mapa%20Unidades%20Biogeogr%0E1ficas.pdf
- Kautz, T., and R. Gradstein. 2001. On the Ecology and Conservation of *Spruceanthus theobromae* (Lejuneaceae, Hepaticae) from Western Ecuador. *The Bryologist* 104, 4: 607-612.
- Kotto, J., Woome, P. L., Appolinaire, M., and Zapfack Louis. 1997. Carbon Dynamics in Slash and Burn Agriculture and Land Use Alternatives of the Humid Forest Zone in Cameroon. *Agriculture, Ecosystems and Environment*, 65: 245-256.
- Lovejoy, T. E. 1997. Biodiversity: What is it?. In *Biodiversity II. Understanding and Protecting our Biological Resources*, edited by M. L. Reaka, D. E. Wilson and Edgar O. Wilson. Washington D.C: Joseph Henry Press, 7-14.
- MAX HAVELAAR. 2002. Cocoa criteria and conditions of FLO, April 25 2002. Available at: <http://www.globalexchange.org/campaigns/fairtrade/cocoa/transfair111998.html>
- Maes, M., and Wendel Trio. 2002. Let's go Fair. In *EFTA Yearbook: Challenges of Fair Trade 2001-2003*. EFTA (European Federation of Fair Trade). Available at: <http://www.eftafairtrade.org/document.asp?DocID=229>
- Ministerio de Agricultura Colombiano and IICA. 2001. Acuerdo Sectorial de Competitividad de la Cadena del Cacao y su Agroindustria. In *Colección de Documentos IICA: Serie Competitividad, Octubre 4/2001*. Available at http://www.agrocadenas.gov.co/documentos/acuerdo_cacao.pdf
- Ministerio del Medio Ambiente. 1999. Tipos de Vegetación en Colombia. Available at <http://minambiente.gov.co/biogeol>
- Myers, N. 1997. The Rich Diversity of Biodiversity Issues. In *Biodiversity II. Understanding and Protecting our Biological Resources*, edited by M. L. Reaka, D. E. Wilson and Edgar O. Wilson. Washington D.C: Joseph Henry Press, 125-138.
- Nestel, D. 1995. Coffee in Mexico: international market, agricultural landscape and ecology. *Ecological Economics*, 15: 165-178.
- Noss, R. F., and Allen Y. Cooperrider. 1994. *Saving Nature's Legacy: Protecting and Restoring Biodiversity*. Washington D.C: Island Press.

- Observatorio Agrocadenas. 2004. Balanza Comercial Cacao y sus Preparaciones. Available at http://www.agrocadenas.gov.co/indicadores/ind_sector_balanza19.htm
- Orozco, M. L. 2002. Colombia Sector Agropecuario 1998-2001: Agrovision Colombia 2025. Available at http://www.agrocadenas.gov.co/agrovision/Documentos/agrovision_informe_final.pdf
- Parrish, J., Reitsma, R. and Russell Greenberg. 1998. *Cacao as Crop and Conservation Tool: Lessons from the Talamanca Region, Costa Rica*. Paper presented at the First Sustainable Workshop on Sustainable Cocoa Growing, Panamá City, Panamá, March 30-April 2, 1998. Available at <http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Cacao/parrish.cfm>
- Pimentel, D., Stachow, U., Takacs, D. A., Brubaker, H. W., Dumas, A. R., Meaney, J. J., O'Neil, J. A., Onsi, D. E., Corzilius, D. V. 1992. Conserving Biological Diversity in Agricultural/Forestry Systems. *BioScience* 42, 5:354-362.
- Prance, G. T. 1990. Rainforested Regions of Latin America. In *Lessons of the Rainforest*, edited by S. Head and R. Heinzman. San Francisco: Sierra Club Books, 53-65.
- Putz, F.E. and V. Viana. 1996. Biological Challenges for Certification of Tropical Timber. *Biotropica* 28, 3: 323-330.
- Rain Forest Alliance. 2002. *Normativas para la Produccion de Cacao*. Red de Agricultura Conservacionista, Standards for Cacao Production. Available at: <http://www.rainforest-alliance.org/programs/cap/socios/cocoa-s.pdf>
- Rain Forest Alliance. 2004. Conservation Programs: Sustainable Agriculture. Available at <http://www.rainforest-alliance.org/programs/cap/can-members.html>
- Raven, P. H. 1988. Our Diminishing Tropical Forests. In *Biodiversity: Proceedings of the National Forum on Biodiversity*, Washington D.C, 1986, edited by E. O., Wilson and, Frances M. Peter. Washington D. C: National Academy Press, 119-122.
- Reitsma, R., Parrish, D., and William McLarney. 2001. The role of Cacao Plantations in Maintaining Forest Avian Diversity in Southeastern Costa Rica. *Agroforestry Systems*, 53:185-193.
- Renkema, David. 2002. *Coffee: The Speculators' Plaything*. EFTA Yearbook: Challenges of Fair Trade 2001-2003. EFTA (European Federation of Fair Trade). Available at: <http://www.eftafairtrade.org/document.asp?DocID=229>
- Rice, A. Robert and Justin Ward. 1996. *Coffee, Conservation and Commerce in the Western Hemisphere*. White Paper No. 2 by the Smithsonian Migratory Bird Center. Washington DC: Smithsonian Migratory Bird Center/Natural Resources Defense Council.

