Competing land use systems in the Toledo Uplands of Belize: An analysis of limited supply response and adoption of organic shade-grown cacao

By

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Chapter 1: Introduction

Significant amounts of forest conversion around the world can be attributed to shifting cultivation (Committee on Sustainable Agriculture, 1987; Brady, 1996; Bulte and van Soest, 1996). The predominating argument is that smallholders deforest as a means to improve their livelihoods by converting stored nutrients in forest biomass into usable nutrients for crop production and to open up land for cultivation or livestock (Kleinman, 1995; Harwood, 1996; Vosti et al., 2001). Slash-and-burn is the primary agricultural system used by small-scale farmers in the Toledo district of Belize and is used to produce corn, upland rice, beans, livestock, vegetables and root crops for home consumption and income (Pulver and Arya, 1993; Marcus, 1996; Levasseur and Olivier, 2000). However, the ability of the system to satisfy farmer livelihood and social environmental objectives is in question. The Toledo district faces the intertwined challenges of declining fallow periods in the slash-and-burn land use system (Pulver and Arya, 1993; Levasseur and Olivier, 2000), a young and growing population with 44% under age fourteen and that increased 35% during 1991-2000 (National Human Development Advisory Committee (NHDAC), 1998; Central Statistical Office (CSO), 2002), widespread poverty (fifty-seven percent of the Toledo population remain below the national poverty line (Caribbean Development Bank (CDB), 1996)), and the potential for increased land competition as road development progresses (Environmental, Social and Technical Assessment Project (ESTAP), 1998; Grimshaw and McGill, 2002).

Organic cacao production has been described as an alternative land use system capable of increasing small-scale farmer income, contributing to foreign exchange earnings and
reducing the negative impacts of deforestation (Young, 1994; Laird et al. 1996; Sams, 1998; Parish, 1998). Belize has been producing small amounts of cacao commercially since 1980 and more recently began producing organic, shade-grown cacao in the southernmost district of Toledo. Smallholders have a guaranteed, five-year rolling contract with an organic chocolate producer in England who is committed to purchasing up to 500,000 pounds of dry cacao beans. However, production has grown from just over 50,000 pounds in 1994 to 65,535 pounds in 2001 and smallholders have not been widely adopting cacao production. Explaining why organic, shade-grown cacao production has not been widely adopted by smallholders in the Toledo Uplands of Belize is the intent of this research project. The basis for this study first was established in 1998 while evaluating the larger cocoa industry in Belize – including a plantation-based system in central Belize and the organic sub-sector in Southern Belize – the latter is the focus of this research project.

Organization of paper

This research is intended to inform farmers, policymakers, project administrators and government and non-government agencies involved in agricultural development in the Toledo region and is organized into 8 chapters. Chapter 2 introduces Belize, the Toledo district and the Toledo Uplands. Chapter 3 presents a review of the literature regarding slash-and-burn agriculture, organic cacao as an alternative land use system (LUS) and criteria for adoption and supply response to occur. Chapter 4 details research objectives and methods. Chapter 5 provides an overview of farm/farmer characteristics and factors of production and a review of agricultural credit, land tenure, price and trade policy.
Chapter 6 presents a land use system analysis of financial returns across the primary agricultural systems in the Uplands. Chapter 7 uses principal components analysis (PCA) and bivariate correlation analyses to detail competing livelihood strategies and identify entry points to enhance cacao adoption. Lastly, chapter 8 presents policy and research implications intended to guide agricultural development activities in the Toledo region in general and to increase the adoption and supply of organic cacao specifically.
Chapter 2: The Toledo District and the Uplands

Belize is a small, English-speaking country in Central America bordered on the north by Mexico, in the south and west by Guatemala and on the east by the Caribbean Sea. It has a total area of 22,972 square kilometers. The total population in 2000 was 240,204 (CSO, 2001) with roughly 10 people per square kilometer. Gross domestic product per capita in 1999 was BZ$5,746\(^1\) (International Monetary Fund (IMF), 2001). The annual population growth rate is 1.9\% (recent 1999 period, IMF, 2001) with approximately 44\% of the population under the age of fourteen (NHDAC, 1998).

Toledo is the southernmost district of Belize and covers approximately 3,749 square kilometers (See figure 2.1). The landscape in Toledo slopes upward from the sea westward to 2,600 feet above sea level and is bisected into two distinct regions: the Maya Mountains and foothills and the coastal plain and floodplains. The Toledo Foothills make up the majority of the upland agricultural area. Within this area there are two sub-systems that can support both cacao and slash-and-burn production - the Toledo Uplands and the Xpichila Hills consisting of 269 km\(^2\) and 1,521 km\(^2\) respectively. Land suitability characteristics are derived from the most recent land survey conducted in the Toledo district (King et. al., 1986). The survey ranks land suitability for particular crops (maize, beans, cacao, citrus, rice, etc.) from highly suitable (class S1) to permanently not suitable (class N2) as set forth in the 1983 FAO publication -- Guidelines: land evaluation for rain-fed agriculture (Soils Bulletin FAO no. 52). Lands ranging from marginally suitable to highly suitable for cacao production were chosen. Areas that were currently not

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\(^1\) All monetary figures are expressed in Belize dollars. The Belize dollar is tied directly to the US dollar at BZ$2 to US$1.
suitable or conditionally suitable because of the large investment needed to make them suitable were not included (i.e., drainage or construction of levees). These two systems make up over three-quarters of the lands outside of the low-lying coastal plains. One area, the Uplands, has been chosen to be the focus of this research because:

1. Population density is considerably higher than the currently inaccessible Xpichila region thereby increasing the pressure on the land base.
2. The bulk of cacao production is currently located here alongside extensive Milpa (slash-and-burn) production.
3. The main east-west transportation corridor runs along the southern stretches of this area and is slated to be upgraded and linked to Guatemala and the Pan American Highway in 2006.²

² The establishment of this border crossing will be only the second border crossing into Guatemala and will likely increase further the pressure on the land base. It is anticipated that demand in Guatemala for crops such as corn, rice, beans and livestock will increase with population growth in the North-eastern region of Guatemala and investment from within (i.e., wealthier individuals from northern Belize) in productive uses for the land will increase.
Figure 2.1: Belize and the Toledo District
The Toledo population in 2000 was 23,297, increasing 33.6% from 17,439 in 1991 (CSO, 2001). The latest published poverty study\(^3\), conducted in 1996, indicated that the Toledo district is the poorest in the country and has the highest percentage of households (40.2%) and individuals (47.2%) unable to meet minimum food requirements for existence (indigence). This level of poverty is considerably higher than the Belize national average of 9.6 and 13.4 percent indigent households and individuals respectively (CDB, 1996)\(^4\).

The population in Toledo is comprised of 40% Maya Ketchi, 21% Maya Mopan, 13% Mestizo, 10% Garinagu, 8% East Indian, 6% Belize Creole, and the remaining 3% other. Toledo has the highest percentage of Maya in the country and they account for 61% of Toledo’s population compared with 10 percent nationally (CIA Factbook, 2001).

Agriculture is the main economic activity in the Toledo district outside of the district population center, Punta Gorda Town. District-wide, agricultural and forestry activities account for 35% of employment (CSO, 2001). The region has significant stream and rainwater resources and land suitable for agriculture. However, 282,900 (44%) of lands are in protected or forest reserve areas.

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\(^3\) The CSO has yet to release a more recent (2002) poverty study, however, discussions in Belize indicate that results show that the level of poverty in the Toledo district has actually increased in recent years.

\(^4\) The Caribbean Development Bank study defines indigent as individuals barely able to meet the minimum food requirements necessary for existence. They further state that individuals below this line are ‘threatened with ill-health and even death’. This study illustrates the extent of poverty in the region, however, it is based on annual income and in a region with large numbers of subsistence households and households participating in un-regulated trade with Guatemala the severity of poverty may be overstated.
Small-scale farmers in Belize account for 49% of agricultural holdings.⁵ In Toledo small-scale farmers account for about 48 percent of total holdings, but only account for 10 percent of the land acreage (Belize Agriculture Census, 1985).⁶ Farmers produce upland rice (hereafter rice), corn (main-season and second season *matahambre* (to kill hunger)), beans, coco yams, plantain, livestock, fruit trees and organic cacao (See appendix 1 for a calendar of the primary slash-and-burn and cacao production activities). The dominant agricultural system in the region is shifting cultivation, or more commonly known as slash-and-burn or the ‘*milpa*’ system.⁷ The villages in this study area are predominately Maya and are composed of Ketchi and Mopan Maya. Homesteads in each community are clustered and the majority of farming takes place away from the homestead at the farmer’s *milpa*. Community activities, including agricultural clearing, production and harvesting, are often conducted in a communal manner whereby tasks are shared among neighbors within the village and at individual farmers *milpas*. However, off-farm activities and labor markets are evolving and many farmers reported not participating in communal agricultural activities.

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⁵ Farm size alone may not categorize all small-scale agriculturists, but for classification purposes I have adopted the Inter-American Institute for Cooperation on Agriculture Belize estimate of farms less than twenty acres, primarily non-mechanized, and subsistence or semi-commercialized.

⁶ The Belize Farmer Registry is the latest form of an agricultural census, yet detailed data has not been released at the time of this research.

⁷ It was estimated by the MAFC that Toledo had 1,647 acres of black beans, 1,060 acres of rice, and 450 acres of corn planted in 2001. It is possible that corn acreage was miscalculated because 1998, 1999 and 2000 corn acreage is reported to be 7,200, 8,400, and 6,800 acres respectively (Toledo Agricultural Department, 2001). Pulver and Arya (1993) reported that 99% of smallholders in the Upland villages they surveyed practiced slash-and-burn.
Chapter 3: Exploring the issues

This chapter begins with a review of the predominant slash-and-burn system utilized by most smallholders in the Toledo Uplands. Then, it introduces organic cacao production as an alternative and highlights the benefits frequently cited by agroforestry and environmental advocates. In addition to a discussion of the cacao agroforestry system, I have included a short review of alternative Fair Trade (FT) marketing and its requirements in order to clarify the marketing framework in which Toledo smallholders operate. Lastly, the adoption, diffusion and supply response literature is reviewed and sets the stage for this project’s analysis and discussion of factors that influence product mix and production technology decisions among smallholders in the Toledo Upland region.

Slash-and-burn agriculture and its impacts on forests

Agricultural expansion for crops and pasture development are linked to deforestation, with shifting cultivation alone accounting for an estimated 40-60% of total deforestation worldwide (Lanly, 1982, Brunig, 1989 and Myers, 1994 cited in Bulte and van Soest, 1996). In 1985, the United Nations Food and Agriculture Organization (FAO) (in Brady, 1996) estimated that shifting cultivation is ‘a way of life’ for 300-500 million people. Brady (1996) also estimates that 240 million ha of closed forest and 170 million ha of open forest are involved in some kind of shifting cultivation and account for up to 30% of the world’s arable lands (Brady, 1996).
In Toledo, shifting cultivation is used to provide corn, rice, beans, livestock, vegetables and root crops for home consumption, with surpluses marketed domestically (Pulver and Arya, 1993) and more recently across the border to Guatemala (Levasseur, 2000). Smallholders thus rely on this system to not only provide food, but increasingly for income and regularly sell corn, rice and beans. This is critical since farmers that are no longer producing strictly for subsistence are expanding acreages for commercialized production using the slash-and-burn system. Although district level estimates of deforestation due to agriculture are unavailable, clearing is evidenced by satellite imagery (see appendix 2) on an eastward track from the Guatemalan border and by first hand accounts as one travels westward along the San Antonio road towards the border. Farmers in this area clear extensive tracts of land to produce crops for export to Guatemala (Marcus, 1995).

The slash-and-burn system involves clearing the forest biomass, allowing it to dry, burning it and then planting a short term crop of corn, beans or rice and subsequently allowing it to return to a mix of native species. Traditional slash-and-burn has been considered ‘sustainable’ as long as there is a balance between population pressures and land availability in a given area (Committee on Sustainable Agriculture, 1987; Palm, et. al., 1996). Shifting cultivation requires high labor inputs with few purchased inputs and is characterized by extensive land use. The adoption and continuation of this land use system has been associated with insecure land title and weak incentives to invest in soil

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8 Corn is sold locally (typically in the village, but also in the main market in Punta Gorda) and beans are sold primarily to Guatemala. Rice is purchased by the Belize Marketing Board at a subsidized price (BZ$0.20-0.25 per pound depending on water and debris content). The government sets the subsidy each year and regulates rice importation. It is not clear at this point how this will be impacted now that Belize is now a signatory of international trading agreements.
fertility (Norton and Alwang, 1993; Schuck et. al., 2002). Slash-and-burn agriculture is increasingly criticized as not sufficient to maintain productivity over the long run, especially in areas where adequate land resources may not be available.

Steinberg (1998) argues that the Toledo Upland swidden system has only recently become less stable and that there are considerable 'political ecological factors that have led the Mopan Maya to reject a more diverse swidden-fallow management strategy (traditional Maya production) for a system where an abandoned milpa provides few forest products' (speaking about the current system). He argues that the 'rejection' stems from discouraging government policies (i.e., insecure land titling coupled with forest concessions for outside investors) and missionary involvement in the region advocating for a 'shedding of remnants of the old ways and embracing a Western, global economy'. Undoubtedly the Toledo Uplands are being affected by the global economy and will further open up as the infrastructure is upgraded.

There is a substantial body of work detailing the challenges of slash-and-burn agricultural production. Within this literature the basic system has been described very comprehensively (Committee on Sustainable Agriculture, 1987; Kleinman et. al., 1995; Tinker et. al., 1996) with more specific papers examining the specific reasons smallholders deforest (Vosti and Witcover, 1996; Schuck et. al., 2002) and on the need for alternatives and policy options to encourage their adoption (Brady, 1996; Harwood, 1996; Tomich, 1998). More recently slash-and-burn and its effects on carbon content above and below ground (Palm et. al., 2000) and on climate change (Tinker et. al., 1996)
have been explored and are encouraging significant debate on policy instruments
designed to reward farmers who store carbon on-farm.

The predominate argument is that smallholders deforest as a means to improve their
livelihoods by converting stored nutrients in forest biomass into usable nutrients for crop
production (and to open up land for cultivation or livestock). Although there is an
increasing awareness among farmers of jeopardizing the long-term sustainability of the
system, current food and economic needs at the household outweigh this consideration. In
addition, profit maximization may also be driving smallholder decisions to continue and
extend slash-and-burn production (Vosti, personal communication 2003). Smallholders
are also aware of alternative production (citrus, cacao, cattle) but, under certain
circumstances (insecure property rights, availability of extension services, limited access
to financial capital), continue to deforest (Schuck et. al., 2002). The cause of alarm in
regards to slash-and-burn agriculture stems from the slow breakdown of the system. In
particular the fallow period – or length of time the land remains uncultivated – grows
shorter as farmers cannot get access to new lands or the distance to new land becomes
prohibitive. This can result in the mining of soil nutrients, weed infestation, increased soil
erosion and increasingly poor yields. The system itself can work very well and is
considered sustainable (Kleinman et. al., 1995) if the fallow periods are not decreasing to
a point where the land cannot recuperate.

Agroecological conditions vary widely from farm to farm and make generalizations
regarding minimum fallow-periods difficult to estimate. Kleinman et. al. (1995) examine
ecological sustainability based on the relationship between slash-and-burn and soil productivity and on the role of soil parameters in limiting crop productivity. They state that land use history plays a key role in soil conditions at the time of clearing and subsequently affect the length of cultivation and required fallow period. Several ratios of cultivation years to fallow years are presented in their discussion and range from Greenland and Nye's (1959) recommended 1:3 ratio to maintain organic matter levels in Alfisols in west Africa to Zinke et. al. (1978) suggesting 9 years of fallow for 1 year of cultivation to maintain soil fertility in moist tropical soils in Thailand (in Kleinman et.al., 1995). More recent estimates are also presented and accommodate multiple cropping years followed by longer falls. Van Wambeke (1992) listed ratios from 5:12 to 6:15 to maintain long-term organic matter in Oxisols of high basic cation status and Watters stated that soils in Venezuela required a ratio of 3:15 to maintain soil fertility (again in Kleinman et. al., 1995).