- Rice, Robert, and Russell Greenberg. 2000. Cacao Cultivation and the Conservation of Biological Diversity. *Ambio* 29, 3: 167-713.
- Rice, Robert, and Russell Greenberg. 2003. The Chocolate Tree: Growing cacao in the forest can provide a living and a habitat to diverse creatures. *Natural History* 112, 6: 36-44.
- Robins, N. and Tom Fox, eds. 2000. *Stimulating Sustainable Trade*. Phase 2. Documents in Sustainable Trade and Supply Chains. London: International Institute for Environment and Development.
- Robins, N., and Sarah Roberts, eds. 2000. *Sustainable Markets: Documents in Sustainable Trade and Supply Chains*. London: International Institute for Environment and Development.
- Roth D. S., Perfecto, I., and Beverly Rathcke. 1994. The Effects of Management Systems on Ground-Foraging Ant Diversity in Costa Rica. *Ecological Applications* 4, 3:423-436.
- Ruf, F. and Honoré Zadi. 1998. *Cocoa: From Deforestation to Reforestation*. Paper presented at the First Sustainable Workshop on Sustainable Cocoa Growing, Panamá City, Panamá, March 30-April 2, 1998. Available at <http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Cacao/ruf.cfm>
- Somarriba, E. and John Beer. 1998. *Cocoa-Based Agroforestry Production Systems*. Paper presented at the First Sustainable Workshop on Sustainable Cocoa Growing, Panamá City, Panamá, March 30-April 2, 1998. Available at <http://nationalzoo.si.edu/conservationandscience/migratorybirds/research/cacao/somarriba.cfm>
- Sorby, Kristina. 2002. *Toward more sustainable coffee*. Background Paper to World Bank Agricultural Technology Note 30. June 2002. Available at [http://lnweb18.worldbank.org/ESSD/ardext.nsf/26ByDocName/ProductionCostsandIncomefromSustainableCoffee/\\$FILE/ATN30BackgroundPaper3.pdf](http://lnweb18.worldbank.org/ESSD/ardext.nsf/26ByDocName/ProductionCostsandIncomefromSustainableCoffee/$FILE/ATN30BackgroundPaper3.pdf)
- Thiollay, J.M. 1995. The Role of Traditional Agroforests in the Conservation of Rain Forest Bird Diversity in Sumatra. *Conservation Biology* 9, 2: 335-353.
- Tucker, R. P. 1990. *Five Hundred Years of Tropical Forest Exploitation*. In *Lessons of the Rainforest*, edited by S. Head and R. Heinzman. San Francisco: Sierra Club Books, 39:52.
- Van Der Hammen, T. 1998. *País Perdido*. In *Cambio: Especial Colombia Ecológica*. Octubre, 40-43.
- Wilson, E. O. 1988. *The Current State of Biological Diversity*. In *Biodiversity: Proceedings of the National Forum on Biodiversity*, Washington D.C, 1986, edited by E. O., Wilson and, Frances M. Peter. Washington D. C: National Academy Press, 1:18.

- Wood, G. A. and R.A. Lass. 1978. *Cocoa*. Third Edition. Longman: London.
- Young, Allen. 1994. *The Chocolate Tree*. Smithsonian Institution Press: Washington D.C.
- Zapfack, L., Engwald, S., Sonke, B., Achoundong, G., and, Birang A. Madong. 2002. The impact of land conversion on plant biodiversity in the forest zone of Cameroon. *Biodiversity and Conservation* 11: 2047-2061.

APPENDICES

Appendix A. Framework for the analysis of compliance with the Rainforest Alliance guidelines

Criteria	Indicators and standards	Means of verification
Conservation and restoration practices	<ul style="list-style-type: none"> Areas not suited for cultivation must be devoted to conservation Natural/restoration habitats must be delimited 	<ul style="list-style-type: none"> Visual verification in the field Farm maps
	<ul style="list-style-type: none"> Width buffer zone between natural ecosystem and productive area: 5 meters (native species or natural succession) Width buffer zone for streams: 10-50 meters (both banks must be protected). Minimum two rows of trees per buffer zone, 2-3 meters separation between rows and 2-3 meters between trees. The species used in reforestation must have different heights. Vegetation barriers must consist of two rows of several species, having each row two strata (trees and bushes). The corridors for wildlife must be in correspondence with the adjacent type of habitat and vegetal community 	<ul style="list-style-type: none"> Visual inspection in the field for <ul style="list-style-type: none"> Mono/multi-species Different heights of trees Measurement of planting distances Correspondence with the adjacent type of habitat and vegetal community will be determined by comparing the species used against the description given by the Ministerio del Medio Ambiente Colombiano (1999) for the natural vegetal communities in the region
	<ul style="list-style-type: none"> Density, and species composition of shade: 40 shade trees/ha and 4 species/ha Minimum one pruning of shade trees a year Firewood must come from species planted for that purpose, and/or from pruning of shade trees. Otherwise, firewood must be replaced with gas or electricity 	<ul style="list-style-type: none"> Three (3) 20 x 20 m sample areas/farm. Direct measure planting distances for shade trees. Visual inspection in the field for species composition Questions in interview asking <ul style="list-style-type: none"> Pruning frequency Sources of energy for cooking and sources of firewood
	<ul style="list-style-type: none"> Priority of mechanical and/or – manual control of weeds Fire is forbidden as a weed control practice The only synthetic herbicide allowed is glyphosate 	<ul style="list-style-type: none"> Questions in interview asking <ul style="list-style-type: none"> Whether fire is used as an agricultural practice Weed control method Frequency of weed control
Soil protection	<ul style="list-style-type: none"> Measures for conservation of soils 	<ul style="list-style-type: none"> Questions in interview asking about <ul style="list-style-type: none"> Frequency of tillage Practices of weed control Availability of soil analysis Utilization of organic fertilizers Visual inspection in the field for <ul style="list-style-type: none"> Ground covers Barriers

Cont. Appendix A. Framework for the analysis of compliance with the Rainforest Alliance guidelines

Criteria	Indicators and standards	Means of verification
Integrated Pest Management Plan (IPMP)	<ul style="list-style-type: none"> ▪ Implementation of IPMP <ul style="list-style-type: none"> ▪ Pest monitoring to determine thresholds of economic damage, in order to apply pesticides only when the pest population exceeds such thresholds ▪ Biocontrol as first alternative ▪ Pesticides utilized must be registered in the United States and/or the European Union for use in cacao, EPA (Environmental Protection Agency) approved, and ICA (Instituto Colombiano Agropecuario) registered ▪ Decrease in pesticide dosage and/or application cycles must be demonstrated ▪ The products must be alternated in order to avoid resistance ▪ Avoid pesticide with toxicity I and II (applications of these categories must be justified) 	<ul style="list-style-type: none"> ▪ Questions in interview asking <ul style="list-style-type: none"> ▪ How the application decisions are made in the farm ▪ How many times a year is needed an application for each sanitary problem in the crop ▪ How is the calendar of applications and/or the products rotation used ▪ Dosage of each product ▪ Knowledge/utilization of biocontrols ▪ Direct inspection of products used in the farm looking for <ul style="list-style-type: none"> ▪ Commercial and common name of product ▪ Toxicological category ▪ The list of products used in each farm will be compared with the ICA listings of registered products for cacao, as well as with the United States and European Union listings.

Cont. Appendix A. Framework for the analysis of compliance with the Rainforest Alliance guidelines

Criteria	Indicators and standards	Means of verification
Program for the Safe Management of Agrochemicals (PSMA)	<ul style="list-style-type: none"> ▪ Implementation of PSMA <ul style="list-style-type: none"> ▪ None of the pesticides in the “Dirty Dozen” (Pesticide Action Network 1995) is allowed, neither are products whose license for use in cacao has been canceled ▪ Material Safety Data Sheets for pesticides ▪ Transportation of pesticides according to paragraph 5.3 in Normas e Indicadores para la Certificación del Cultivo del Cacao (Red de Agricultura Sostenible and Rainforest Alliance 2002) ▪ Facilities for storage of agrochemicals must be located at a minimum of <ul style="list-style-type: none"> ▪ 60 m from buildings ▪ 100 m from public roads ▪ 120 m from water bodies ▪ 200 m from water sources for human consumption ▪ 50 m from tanks for combustible storage ▪ and, follow the infrastructure rules set by paragraph 5.4 in Normas e Indicadores para la Certificación del Cultivo del Cacao (Red de Agricultura Sostenible and Rainforest Alliance 2002) ▪ Application of agrochemicals must be ruled by paragraph 5.5 in Normas e Indicadores para la Certificación del Cultivo del Cacao (Red de Agricultura Sostenible and Rainforest Alliance 2002), which follow the principles set by EPA (Environmental Protection Agency) for that matter. 	<ul style="list-style-type: none"> ▪ The list of products used in each farm will be checked for compliance with the guidelines of the Pesticide Action Network (1995). ▪ Direct inspection of the vehicles/equipment/facilities used in transportation, storage, and application of pesticides. ▪ Questions in the interview asking for <ul style="list-style-type: none"> ▪ Who is responsible of making applications ▪ What safety precautions are taken ▪ How is the equipment handled before and after applications ▪ Where the equipment/clothes used in application are washed ▪ Direct measure of distances between facilities for storage of agrochemicals and buildings, public roads, water bodies, water sources and storage of combustibles. ▪ Comparison with the findings in the farm with standares set in paragraphs 5.3,5.4,5.5 in Normas e Indicadores para la Certificación del Cultivo del Cacao (Red de Agricultura Sostenible and Rainforest Alliance 2002)

Cont. Appendix A. Framework for the analysis of compliance with the Rainforest Alliance guidelines

Criteria	Indicators and standards	Means of verification
Harvest and post-harvest practices	<ul style="list-style-type: none"> ▪ The harvested cacao beans will be managed according to the standard set by paragraph 5.6 in Normas e Indicadores para la Certificación del Cultivo del Cacao (Red de Agricultura Sostenible and Rainforest Alliance 2002) 	<ul style="list-style-type: none"> ▪ Direct inspection of <ul style="list-style-type: none"> ▪ Recipients for collection ▪ Bags for transportation ▪ Fermentation devices ▪ Structures for drying ▪ Questions in the interview asking for <ul style="list-style-type: none"> ▪ Management of harvest remnants ▪ Quality standards
Integrated Waste Management Plan (IWMP)	<p>Implementation of IWMP (Integrated Waste Management Plan) based on Reduce-Reuse-Recycle principles. The criteria for waste management are described in Chapter 6 of Normas e Indicadores para la Certificación del Cultivo del Cacao (Red de Agricultura Sostenible and Rainforest Alliance 2002)</p>	<ul style="list-style-type: none"> ▪ Questions in the interview asking about waste management practices and knowledge/utilization of recycling, reusing and composting ▪ Direct inspection of devices and/or structures used for waste management in the farm
Water management	<ul style="list-style-type: none"> ▪ Water management criteria based on conservation of the quantity and quality of the resource are described in Chapter 7 of Normas e Indicadores para la Certificación del Cultivo del Cacao (Red de Agricultura Sostenible and Rainforest Alliance 2002) 	<ul style="list-style-type: none"> ▪ Questions in interview asking for <ul style="list-style-type: none"> ▪ Water consumption ▪ Water treatment systems/devices ▪ Monitoring of water quality ▪ Direct inspection of <ul style="list-style-type: none"> ▪ Water bodies in the farm ▪ Places where water is collected and consumed ▪ Drains
Fair treatment of workers	<ul style="list-style-type: none"> ▪ Compliance with ILO (International Labor Organization) standards, and with national labor legislation 	<ul style="list-style-type: none"> ▪ Questions in interview asking for <ul style="list-style-type: none"> ▪ Wages ▪ Vacation ▪ Legal benefits to workers (health care, retirement funds, workers compensation)

Appendix B. Survey Tools. Agronomists Survey – Spanish version
San José State University-Departamento de Estudios Ambientales
Cultivo del cacao en la Montaña Santandereana
Encuesta Técnicos

Institución: _____

Nombre: _____

Cargo: _____

1. Cuántas fincas atiende esta oficina? _____
2. Cuántas son su responsabilidad? _____
- 3.Cuál es el tamaño de finca más común en su zona _____
4. De las fincas en su zona, cuántas de ellas están produciendo cacao para la venta en la actualidad?

5. Por favor identifique al menos 10 agricultores en la zona que podrían estar interesados en cooperar con esta investigación.

Agricultor	Finca	Agricultor	Finca

6. Usando una escala de 1 a 3, califique el bienestar económico de estos agricultores.

7. Califique de 1 a 5 los problemas sanitarios mas limitantes para el cultivo del cacao en la zona.

Enfermedades	Plagas
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

8. Por favor describa la cadena de comercialización del cacao en esta zona.

9. Por favor enuncie la escala de calidad y precios para cacao utilizada por los compradores en esta zona.

10. Cuáles son las entidades prestando apoyo financiero a los productores de cacao en esta región, y como califica usted dicho apoyo?

Appendix B. Survey Tools. Agronomists Survey - English version
San José State University-Environmental Studies Department
Cacao cultivation in the Santander Mountains

Institution: _____

Name: _____

Position: _____

1) How many farms does this office serve? _____

2) How many are your responsibility? _____

3) What are the most common farm sizes in this region?

4) How many farms are currently producing and selling cacao?

5) Please identify at least ten farmers in the region whom could be interested in cooperating with this research.

Farmer	Farm	Farmer	Farm

6) In a scale from 1 to 3, please qualify the financial well-being of these farmers.

7) In a scale from 1 to 5, please qualify the most limiting sanitary problems for cacao cultivation this region.

Diseases	Insects
1.	1.
1.	2.
2.	3.
3.	4.
4.	5.

8. Please describe the cacao marketing chain in your influence region.

9. Please name the different cacao quality grades and their prices at the different sales points in this region.

10. Which are the organizations giving financial support to the cacao producers in this region? How do you qualify such support?

Appendix B. Survey Tools. Farmers Survey. Spanish version
 San José State University- Departamento de Estudios Ambientales
 Cultivo del cacao en San Vicente y El Carmen
 Encuesta con agricultores

Código de la Finca	Código Propietario
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1. Cuantos árboles de cacao tiene en su finca?

2. A qué distancia de siembra está plantado el cacao?

3. Cuánto es el área de cacao en su finca?

4. Cultiva usted *Comunes* o *Híbridos*?

5.Cuál es la edad de sus plantas de cacao?

a) *Menos de 3 años* _____

b) *Entre 3 y 7 años* _____

c) *Entre 7 y 20 años* _____

d) *Más de 20 años* _____

6) Resiembra usted plantas de cacao que han muerto o que están enfermas o improductivas?