Estimates of the fallow period have been calculated in the Toledo region and demonstrate a declining trend. Pulver and Arya (1993) reported fallow period lengths of five years and report on fallow lengths presented in previous research studies. Recent data on this indicator was also collected in 2002. Table 3.1 illustrates this declining trend over the last two decades.
Table 3.1: Trends in Fallow Duration in the Toledo Uplands

<table>
<thead>
<tr>
<th>Research and Date</th>
<th>Toledo District Fallow (average number of years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toledo Rural Development Project (early 1980)</td>
<td>8</td>
</tr>
<tr>
<td>Land Resource Assessment Study (1986)</td>
<td>7</td>
</tr>
<tr>
<td>Pulver and Arya (1993)</td>
<td>5</td>
</tr>
<tr>
<td>Marcotte (2002)9</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Note: Adapted from Pulver and Arya (1993) and from author’s fieldwork.

Belize has relatively low population density and high levels of standing forest. Current estimates are 10 people per square kilometer (CSO, 2001) and 85% of Belize is under forest cover as of 1997 (FAO in Levasseur, 2000)10. However, the rate of deforestation in the country is slightly higher than in neighboring countries. During the 1990 to 2000 period, FAO reported that Belize was losing 2.32% of its forest per year. This is higher than neighboring countries Guatemala (1.7%) and Honduras (1.7%), but lower than the world average of 2.4% and significantly lower than highly populated El Salvador (4.6%) (FAO, 2003).

The rate of deforestation in the Toledo district has not been reported, but the problem of deforestation may become more acute as two main forces have the potential to exacerbate the situation. The first driving force is the increasing establishment of community settlements and subsequent land clearing near the Guatemalan border where Belizeans and Guatemalan immigrants are expanding production to meet growing local food demand and that of an increasing population in the northeastern region of Guatemala.

Belize has seen an influx of refugees, upwards of 25,000 in the past twenty years from El

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9 The research survey I conducted with 125 farmers in the Toledo district detailed farmers that incorporated cover crops into their systems and reported fallows of only 1 year (10 reported not clearing any land during the survey year). 12 farmers had 1 year fallow periods, 14 cut high bush with fallows of 8.2 years and the remaining 89 reported clearing wamil (young re-growth) with fallow lengths of only 3.4 years.

10 Population density in Belize and the Toledo district may be considered low, but in 2000, population in Toledo was 23,297, an increase of 33.6% from 17,439 in 1991 (CSO, 2001).
Salvador and Guatemala (Chomitz, 1996; NHDAC, 1998) and is experiencing growing informal trade with Guatemala across the Toledo border. The second driving force will be the completion of the southern highway-paving project (connecting Belize City with the Toledo District) and the subsequent link road connecting Toledo’s main city, Punta Gorda, with Guatemala and Puerto Barrios. Only recently has there been discussion in Belize regarding the impacts of these two road projects on agriculture and deforestation (see ESTAP (1999) for a discussion on the southern highway and Grimshaw and McGill (2002) for a discussion of the ‘link road’), however permanent crops and agroforestry systems have been advocated to curb the extent of slash-and-burn production (Grimshaw and McGill, 2002).

Organic Cacao as an Alternative

Cacao has been produced for home use in this region for hundreds of years including estimates that go as far back as 1000 B.C. with more intensive cacao farming beginning by 250 B.C. (Young, 1994). In the early 1980s commercial cacao production was introduced in southern Belize to meet the expected demand of the Hershey Corporation which, at that time, had developed 300 acres of cacao in the Cayo district and was committed to buying both wet and dry cacao beans. The Government of Belize (GOB) and the United States Agency for International Development (USAID) implemented a project geared to help smallholders plant 500 acres of cacao trees, primarily in the Toledo Uplands. In 1988 to 1990 a joint project between USAID and the Pan American Development Foundation (PADF) assisted with the establishment of another 3-400 acres.\textsuperscript{11} However it

\textsuperscript{11} Although these projects were intended to firmly establish 8-900 acres of cacao, the Toledo Cacao Growers Association lists only 175 acres currently established.
was less than ten years before the market for Toledo cacao collapsed. The export of organic cacao production began in 1992 when a company from England (Green and Black’s) began purchasing organic cacao beans under a certified fair trade agreement. Green and Black’s led the re-invigoration of Toledo cacao production, but has not met its production target for 200-500,000 pounds at the current price and shaded cacao production in the Toledo region has remained small relative to the production target over the last decade. Figure 3.1 illustrates organic cacao output in the Toledo district and shows a declining trend. Even without data from 2002 there is still only a very slight increase in supply from 1994 to 2001.

Figure 3.1: Organic cacao production in Toledo, 1994-2002


Notes: In the fall of 2001 hurricane Iris hit the Toledo district and resulted in major cacao losses, thus pre-2002 production trend indicated a small increase over the 1994-2001 period. Although cacao was produced and sold prior to 1994, national production figures cannot be disaggregated and include plantation-based production in the Cayo district and TCGA records are not available for pre-1994 Toledo district production (Cho, personal communication 2003).

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12 The reasons Hershey USA sold it operations in the Cayo District are unclear. Some reasons put forth are that they completed the research they had planned for the plantation or that they were worries about losing money as world cocoa prices declined in the late eighties and early nineties. Cost of labor, inputs, fuel and power are typically higher than in neighboring countries (IMF, 2001) and may have played a role.
Green and Black’s have been encouraging producers to increase production and has provide numerous incentives, including a contractual agreement that commits to purchasing beans at the premium price for at least five years,\(^\text{13}\) a contract that is automatically renewed each year unless otherwise negotiated. They also provide ‘spot cash’ in advance to the Toledo Cacao Growers Association (TCGA) to be able to pay farmers immediately upon delivery while beans are still in Belize (Nesbitt, personal communication 2002). The alternative purchasing and incentive structure is intended to increase smallholder returns and encourage the adoption of land use practices considered more sustainable by tapping consumers willingness to pay a premium for organic and Fairtrade certification – in particular a commitment to social, economic, and environmental development in the south (FLOI, 2003). Although incentives to invest in cacao production exist, it is important to further explore factors involved in cacao adoption and diffusion. The following section will highlight the literature on alternative land use adoption and technology diffusion and lay the groundwork for the factors influencing smallholder decision-making that will be analyzed in later chapters.

*Adoption and diffusion*

This section will discuss factors involved in agricultural innovation, adoption, diffusion, and supply response. I will review both the adoption and supply response literatures because there are smallholders in the region that do not grow cacao at all and there are

\(^{13}\)Green and Blacks is a member of the Fair Trade Association and bases its price and procedures on the FLO Fairtrade Standards (2003). The price is calculated on world market price quotations plus fair trade (FT) and organic premiums (see appendix 3 for world and FT floor trends). The formula is as follows: Market price (with a floor at US$1,600 metric ton + FT premium (US$150/mt) + organic premium (US$200/mt) = the minimum FOB price (US$1,930/mt) guaranteed to the Toledo Cacao Growers Association (TCGA). This translates to BZ$1.77 per pound to TCGA and BZ$1.41 to cacao growers (TCGA uses the difference for operations, including extension).
low-productivity producers that are not increasing supply in response to the supply needs agreed upon with Green and Black’s. Adoption is primarily concerned with the introduction and ongoing utilization of a new technology or an entire production system, in this case organic, shade grown cacao. The supply response literature is important because southern Belize has existing mature cacao that could be managed to improve supply, but is not currently being managed to do so. The expansion of cacao output in the Toledo Uplands can be accomplished by (1) increasing the acreage of organic cacao through system adoption or by (2) increasing yields on existing plots by influencing farm management.

Much of the adoption and innovation literature deals with enhancing systems, primarily productivity, income potential and product quality with a new technology or innovation (Feder and Umali, 1993; Boahene et. al., 1999) and with the wholesale adoption of an alternative system (Pomp and Burger, 1995; Pannell, 1999; Fairweather, 1999).

Feder and Umali (1993) provide an extensive review of the adoption of agricultural innovations literature, including household level adoption models and aggregate level diffusion models. Feder and Umali conclude (p. 230-4) that lack of credit, limited access to information and inadequate infrastructure can constrain technology adoption. They further state that governments typically overcome these through two strategies: providing information (i.e., research and extension) and by providing subsidies and support.

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14 Although Green and Black’s has indicated that it is willing to purchase all production up to 500,000 pounds at the premium price, the contractual agreement does not state that TCGA or the Toledo growers have agreed to supply the beans. This may indicate that supply has met demand and that the current price under the current policy environment is not sufficient to increase cacao supply.
programs (i.e., output, input and credit subsidies, complementary infrastructure, and risk-reducing programs). These strategies are incorporated in the GOB agricultural policy (Ministry of Agriculture, Fisheries, and Cooperatives (MAFC), 1997), however concrete policy actions to achieve these strategies in the southernmost region of Belize have not been specified nor implemented.\(^{15}\) in particular insufficient access to credit by smallholders, insecure land rights, poor infrastructure and weak agricultural extension.

Pannell (1999) summarizes the necessary conditions for adoption in relation to complex farming systems, particularly from the perspective of farmers. The primary condition is that farmers have an awareness of the innovation and that it seems to have some degree of practical relevance to the farmer. In the case of organic cacao production, each farmer I spoke with had heard of the possibility of organic cacao production and export. Many knew neighbors or relatives that grew cacao and some had a very clear idea of the price and the requirements for export. Secondly, Pannell discusses the need for farmers to ‘perceive that it is feasible to trial the innovation’ and that it is best if the innovation, or in the case of cacao the system, can be tested on a small-scale. This may be much easier for a new HYV or new annual crop, however in the case of cacao production it is more time consuming and expensive and may prove to be a more difficult crop to experiment with (given that annuals can be ‘trialled’ in less than a year as opposed to cacao which takes 3-5 years for a first harvest depending on management strategies). Thirdly, he

\(^{15}\) One exception is the case of rice price policy in Belize, which uses a complementary set of price and trade policies to encourage adoption. The price of rice is held above the import price as a means to encourage production and the border is regulated to ensure a market for production. Slash-and-burn rice acreage fluctuated between 2,819 acres in 1990 to 4,310 in 1996 and has declined to roughly 3,500 acres in 1998-2000 (MAFC Toledo District, 2002). Although rice is not necessarily central to this analysis, Chapter 6 will provide some insight into this current decline.
discusses that a farmer must hold the ‘perception that the innovation is worth trialing’; meaning that its return must be greater than the costs and time involved in establishing the trial and of the system the farmer is considering replacing. Again, in the context of agroforestry options, like shade-grown cacao, each farmer may not conduct these trials. Rather, individual farmers may monitor their neighbor’s successes/failures and decide from there. Lastly, Pannel argues that smallholders must perceive that the innovation or new system will meet farmer objectives – including profit, risk management, availability of household labor, desire for leisure and environmental protection\textsuperscript{16}.

The adoption of a land use system, in this case an agroforestry system is based on several factors. It is critical to understand technical factors (e.g., species-site matching), social factors (e.g., land tenure security), cultural factors (e.g., gender or community pressures) and very importantly economic incentives (returns to land and labor) (Scherr, 1995). In order for adoption to occur, the land use system must complement household resources (and address constraints) and meet or exceed the benefits of alternative investments (Scherr, 1995; Vosti and Witcover, 1996). As Scherr (1995) states in a discussion about livelihood strategies, “rather than assume all farmers are ‘profit maximizers’, this theory focuses on ‘welfare (utility) maximization’ and posits multiple household objectives”, such as food, cash, savings and social security.

\textsuperscript{16} It is often argued that environmental protection is not necessarily a private interest of a smallholder unless it impacts the stability of the production system directly. This is important as one of the main attractions of shade grown organic cacao is its contribution to social goals of forest conservation, carbon sequestration and maintenance of biodiversity. Pannell does not explore this issue very thoroughly.
Supply response

Mature cacao stands exist in the Toledo district, yet are not being actively managed and are not contributing significantly to the production purchased by TCGA (Peck, personal communication, 2003). This raises the critical question: is the current price for organic cacao in Toledo sufficient to interest farmers in managing and harvesting cacao from these stands in order increase output? In general, the supply response literature indicates that individual commodity output is responsive to price (Winter-Nelson, 1995; Gafer, 1997) indicating that the price may not be sufficient.\(^{17}\) There is further evidence that investments in research, infrastructure and extension can also have long-run positive benefits on supply response (Rosegrant et. al., 1996). The challenge that arises in the market strategy of fair- and organic-trade schemes is that they do not consider local input prices and/alternative income generating opportunities. A price above world cacao prices means very different things to a farmer in relatively high-cost Belize than to a farmer in relatively low-cost Guatemala\(^{18}\) and will impact supply response. Winter-Nelson (1995), in a discussion of price expectation, supply response and marketing boards involving the export of pyrethrum in Kenya states that, “Production behavior is consistent with the expectations of future prices based on indicators of aggregate supply and the marketing boards capacity to purchase” (p. 1). Although the research involves parastatal marketing boards (and TCGA is a private cooperative), the pricing process and legislative guarantee are similar to the fair-trade floor price and long-term contract with Green and Black’s. Basically, farmers plan their investments on the anticipated price in the future, or if that

\(^{17}\) Examples of the power of price policies increasing supply can be seen in the Belize Marketing Board subsidized rice price program which has led to domestic self-sufficiency in rice and the vegetable programs occurring in northern districts aimed at foreign exchange savings. Although it is unclear at this time, these two programs may be challenged in the future by trade rules under the WTO.

\(^{18}\) For example, Belize labor costs are very high (3 times) relative to Honduras and Guatemala (IMF, 2001).
information is not available, on the price received for the last harvest as is the case for Toledo. The fact that the price paid to farmers in Toledo has been set above the world price for roughly 10 years, yet supply has remained low may be because the price is not sufficient to induce labor investments into reclaiming and/or managing more intensively standing cacao groves (because the buyers “capacity to purchase” is not an issue in Toledo because they contractually agree to purchase over 8 times current production).

Later chapters will include a detailed analysis of production and marketing, institutional support and financial returns to organic cacao production in Toledo. The concluding chapter will discuss policy recommendations to address limited agricultural adoption and supply response.
Chapter 4: Research Objectives and Methodology

In order to assess the reasons farmers have been slow to invest in organic cacao a comprehensive approach to evaluating land use decision-making among smallholders was designed and implemented.

A general hypothesis guided this approach: Organic, shade grown cacao can be a profitable land use system for the Toledo Uplands, however, current prices and policy and institutional\textsuperscript{19} environments favor the production of slash-and-burn crops.

The following specific hypotheses have been developed and will be addressed individually:

1) Current land, credit, and price policy favor slash-and-burn production over cacao.

2) Organic, shade-grown cacao is a profitable land use system, yet slash-and-burn production is more profitable given household characteristics and current policy.

3) Livelihood strategies compete for Upland smallholder investment.

Data collection and analysis was conducted to: 1) identify farmer, household, and farm characteristics, 2) identify conditioning factors that influence expected returns to cacao investments and 3) develop a land use framework capable of comparing the economic

\textsuperscript{19} Hall et. al. (2001) discuss institutional arrangements in the process of developing new technologies for the poor and highlight the range of meanings for institution(al) from ‘specific organizations to meet specific functions’ to ‘social rules and norm’. Ultimately they define institutional as the “combined environment of the ‘rules of the game’”. In designing the research approach the focus was on policies and specific institutions (credit agencies for example) that impacted adoption decisions (although they are part of the rules of the game) and less on the communal ‘rules of the game’ such as, the tendency of Maya to avoid differentiating themselves from the group (Levasseur and Olivier, 2000).
returns among the predominant land use options in the Toledo Uplands. To collect the necessary data, a comprehensive farmer survey was undertaken alongside key informant interviews, and land use system and cost of production analyses were conducted in the Toledo District during 3 months in fall 2002 (all sources and instruments for field data collection are presented together in appendix 4).

*Land Use System Analysis*

The farmer level land use systems (LUS) analysis is designed to highlight the financial returns of the predominant LUS in the Toledo Uplands – namely corn, *matahambre*, rice, black beans and cacao production. As has been explained previously, in order for a LUS to be adopted it must be more profitable than alternative activities on or off farm and fit smallholder objectives and constraints. This analysis projects each of the systems over a 25-year period, calculates discounted streams of costs and benefits of the system and derives returns to labor, returns to land and net present value (NPV) that are comparable across LUS (Gittinger, 1982; Kragten et. al. 2001).

Crop production input/output data were drawn from cost of production estimates developed with extension agents and farmers in 1998 and 2002. Labor wages, yields, cultivation practices, and input prices were updated for cacao in Fall 2002 and generated for corn, rice and beans from interviews with key informants and surveys conducted with

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20 Although off-farm activities are alternative income strategies for Toledo farmers, this research focuses predominately on land use strategies, within which, off-farm income and opportunities are likely to have an important impact.