7) Cuántas plantas resiembra usted en un año? _____

8) Cuántos jornales gasta en resiembra? _____

9) Cada cuánto tiempo realiza usted podas en el cacao y cuántos jornales gasta?

10) Cada cuánto tiempo realiza usted podas en el sombrío y cuántos jornales gasta?

11) De dónde provienen la energía usada en la finca?

Fuente	Electricidad	Gas	Carbón/otro	Leña

12) Si usa leña, esta proviene de

a) *Poda de sombrío* _____

b) *Bosque* _____

c) *Otras fuentes, como socas de café* _____

13) Emplea usted a alguien en su finca? _____

14) Cómo contrata?

a) *Formal* _____

b) *Informal* _____

15) Si contrata formalmente,

a) *salario \$* _____

b) *vacaciones* _____

- c) *salud* _____
- d) *pensiones* _____
- e) *cesantías* _____
- f) *riesgos profesionales* _____

16) Cómo controla usted malezas en cacao?

17) Con qué frecuencia controla usted malezas?

18) Cuántos jornales usa usted en cada desayerba? _____

19) Fertiliza usted el cacao? _____

20) Cuántas veces al año fertiliza?

21) Cómo decide usted cuándo y cuánto fertilizar?

22) Qué abonos usa usted y en qué cantidades?

23) Cuántos jornales gasta usted por abonada

24) Controla usted plagas y enfermedades en cacao? _____

25) Qué plagas y enfermedades controla usted, y con qué método?

26) Cuántas veces al año controla usted cada problema?

27) Cómo decide usted cuándo y con que método controlar cada problema?

28) Cuándo escoge control químico, qué pesticidas utiliza y en qué dosis?

29) Cuántos jornales gasta usted fumigando cada enfermedad o peste?

30) Calibra usted sus fumigadoras? _____

31) Posee usted boquillas diferentes para aplicar

a) Herbicidas _____

b) Fungicidas _____

c) Insecticidas _____

32) Quién realiza las aplicaciones de pesticidas en la finca? _____

33) Ha recibido dicha persona entrenamiento en manejo de pesticidas?

34) Posee usted equipo de seguridad para aplicación de pesticidas? De qué tipo?

35) Es dicho equipo usado por la persona encargada de asperjar? _____

36) Describa las precauciones que se toman en la finca durante y después de aplicar pesticidas.

37) Dispone la finca de un lugar separado para lavar ropa y equipo contaminados?

38) Cómo transporta usted pesticidas hasta la finca?

39) En la finca?

40) Posee la finca una bodega para almacenar pesticidas? _____

41) Describa la cosecha y poscosecha en la finca

a) Cosecha y apertura de la
mazorca _____

b) Manejo de residuos de
cosecha _____

c) Acopio en el campo

d) Cómo y dónde fermenta y seca

e) Duracion del proceso de fermentado.

f) Recipientes usados en cosecha y transporte

g) Cuántos viajes realiza para mercadear el producto?

h) Cuántos jornales se gasta en cosechar, preparar el cacao para la venta y comercializarlo?

42) A dónde va a parar la basura proveniente de

a) cultivo _____

b) Casa _____

c) Otros envases plásticos _____

d) Envases de pesticidas _____

43) De dónde proviene el agua que se usa en la finca?

44) Cuál es el destino de las aguas residuales de la finca?

45) Realiza usted alguna(s) practica(s) para conservar el suelo?

Descríbala(s) _____

46) Es el cacao un buen negocio para usted?

47) Si no lo es, está usted perdiendo dinero?

48) Alguien en su familia ha emigrado debido a la mala situación económica?

49) Por favor asigne su ingreso a una de las siguientes categorías (por definir)

a) _____ b) _____ c) _____ d) _____

Appendix B. Survey Tools. Farmers Survey. English version

San José State University-Environmental Studies Department
Cacao cultivation in Santander Mountains

Farm Code	Owner Code
-----------	------------

- 1) How many cacao trees there are in the farm _____
- 2) What are the planting distances for cacao in your farm?

- 3) What is the area cultivated in cacao in your farm? _____
- 4) Are your cacao trees Comunes or Híbridos?

- 5) Assign the age of their crops to one of the following categories:
 - a) *Less than 3 years old* _____
 - b) *Between 3 and 7 years old* _____
 - c) *Between 7 and 20 years old* _____
 - d) *More than 20 years old* _____
- 6) Do you re-plant cacao plants in sites where the trees have died or are very ill?

- 7) How many sites do you replant in a year? _____
- 8) How many man/days do you spend in doing it? _____
- 9) How often the cacao trees are pruned, and how much labor (man/days) this practice requires? _____
- 10) How often the shade trees are pruned, and how much labor (man/days) this practice requires? _____
- 11) Where your energy for cooking and other uses comes from?

Source	Electricity	Gas	Coke/other	Firewood
- 12) If firewood, do you obtain it from:
 - a) *Pruning of shade trees* _____
 - b) *Natural ecosystems* _____
 - c) *Other sources like pruning of coffee trees* _____
- 13) Do you utilize hired labor in you farm _____
- 14) How do you hire them
 - a) *Formally* _____
 - b) *Informally* _____
- 15) If formally,
 - a) *wages \$* _____
 - b) *vacation* _____

- c) *health care* _____
- d) *retirement funds* _____
- e) *unemployment prevision* _____
- f) *workers compensation* _____

16) How do you control weeds in cacao?

17) How often do you control weeds in cacao?

18) How many man/days do you use in each weed control activity?

19) Do you fertilize the cacao trees?

20) How many times in a year do you fertilize?

21) How do you decide when and how much to fertilize?

22) Which fertilizers do you use and in what dosages?

23) How many man/days do you use in each fertilization?

24) Do you control pests and diseases in the cacao trees?

25) What pests and diseases do you control?

26) How many times a year do you control for each of the above-mentioned pests?

27) How do you decide when and how control each of the above-mentioned pests and diseases?

28) When using chemical control, what pesticides do you use and in what dosages?

29) How many man/days do you use spraying for each disease?

30) Do you calibrate your spraying equipment?

31) Do you have separate nozzles for

a) Herbicides _____

b) Fungicides _____

c) Insecticides _____

32) Who is responsible of doing pesticides applications?

33) Have that person had training for doing pesticides applications?

34) Do you have safety equipment for pesticides application? What kind?

35) Does the person in charge of applications use such equipment?

36) Describe the precautions used during and after applications.

37) Is there in the farm a separate place for washing contaminated clothes and equipment?