21 Although red kidney beans are grown in the Uplands, few reported doing so and it was not a LUS considered in this section. Reports have indicated that the red bean variety does not do as well as black bean varieties in the heavier rainfall of southern Belize (ESTAP, 1999).
smallholders. Interviews were also conducted with informants that live in Toledo and work for the MAFC, TCGA and Toledo Maya Cultural Council (TMCC) or are members of the village council or are Alcaldes.

Smallholder survey

A smallholder survey was designed and tested to collect information on production, household and hired labor and availability, type of and access to land, food/income security (vulnerability), and institutional support among smallholders involved in permanent cacao and slash-and-burn land use systems in the Toledo Uplands. The survey included questions for all respondents regardless of what they produced as well as specific questions related to individual crops and a slightly more detailed section for respondents that were growing cacao at the time of the survey (see appendix 4 to view the full Toledo Upland smallholder survey).22

A two-stage cluster design was developed to select farmer participants. In order to reduce the number of villages in the survey sample, villages were selected in the first stage using a probability-proportional-to-size (PPS) strategy – meaning that larger villages are given a greater chance of being selected. This approach was selected because of the need for a generalized population sample (farmers in a region suitable for producing cacao, corn, rice and beans) and because it would be difficult to visit every farmer in the 9-village

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22 Hurricane Iris hit the Toledo district in the fall of 2001 and resulted in extensive household and crop damage. In particular, farm acreages are considered lower than previous years due to labor being dedicated to ‘cleaning up’ after the hurricane downed trees and damaged infrastructure. Rice crop yields seemed to be recovering the slowest of annual crops and are still suffering as downed trees, increase incidence of pests and time dedicated to recovery shifted farmers focus. Every effort was used in the survey design, testing and implementation to account for Hurricane Iris related data challenges.
universe. According to Magnani (1997) "when measures of cluster [villages] size are available, the statistically most efficient two-stage cluster design is one in which (1) clusters are selected with probability-proportional to size (PPS) at the first stage of sample selection and (2) a constant number of households is chosen from each cluster at the second stage". He further states that, "the procedure is relatively efficient in terms of sampling precision and that if an equal number of elements is chosen in each cluster at the second stage of sample selection the end result will be a sample in which each households has the same overall probability of selection, or is self-weighting".

The following steps illustrate the selection of a systematic-random sample of clusters with PPS (adapted from Magnani, 1997):

1) Prepare a list of first stage sampling units (clusters/villages) with corresponding measure of size for each.

2) Starting at the top of the list, calculate the cumulative measure of size and enter these figures in a column next to the measure of size for each unit.

3) Calculate the sampling interval (SI) by dividing the total cumulative measure of size for the domain or stratum (M) by the planned number of units to be selected (a) – that is, SI = M/a.

4) Select a random number (random start (RS)) between 1 and (SI). Compare the number with the cumulative measure of size column. The unit within whose cumulative measure of size number (RS) falls is the first sample unit.

5) Subsequent units are chosen by adding the sampling interval (SI) to the number identified in step 4; that is RS + SI, RS + SI*2, RS + SI*3, etc.
6) This procedure is followed until the list has been exhausted. The resulting number of units should be approximately equal to the target number of clusters.

A target of 120-140 heads of farm households (~15% of village HH) was selected from the four clusters that represent the Toledo Uplands area. The first stage of selection was defining four clusters. These were randomly selected using the PPS strategy detailed above. The clusters (villages) were: San Miguel (71 HHs), San Antonio (229), Santa Cruz (55), and San Jose (139). Two villages in the sample fall above the Upland average (~90 HH/village) and two below for number of households per village.

The second-stage selection was to select randomly 35 heads of households (typically male farmers) from each cluster. A current list of farmers for each village from the Ministry of Agriculture was compiled in 2001 during an agricultural census and farmer registry project funded by the FAO.23

The survey period (October-November 2002) was during the main season corn harvest and during the period when farmers prepare land and plant matahambre corn. Although it is common to not find farmers home during the daytime hours, the increase in work on farms due to corn harvesting and preparation for matahambre made it more challenging to survey more than a few farmers each day and so made it necessary to hire 4

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23 I reviewed the list with the enumerators I hired in each village and cross-referenced it with the Toledo Cacao Growers Association list of members to verify the list was complete. The lists were considered complete in 2 villages, missing a few farmers in one village (the largest) and the last village experienced a loss of farmers likely due to recent road construction and other off-farm jobs available nearby.
enumerators\textsuperscript{24,25}. This also meant conducting surveys in multiple villages and making more time to accommodate farmer’s schedules (i.e., before 7 am and after 4 pm).

**Table 4.1. Village, Farmer, and Respondent Populations**

<table>
<thead>
<tr>
<th></th>
<th>San Jose</th>
<th>San Antonio</th>
<th>Santa Cruz</th>
<th>San Miguel</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population*</td>
<td>781</td>
<td>1158</td>
<td>323</td>
<td>439</td>
<td>2701</td>
</tr>
<tr>
<td># of households*</td>
<td>144</td>
<td>260</td>
<td>79</td>
<td>90</td>
<td>573</td>
</tr>
<tr>
<td># of reg. Farmers**</td>
<td>101</td>
<td>158</td>
<td>74</td>
<td>54</td>
<td>387</td>
</tr>
<tr>
<td># of survey respondents</td>
<td>35</td>
<td>32</td>
<td>35</td>
<td>24</td>
<td>126</td>
</tr>
<tr>
<td>% of reg. Farmers surveyed</td>
<td>35</td>
<td>20</td>
<td>47</td>
<td>44</td>
<td>33%</td>
</tr>
<tr>
<td># of TCGA members***</td>
<td>-55</td>
<td>~63</td>
<td>5</td>
<td>1</td>
<td>124</td>
</tr>
<tr>
<td># of cacao farmers surveyed</td>
<td>18</td>
<td>9</td>
<td>4</td>
<td>4</td>
<td>35</td>
</tr>
<tr>
<td>% of TCGA members surveyed</td>
<td>33</td>
<td>14</td>
<td>80</td>
<td>100</td>
<td>28%</td>
</tr>
</tbody>
</table>

*Central Statistical Office visitation records for 2000 census
**Ministry of Agriculture and UNFAO 2000 Belize Farmer Registry
***Toledo Cacao Growers Association membership roster

*Policy and Institutional Analysis*

Interviews were conducted with agricultural and natural resource policymakers, regional planners, and rural development NGOs operating in this region. This component was intended to develop a clear timeline of policy initiatives impacting Toledo smallholders - detailing changes over time, specific ways policies have been implemented (and enforced/supported), amount invested in implementing policies, and regional differences in effort. Although interviews and informal discussion were conducted with all the rural development organizations involved in the region – and numerous persons within several – solid historical data regarding policies and work objectives were difficult to ascertain.

\textsuperscript{24} Individuals from the communities that have worked on survey implementation (census or other NGO survey data collection) were selected. There is a growing reluctance for farmers to participate in research (Belizean or foreign) and it was envisioned that having enumerators that were members from the community with me would help reduce some of the apprehension. In each village I meet with the village Alcalde (mayor/sheriff) and asked for recommendations; ideally someone who had completed high school, had experience with agriculture, had done survey work before and would not be taking too much time from other important work. I also spoke with the Central Statistical Office and the Ministry of Agriculture to get recommendations based on their experiences with enumerators in the target villages.

\textsuperscript{25} Additional names in each village were randomly selected as back-up names since it was anticipated that a few farmers may have moved, died, or away during the survey period. In these cases, back-up farmers were substituted.
Information regarding activities and particular focus areas as they relate to slash-and-burn agriculture and organic cacao production were collected for the current period. These discussions also shed considerable light on the operational and organizational constraints common to professional organizations in Belize, both governmental and non-governmental.
Chapter 5: Household characteristics and factors of production

Household assets, characteristics, and access to factors of production are detailed in this chapter. Based on the farm and farmer survey conducted in the uplands, general household characteristics are presented first. The chapter proceeds with a summary of the factors of production — land (tenure specifically), access to capital, and labor — and discusses general challenges associated with investment choices. The chapter concludes with an overview of current production and marketing activities of the Toledo Uplands.

General household characteristics

Smallholders in the region are comprised of Mopan and Ketchi Mayan. San Jose, Santa Cruz and San Antonio are predominately Mopan Mayan and San Miguel is predominately Ketchi. The bulk of the sample (70%) indicated that they spoke Mopan most often. It is also important to point out that the majority of smallholders speak English sufficiently to understand and discuss the questions in the survey. Of the smallholders that did not readily speak English, older farmers dominated.

Table 5.1: Farmer residence: sample, cacao-growers, and non-growers

<table>
<thead>
<tr>
<th></th>
<th>Cacao Growers (n=33)</th>
<th>Non-Cacao Growers (n=87)</th>
<th>Sample (n=120)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>Percent</td>
<td>Frequency</td>
</tr>
<tr>
<td>San Jose</td>
<td>54.5</td>
<td>20.7</td>
<td>36</td>
</tr>
<tr>
<td>San Antonio*</td>
<td>24.2</td>
<td>19.5</td>
<td>25</td>
</tr>
<tr>
<td>Santa Cruz</td>
<td>12.1</td>
<td>35.6</td>
<td>35</td>
</tr>
<tr>
<td>San Miguel**</td>
<td>9.1</td>
<td>24.1</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>120</td>
</tr>
</tbody>
</table>

*The San Antonio target number was 32 but 3 farmers were no longer farming and 4 surveys were unusable.

**San Miguel is a small village with increasing off-farm work opportunities. Of the 54 farmers listed by the GOB, we were only able to locate 24 that still farmed. This may introduce bias, including that more residents that are considered farmers, but work off-farm part of the year, were not interviewed.
Table 5.1 above details the villages where farmers currently live. It also highlights some of the production differences across the four-village sample. San Jose and San Antonio are considered primary cacao growing villages. This is evident as together they represent more than 78% of cacao growers in the sample and 85% of cacao acreage in the sample.

Table 5.2: Farmer household characteristics

<table>
<thead>
<tr>
<th>Farmer Household Characteristics</th>
<th>Overall Sample (mean values and percentages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH Size (# of members)</td>
<td>5.66</td>
</tr>
<tr>
<td>Age of farmer (years)</td>
<td>42.8</td>
</tr>
<tr>
<td>Number of years farming in village</td>
<td>22.4</td>
</tr>
<tr>
<td>Origin (percent of farmers from Belize)</td>
<td>95</td>
</tr>
<tr>
<td>Education (percent of farmers that attended school in Belize)</td>
<td>84.2</td>
</tr>
<tr>
<td>Percent of farmers that completed std. 6</td>
<td>45</td>
</tr>
<tr>
<td>Hired labor (percent of farmers that hired labor in the past 12 months)</td>
<td>45</td>
</tr>
<tr>
<td>Off-farm income in the past 12 months (BZ$)</td>
<td>$1,280</td>
</tr>
</tbody>
</table>

Farm Characteristics

| Farm size (# of acres)                                                | 5.06                                        |
| Crop production (percentage of sample cultivating crop in the past 12 months) | --                                          |
| Main season corn                                                      | 85                                          |
| Matahambre (second season corn)                                       | 77.5                                        |
| Rice                                                                  | 23.3                                        |
| Black Beans                                                           | 55                                          |
| Cacao                                                                 | 27.5                                        |
| Total value of crops sold in past 12 months (BZ$)                     | $774                                        |

The family size in the sample was, on average, 5.66 members. The average ratio of children in school to those not is school is .51 with 1.92 children in school in each family. The average dependency ratio is 1.065 with 2.92 members under 15 and 2.74 members over 15. Although the survey included questions regarding retirement, older members of households in this region did not consider themselves retired so it is not considered further (0.1% indicated having retired members). The average age of farmers surveyed was 42.8 years, considerably older than the greater Toledo population. According to the 2000 census, the population of the Toledo district has only 7.5% of the population
between ages 40 and 50. The Toledo population is growing (33.4% between 1991 and 2000) with the rate likely to increase as the bulk of the population (56%) is under the age of 18 (CSO; 2000).

The Toledo district is the most remote district in Belize and the Maya have arguably received the least education. However, basic education is available in all the villages in the Toledo uplands (it is provided by the GOB, but smallholders are financially responsible for uniforms and books and sacrifice valuable labor as older children spend the day in school) and the majority of farmers in the region have attended school. Seventeen percent of smallholders in the sample never attended school. On average, 45.8% of smallholders completed their education through standard 6 – the last level before high school. Interestingly, of the cacao-growers, 60.6% have completed standard 6 opposed to only 40.2% for non-cacao growers.

Land tenure type and access

The land situation in Toledo is complicated and poorly documented. Data on legal arrangements is insufficient and interviews often yielded conflicting views on the status and meaning of current tenure arrangements. Land tenure arrangements are diverse and include Maya reservation (see discussion below about the level of insecurity within the reservation system), privately owned land, government land and protected forest reserve. Of the land that is not in protected areas, 66% is national or ‘Crown land’, followed by privately owned land (88% of private lands are held as single plots over 1,000 acres) and
the remaining consisting of Maya reservation land\(^{26}\) (<77,000 acres). Fifty percent of the land currently outside of protected reserves is considered to be productive land\(^{27}\) (ESTAP, 1999). In sum, suitable land for agriculture exists, however access by smallholders is constrained by political and financial barriers to markets for private lands and very limited access to lease lands held by the government. ESTAP (1999) further estimates that there is no land within the Maya reservations that is not currently cultivated. In fact, they estimate that there are 60,000 acres of land outside of Maya reservations being cultivated on unleased, national lands.

Farmers were asked a series of questions about land and land tenure, including whether they were seeking more land, the tenure of land they were farming, what tenure arrangement they would prefer, and what kinds of tenure agreements would be on lands that they could access. Fifty-nine percent of the respondents in the sample indicated they would be seeking more land. Of these, 64% indicated they wanted it for *milpa* farming, 14% for other tree crops (mostly citrus, but this could include cacao), 12.5% specifically for cacao and lastly, 8.3% were interested in getting more land for livestock. Of these, 40% indicated that if they did cultivate more land it would be further away than their current plots. Figure 5.1 illustrates the available land tenure arrangements among farmers seeking more land and compares this to the kind of tenure they would prefer.

\(^{26}\) Berkey (1996) concludes that historically, GOB reported acreages vary by as much as 4,000 acres. ETAP (1999) reports that there are roughly 77,000 acres considered part of the Maya Reservations.

\(^{27}\) The definition of productive land is based on King, et. al. (1986) land suitability classification of grades 1-3 and include the most accessible broadleaf forested land.
Figure 5.1: Land tenure arrangements among farmers seeking additional land

<table>
<thead>
<tr>
<th>Land tenure arrangements (n=89)</th>
<th>owned</th>
<th>leased</th>
<th>reservation</th>
<th>no response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of respondents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of tenure new land would likely have</td>
<td>3</td>
<td>11</td>
<td>71</td>
<td>4</td>
</tr>
<tr>
<td>Type of tenure farmer would prefer</td>
<td>19</td>
<td>40</td>
<td>24</td>
<td>6</td>
</tr>
</tbody>
</table>

The entire land situation in the Toledo Uplands is extremely complex and not well understood across farmers, policymakers, or development organizations. In addition to farmers often indicating that the land they were farming was reservation (even when it was considered government land), government agencies in charge of lands in the region also misunderstand the situation on the ground and do not know how many reservations there are in the Toledo. There is evidence that 12 reservations have been delineated in Toledo with acreages around 77,000 acres (King et. al., 1986; Berkey, 1994; ESTAP, 1999). A discussion about reservation lands follows in an attempt to clarify the level of land tenure security within reservation lands.

Almost certainly, the Maya have an ownership right that precedes the rules articulated by current laws, which themselves are considered to be insecure. Berkey (1994) discusses Maya land rights and refers to the occupation of Toledo lands since at least 2000 b.c. and particularly intensive settlements between 300 and 900 a.d., he also indicates that even though the Maya have 77,000 acres on 12 reservations, they remain insecure. Berkey
reviews the lands policy and states that the “Maya occupancy of the reservations is largely subject to the whims of the Commissioner of Lands and Surveys” (p. 30) and that they were created under the Crown Lands Act and re-authorized under the National Lands Act of 1992. Berkey further states, “the Indian inhabitants of the reservations do not have legal rights of ownership to the reservations as a whole nor to any of the individual parcels within the reservation boundaries” (p. 32). The question here is whether or not the legal status of the land has had an impact on the kinds of agricultural land use systems smallholders have adopted.