38) How do you transport pesticides from the store to the farm?

39) Inside the farm?

40) Is there in the farm a separate place for storing agrochemicals?

41) Describe the harvest and fermentation practices in the farm.

a) Harvesting and cutting the pod open

b) Management of harvest remnants

c) Temporary storage in the crop site

d) Fermentation practices and facilities

e) Duration of the fermentation process.

f) Recipients used for harvest and transportation

g) Amount of traveling associated to marketing the product.

h) How many man/days are dedicated to harvest, post/harvest and marketing respectively?

42) What destination do you give to

a) Harvest remnants

b) Domestic residues

c) Plastic containers

d) Agrochemicals containers

43) Where do you get water from?

44) Where the wastewater from the farm and the house goes?

45) Do you realize any practices to conserve the soil? Please name and describe

46) It is cacao profitable for you?

47) If not, are you losing money?

48) Has someone in your family emigrated because of financial difficulties?

49) In which of the following categories (to be defined) does your income fall?

a) _____ b) _____ c) _____ d) _____

Appendix B. Survey Tools. Field Guide. Spanish version

San José State University-Departamento de Estudios Ambientales

Cultivo del cacao en San Vicente y El Carmen

Encuesta de Fincas

Guía de campo

I. INFORMACION GENERAL DEL PREDIO

Código de la Finca	Código Propietario
Altura sobre el nivel del mar	Precipitación anual
Temperatura media annual	Lat-Long aproximada
Zona de vida según Holdridge	

II. CULTIVO DEL CACAO

Area cultivada		Número de plantas		Distancia de siembra	
Material de Siembra		Comunes		Híbridos	
Factores de Producción	Producción/año	Edad		E. sanitario	
Podas en cacao		Frecuencia (podas/año)		Jornales/poda	
Sombrío					
Especies		Densidad/distancia		Usos	
Labores en el sombrío					
Podas	Frecuencia	Método	Criterio	%	
Desyerba	Frecuencia	Método/producto	Criterio	Intensidad/dosis	
Fertilización	Frecuencia	Producto	Criterio	Dosis	
Control sanitario	Frecuencia	Producto	Criterio	Dosis	

V. LABORES DE CULTIVO

Podas	Jornales	Frecuencia	Método	Criterio	%
Fertilización	Jornales	Frecuencia	Producto	Criterio	Dosis
Malezas		Frecuencia	Método/prod ucto	Criterio	Intensidad/d osis
Control sanitario	Jornales	Frecuencia	Producto	Criterio	Dosis
Cosecha	Jornales	Frecuencia	Producto	Criterio	Producción
Poscosecha	Jornales	Frecuencia	Producto	Criterio	Pérdidas
Secado					
Selección					
Empaque					

VI. MERCADEO

Mercadeo	Empaques	Costo/ Unidad	Costo transporte	Precio		
				Grado I %	Grado II %	Rechazo %
Comentarios						

VII. MAQUINARIA Y EQUIPO

Herramienta/a parato	Cantidad	\$/unidad	\$/total	Estado	Comentarios
Labranza					
Fumigadora					
Boquilla fungicida					
B. insecticida					
B. herbicida					
Machetes					

Guadañas					
Escalera					

VIII. CONSERVACION DE SUELOS

Siembras en contorno	
Barreras vivas	
Coberturas	

IX. MANEJO DEL AGUA EN EL PREDIO

Origen		Acueducto Rural			Nacimiento	
Riego artificial	Si	No	Trampa de grasas	Si	No	Laguna de oxidación /sedimentación
Alcantarillado rural		Vertidos de lavado de equipos			Llaves y cheques	

X. INFRAESTRUCTURA

Edificaciones		
Tipo	Cantidad	Uso
Almacén		
Bodega		
Lavado de equipos		
Otros		

XI. CARRETERAS Y CAMINOS INTERNOS

Tipo	Longitud	Ancho

V. CULTIVATION PRACTICES

Pruning	Man/day	Frequency	Method	Criteria	%
Fertilization	Man/day	Frequency	Method	Criteria	Dosage
Weeds control	Man/day	Frequency	Method/product	Criteria	Intensity/dosage
Pest/disease control	Man/day	Frequency	Product	Criteria	Dosage
Harvest	Man/day	Frequency	Product	Criteria	Production
Post-harvest	Man/day	Frequency	Product	Criteria	Losses
Drying					
Selection					
Packaging					

VI. MARKETING

Marketing	Packages	Cost/Unit	Transportation cost	Prices		
				Grade I %	Grade II %	Rejection %
Comments						

VII. MACHINERY AND EQUIPMENT

Tool/machine	Quantity	\$/unity	\$/total	Condition	Comments
Tillage					
Aspersions					
Accessory fungicide					
A. insecticide					
A. herbicide					
Machetes					

Brushcutters					
Stairs					

VIII. SOIL CONSERVATION

Level plantings	
Live barriers	
Ground Coverage	

IX. WATER MANAGEMENT IN THE FARM

Origin		Rural Aqueduct			Spring	
Artificial Watering	yes	no	Grease trap	yes	no	Oxidation/sedimentation lagoon
Rural sewage		Destination of waste water from equipment washing			Faucets and checks	

X. INFRASTRUCTURE

Buildings		
Type	Quantity	Use
Storage		
Drying		
Equipment washing		
Others		

XI. ROADS AND INTERNAL PATHS

Type	Length

Appendix C. Statistical Tests. a) Certification costs.

Certification Costs per ha			
	High	Medium	Low
	4,945,904.61	3,965,970.00	5,127,527.00
	8,376,377.57	4,692,339.12	2,586,585.00
	3,177,717.14	1,639,183.65	2,748,085.00
		2,781,447.50	1,779,198.58
		2,447,345.00	5,630,790.00
			3,357,737.00
mean	5,499,999.77	3,105,257.05	3,538,320.43
variance	6,986,783,638,038.52	1,486,682,100,513.62	2,312,279,765,626.08
skewness	1.207477		
Log-normal Transformation			
	High	Medium	Low
	15.41	15.19	15.45
	15.94	15.36	14.77
	14.97	14.31	14.83
		14.84	14.39
		14.71	15.54
			15.03
mean	15.44	14.88	15.00
variance	0.24	0.17	0.19
skewness	0.161364		

ANOVA Single Factor, $\alpha=0.05$

H_0 : Cc Li = Cc Mi = Cc Hi $\therefore H_0$: 3,538,320.43 = 3,105,257.05 = 5,499,999.77

H_1 : Cc Li $\neq$ Cc Mi $\neq$ Cc Hi $\therefore H_1$: 3,538,320.43 $\neq$ 3,105,257.05 $\neq$ 5,499,999.77