**Figure 5.2: Tenure status of land, by predominant crops**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Corn (n=102)</th>
<th>Maize/maize (n=35)</th>
<th>Rice (n=28)</th>
<th>Red Kidney Beans (n=31)</th>
<th>Black Beans (n=66)</th>
<th>Cacao (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percent of respondents cultivating crop</strong></td>
<td>76.5</td>
<td>66.7</td>
<td>89.3</td>
<td>58.1</td>
<td>77.3</td>
<td>68.8</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td><strong>own</strong></td>
<td><strong>lease</strong></td>
<td><strong>reservation/government land</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>22.5</td>
<td>76.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1</td>
<td>32.3</td>
<td>66.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>10.7</td>
<td>89.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>41.9</td>
<td>58.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>21.2</td>
<td>77.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.1</td>
<td>25</td>
<td>68.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For this analysis I have grouped reservation land and government land because of the confusion that exists to whether or not government land farmers cultivate is part of the reservation (i.e., farmers regularly stated that they farmed on the reservation, yet no reservation exists near where they were farming). It would seem from figure 5.2 that red
kidney beans, matahambre, and then cacao were planted most often on secure\textsuperscript{28} land with corn, rice and black beans on the least secure land. Nonetheless, 68.8\% of farmers growing cacao have still planted on ‘insecure’ land so it is difficult to conclude that cacao farmers plant on secure land. It is likely that farmers may not expand production, or invest in cacao, because land is insecure, but it cannot be tested here with available data. What we can draw from figure 5.2 is that across all crops, over 65-70\% of plots are on insecure land and one of the more widely adopted cash crops historically, rice, is planted heavily on either reservation or government land that is not leased or owned. In addition, this research cannot ascertain whether certain land considered ‘reservation’ is more secure for non-legal reasons such as communal, inheritance, or village traditions as is likely to be the case in some instances. In sum, the land security issue demands attention in Toledo and needs a thorough analysis of the land availability and projected needs of the population and the development of secure ownership arrangements for the farmers in the region.

\textit{Access to Credit}

Small farmers in the Toledo district have very little access to and experience with credit. In addition to a lack of institutions lending to small farmers, the farmers in the Toledo Uplands often do not own their land, a major form of collateral required by lending institutions that do operate in the region. The survey of smallholders in the Uplands

\textsuperscript{28} For this and future analyses, secure land tenure includes land that is either owned privately by a farmer or leased from the government. Insecure land tenure includes land on reservations, government lands being cultivated but not leased, and forest reserve areas where agricultural production is illegal. This is a difficult area within which to create rigid definitions because cultural norms that may be associated with ‘security’ of lands within the reservation system. A plot that is part of the reservation may be very secure within the community (i.e., nobody will try to take it away from their neighbor), but within the GOB legal system, the plot carries no ownership rights thus very little security.
reinforced the fact that although some credit programs exist, they are not designed to assist landless, poor and relatively inexperienced borrowers (have not borrowed or repaid loans in the past) like many Toledo Upland farmers. Of the 120 respondents in the survey, 98% indicated that they had not borrowed from a bank or credit agency in the 12 months preceding the date of the survey and 93% indicated that they had not borrowed from a bank or credit agency in the past five years. A brief description of the main credit opportunities for smallholders is presented below and highlights the relatively few opportunities for smallholders in the Uplands to access credit.

The Development Finance Corporation (DFC)\(^29\) is Toledo’s primary lending institution for agricultural loans, however there is very limited credit for small agricultural enterprises available from this source. The minimum loan is BZ$7,000 with loans going primarily to housing, education, and tourism. The current interest rate for farmers on DFC loans is 13%. The criteria for borrowing from the DFC contains several obstacles to potential borrowers in the Upland region. The criteria are that (i) repeat clients are looked upon very favorably; (ii) borrowers must be Belizean or naturalized citizens; and (iii) borrowers must present collateral either in the form of land and/or a promissory note from the Belize Marketing Board (BMB)\(^30\). The DFC sees problems with farmers who have inherited land and have not been able to get the title formalized, therefore they cannot prove they own land.

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\(^{29}\) Information based on personal interview with Mr. Shol, DFC loan officer for the Toledo District, September 2002.

\(^{30}\) The BMB has undertaken a program in the north whereby they guarantee vegetable purchases from farmers in advance, thus demonstrating a secure market to the DFC. In Toledo the BMB can guarantee rice production, but the loan minimum prevents many Upland farmers from participating.
The DFC is responsible for another lending program that was initiated during the Toledo Small Farmer Development Project (TSFDP) implemented in 1987 and concluded in 1994 (this was the first phase of a two-phase IFAD project). This program was targeted to small farmers in the Toledo district interested in growing rice and, incidentally, resulted in almost 60% default on loans during this period. The current lending program is considered a re-flow program whereby the monies lent during the nineties are re-lent to basically the same farmers each year. The interest rates for the program are 12% and range from $500 to $15,000 lent at the beginning of rice season and repaid after the sale of harvest. Repayment is tied to the BMB which deducts payment from the farmers sales to the Rice Mill and pays DFC (the mill is operated by the BMB which is within the Ministry of Agriculture). Criteria for these loans are that farmers must have already borrowed from the re-flows program and have not defaulted. There are only 30 or so farmers involved in this program.

A second, more recent credit program, the Rural Financial Services (RFS)\(^{31}\) is a component of the current Community Initiated Agriculture and Rural Development Project (CARD). The goals of this credit component are to increase Toledo residents’ access to credit and savings services. Their lending methodology is based on the micro-finance model – using flexible collateral and ‘character-based’ loans. The program is designed to lend for “any income generating activity” with initial loans no larger than $1,000 for first time borrowers. Loans may reach $10,000 depending on performance of borrower. The loans are intended to be short- and medium-term loans of no more than 3

\(^{31}\) Information based on personal interview with the director of RFI, Mr. Assad Magaña September 2002.
years (effectively removing a cacao investment from the list of “any income generating activities”).

The RFS will oversee the lending of IFAD monies to DFC and then to an independent financial institution (such as a credit union or NGO with micro-finance experience).

Initial rates from IFAD are 6.5%, DFC will loan at 7.5% and the IFI is expected to bring loans to farmers and other borrowers for about 12%. The idea is that transaction costs will be lower for borrowers by “brining the loans to rural areas” and reducing paperwork. Loan officers are expected to be in the field 3-4 days and one day in the office – this will increase assistance to borrowers and is expected to decrease default rate. Eligibility is also based on income – borrowers cannot earn more than $300 per month.

*Labor requirements and availability*

The survey was also designed to identify household labor availability, labor hiring practices and potential labor shortages throughout the year. This section will detail characteristics of family, in-kind and hired labor in the Toledo Upland region.

Smallholders in the Toledo Uplands still practice communal land clearing, planting and harvesting and also come together for house repair, building and village clean-up days. Typically, when a farmer helps on a neighbor’s farm they receive an equal days labor on their farm. In kind labor, therefore, is presented, but has not been calculated as a cost or benefit – one day on one farm theoretically equals one day on another farm.
Across the Toledo Upland farms there are, on average, 1.36 persons that work on the farm all year. This can be misleading because smallholders often think of the farm as the milpa, or fields where crops are produced, and not include the house plot and agricultural activities that occur there (i.e., shelling corn, drying cacao). Many of these activities undertaken closer to the home are performed by women and children and may be overlooked as labor when tallying the amount of labor dedicated to farming activities throughout the year.

In addition to in-kind labor, farmers in the region also hire labor to assist with production. Fifty-four farmers in the sample (45%) indicated that they hired labor to help them on their farms. The most common activity was chopping or clearing bush prior to planting (77%), followed by planting corn, rice or beans (26%) and then harvesting rice, corn, cacao (15%)\textsuperscript{32}. Other activities reported were construction or clearing for pasture but only by a few respondents. Of the 54 farmers that hired labor, the median number of man-days hired over the course of the previous year was 10. The total median amount spent on hired labor was BZ$142.00 with one farmer spending over BZ$1,000. An important consideration is that 34 respondents (63% of those that hire) indicated that they had trouble hiring labor in the twelve months preceding the date of the survey. During the survey interview farmers were asked if there were times in the last 12 months that they needed labor – and had the money to pay for it – but could not find labor available to hire. Figure 5.3 details the number of times farmers indicated that they had trouble hiring

\textsuperscript{32} Often smallholders reported that they hired for more than one activity hence the percentages equal more than 100%.
labor, by month. It is evident that there are bottlenecks in labor availability during the early part of the calendar year (February and March) due to clearing and preparing for burning in the milpa and during the main-season corn harvest, rice harvest and preparation for matalambre (October and November).

Figure 5.3: Reported labor shortages, by month 2001-02

Most farmers indicated that the shortage was due to labor (other farmers) being too busy working on their own farms during these times to sell their labor. In regards to cacao production, once the system is established the main harvest (Jan-June) is the most labor-intensive period of the year. Nineteen percent and 25% of the 32 respondents indicated that they had trouble hiring labor during February and March respectively.

\(^{33}\) Unfortunately data was not collected on the number of days needed each month and whether labor was absent for the entire month or if they only asked one time in a month.
Production and marketing

The majority of farm production is done by hand – from clearing the forest, planting, harvesting and processing and follows the bi-modal rain pattern in Toledo (see rainfall and seasonal agricultural production activities in appendix 3). The mean acreage cultivated during the twelve-month period preceding the survey was 6.62 acres.34

Figure 5.4: Mean plot size and gross acreage

<table>
<thead>
<tr>
<th>Crop</th>
<th>Mean Crop Acreage (left axis)</th>
<th>Gross Crop Acreage (right axis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (n=102)</td>
<td>2.90</td>
<td>295.50</td>
</tr>
<tr>
<td>Matahambre (n=93)</td>
<td>2.30</td>
<td>214.13</td>
</tr>
<tr>
<td>Rice (n=28)</td>
<td>1.78</td>
<td>49.75</td>
</tr>
<tr>
<td>Red Kidney</td>
<td>0.63</td>
<td>19.44</td>
</tr>
<tr>
<td>Black Beans</td>
<td>1.29</td>
<td>65.45</td>
</tr>
<tr>
<td>Cacao (n=32)</td>
<td>2.27</td>
<td>72.63</td>
</tr>
</tbody>
</table>

Note: one cacao farmer was unable to estimate his current cacao acreage

Figure 5.4 presents the mean plot size for individual farmer plots and the gross acreage, (total amount of land) dedicated to selected crops in the survey sample. Figure 5.4 indicates that corn, main-season corn and matahambre, was the most widely produced crop in the Toledo Uplands. Smallholders dedicated an average of 5.2 acres for the year to corn with 102 and 93 respondents having grown main season corn and matahambre respectively. Fifty-five percent (55%) of smallholders grew black beans during the 12 month period prior to the survey. Most indicated that it is important because it is a staple

34 In general, 42.5% of smallholders indicated they were farming less than before hurricane Iris, 34.5% indicated they cultivated the same amount, and only 22.7% indicating that they actually were cultivating more than before the hurricane.
like corn and, increasingly, because of the strong demand for beans in Guatemala (90% of farmers growing black beans indicated that they sell them). Although rice is produced in large quantities in this region, only 28 (23%) of smallholders interviewed reported growing rice, just less than the 26.6% producing cacao at the time of the survey. Figure 5.4 also highlights the extensive production of corn and underscores the importance of corn as a staple in the Toledo Uplands. Corn is produced primarily for home consumption while beans and rice are produced for home consumption and for sale. Cacao is consumed at home and locally, but is produced primarily for the export market.

Figure 5.5: Per acre and gross crop production

<table>
<thead>
<tr>
<th>Crop</th>
<th>Mean crop yield/acre (left axis)</th>
<th>Gross crop production (right axis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (n=95)</td>
<td>737.05</td>
<td>70,019</td>
</tr>
<tr>
<td>Matalambiri (n=87)</td>
<td>851.00</td>
<td>74,037</td>
</tr>
<tr>
<td>Rice (n=28)</td>
<td>1,143.93</td>
<td>32,030</td>
</tr>
<tr>
<td>RK Beans (n=29)</td>
<td>705.52</td>
<td>20,460</td>
</tr>
<tr>
<td>Blk Beans (n=65)</td>
<td>928.08</td>
<td>60,325</td>
</tr>
<tr>
<td>Cacao* (n=32)</td>
<td>273.00</td>
<td>7,931</td>
</tr>
</tbody>
</table>

*Farmers were asked to report their highest cacao yields before Hurricane Iris. I used this estimate because yields after Iris were extremely low (many farmers indicated not harvesting at all) and trying to ascertain yields during the harvest before the hurricane created confusion. Farmers were readily able to recall the highest yields from their groves. It also demonstrates that even the highest reported yields are low.

Figure 5.5 illustrates the mean yields per acre reported in the survey and overlays this with the gross production for all 120 farmers in the sample (both reported in pounds).
This figure is presented this way to illustrate the productivity of crops and to set the stage.

35 Pulver and Arya (1993) reported that 58% of farmers in their sample grew rice. Unfortunately they do not break this production down by village.
for the analyzing the returns to a smallholder’s investment in different land use systems. Gross production is presented to illustrate the overall importance of each crop to household consumption and regional income generation.

Figure 5.5 also emphasizes the yield situation with cacao very clearly. Actual yields (even when they are reported as the highest achieved ever) are considerably lower than commonly reported yields per acre. Yields expectations are commonly reported as between 500-1,000 pounds per acre by the TCGA, past implementing bodies of development projects and in the cacao production literature (Wood, 1985; Stevenson, 1987; International Fund for Agricultural Development (IFAD), 1998; TCGA, 2001).

Yields vary considerably across smallholders and can present challenges to drawing conclusions from means.36 Data collected regarding yields is likely to change from year to year and from plot to plot depending on factors like weather and soil/crop management, thus the resulting yields are only a snapshot of a single year. In an attempt to address this situation, yields for corn, rice and beans from this study have been compared with yields from two other studies conducted in the region and are incorporated into the financial analysis in chapter 6.

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36 Farmers calculate production in a number of ways. I was careful to ascertain what size bags they were using when reporting bags (i.e., big sugar bags or small) and whether corn was shelled or not. This kind of work can introduce miscalculations and may be responsible for variation among other studies. The production year was also the first full season after Hurricane Iris and could result in lower yields as farmers are still working to reclaim their lands, invest in their homes, and may have little cash to purchase inputs that would improve yields.
Table 5.3: Mean yields across recent studies (pounds per acre)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Marcotte*</th>
<th>NARMAP**</th>
<th>FPMP***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Season Corn</td>
<td>737</td>
<td>1050</td>
<td>828</td>
</tr>
<tr>
<td>Matahambre</td>
<td>850</td>
<td>901</td>
<td>600</td>
</tr>
<tr>
<td>Rice</td>
<td>1144</td>
<td>1264</td>
<td>2089</td>
</tr>
<tr>
<td>Black Beans</td>
<td>928</td>
<td>767</td>
<td>684</td>
</tr>
<tr>
<td>Red Kidney Beans</td>
<td>546</td>
<td>598</td>
<td>683</td>
</tr>
</tbody>
</table>

* yields calculated in current research project
***Marcus, R. (1994) Forest Planning and Management Project. Results from 90 smallholders in the border region with Guatemala. This region is characterized by more extensive production for export to Guatemala.

Crops are produced in the Uplands for both household consumption and for sale.

Smallholders that sold their crops reported the amount of crop production they sold, where it was sold, and what the price was per pound. Average prices per pound were multiplied by mean yields/acre and gross production to estimate the revenues per acre and overall monetary contribution to the Upland economy and are presented in figure 5.6 below.

Figure 5.6: Mean and gross crop revenue for commercialized farmers

![Bar chart showing mean and gross crop revenue for commercialized farmers]

Note: the above table illustrates the 2001-2002 revenues for corn, rice and beans, however, it is important to reiterate that the cacao yields reported in the survey were not 2002 yields and thus may show higher than average revenues relative to other crops.
Figure 5.6 demonstrates the importance of black beans to households and the Upland economy. It is not clear when marketing black beans across the border with Guatemala began nor if production has been increasing, however observation and casual discussion with farmers would indicate it is indeed expanding.\(^{37}\) Although red kidney beans have high revenues per acre, it is recognized as a crop faced with many production challenges in the Toledo region, hence the limited number of growers. Figure 5.6 also indicates that cacao has the potential to contribute to growth in the region and possibly more to individual household income.