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
High	3	46.33	15.44	0.24
Medium	5	74.41	14.88	0.17
Low	6	90.00	15.00	0.19

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0.62	2	0.31	1.60502728	0.244558729	2.859508186
Within Groups	2.11	11	0.19			
Total	2.73	13				Accept H_0

Appendix C. Statistical Tests. b) Income decrement when certifying without a premium

Income Decrement			
	High	Medium	Low
	35%	34%	198%
	26%	58%	90%
	8%	16%	49%
		16%	26%
		18%	58%
			35%
mean	23.13%	28.25%	75.92%
variance	1.84%	3.38%	40.61%
skewness	2.596779		
Log-normal Transformation			
	-104.46%	-108.36%	68.20%
	-135.50%	-54.09%	-10.32%
	-247.47%	-185.94%	-72.02%
		-184.55%	-135.28%
		-172.41%	-54.14%
			-105.41%
mean	-162.48%	-141.07%	-51.49%
variance	56.59%	33.80%	52.76%
skewness	0.448934		

ANOVA Single Factor, $\alpha=0.05$

$H_0: Id Li = Id Mi = Id Hi \therefore H_0: 75.92\% = 28.25\% = 23.13\%$

$H_1: Id Li \neq Id Mi \neq Id Hi \therefore H_1: 75.92\% \neq 28.25\% \neq 23.13\%$

SUMMARY

Groups	Count	Sum	Average	Variance
High	3	-487.43%	-162.48%	56.59%
Medium	5	-705.35%	-141.07%	33.80%
Low	6	-308.96%	-51.49%	52.76%

ANOVA

Source of variation	SS	df	MS	F	P-value	F crit
Between groups	3.352181317	2	1.676090658	3.59979195	0.062707826	3.982307817
Within groups	5.121684108	11	0.465607646			
Total	8.473865424	13				

Accept H_0 (Significance trend)

Appendix C. Statistical Tests. c) Increment in production costs per hectare under certification

Increment in Production Costs/ha			
	Low	Medium	High
First Year	\$0	\$83,316.01	\$238,554.00
Subsequent Years	\$0	\$84,200.20	\$375,617.41

ANOVA Two factors without replication, $\alpha=0.05$

Increment in production costs/ha first year versus Increment in production costs/ha subsequent years

$HA_0: Ipc\ Fy = Ipc\ Sy \therefore HA_0: \$107,290 = \$153,272$

$HA_1: Ipc\ Fy \neq Ipc\ Sy \therefore HA_0: \$107,290 \neq \$153,272$

Increment in production costs/ha among groups

$HB_0: Ipc\ Li = Ipc\ Mi = Ipc\ Hi \therefore H_0: \$0 = \$83,758 = \$307,085$

$HB_1: Ipc\ Li \neq Ipc\ Mi \neq Ipc\ Hi \therefore H_1: \$0 \neq \$83,758 \neq \$307,085$

SUMMARY	Count	Sum	Average	Variance
First Year	3	321,870.01	107,290.00	14,658,067,024.59
Subsequent Years	3	459,817.61	153,272.54	38,850,350,968.81
Low	2	0	0	0
Medium	2	167,516.21	83,758.10	390,893.78
High	2	614,171.41	307,085.71	9,393,189,348.23

ANOVA

Source of variation	SS	df	MS	F	P-value	F crit
Years	3,171,589,999.6	1	3,171,589,999.6	1.0194776	0.41893737	18.5127646
Groups	100,794,845,744.3	2	50,397,422,872.1	16.199775	0.05814029	19.0000264
Error	6,221,990,242.4	2	3,110,995,121.2			
Total	110,188,425,986.4	5	Accept HA_0 Accept HB_0 (Significance trend for differences between groups)			

Appendix C. Statistical Tests. d) Cost of investments per hectare under certification

Investments per hectare			
	Low	Medium	High
First Year	\$365,659.79	\$212,973.67	\$196,899.38
Subsequent Years	\$186,651.09	\$131,118.11	\$115,283.42

ANOVA Two factors without replication, $\alpha=0.05$

Investments costs/ha first year versus Investment costs/ha subsequent years

$HA_0: Ic Fy = Ic Sy \therefore HA_0: \$258,510 = \$144,350$

$HA_1: Ic Fy \neq Ic Sy \therefore HA_0: \$258,510 \neq \$144,350$

Investment costs/ha among groups

$HB_0: Ic Li = Ic Mi = Ic Hi \therefore H_0: \$276,155 = \$172,045 = \$156,091$

$HB_1: Ic Li \neq Ic Mi \neq Ic Hi \therefore H_1: \$276,155 \neq \$172,045 \neq \$156,091$

SUMMARY	Count	Sum	Average	Variance
First Year	3	775,532.84	258,510.95	8,675,251,745.65
Subsequent years	3	433,052.63	144,350.88	1,404,665,745.36
Low	2	552,310.88	276,155.44	16,022,056,549.76
Medium	2	344,091.78	172,045.89	3,350,165,987.65
High	2	312,182.80	156,091.40	3,330,582,489.27

ANOVA

Source of variation	SS	df	MS	F	P-value	F crit
Years	19,548,782,541.4	1	19,548,782,541.4	12.3960958	0.07205956	18.5127646
Groups	17,005,812,496.8	2	8,502,906,248.4	5.39178543	0.15645080	19.0000264
Error	3,154,022,485.2	2	1,577,011,242.6			
Total	39,708,617,523.4	5				

Accept HA_0 (Significance trend for differences between years)
Accept HB_0

Appendix C. Statistical Tests. e) Costs of certification processing per hectare

Certification Processing			
	Low	Medium	High
First Year	213,168.73	122,283.86	87,940.69
Subsequent Years	142,181.34	83,202.08	62,055.36

ANOVA Two factors without replication, $\alpha=0.05$

Certification processing costs/ha first year versus Certification processing costs/ha subsequent years

$H_{A0}: C_p F_y = C_p S_y \therefore H_{A0}: \$141,131 = \$95,812$

$H_{A1}: C_p F_y \neq C_p S_y \therefore H_{A0}: \$141,131 \neq \$95,812$

Investment costs/ha among groups

$H_{B0}: C_p L_i = C_p M_i = C_p H_i \therefore H_0: \$177,675 = \$102,742 = \$74,998$

$H_{B1}: C_p L_i \neq C_p M_i \neq C_p H_i \therefore H_1: \$177,675 \neq \$102,742 \neq \$74,998$

SUMMARY	Count	Sum	Average	Variance
First Year	3	423,393.28	141,131.09	4,186,929,151.33
Subsequent Years	3	287,438.78	95,812.93	1,724,318,324.06
Low	2	355,350.07	177,675.04	2,519,604,794.81
Medium	2	205,485.94	102,742.97	763,692,677.14
High	2	149,996.05	74,998.02	335,025,240.89