Chapter 5 set out to provide an overview of household demographics and a summary of production and marketing occurring in the Toledo Uplands. It also demonstrates that credit and land tenure policies, such as 3 year loan periods and lack of ownership rights within the Maya reservations, are likely to favor slash-and-burn agricultural land use systems. Unfortunately, the lack of secure land and very little experience with credit among farmers in the survey sample does not allow for a rigorous analysis of whether land or credit policy impacts different land use systems specifically. Chapter 6 will provide a land use system analysis of the selected crops and will compare returns to land and labor and net present values of each land use system as a second layer in determining why smallholders are not widely adopting organic cacao production.

\(^{37}\) The Community Initiated Agriculture and Rural Development (CARD) development project currently operating in Toledo has funded a market analysis of the informal market in Guatemala yet results have not been released.
Chapter 6: LUS Modeling and Outputs

In chapter 2, factors that influence LUS adoption were introduced. This section deals specifically with the capability of a LUS to contribute to smallholder income objectives. In order for farmers to consider adopting a LUS it must provide financial returns that match or exceed their other investment opportunities, controlling for risk and other factors. The amounts and values of land, labor, purchased inputs, outputs, and timing for each production factor shape overall financial returns. The LUS model specifies all factors in matrix form over the lifespan of the land use to explicitly and quantifiably represent a smallholder’s land-use activities (Vosti et al., 2000). LUS analysis can then explore socioeconomic implications for a wide range of scenarios, including changing cultivation practices, inputs, and exogenous variables (e.g., market prices). The LUS presented here is designed to present returns to labor, returns to land, and net present values (NPV) for main season corn, matahambre, rice, black beans and cacao. It is recognized that this analysis is a ‘snapshot’ based on interviews conducted during specific periods of time and that prices, inputs, and Mother Nature can change system returns dramatically.\textsuperscript{38} Further sensitivity analysis will be an important future exercise, as only some basic analysis is included in this research project.

Table 6.1 reports and notes the sources of a series of production parameters and input/product values that have been identified for each LUS.

\textsuperscript{38} Different yield scenarios were built into the model and are intended to capture changes in system performance due to changes in yields.
Table 6.1: LUS summary parameters

<table>
<thead>
<tr>
<th>Variable Parameters</th>
<th>Value</th>
<th>Description (unless stated otherwise, values are from 2002 smallholder survey and key informant interviews)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor wage (BZ$)</td>
<td>14.7</td>
<td>Based on reported village wages (mean BZ$14.7/day). 50% of HH hiring labor reported between BZ$10 and 15 for agricultural work.</td>
</tr>
<tr>
<td>Discount rate (%)</td>
<td>0.12</td>
<td>IMF (2000) national interest rate and cost of credit from current rural development project. DFC loans for 13% in the district.</td>
</tr>
<tr>
<td>Land rental rate (BZ$/acre)</td>
<td>0</td>
<td>Much of land is “Crown” land and without a lease farmers pay nothing. Leases are few and rates are low (~BZ$2/acre/yr.).</td>
</tr>
<tr>
<td>Plot size (acres)</td>
<td>1</td>
<td>Farmers cultivate numerous plots differing in size (mean acreage from survey: corn-2.8, matanabre-2.3; rice-1.7; black beans-1.28; cacao-2.2), input data was collected was based on the size of the farmers operation and then reported as one acre for clarity.</td>
</tr>
<tr>
<td>Fallow period (years)</td>
<td>3.8</td>
<td>Mean fallow period from 120 farmer survey.</td>
</tr>
</tbody>
</table>

Main season corn

| Seed price (BZ$/pound) | 0.25  | Farmers typically save seed and use local varieties. Value is based on opportunity cost of not selling seed. |
| Corn market price (BZ$/pound) | 0.23  | Mean price reported by 31 farmers selling corn. |
| Yield1 (pounds of shelled corn/acre) | 740   | Mean yields of 102 farmers. |
| Yield2 (pounds of shelled corn/acre) | 1050  | Pulver and Aya (1993) Results from 100 smallholders in the Toledo Uplands. |

Second season corn (matanabre)

| Seed price (BZ$/pound) | 0.25  | Farmers typically save seed and use local varieties. There is interest in using improved varieties (hybrid, ICTA), but the sale price is BZ$2.50/pound. |
| Matanabre market price(BZ$/pound) | 0.252 | Mean price reported by 34 farmers selling corn. |
| Yield1 (pounds of shelled corn/acre) | 850   | Mean yields of 93 farmers. |
| Yield2 (pounds of shelled corn/acre) | 901   | Pulver and Aya (1993) Results from 100 smallholders in the Toledo Uplands. |
| Pesticide (BZ$/liter) | 12.5  | Average cost derived from farmer survey and Toledo district input suppliers. |

Rice

| Seed price (BZ$/pound) | 0.3   | Although seed costs per acre vary across varieties (3BZ$0.30-60/pound) and spacing (24 pounds/acre-125 pounds/acre), low price and density predominates in the upland rice system. |
| Rice market price(BZ$/pound) | 0.232 | Mean price reported by 18 farmers selling rice. The BMB pays BZ$0.20-0.25/pound depending on moisture and debris content. |
| Yield1 (pounds of hulled and dried rice/acre) | 1144  | Mean yields of 28 farmers. |
| Yield2 (pounds of hulled and dried rice/acre) | 2089  | Marcus, R. (1994). Results from 90 smallholders in the border region of the Uplands. |
| Herbicide (BZ$/litre 2-4-D) | 10   | Average cost derived from farmer survey and Toledo district input suppliers. |
| Transport cost (BZ$/100 pounds) | 2     | Buses are the main source of transport to the Belize Marketing Board where rice is sold. |

Black Beans

| Seed price (BZ$/pound) | 1     | Farmers typically save seed and use local varieties, however, farmers interviewed for this IO analysis purchased seed by the pound. |
| BB market price (BZ$/pound) | 0.58  | Mean price reported by 34 farmers selling black beans. |
| Yield1 (pounds of dried black beans/acre) | 928   | Mean yields of 66 farmers. |
| Yield2 (pounds of dried beans/acre) | 684   | Marcus, R. (1994). Results from 90 smallholders in the border region of the Uplands. |
| Aggregate transport costs (BZ$/100 pounds) | 4.5   | Buses are taken to the border where horses are often rented to bring product to Guatemala. |

Cacao

| Seed price (BZ$/seed) | 0.15  | TCGA and CARD (2000) cost of production for organic cacao. |
| Cacao Market Price (BZ$/pound) | 1.4   | TCGA, (2002), |
| Yield1 (pounds of dried cacao/acre) | 273   | Mean yields of 32 farmers. |
| Transport costs (BZ$/100 pounds) | 2     | Buses are the main source of transport to the TCGA where cacao is sold. |
Based on the annual tabulated benefits and costs (see appendix 5 for these calculations across selected crops), the LUS model returns financial performance indicators for net present value (NPV), returns to labor, and returns to land. These indicators were chosen because they represent critical calculus that smallholders consider when making LUS decisions and how existing policies can influence returns.

$NPV \ [\text{BZ in Year 1}]$ was calculated by discounting the benefits and costs associated with each year in the 25-year production cycle:

$$NPV = \sum_{t=1}^{T} [B(t) - C(t)] \cdot (1 + i)^{-t-1}$$

where: B(t) and C(t) are total benefits and costs in year t [BZ], T is the length of the production cycle [25 years in each case], i is the discount rate, and $(1+i)^{-t-1}$ is the conversion factor for year t. One benefit of NPV is that it captures the time value of money, which can be of critical importance to poor smallholders with high discount rates. This stresses the challenge agroforestry projects often encounter whereby a LUS requires an initial investment in establishment, yet returns on the investment are 5, 6, or 10 years into the future. In savings- and credit-constrained Toledo, smallholders face this challenge daily and as seen in chapter 5, invest in LUS’s that will generate returns in a year or less.

$Returns \ to \ labor \ [BZ \ day^{-1}]$ were calculated by iteratively searching for the wage rate paid to household labor that sets NPV to zero. This indicator is likely to be the most important variable for individual farmer decisions regarding LUS selection. For each unit
of labor invested in the LUS, smallholders are very aware of the benefit they receive and it must be greater than their alternatives.

*Returns to land* [$BZ \text{ ac}^{-1}$] was calculated by dividing NPV with necessary LUS plot size. For slash-and-burn LUS, four acres was used as the total plot size necessary for 1 acre of production to occur in each year of the 25-year period. For example, producing 1 acre of black beans each year for 25 years requires access to 4 acres of land based on the reported 3.8 years that each acre would need to remain fallow before cultivating again. Also, if 3.8 years is below the necessary fallow period, returns to land would be worse if fallow durations required, say, 6 years between cultivation. This would require access to 6 acres for every 1 acre of beans produced annually. As access to land for extensive cultivation decreases, a LUS ability to return positive returns to land will become an increasingly important financial indicator and will favor more intensive LUS.
Table 6.2: LUS financial returns

<table>
<thead>
<tr>
<th>System Returns – per acre</th>
<th>Main Season Corn</th>
<th>Second Season Corn (matanambre)</th>
<th>Rice</th>
<th>Black Beans</th>
<th>Cacao</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield 1 Scenario: Mean survey yields*</td>
<td>740 Pounds/acre:</td>
<td>850</td>
<td>1144</td>
<td>928</td>
<td>273</td>
</tr>
<tr>
<td>Total labor for system (pers/day)</td>
<td>275</td>
<td>370</td>
<td>500</td>
<td>500</td>
<td><strong>399.3</strong></td>
</tr>
<tr>
<td>NPV of system (BZS)</td>
<td>$35.29</td>
<td>($303.28)</td>
<td>($577.82)</td>
<td>$1,211.61</td>
<td>($89.66)</td>
</tr>
<tr>
<td>Returns to labor (BZS/day)</td>
<td>$15.11</td>
<td>$11.95</td>
<td>$11.02</td>
<td>$22.42</td>
<td>$13.99</td>
</tr>
<tr>
<td>Returns to land (BZS/acre)</td>
<td>$9.29</td>
<td>($81.13)</td>
<td>($152.06)</td>
<td>$318.84</td>
<td>($89.66)</td>
</tr>
<tr>
<td>Yield 2 scenario: Alternative yields**</td>
<td>1050 Pounds/acre:</td>
<td>901</td>
<td>2089</td>
<td>684</td>
<td>500</td>
</tr>
<tr>
<td>Total labor for system (pers/day)</td>
<td>275</td>
<td>370</td>
<td>500</td>
<td>500</td>
<td><strong>399.3</strong></td>
</tr>
<tr>
<td>NPV of system (BZS)</td>
<td>$594.51</td>
<td>($77.51)</td>
<td>$2,312.78</td>
<td>$205.91</td>
<td>$1,437.62</td>
</tr>
<tr>
<td>Returns to labor (BZS/day)</td>
<td>$21.59</td>
<td>$14.03</td>
<td>$21.98</td>
<td>$15.35</td>
<td>$26.10</td>
</tr>
<tr>
<td>Returns to land (BZS/acre)</td>
<td>$156.45</td>
<td>($20.40)</td>
<td>$608.63</td>
<td>$54.19</td>
<td>$1,437.62</td>
</tr>
</tbody>
</table>

*Mean yield results from Toledo Upland survey (Marcotte, 2002)
**Mean yields for corn and matanambre from Pulver and Arya (1993); rice and beans from Marcus, R. (1994); cacao yields from TCGA (2000).
Financial indicators are presented in table 6.2 and illustrate the NPV, returns to labor, and returns to land for each of the LUS researched. Two yield scenarios are presented: yield 1 scenario and yield 2 scenario. Yield one is based on the results of the current research project and the calculation of yields per acre based on farmer reported annual production and plot size in the Upland survey of 120 farmers. Yield 2 is derived from yields reported in previous research projects implemented in the region and includes slash-and-burn crops corn, matahambre, rice and beans. Cacao yields for scenario 2 are from regularly reported expected yields (i.e., yield estimates developed by agronomists, extension agents, and development project economists working in the Toledo district) and form a key challenge to cacao adoption based on the difference between existing yields and expected yields and the subsequent impact on returns to smallholder investment. The following figures will illustrate NPV, returns to labor and returns to land and will be followed a brief discussion of issues apparent in each figure.

**Figure 6.1. Net present value of selected LUS**

<table>
<thead>
<tr>
<th></th>
<th>Net Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Belize dollars</strong></td>
<td>$3,000 (max)</td>
</tr>
<tr>
<td></td>
<td>$2,000 max</td>
</tr>
<tr>
<td></td>
<td>$1,000 max</td>
</tr>
<tr>
<td></td>
<td>$0 max</td>
</tr>
<tr>
<td></td>
<td>-$1,000 max</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main Season Corn</th>
<th>Second Season Corn</th>
<th>Rice</th>
<th>Black Beans</th>
<th>Cacao</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield 1: NPV of system (BZS)</td>
<td>$35.29</td>
<td>($308.28)</td>
<td>($577.82)</td>
<td>$1,211.61</td>
</tr>
<tr>
<td>Yield 2: NPV of system (BZS)</td>
<td>$594.51</td>
<td>($77.51)</td>
<td>$2,312.78</td>
<td>$205.91</td>
</tr>
</tbody>
</table>
Figure 6.1 presents the NPV for the target crops and highlights a few key issues. As was indicated earlier, main season and matahambre corn production are not considered major commercial activities. Matahambre, for example, has negative NPV for both yield scenarios begging the question why would anyone grow matahambre? Although the NPV is negative, the returns to labor are only slightly below the mean wage of $BZ14.7/day and may account for regional or seasonal differences in labor demand (i.e., during the matahambre season labor demand and subsequent wages could be below both the mean wage rate and the returns to labor wage for matahambre between $BZ11.95 and $BZ14.07). This coupled with the cultural tradition of producing one's own corn may account for farmers that are still producing matahambre.

A second issue to note from figure 6.1 is the dramatic change in rice NPV between yield 1 and yield 2. Based on yields reported by Marcus (1994) rice NPV is significantly greater than with current reported yields. Based on previous sales to the BMB, NPV of the rice LUS is likely to be higher (see appendix 5 for rice sales trends). A similar analysis of growers from each village selling to the BMB reinforces this hypothesis.

Three factors may contribute to this outcome. The challenge of not knowing the level of inputs invested in rice production in 1994 could lead to a miscalculation of returns due to farmers investing more time and/or purchased inputs into the production, resulting in greater yields, but not necessarily greater returns. Secondly, farmers indicated declining yields due to pests resulting from hurricane Iris. The claim is that birds and other animals are eating more of their crops because of the loss of food provided by natural forest temporarily destroyed by Iris. Lastly, there may be a breakdown in the slash-and-burn
rice LUS resulting in declining yields as the reported fallow periods have dropped below 4 years, however farmers reported that they often selected more mature and thus more nutrient-rich and weed-free forest to clear for rice. Unfortunately, this is difficult to determine with existing data, but there is some evidence that supports the second hypothesis. During the 1997 to 2000 period, the BMB purchased an increasing amount of rice from San Jose and Santa Cruz. San Miguel and San Antonio also increased their production between 1998 and 2000 after a dip from 1997 levels. This pre-Iris increase can be attributed to the subsidized price the BMB gives for rice and it will be interesting to see if the rice industry recovers after the significant setbacks caused by Iris. One thing that the increase in rice production (and in the number of farmers producing rice) during the late 1990’s indicates is that farmers are responsive to price signals and are willing to invest in LUS that provide positive returns, and, if the rice sub-sector recovers it will indicate that the subsidy provides sufficient incentive for farmers to re-invest after shocks such as hurricane Iris.

Finally, figure 6.1 indicates that the NPV of black beans is positive and that for cacao production it is negative under yield scenario 1. This relationship explains the current situation on the ground in the Toledo Uplands where farmers are expanding black bean production for the market in Guatemala and cacao production and acreage expansion remains limited.
Returns to labor is a critical component in farmer decision-making and one that aids comparing LUS in a way that farmers, policymakers, development agencies can all relate to. Based on farmer reports, black beans are the clear leader in returning the most money for a farmer’s investment in labor. Again, the rice return in yield scenario 1 indicates that farmers are still wrestling with problems related to Iris and if yields moved towards levels reported by Marcus (1994), their returns would be significantly higher. Cacao returns are below the mean local wage and below current returns for corn and black beans given yields reported for this study (scenario 1).

In the survey, farmers not growing cacao were queried about their interest in the organic cacao market. Just over half of the farmers in the survey (51%) indicated they were interested in growing cacao, with 61% of these smallholders stating they were interested in growing because it might improve their incomes. However, they also indicated reluctance because of the length of the time to maturity and insufficient access to seeds.
The remaining 43% indicated they were not interested. They were not interested because of other opportunities for income (30%), that they were too old to invest in long-term crops (30%), they had no access to inputs or assistance (16.7%), they felt cacao doesn’t earn enough money (13.3%), and that the establishment time was too long (10%). It is difficult to rank farmer reasons for not investing in a LUS, but the feeling that cacao does not pay well enough to draw them from other opportunities or the put forth investment in seeds or establishment time stands out based on these responses.

NPV and returns to labor are very important financial indicators from the point of view of a farmer or other potential investors, however returns to land is important to additional stakeholders and can stress important areas useful for policymakers and development agencies.

**Figure 6.3: Returns to land of selected LUS**
A shift occurs when we look at the performance of the selected LUS in terms of returns to land presented in figure 6.3. In general the returns to land are only positive for black beans under yield scenario 1 and for cacao, rice and to a lesser degree corn under yield scenario 2. Land utilization by cacao is less than the slash-and-burn alternatives and, if it were profitable (had a positive NPV), it would have comparatively higher returns to land because it is a permanent crop (NPV is negative in yield scenario 1, thus this typical benefit of an agroforestry system is only demonstrated under the second yield situation). For each acre in production it only requires access to that parcel alone, which puts all shifting cultivation at a relative disadvantage. This indicator is important to consider because it demonstrates that cacao has the potential to have significant returns to land and should be considered more carefully as a viable option to extensive slash-and-burn crops that do not return very much for each unit of land invested (or tied-up in the case of fallow) in these LUS. Returns to land are not considered widely, but as expected land pressure increases in the Toledo Uplands due to population growth and road development, it will become increasingly important.

This chapter explored in detail the financial returns from the predominant agricultural land use systems in the Toledo Uplands. It indicates that returns for cacao based on farmers reporting highest yields ever are close the current labor wage rate. It has also shown that the cacao LUS returns to labor based again on highest reported yields are lower than corn and black bean returns in both their yield scenarios and lower than matalahambre and rice in one yield scenario. It also emphasizes that if cacao growers could achieve the expected yield results (under the same input regime) then returns would be
very positive. This chapter demonstrates that the cacao LUS can be profitable, but more clearly illustrates that recent cacao production is not as profitable as some other LUS being practiced in the Toledo Uplands.
Chapter 7: What differentiates Upland farmers: A statistical analysis

This research project was designed to clarify why smallholders in the Toledo Uplands have not been widely adopting organic shade-grown cacao. Results thus far have indicated that smallholders invest in a range of agricultural activities in the Uplands and that they compete with one another for farmer investments. They have also shown that returns to labor and Net Present Values of the cacao LUS are lower than black bean, main-season corn and pre-hurricane Iris rice production. Given that farmers are maximizing their welfare through their selection of crop mixes (or working off-farm), it is important to better understand the characteristics of farmer livelihood strategies and use this information to inform recommendations aimed at increasing the adoption of the cacao LUS and overall cacao output. Understanding how demographic, income and expenditure, land tenure, farm size, and extension support variables relate to crop selection and mix and location forms the basis of the analysis in this chapter and will be used to help target recommendations presented in chapter 8.

This chapter presents a statistical analysis of household demographic, land, extension support, marketing and income data using principal component analyses (PCA) and bivariate correlations. PCA was selected because of its ability to identify the underlying dimensions of a dataset by looking for groups, or components, among the inter-correlations of a set of variables. Separate PCA’s were conducted for the entire survey sample, cacao-growers\(^{39}\) themselves, and among non-cacao growers. The results of the entire survey sample PCA are the primary focus of this chapter. Bivariate correlations

\(^{39}\) Farmers were considered cacao-growers if at the time of the survey they were actively growing cacao with the intention to sell it.
were conducted to identify relationships among selected variables and farmer location and among selected variables and a sub-group of only cacao-growers to further understand the characteristics that contribute to the differentiation among smallholders in the Toledo Uplands.

*Principal Component Analysis*

Twenty-five variables (A-Y in table 7.1) were tested using PCA. The basic principle of PCA is that it seeks the "linear combination of the variables with the maximum variance and then finds the second linear combination of variables, orthogonal to (independent of) the first, with maximum remaining variance, and so on" (Lindeman et. al., 1980 p. 263).

For this analysis, only factors with eigenvalues greater than 1 are presented and analyzed (eigenvalues of each component (or factor) represents the amount of total variance explained by that factor). Table 7.1 presents the 25 variables used for the PCA and their means, standard deviation and percentages where applicable.

<table>
<thead>
<tr>
<th>Table 7.1: Variables used in PCA (n=120)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>A. Current age of farmer (years)</td>
</tr>
<tr>
<td>B. How many years of school has farmer completed (years)</td>
</tr>
<tr>
<td>C. Number of family members living on farm</td>
</tr>
<tr>
<td>D. How much land have you been farming this year? (acres)</td>
</tr>
<tr>
<td>E. How much do you spend on food each month? (BZ$)</td>
</tr>
<tr>
<td>F. If you had an extra $25-30 each month, how much would you spend on food? (BZ$)</td>
</tr>
<tr>
<td>G. Will you be trying to get more land in the next 5 years? (Y/N)</td>
</tr>
<tr>
<td>H. Have you received any assistance from extension agents in the last 12 months? (Y/N)</td>
</tr>
<tr>
<td>I. Overall land tenure security* (continuous 0-5, 5 being most secure)</td>
</tr>
<tr>
<td>J. Does farmer get help from neighbors? (Y?N)</td>
</tr>
<tr>
<td>K. Total on-farm income (selected crops only) (BZ$)</td>
</tr>
<tr>
<td>L. How much money did you receive from off-farm labor in the last 12 months? (BZ$)</td>
</tr>
<tr>
<td>M. Number of man days hired since January</td>
</tr>
<tr>
<td>N. How much bush did you clear in the last 12 months? (acres)</td>
</tr>
</tbody>
</table>
O. How long has it been fallow? (age of re-growth for the cleared bush in N) (years) 3.80 2.88
P. How many acres are grown on the plot? (corn) 2.46 2.18
Q. How many acres are grown on the plot? (matahambre) 1.78 1.52
R. How many acres are grown on the plot? (rice) .41 .91
S. How many acres are grown on the plot? (black beans) .74 .98
T. How many acres are grown on the plot? (cacao) .60 1.5
U. Corn revenues (amount sold*price sold) (BZ$) 83.77 269.25
V. Matahambre revenues (amount sold* price sold) (BZ$) 95.44 247.71
W. Rice revenues (amount sold*price sold) (BZ$) 66.80 204.32
X. Black bean revenues (amount sold*price sold) (BZ$) 275.18 433.93
Y. Cacao revenues (amount sold*price sold) (BZ$) 211.50 722.5

*Overall land tenure security assumes that land that is leased or owned is more secure (=1) than land held in the reservation system or not owned or leased by the farmer (=0). This is based on an aggregation across individual plot results for each farmer.

PCA was performed first for the entire Upland survey sample and resulted in 9 components with eigenvalues greater than 1. These are presented in the component matrix below with the coefficients greater than 4 highlighted in bold. In a discussion regarding both quartirmax and varimax solutions (the latter used here), Lindeman et. al. (1980) state that coefficients greater than 4 indicate variables loading heavily on the specific component and making ‘meaningful contributions to defining factors’ (p. 273).

The 9 components account for 72.87% of the variation within the entire Upland sample.

Table 7.2: Component Matrix - entire sample (n=120)

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Current age of farmer</td>
<td>-.205</td>
<td>.246</td>
<td>-.138</td>
<td>.101</td>
<td>-.107</td>
<td>-.725</td>
<td>-.115</td>
<td>.105</td>
<td></td>
</tr>
<tr>
<td>B. How many years of school has farmer completed</td>
<td>-.109</td>
<td>.178</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Number of family members living on farm</td>
<td>.230</td>
<td>.113</td>
<td>.299</td>
<td>.105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. How much land have you been farming this year?</td>
<td>.469</td>
<td>.230</td>
<td>.101</td>
<td>.414</td>
<td>.112</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. How much do you spend on food each month?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.847</td>
</tr>
<tr>
<td>F. If you had an extra $25-30 each month, how much would you spend on food?</td>
<td>.416</td>
<td>.117</td>
<td>.336</td>
<td>-.352</td>
<td>-.314</td>
<td>-.105</td>
<td>-.176</td>
<td></td>
<td>.330</td>
</tr>
<tr>
<td>G. Will you be trying to get more land in the next 5 years?</td>
<td>.105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.749</td>
</tr>
<tr>
<td>H. Have you received any assistance from extension agents in the last 12 months?</td>
<td>.214</td>
<td>-.195</td>
<td></td>
<td>.647</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.344</td>
</tr>
<tr>
<td>I. Overall land tenure security</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.152</td>
</tr>
<tr>
<td>J. Does farmer get help from neighbors?</td>
<td>-.226</td>
<td>-.339</td>
<td>.490</td>
<td>.259</td>
<td>-.445</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K. Total off-farm income (target crops only)</td>
<td>.578</td>
<td>.591</td>
<td>.190</td>
<td>.407</td>
<td>.104</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. How much money did you receive from off-farm labor in the last 12 months?</td>
<td>-.167</td>
<td>-.130</td>
<td>.632</td>
<td>.220</td>
<td>.281</td>
<td>-.175</td>
<td>-.104</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. Number of man days hired since January</td>
<td>-.105</td>
<td>.792</td>
<td>-.104</td>
<td>-.107</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. How much bush did you clear in the last 12 months?</td>
<td>.532</td>
<td>.374</td>
<td>.412</td>
<td>-.103</td>
<td>.259</td>
<td>-.200</td>
<td>-.151</td>
<td>.203</td>
<td></td>
</tr>
<tr>
<td>O. How long has it been fallow? (age of regrowth)</td>
<td>.112</td>
<td>-.147</td>
<td>.752</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. How many acres are grown on the plot? (corn)</td>
<td>.655</td>
<td>.140</td>
<td>.208</td>
<td>.247</td>
<td>-.164</td>
<td>-.177</td>
<td>.367</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q. How many acres are grown on the plot? (matalambre)</td>
<td>.349</td>
<td>.116</td>
<td>.731</td>
<td>-.167</td>
<td>.226</td>
<td>-.114</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. How many acres are grown on the plot? (rice)</td>
<td>.103</td>
<td>.912</td>
<td>.115</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. How many acres are grown on the plot? (black beans)</td>
<td>.806</td>
<td>.148</td>
<td>-.104</td>
<td>.277</td>
<td>.166</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. How many acres are grown on the plot? (cacao)</td>
<td>.892</td>
<td>.103</td>
<td>-.110</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U. corn revenues (amount sold*price sold)</td>
<td>.703</td>
<td>.110</td>
<td>-.245</td>
<td>.151</td>
<td>-.180</td>
<td>.123</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V. matalambre revenues (amount sold*price sold)</td>
<td>.121</td>
<td>.876</td>
<td>-.131</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W. rice revenues (amount sold*price sold)</td>
<td>.93</td>
<td>.893</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X. black bean revenues (amount sold*price sold)</td>
<td>.796</td>
<td>.187</td>
<td>.212</td>
<td>-.123</td>
<td>.244</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y. cacao revenues (amount sold*price sold)</td>
<td>.941</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


The PCA provides an important step in thoroughly understanding the livelihood options that smallholders in the Uplands seek or develop. An analysis of each component, including its’ major underlying variables and interpretation is presented below in Table 7.3.

Table 7.3: Interpretation of PCA results for the Upland sample

<table>
<thead>
<tr>
<th>Component</th>
<th>Percent of Variance</th>
<th>Key Variables</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.14%</td>
<td>D, F, K, N,</td>
<td>These eight variables underscore the influence of farm size and its relationship to on-farm income – particularly from corn and black beans. It further indicates that corn and bean slash-and-burn crops, are the primary sources of income within this component. There is also a high loading regarding the desire to spend more money on food and a negative relationship (albeit small) to hiring labor. This grouping also correlates with lower levels of education and younger farmers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P, S, U, X</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9.5%</td>
<td>K, T, Y</td>
<td>Key variables group around cacao farming and its relationship with on-farm income. Other less heavily loaded variables</td>
</tr>
<tr>
<td>Component</td>
<td>Percentage</td>
<td>Variables</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>------------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>3</td>
<td>8.9%</td>
<td>R, W</td>
<td>Two variables load heavily, each directly related to rice acreage and revenues. Less heavily loaded variables indicate a negative relationship with age (this component indicates a younger group), a slight negative correlation with land security and extension support.</td>
</tr>
<tr>
<td>4</td>
<td>8.6%</td>
<td>D, K, N, Q, V</td>
<td>This component differentiates by crop, yet highlights matahambre production. It also loads heavily on amount of cleared land – again highlighting the relationship between slash-and-burn and corn.</td>
</tr>
<tr>
<td>5</td>
<td>8.5%</td>
<td>E, L, M</td>
<td>Component 5 stresses off-farm generated income and expenditures. Clearing, working with neighbors, and corn and bean production are weakly correlated to this component. Interestingly, this grouping loads heavily on hiring labor, but not income generated from farm sales leaving an unclear explanation for the allocation of hired labor.</td>
</tr>
<tr>
<td>6</td>
<td>6.4%</td>
<td>C, D, H, J</td>
<td>Key variables indicate larger farms with larger families and a higher overall land security and more assistance from extension. This is an interesting component as it includes off-farm income, a bit more land clearing and black bean and cacao sales, but indicates that corn is consumed (negative relation with corn and matahambre revenues). This may explain some of the cultural significance of corn and that farmers may be paying to have their household corn grown.</td>
</tr>
<tr>
<td>7</td>
<td>6.25%</td>
<td>A, B</td>
<td>Older farmers with significantly less education than younger farmers load heavily. This grouping also highlights that younger, more educated farmers have a positive correlation with off-farm income. Increased education among younger farmers may further increase competition between agricultural and no-farm income opportunities.</td>
</tr>
<tr>
<td>8</td>
<td>5.77%</td>
<td>G, I, J</td>
<td>Three variables that load heavily and include getting more land, a high degree of tenure security and not working with neighbors. This grouping is linked also with receiving assistance from extension, yet is only positively linked with one crop - black bean revenues.</td>
</tr>
<tr>
<td>9</td>
<td>4.88%</td>
<td>Q</td>
<td>The last component, loads heavily only with only one variable – long-term fallows. Small families, insecure land tenure, a limited need to spend more money on food and corn production are evident in this component, but to a lesser degree. It would seem that this component is highlighting older and more traditional farmers with access to land with longer fallows and are able to successfully meet household food needs.</td>
</tr>
</tbody>
</table>

The PCA breaks the Upland sample into nine components and highlights the importance of livelihood strategies and demographics in the differentiation among the sample. The first five components make up and almost half of the total variance and distinguish the following livelihood strategies: (1) extensive slash-and-burn with a focus on
commercialized corn and bean production, (2) cacao production for income by older farmers who do not work with neighbors, (3) younger, less secure rice growers (i.e., less support from extension and tenure insecurity), (4) a matahambre production strategy, but with a clear linkage to extensive slash-and-burn evidenced in variable 1\textsuperscript{40}, and (5) a clear strategy of meeting food needs through off-farm work and a tendency to hire workers. A second segment includes components identify demographic patterns and include (6) larger farm and family size with more support (extension and land security), (7) older, less educated farmers and inversely younger farmers with more schooling and tendency to work off-farm. The remainder of the variance is accounted for by (8) positive experiences with farming (land security, support from extension) perhaps leading to expansion and (9) long-term falls differentiating this group of farmers from the majority of farmers.

PCA was also conducted for non-cacao grower and cacao-grower subsets (see appendix 7 for results and analyses of each PCA). There was a lot of similarity among the grouping (influence of farm size, slash-and-burn crops, rice production, off-farm work and education on variance), especially between the entire sample and the non-cacao grower sample as one may expect (non-cacao growers make up a majority of the entire Upland sample). The key features of the cacao sub-analysis lie heavily among the first four components (accounting for 44.7% of variance). Variance within this group is accounted for by the influence of other crops being produced for income (i.e., rice and matahambre loaded high on component 1 and black beans on component 4) and the association with

\textsuperscript{40} In my fieldwork most farmers that grew second season corn, matahambre, also grew main season corn. The emphasis here may be because of a few farmers that produce and sell green matahambre corn that can be eaten fresh.
changes in the size of slash-and-burn crop acreage. Secondly, variation among this group is tied to on-farm income. Among cacao-growers producing black beans (component 4), cacao revenues are moderately, yet negatively related to black bean revenues, indicating a likelihood that this group is investing more heavily, and earning more from black bean production. As with the other PCA’s, off-farm income loads heavily on a single component (component 6) and includes a positive relationship between off-farm income, hiring labor, and larger rice acreages (cacao and other crops do not load at all). This may indicate that farmers that have the means to hire labor are investing it in rice production and not cacao or other crops.