ANOVA

Source of variation	SS	df	MS	F	P-value	F crit
Years	3,080,604,411.55	1	3,080,604,411.55	11.45806049	0.077291933	18.51276465
Groups	11,284,776,649.48	2	5,642,388,324.74	20.98640984	0.045482642	19.00002644
Error	537,718,301.28	2	268,859,150.64			
Total	14,903,099,362.32	5	Accept H_{A0} (Significance trend for differences between years) Reject H_{B0} (Significant difference between groups)			

Appendix C. Statistical Tests. f) Base Premium

Base premium	High	Medium	Low
	21.69%	20.76%	110.02%
	14.60%	25.34%	12.50%
	6.07%	10.64%	32.36%
		12.44%	19.65%
		14.45%	41.44%
			23.63%
mean	14.12%	16.73%	39.93%
var	0.61%	0.38%	12.80%
skewness	2.979288		
Log-normal Transformation			
	High	Medium	Low
	-152.85%	-157.22%	9.55%
	-192.43%	-137.26%	-207.98%
	-280.17%	-224.06%	-112.81%
		-208.45%	-162.70%
		-193.47%	-88.09%
			-144.27%
mean	-208.48%	-184.09%	-117.72%
var	42.46%	12.98%	55.95%
skewness	0.874742		

ANOVA Single Factor, $\alpha=0.05$

$H_0: Bp Li = Bp Mi = Bp Hi \therefore H_0: 39.93\% = 16.73\% = 14.12\%$

$H_1: Bp Li \neq Bp Mi \neq Bp Hi \therefore H_1: 39.93\% \neq 16.73\% \neq 14.12\%$

SUMMARY

Groups	Count	Sum	Average	Variance
High	3	-625.44%	-208.48%	42.46%
Medium	5	-920.46%	-184.09%	12.98%
Low	6	-706.31%	-117.72%	55.95%

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.06694298	2	1.03347149	2.72876104	0.109057444	2.859508186
Within Groups	4.16606154	11	0.37873286			
Total	6.23300453	13			Accept H_0	

Appendix C. Statistical Tests. g) Incentive Premium

Incentive Premium			
	High	Medium	Low
	27.85%	26.89%	115.58%
	20.26%	29.93%	27.76%
	12.93%	17.47%	39.01%
		20.31%	27.25%
		22.55%	48.56%
			30.41%
mean	20.34%	23.43%	48.10%
var	0.56%	0.25%	11.60%
skewness	3.001232		
Log-normal Transformation			
	High	Medium	Low
	-127.83%	-131.33%	14.48%
	-159.67%	-120.64%	-128.15%
	-204.59%	-174.47%	-94.12%
		-159.40%	-130.00%
		-148.95%	-72.23%
			-119.05%
mean	-164.03%	-146.96%	-88.18%
var	14.87%	4.63%	30.26%
skewness	1.417607		

ANOVA Single Factor, $\alpha=0.05$

$H_0: \text{Ip Li} = \text{Ip Mi} = \text{Ip Hi} \therefore H_0: 48.10\% = 23.43\% = 20.34\%$

$H_1: \text{Ip Li} \neq \text{Ip Mi} \neq \text{Ip Hi} \therefore H_1: 48.10\% \neq 23.43\% \neq 20.34\%$

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
High	3	-492.09%	-164.03%	14.87%
Medium	5	-734.78%	-146.96%	4.63%
Low	6	-529.07%	-88.18%	30.26%

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	1.51126917	2	0.75563458	4.16525628	0.04501126	2.859508186
Within Groups	1.99555078	11	0.18141370			
Total	3.50681995	13				Reject H_0

Appendix C. Statistical Tests. h) Risk

CV of VPNs under certified operation			
	High	Medium	Low
	61.92%	59.18%	89.25%
	68.40%	81.82%	129.94%
	43.91%	51.75%	59.69%
		42.44%	47.24%
		46.11%	63.86%
			61.04%
mean	58.07%	56.26%	75.17%
var	1.61%	2.44%	9.09%
skewness	1.887022		
Log-normal Transformation			
	High	Medium	Low
	-47.94%	-52.46%	-11.37%
	-37.99%	-20.07%	26.19%
	-82.31%	-65.87%	-51.61%
		-85.71%	-74.99%
		-77.42%	-44.85%
			-49.36%
mean	-56.08%	-60.31%	-34.33%
var	5.41%	6.63%	12.96%
skewness	1.066747		

ANOVA Single Factor, $\alpha=0.05$

$H_0: R_{Li} = R_{Mi} = R_{Hi} \therefore H_0: 75.17\% = 56.26\% = 58.07\%$

$H_1: R_{Li} \neq R_{Mi} \neq R_{Hi} \therefore H_1: 75.17\% \neq 56.26\% \neq 58.07\%$

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
High	3	-168.24%	-56.08%	5.41%
Medium	5	-301.53%	-60.31%	6.63%
Low	6	-205.99%	-34.33%	12.96%

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0.20727592	2	0.10363796	1.11657285	0.36183681	2.8595081
Within Groups	1.02099706	11	0.09281791			
Total	1.22827299	13				

Accept H_0

Appendix D. Risk analysis

High	A	B	C			
mean	161,588,458.60	257,160,888.59	459,877,786.17			
sd	100,047,650.22	175,887,704.99	201,916,119.30			
cv	0.619150966	0.683959781	0.439064737			
min	-90,057,153.77	-145,634,996.6	-16,576,936.86			
max	760,739,222.40	1,275,643,846	1,640,593,376.			
p-1	-11,072,424.94	-47,492,380.96	99,879,188.94			
p-5	21,266,635.03	16,910,818.25	175,735,920.49			
p-10	45,127,086.45	54,790,493.74	225,483,518.72			
p-25	89,463,337.30	132,007,724.42	319,517,772.53			
p-50	149,548,648.04	234,573,232.40	436,092,291.71			
p-75	220,252,192.23	354,001,967.78	569,629,286.18			
p-90	292,627,648.56	484,443,547.53	716,519,751.99			
p-95	340,922,685.60	574,182,910.72	819,440,349.51			
p-99	455,151,429.67	798,466,496.52	1,065,115,820.			
Middle	D	E	F	G	H	
mean	76,809,674.86	77,800,280.14	76,575,298.49	89,421,715.42	88,625,258.97	
sd	45,456,912.35	67,397,689.02	39,627,773.41	41,228,571.55	37,613,517.45	
cv	0.591812326	0.866291084	0.517500737	0.461057712	0.424410804	
min	-24,820,384.99	-78,653,186.92	-12,908,086.65	-6,080,445.38	-367,073.21	
max	400,374,993.59	546,420,776.19	349,636,320.76	320,444,745.75	349,712,508.67	
p-1	-3,894,395.96	-39,355,619.19	6,730,600.00	17,890,046.16	21,327,825.32	
p-5	13,695,850.98	-15,386,138.93	21,773,323.30	32,954,011.09	36,536,681.39	
p-10	24,348,879.12	17,021.42	32,258,429.56	42,599,841.28	45,037,985.00	
p-25	45,312,545.91	30,413,368.92	49,294,089.22	60,520,679.51	62,342,712.86	
p-50	70,718,827.89	68,830,535.97	71,321,955.74	83,525,285.70	84,312,091.14	
p-75	102,367,585.25	115,474,125.49	97,953,491.05	112,007,288.31	109,443,045.66	
p-90	133,821,359.41	165,140,509.99	127,113,469.97	143,001,353.01	136,754,475.41	
p-95	158,910,051.07	200,939,942.14	148,090,132.67	166,409,343.18	155,106,232.77	
p-99	213,685,329.83	282,059,624.46	198,434,347.99	212,423,747.02	202,044,832.75	
Low	I	J	K	L	M	N
mean	5,042,684.59	10,370,094.87	28,455,866.79	31,412,931.85	39,958,682.19	30,814,275.94
sd	4,500,802.77	13,978,283.59	17,600,419.13	20,059,747.70	24,390,823.80	14,556,877.72
cv	0.892541005	1.347941727	0.618516359	0.638582473	0.610401106	0.472406937
min	-5,243,134.68	-23,559,245.47	-10,902,552.70	-14,975,712.17	-13,848,378.46	-4,765,156.23
max	33,884,439.34	86,052,113.56	152,216,218.75	177,315,487.42	187,291,546.14	108,473,272.21
p-1	-3,071,168.20	-15,458,330.63	-2,828,082.80	-3,824,092.30	-2,649,350.14	4,614,158.93
p-5	-1,367,668.32	-9,644,260.07	4,145,121.48	3,878,096.83	6,543,208.35	10,370,321.94
p-10	-261,416.67	-6,215,479.10	8,236,524.72	8,741,009.35	12,104,353.75	13,808,177.77
p-25	1,945,679.19	468,710.19	15,977,592.32	17,654,629.40	22,548,290.87	20,631,743.54
p-50	4,582,748.23	8,846,563.08	26,443,160.08	28,518,517.21	36,757,300.39	29,157,010.13
p-75	7,512,649.49	18,511,974.50	38,124,163.63	42,476,740.82	53,460,234.84	38,973,052.20
p-90	10,825,170.67	28,690,525.92	50,832,139.36	57,645,976.82	71,812,632.38	49,551,470.20
p-95	13,258,242.90	35,549,641.13	60,266,725.60	67,623,947.43	84,989,373.45	57,370,678.52
p-99	18,183,347.28	50,995,299.28	83,814,075.08	91,573,408.43	113,169,546.06	75,415,471.53

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II. STUDIES

Bachelor of Sciences. Agronomy. Facultad de Ciencias Agropecuarias -
Universidad de Caldas

Graduation date. December 15 1999.

Graduation thesis. Estado Actual del Conocimiento, la Conservación y
la Legislación Referente a Acceso y Propiedad Intelectual de la Diversidad
Vegetal en Colombia (Plant Diversity in Colombia: Current State of the
Knowledge, Conservation and Legislation on Access and Intellectual
Property). Awarded With Merit.

Master of Sciences. Environmental Studies. College of Social Sciences. San
Jose State University.

Planned graduation date. Fall 2004

III. WORK EXPERIENCE

College of Agricultural Sciences, 1993. Teaching Assistant Organic Chemistry.

Fundación Ka-Doariun, 1991. Instructor in workshops on essential oils
extraction for medicine men and women in the San Lorenzo Indian Reservation.
Riosucio. Caldas

PNR - Corporación Opción Colombia, 1994. Environmental education with
children, peasants and indigenous. Assessor for agricultural production and
stream protection in farms of ex-rebels from the PRT and EPL guerrillas. Design
of a community plan for restoration of Arroyo Mancomoján (Sucre).

Universidad de Caldas. Design and development of a program for reduction in pesticide use in Aldea Agrícola La Paz. Development of a program for manufacturing and marketing organic preserves Villamaría (Caldas).

BIOAMERICA LTDA, 1999. Design of efficacy tests for biopesticides and biocontrols in flowers crops in the Sabana de Bogotá area. Biology, behavior and management of chisas (COLEOPTERA) attacking flowers in the Sabana de Bogotá area-research Project.

FUNDACION NATURA, 2000. Design of the community plan for sustainable agricultural production in EL ENCINO (Santander).

FUNDACION NATURA, 2000. Essential oils as non-timber forest products in Tribuga (Choco). Preliminary feasibility study.

UICN-Sustainable Use Initiative. Andean Region. and INSTITUTO DE INVESTIGACION DE RECURSOS BIOLOGICOS ALEXANDER VON HUMBOLDT, 2000. Two case studies on sustainable use of biodiversity resources by traditional communities in the Cordillera Occidental, Valle del Cauca, Colombia. Work presented in the UICN annual conference in Amman (Jordan). October 2000.

CALIFORNIA FISH AND WILDLIFE SERVICE AND SAN JOSE STATE UNIVERSITY, 2003. Observational Study of Harbor Seal and Watercraft Activity around Bair Island in Redwood City, California.

DEPARTMENT OF ENVIRONMENTAL STUDIES, SAN JOSE STATE UNIVERSITY, 2004. Teaching Assistant for *Introduction to Sustainable Agriculture*

IV. PUBLICATIONS

Pequeños Habitats: Una aproximacion al concepto de agricultura sostenible (Small habitats: An approach to the sustainable agriculture concept). In: Luna Azul. No 1. 1997.

Estado Actual del Conocimiento, la Conservación de la Diversidad Vegetal en Colombia (Plant Diversity in Colombia: Current State of the Knowledge and Conservation). In: *Sistemas de Produccion*. V10, No. 2. 2001

Marco Jurídico en Torno al Acceso y Propiedad de Recursos Genéticos Vegetales y Productos Derivados (Legal Framework in Access and Property of Plant Genetic Resources and Derived Products). In: *Universidad de Caldas*. V21, No. 1. 2001.

Las Comunidades Locales y su Conocimiento Sobre Recursos de la Biodiversidad (Local Communities and Their Knowledge on Biodiversity Resources). In: *Luna Azul*. No. 5. 2002

VI. AWARDS AND HONORS

September 2003. College of Social Sciences Research Grant