The PCA yielded clear distinctions among smallholders in the Upland sample and that LUS are competing for farmer investment. However, before these are discussed further, correlations at the village level and at the cacao-grower subgroup level will be analyzed. The PCA and correlation analyses will be discussed at the end of this chapter, and, in particular, will address how the promotion of cacao production can be targeted in light of the PCA and correlations analyses.

Village level characteristics

Although there are similarities among farmers in the region, my experience in the area indicates that important variation exists across villages and that understanding it can help guide actions aimed at increasing cacao output. Bivariate correlations are conducted among selected variables and farmer location with the objective of determining how farmer location impacts key variables and, how farmers and their livelihood strategies
differ depending on where they live. These variables and their correlation coefficients are presented in table 7.4.

### Table 7.4: Village level correlations

<table>
<thead>
<tr>
<th>Current age of farmer</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>How many years of school has farmer completed</td>
<td>-.015</td>
<td>.232*</td>
<td>-.287**</td>
<td>.107</td>
</tr>
<tr>
<td>Number of family members living on farm</td>
<td>.151</td>
<td>-.358**</td>
<td>.132</td>
<td>.041</td>
</tr>
<tr>
<td>How much land have you been farming this year?</td>
<td>.210*</td>
<td>-.228*</td>
<td>.109</td>
<td>-.133</td>
</tr>
<tr>
<td>How much money did you receive from off-farm</td>
<td>-.134</td>
<td>.128</td>
<td>-.073</td>
<td>.108</td>
</tr>
<tr>
<td>labor in the last 12 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does farmer get help from neighbors?</td>
<td>-.008</td>
<td>-.425*</td>
<td>.300**</td>
<td>.100</td>
</tr>
<tr>
<td>Does farmer hire labor?</td>
<td>.139</td>
<td>.031</td>
<td>-.322**</td>
<td>.176</td>
</tr>
<tr>
<td>Corn revenues (amount sold*price sold)</td>
<td>-.035</td>
<td>-.066</td>
<td>.213*</td>
<td>-.135</td>
</tr>
<tr>
<td>Matahambre revenues (amount sold* price sold)</td>
<td>.017</td>
<td>-.007</td>
<td>.067</td>
<td>-.088</td>
</tr>
<tr>
<td>Rice revenues (amount sold*price sold)</td>
<td>-.075</td>
<td>-.154</td>
<td>.358**</td>
<td>-.164</td>
</tr>
<tr>
<td>Red kidney bean revenues (amount sold*price sold)</td>
<td>.218*</td>
<td>-.060</td>
<td>-.131</td>
<td>-.041</td>
</tr>
<tr>
<td>Black bean revenues (amount sold*price sold)</td>
<td>.313**</td>
<td>-.296**</td>
<td>.204*</td>
<td>-.289**</td>
</tr>
<tr>
<td>Cacao revenues (amount sold*price sold)</td>
<td>.240*</td>
<td>.064</td>
<td>-.180</td>
<td>-.135</td>
</tr>
<tr>
<td>Overall land tenure security</td>
<td>.243**</td>
<td>-.145</td>
<td>-.367**</td>
<td>.286**</td>
</tr>
<tr>
<td>How much bush did you clear in the last 12 months?</td>
<td>.188</td>
<td>-.234*</td>
<td>.324**</td>
<td>-.349**</td>
</tr>
<tr>
<td>How long has it been fallow? (age of re-growth)</td>
<td>-.021</td>
<td>.106</td>
<td>.177</td>
<td>-.284**</td>
</tr>
<tr>
<td>Have you received any assistance from extension</td>
<td>.336**</td>
<td>-.162</td>
<td>-.194*</td>
<td>.000</td>
</tr>
<tr>
<td>agents in the last 12 months?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

San Jose tends to have larger more secure farms and receives more support from extension. Although San Jose is the furthest village from Punta Gorda, it has historically, been involved in development projects (i.e., a pesticide and fertilizer depot, Peace Corps sponsored projects, and housing for extension agents). It has organized to acquire large tracks of leased land and the current chairman of the TCGA resides in San Jose. Farmers in San Jose earn money from black beans and cacao and have the only significant income from red kidney beans (primarily due to one grower who reported growing almost 4 acres of red kidney beans, much more than other growers). San Antonio is the largest and most economically diverse village in the Uplands. It has many residents that commute to jobs
in Punta Gorda and tends to have older farmers with smaller families. Farmers also do not work communally as often nor clear very much land and there is a negative correlation between black bean and rice production. Santa Cruz is a relatively young village and has younger farmers that clear a lot of land for slash-and-burn agriculture. They tend to work together and earn most money from selling corn, black beans and rice. Santa Cruz receives very little assistance from extension and has the least number of farmers who own or lease land. San Miguel is located nearest to road construction taking place on the southern highway and has a lot of farmers working outside of agriculture at least part of the year. Farmers also have high levels of land security (due primarily to a one-time leasing arrangement between the GOB and San Miguel). This has also led to more farmers reducing their fallow periods by incorporating cover crops (i.e., macuna or velvet bean) into their production – this is evidenced by negative correlation between amount of land cleared and age of fallows.

Correlations specific to cacao-growers

A final correlation analysis was conducted strictly among cacao growers in an attempt to ascertain specific differences in characteristics of the system (such as yields and cacao revenues) and what impacts them. Appendix 8 has the complete correlation matrix, with only the significant (at 0.01 and 0.05 level (two-tailed)) correlations discussed below in Table 7.6.
Table 7.6: Cacao grower significant correlations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description of correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>How long have you been growing cacao? (years)</td>
<td>Positively correlated with age of farmer and plans to expand production. Negatively correlated with the size of family</td>
</tr>
<tr>
<td>Did your parents grow cacao? (Y/N)</td>
<td>Positively correlated with grandparents producing and farmer’s age. Negatively correlated with level of education.</td>
</tr>
<tr>
<td>Have you borrowed money to invest in cacao? (Y/N)</td>
<td>Positively correlated with farmers who visit extension offices. Negatively correlated with number of family members living on-farm.</td>
</tr>
<tr>
<td>Current age of farmer. (Years)</td>
<td>Positively correlated with number of family members living on-farm and total farm income. Negatively correlated with farmer plans to expand cacao production.</td>
</tr>
<tr>
<td>How many years of school has farmer completed? (years)</td>
<td>Positively correlated with number of family members living on-farm and total farm income. Negatively correlated with farmer plans to expand cacao production.</td>
</tr>
<tr>
<td>Number of cacao acres (Acres)</td>
<td>Positively correlated with amount of cacao sold, revenues, and total on-farm income.</td>
</tr>
<tr>
<td>Does the cacao plot have secure land tenure? (Y/N)</td>
<td>Positively correlated with overall land security. Positively correlated with visiting extension offices.</td>
</tr>
<tr>
<td>How much land did farmer clear in the last year? (acres)</td>
<td>Positively correlated with visiting extension offices.</td>
</tr>
<tr>
<td>Did farmer get training when they began growing cacao? (Y/N)</td>
<td>Negatively correlated with farmer’s plans to expand cacao production.</td>
</tr>
<tr>
<td>Extension assistance within the last year (Y/N)</td>
<td>Positively correlated with farmers that visit extension offices.</td>
</tr>
<tr>
<td>What was the most cacao you sold before hurricane Iris? (pounds of beans)</td>
<td>Positively correlated with cacao yields, revenues, and total on-farm income.</td>
</tr>
<tr>
<td>Cacao yield (pounds)</td>
<td>Positively correlated with cacao revenues and total on-farm income.</td>
</tr>
<tr>
<td>Cacao revenues (BZ$)</td>
<td>Positively correlated with total on-farm income.</td>
</tr>
</tbody>
</table>

Differences among Upland farmers

The analysis in this chapter emphasizes the strategies that smallholders in the Toledo Uplands use to maximize their welfare. It also highlights some key geographical differences and characteristics specific to cacao-growers. The results of PCA for the entire Upland sample yielded a package of livelihood strategies that smallholders have developed within the Upland environment. These include the dominant, and expanding, commercial and subsistence slash-and-burn production systems, off-farm work being sought by more educated and younger farmers and cacao production (often by older farmers). Each of these is discussed in terms of developing approaches to expand cacao production.
Corn and black bean production both have higher returns to labor and NPV as seen in chapter 6. This coupled with the PCA results indicate that their production is key to on-farm income and emphasizes the need for steps to be taken to improve the financial returns of the cacao LUS. Correlations within this group also indicate a younger, less educated farmer sub-group, a group that may be more likely to invest in agricultural activities since previous results have shown that higher education levels are correlated to off-farm activities.

The challenge of off-farm work drawing farmers to higher-wage and lower risk employment is likely to change the nature of the Uplands. However, within the region, off-farm activities are limited, and especially in more remote villages (i.e., San Jose and Santa Cruz). Cacao production may be adopted by farmers in areas where off-farm employment is limited and, very importantly, can demonstrate higher financial returns than other farm activities. In addition, where smallholders with the means to invest in hired labor exist, cacao can be promoted as an alternative agricultural investment with the potential to earn a profit. For example, farmers in San Miguel may not invest their own labor in cacao establishment and production, but may be interested in hiring labor to develop cacao groves on their leased land as long as returns exceed alternative investments in the land.

The PCA of the cacao-growers also indicated the struggle occurring within livelihood strategies, specifically cacao-producing farmers investing household labor in rice and
black beans themselves and very important, investing hired labor into rice production. Bivariate correlation analyses among cacao-growers also indicate that on-farm income is positively related to cacao production and, in turn, correlated with higher levels of education. Although few farmers have borrowed to invest in cacao, it is positively related to visiting extension agents (and perhaps overall empowerment in general), but has no significant correlation to cacao yield or revenues or total on-farm income. Actions to improve the productivity of the existing cacao systems must be implemented.

Smallholders currently growing cacao are older and it is likely that if their groves are not seen as viable investments they may be abandoned and actually reduce the cacao production in the Uplands. Developing mechanisms to encourage the ‘passing on’ of established, and still productive, groves are needed.

This chapter has presented an analysis of the kinds of livelihood strategies smallholders have developed in the Uplands. In general, promotion of the cacao LUS has several entry points based on the range of livelihood strategies and the relationship to their village location. The first is to demonstrate that the cacao LUS is more profitable than alternative, more dominant systems. Smallholders producing corn and beans indicate that their current income may be insufficient (i.e., reporting in the survey a need for more money to buy food), thus a profitable cacao system could help alleviate this and increase overall supply. Secondly, off-farm workers can be targeted as potential investors (i.e., hiring labor for cacao production). And lastly, groups and/or areas that may have limited off-farm opportunities should be targeted for cacao production.
Chapter 8: Conclusions and Policy Implications

Agricultural, economic and social development in the Toledo district face numerous challenges. The predominant slash-and-burn system has failed to reduce poverty and is demonstrating declining fallow lengths, often a key indicator in the breakdown of the system. Deforestation is also a concern for the Toledo District and, although rates available are not specific to the District, it is occurring in Belize at a higher rate than in neighboring countries. Current pressure on the land base may accelerate as population increases and as two major highway projects improve access to the region. One highway project connecting Toledo with the rest of Belize nears completion, and a second is intended to run east-west and create the second official border crossing into Guatemala. These challenges have led smallholders, government, and donor agencies to seek alternative agricultural and non-farm economic strategies that can address these intertwined challenges. Understanding why organic cacao production is not widely adopted will assist with the design of policy instruments and development programs intended to reduce poverty and the negative impacts of agriculture on the natural resource base.

The purpose of this study has been to look closely at organic, shade-grown cacao production in the Toledo Uplands and compare it to more widespread slash-and-burn systems. Organic, shade-grown cacao production has been presented as an alternative land use system capable of reducing poverty in the Toledo Uplands while simultaneously reducing the degree of environmental degradation occurring in the current slash-and-burn system (Sams, 1998; Levasseur and Olivier, 2000). However, annual cacao output has
remained low and well below the levels the current purchaser is seeking to buy despite a guaranteed contract, extension support, payment for cacao upon delivery, and an above world market price.

A general hypothesis was developed and put forth in chapter 4 to guide the analyses in this study. It states: Organic, shade grown cacao can be a profitable land use system for the Toledo Uplands, however, current prices, policies and institutional environments favor the production of slash-and-burn crops. The cacao LUS can be profitable, but given that actual yields are considerably lower than commonly expected among agriculture research and extension experts, returns to labor are below off-farm activities and below main-season corn, black bean and pre-hurricane Iris rice production.

Although difficult to prove with available data, it is also likely that land and credit policies favor short-term, shifting cultivation over cacao. Also, testing the impact of research and extension on adoption was difficult in this study as research and extension is generally weak in the Toledo district. Interestingly, cacao growers have additional extension support and are provided price information in advance. Thus, institutional support in this regard is above that for many slash-and-burn crops. The remainder of this chapter focuses on the removal of constraints to organic cacao adoption.

*Addressing the challenges to cacao expansion*

The main challenge to cacao adoption and expansion highlighted in this research is that financial returns to cacao production are lower than some competing slash-and-burn
crops (and off-farm work as this was clearly a livelihood strategy being sought in chapter 7). Underlying challenges that are less apparent in this research, but play a role in the overall profitability and competitiveness of a LUS are that access to credit is limited, price policy distorts the profitability of slash-and-burn rice production, land tenure is often not secured with ownership rights and constrained by poorly functioning land markets, and lastly, that ‘food production’ may compete with ‘food purchasing’ in a region only recently moving from subsistence-based agriculture. Each of these constraints is discussed in turn and followed by recommendations for reduction or removal of the constraint.

Profitability

Financial returns can be improved by in two general ways: (1) changing the current pricing structure and/or (2) improving the productivity of the system within the current pricing structure. The current price is based on an organic and Fair Trade premium, but is not calculated using local area inputs costs (it’s effectively a price subsidy based on world prices that are set by larger, lower cost cocoa producing countries). It could be argued then, that the price is not sufficient under current conditions. Sensitivity analysis shows that for cacao to compete with black bean returns to labor - under the current yield, interest rates, and labor input scenarios - the price would need to increase at least by BZ0.81 (over 50%). Specifically, farmers who received BZ$2.21 per pound would receive the same returns to labor as under the black bean production scenario presented in chapter 6. The price to cacao growers can change at two points: at the market price given by Green and Black’s and at the TCGA depot price given to farmers. Although Green and
Black’s has supported TCGA with certification costs and up-front funding, it is not likely it will directly increase the price above world FT prices. Thus, an evaluation should be undertaken regarding the level of funding TCGA needs to carry out its activities and how a larger percentage of the overall price can be given to farmers. If aggregate production could be increased, as is expected given recent investments in expansion, then TCGA could reduce the percentage of cacao sales revenue it devotes to operations and increase the price they pay to farmers upon delivery of beans. Providing farmers with a clear outline of this process, and its intentions, will enhance transparency and make returns on farmer’s investment greater.

Improving productivity can also lead to increased returns. Chapter 6 indicated that if yields were to reach levels expected by researchers in the region (without significant changes in labor and other inputs costs), returns to labor would outweigh those of all other crops. How then can the productivity of the organic cacao LUS be increased? Using labor saving technology and practices to reduce the time needed to cut selected areas of the forest, establish cacao, and manage shade could improve LUS profitability. Researchers should consult with the highest-yield cacao growers and identified best management practices should be extended to other smallholders while simultaneously seeking additional clarity on the problems facing low yield farmers.

Cacao production requires an establishment period followed by a lag-time that other slash-and-burn crops do not require. The combination of the lag-time from establishment to returns generated in the first harvest itself, and more importantly, the cost of establishment and maintenance during the lag-time significantly reduce the profitability
(and overall competitiveness) of the cacao system. Research has been ongoing regarding grafting cacao tree shoots onto rootstock as a means of reducing the time to first harvest. A group of TCGA growers visited Costa Rica and indicated that the number of years to bearing could be reduced from 5 to 2 or 3. Sensitivity analysis show that even under the current low yield scenario (~273 lbs./acre), returns to labor will increase to almost BZ$18 if harvest commences in year 3 opposed to year 5. Smallholders can significantly benefit from research and extension that brings grafting practices from the research station to the field and more investment is required.

Financial performance may also be improved by incorporating alternative shade species such as fruit trees, nuts, or spices in the LUS that generate regular outputs. Further research should investigate how to best promote and facilitate such integration and to develop systems that complement periods when labor is not needed in the cacao LUS. This recommendation parallels conclusions drawn for a low-input cacao system in Cameroon with commercial fruit tree production (Duguma et al., 2001).

Non-cacao price policies can also be developed that will enhance the overall relative profitability of the system. Prices can be developed to pay farmers for other services the cacao LUS provides. Carbon sequestration, biodiversity and soil and watershed protection are all social and ecological services provided by shade-grown cacao and if farmers are compensated then overall financial returns to the system can be increased. These are services that competing slash-and-burn systems are not as capable of delivering. These kind price policies will require developing mechanisms to quantify
ecological services provided by cacao and that are able to deliver payment to smallholders for the service benefits.

**Credit**

Attention must also be given to identifying what changes can be made to credit systems that will enhance the ability of farmers to invest in cacao production. Rosenberg and Marcotte (under review), demonstrate that NPV shows a strong and non-linear response to the discount rate. As the discount rate decreases their analyses show that NPV can increase 2- to 3-fold. This result suggests that low(er) interest credit made available to invest in cacao production could encourage cacao adoption. However, unless terms for the credit are specific to cacao investment, smallholders are likely to invest in the activity that will yield the highest financial return. In addition to lower costs of capital, credit policy needs to explore alternative credit schemes to extend terms beyond the current maximum of three years and reform the criteria for loan approval to include more smallholders.

**Rice Policy**

Rice price policies impact the attractiveness of rice production. In specific, rice is subsidized and has historically had returns that most likely rivaled those of black beans. Rice production in Toledo provides some very interesting lessons and may be an important entry point for policymakers seeking to reduce government expenditures and comply with global and regional trading regulations. Two things should be further evaluated in regards to rice production in Toledo. First, it is uncertain how the rice
subsidy will play out given evolving trading restrictions to domestic market protections. There seems to be no current threat by GOB to reduce or eliminate the subsidy however certain policy changes are out of the hands of national policymakers (i.e., the loss of preferential markets in EU for bananas was not determined by the GOB). Secondly, rice growers consistently seek out the oldest bush to clear, thus there is an environmental incentive (particularly as Belize earns significant foreign exchange from tourists interested in the flora and fauna of the rainforest) for the GOB to seek alternative, more environmentally benign production systems capable of financial performance equal to the return under the subsidized rate. It may be possible to seek a mechanism that will transfer some of the costs of the rice subsidy into the investment in competitive, more environmentally benign agricultural production systems such as organic shade-grown cacao. TCGA may be able to play a role by targeting current rice growers (i.e., Santa Cruz) to develop cacao LUS that can match current rice production returns.

Land Tenure

Land tenure is complicated in Toledo and smallholders are not certain whether they will have access to the same lands each year. Although a significant amount of smallholders seeking land want leaseholder or ownership title to the land, the lease application process is cumbersome and often impacted by politics and outright purchases are still rare. This study did not conclude that smallholders with secure land tenure were more likely to invest in cacao, but if the evidence in the literature is correct, once the profitability constraint is removed, access to secure lands will be an underlying issue affecting adoption of permanent cropping systems. Government policy and development
organizations must move forward on the issue of land tenure in the Toledo District. Whether arrangements are made whereby farmers lease or own land individually, as a cooperative or association, or through innovative community ownership is not as important as smallholders having the security that they can invest time and resources into a piece of land without fear of losing it to a neighbor or outsider.

**Food security**
Food and economic insecurity are still pervasive in the Uplands and are seen by incidences of smallholders reporting a need for more money to buy food, some farmers selling their corn after harvest and buying it back later (often at higher prices), and many producing matahambre for food with returns to labor below current wage rates. Also, results highlighted livelihood strategies that indicate producing food for one’s own consumption is still a necessary activity. As infrastructure improves, food markets will also improve and smallholders will likely shift their concerns even further to producing strictly for the market. A shift is already occurring with smallholders producing extensively for rice and bean markets and using the income to purchase food. Cacao cannot compete as an alternative food crop, but as food markets develop it can play an important role in income generation and the subsequent increase in access to food.

In conclusion, smallholders, development organizations, policymakers and research and extension must develop strategies that enhance the financial performance of organic, shade-grown cacao land use systems. Improving the price received by smallholders through efficiency gains at TCGA, expanding research into grafting and complementary
products, developing mechanism to pay farmers for social services while addressing the underlying issues of credit, rice price policy and land and food insecurity will enhance the adoption and more importantly, the long-term sustainability of organic cacao production in Toledo.
REFERENCES:


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Nesbit, Christopher (2002) Green and Black’s country liaison. Personal communication. Toledo District, Belize. November


Appendix 1: Toledo Rainfall and Agricultural Production Activities

Toledo Rainfall 1999-2001 (mm/month)

<table>
<thead>
<tr>
<th>Agricultural Activity</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Demarcation (res.)</td>
<td></td>
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<td>Land Clearing</td>
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<td>Matalambre</td>
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<tr>
<td>Land Preparation/Planting</td>
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<td>Beans (RK, Black, Macuna)</td>
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<td>TCGA Purchasing</td>
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</tbody>
</table>
Appendix 2: Satellite imagery of land use in Southern Belize

*The Toledo Uplands are approximated by the additional rectangle. The link road will connect from the corner of the 'L' in the southern highway heading westward to the border with Guatemala.*
Appendix 3: Mean world cocoa prices and fair trade price floor
Appendix 4: Data collection: Sources and survey instruments

This appendix presents a series of data collection instruments utilized during field research in the Toledo District. Opening remarks and the formal survey (sections A through I) are presented first, followed by detailed questionnaires for selected crop activities, a list of key informants and an example of questions sent in advance to key informants.

Opening remarks to each farmer

I. Who is doing the research?

- My name is Travis (or enumerators name and description of who is doing the work) and I have worked with agriculture rural development in Belize for almost five years. I am now a graduate student at the University of California studying agriculture.

II. What is the research?

- The idea for this research stems from work that I did almost five years ago for the MAFC and IICA with the assistance of BEST and Help For Progress. The work resulted in a review of the cocoa production and marketing systems for the entire country.

- This research is designed to specifically understand what has helped some farmers to adopt organic cacao production and what keeps others from not producing.

  This is being done by:
  - looking carefully at GOB policies and the policies of other organizations,
  - analyzing the costs and returns of different farming activities – particularly how much labor an activity takes, and
  - discussing agricultural concerns in depth with farmers – which is what the survey is intended to be part of.

- The outcome of this research is intended to develop a better understanding of the range of things that influence a farmer’s willingness or interest in adopting different agricultural systems.

III. Why is it important?

- This research is designed to help policymakers better understand the things that affect how a farmer goes about adopting different agriculture systems - particularly the GOB and other agriculture related organizations to adjust their assistance and policies to better help small farmers.

- It is also intended to highlight the development of an organic cacao sector in Belize and help other countries interested in alternative production to understand what things are important to consider when they promote such activities.

IV. What will your survey be used for?

- Your survey will only be used for my analysis. It will be combined with all other responses from farmers in three other villages. Your responses are confidential and will not be given to anyone.

Do you have any questions before we start?
Toledo Upland Smallholder Questionnaire – Fall 2002

<table>
<thead>
<tr>
<th>Date:</th>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

**Sex:** M / F  
**Village:**  
**I.D. Number:**

### A. Background Information
I just want to ask a few basic questions about your background:

<table>
<thead>
<tr>
<th>1. Where were you born?</th>
<th>2. How many years have you been farming in this village?</th>
<th>3. How old are you?</th>
</tr>
</thead>
</table>

| 4. Have you been to school in Belize? Y / N  
[if no >> 4a if yes >>5] | 4a. Have you been to school elsewhere? Y / N | 5. What level did you complete? | 6. What language do you speak most often? |
|--------------------------|---------------------------------------------|--------------------------|------------------------------------------|

|-------------------------------------------------|--------|--------|----------------|----------------|----------------|----------------|

### B. Labor Characteristics and Availability
Because labor is so important in agriculture I want to ask a few questions about family and hired labor:

<table>
<thead>
<tr>
<th>1. How many family members of your family work on the farm all year?</th>
<th>2. Do any members of your family work off farm but live at home? Y / N</th>
<th>2a. What do they do?</th>
<th>2b. Do they contribute money to the household? Y / N</th>
</tr>
</thead>
</table>

| 3. Are there family members that live away from the property that return to help work? Y / N  
[if no >> 4] | 3a. What do they help with? | 3b. How do you compensate them (money, food, etc.)? |
|-------------------------------------------------------------|--------------------------|--------------------------|

| 4. Do you hire any workers? Y / N  
|--------------------------|----------------|----------------|----------------|----------------|

| 5. Do you get help from your neighbors? Y / N  
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td>Answer Options</td>
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<tr>
<td>-------------------------------------------------------------------------</td>
<td>----------------------</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6. In the last 12 months were there times when you needed labor and could not hire some?</td>
<td>Y / N [if no &gt;&gt; section C]</td>
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</tr>
<tr>
<td>6a. When?</td>
<td></td>
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<tr>
<td>6b. Why not?</td>
<td></td>
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<tr>
<td>6c. What did you need the labor for?</td>
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<tr>
<td>8. If the cost you paid for a worker was five dollars less per day would you hire more workers?</td>
<td>Y / N</td>
<td></td>
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<tr>
<td>8a. What would you hire them for?</td>
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<tr>
<td>7. If you had another two weeks of man-days during the past 12 months, what would you have used the labor for?</td>
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</tr>
</tbody>
</table>

**C. Land Characteristics and Tenure Arrangements**

Next I want to ask a few questions about the land you are farming this year.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. How much land have you been farming this year (since January)?</td>
<td>Y / N</td>
</tr>
<tr>
<td>1b. Is this more or less than last year?</td>
<td>More / Less How much?</td>
</tr>
<tr>
<td>1c. Is this more or less than the average over the last five years?</td>
<td></td>
</tr>
<tr>
<td>2. Will you be trying to get more land in the next five years?</td>
<td>Y / N</td>
</tr>
<tr>
<td>2a. What do you plan to use it for?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plot 1</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>3. List all the plots that you are farming (since Jan) and their acreage?</td>
<td></td>
</tr>
<tr>
<td>[numbers to calculate acreage]</td>
<td></td>
</tr>
<tr>
<td>4. What is the tenure arrangement on the plot? Is the plot (1) owned (2) leased (3) reservation (4) Govt. (5) reserve (6) other [list]</td>
<td>[walking one-way]</td>
</tr>
<tr>
<td>5. How long does it take you to get to the plot?</td>
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<tr>
<td>6. Is the plot surveyed?</td>
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<tr>
<td>7. Do you consider it (1) poor, (2) good, or (3) excellent quality?</td>
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<tr>
<td>8. Is it flat or hilly?</td>
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<tr>
<td>9. Is water available at the plot for when it doesn’t rain?</td>
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<tr>
<td>[Irrigation Stream Well]?</td>
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<tr>
<td>10. How much rent and/or taxes (annually) do you pay on the plot?</td>
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<tr>
<td>11. If you purchased it how much did it cost?</td>
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<tr>
<td>11a. When did you get it? [years ago]</td>
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<tr>
<td>12. Can you get more land if need be?</td>
<td>Y / N [if no &gt;&gt; D]</td>
</tr>
<tr>
<td>12a. Is it closer, the same, or further away from home than your current plots?</td>
<td>Closer / same / further</td>
</tr>
<tr>
<td>12b. What type of tenure arrangement would it have?</td>
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<tr>
<td>Plot 3</td>
<td>Y / N</td>
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<tr>
<td>Plot 4</td>
<td>Y / N</td>
</tr>
<tr>
<td>Plot 5</td>
<td>Y / N</td>
</tr>
<tr>
<td>Plot 6</td>
<td>Y / N</td>
</tr>
<tr>
<td>Others on back</td>
<td></td>
</tr>
</tbody>
</table>

### D. Food and Livestock Production

*And since food is the main reason for farming I want to ask a little about what you produce on your farm*

1. How much bush did you clear in the last 12 months?  
   - [if none >> 2]  
   - More / Less  
   - [spend time calculating this]

2. Do you have livestock today?  
   - Y / N  
   - [if no >> 3]

1a. How much more or less than last year was this?  
1b. How many man-days does it take?  
1c. Was it high-bush/virgin or wamul (re-growth)?  
1d. If it was not virgin forest, how long has it been fallow?

2a. What kind?  
2b. Number  
2c. In the last 12 months, how many have you purchased?  
2d. Number born?  
2e. Number that died?  
2f. Number sold
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</thead>
<tbody>
<tr>
<td>Maize Y / N</td>
<td>Same / Up / Down</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Mathambre Y / N</td>
<td>Same / Up / Down</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Rice Y / N</td>
<td>Same / Up / Down</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>RK Beans Y / N</td>
<td>Same / Up / Down</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Blk. Beans Y / N</td>
<td>Same / Up / Down</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
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</tr>
</tbody>
</table>

[continued]

8. How much of your harvest do you sell? [if none >> section E]

<table>
<thead>
<tr>
<th>8a. Where do you sell?</th>
<th>8b. How much per pound?</th>
<th>9. How do you get it there?</th>
<th>10. Are you planning to grow more next year?</th>
<th>11. If so, would this be more than before hurricane Iris?</th>
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<tbody>
<tr>
<td>Corn</td>
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<td></td>
<td>Y / N</td>
<td>Y / N</td>
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<tr>
<td>Mathambre</td>
<td></td>
<td></td>
<td>Y / N</td>
<td>Y / N</td>
</tr>
<tr>
<td>Rice</td>
<td></td>
<td></td>
<td>Y / N</td>
<td>Y / N</td>
</tr>
<tr>
<td>RK Beans</td>
<td></td>
<td></td>
<td>Y / N</td>
<td>Y / N</td>
</tr>
<tr>
<td>Black Beans</td>
<td></td>
<td></td>
<td>Y / N</td>
<td>Y / N</td>
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</tbody>
</table>

E. Relationship with Cacao

Because what we are after is why some farmers grow cacao and why other may not I want to ask a little about your relationship with cacao

1. Did you grow cacao to sell this year? Y / N [If yes >> 8 ]
2. Have you grown cacao in the past? Y / N

2a. If yes, why have you stopped?
2b. When did you produce?
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Are you interested in growing organic cacao now?</td>
<td>Y / N</td>
</tr>
<tr>
<td>[if no 3a then &gt;&gt; section F]</td>
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<tr>
<td>5. Do you know how to grow cacao organically?</td>
<td>Y / N</td>
</tr>
<tr>
<td>6. Do you know somebody that grows cacao?</td>
<td>Y / N</td>
</tr>
<tr>
<td>7. Would you prefer to plant on land you own, rent, lease from the Govt., or is part of the reservation?</td>
<td>circle one or describe if other</td>
</tr>
<tr>
<td>8. How long have you been growing cacao?</td>
<td>Y / N</td>
</tr>
<tr>
<td>9. Did you already know how to grow cacao when you started?</td>
<td>Y / N</td>
</tr>
<tr>
<td>10. Did your parents grow cacao?</td>
<td>Y / N</td>
</tr>
<tr>
<td>10a. Grandparents?</td>
<td>Y / N</td>
</tr>
<tr>
<td>11. Did you establish, inherit or reclaim your cacao grove?</td>
<td></td>
</tr>
<tr>
<td>12. Have you borrowed money to invest in cacao?</td>
<td>Y / N</td>
</tr>
<tr>
<td>12a. What did you use the money for?</td>
<td></td>
</tr>
<tr>
<td>12b. Who did you borrow from?</td>
<td>Y / N</td>
</tr>
<tr>
<td>13. Did you sell to Hershey?</td>
<td>Y / N</td>
</tr>
<tr>
<td>14. Did you plant during the USAID project?</td>
<td>Y / N</td>
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<tr>
<td>15. Did you get training when you began growing?</td>
<td>Y / N</td>
</tr>
<tr>
<td>15a. Who provided the training?</td>
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<tr>
<td>16. How many pounds of dried cacao beans did you produce this year?</td>
<td>Y / N</td>
</tr>
<tr>
<td>16a. How many pounds of cacao did you sell this year?</td>
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</tr>
<tr>
<td>16b. Before hurricane Iris, what was the most you sold in one year?</td>
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<tr>
<td>17. How do you transport the beans?</td>
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<tr>
<td>18. Are you a member of TCGA?</td>
<td>Y / N</td>
</tr>
<tr>
<td>18a. If not, why?</td>
<td></td>
</tr>
<tr>
<td>19. Have yields changed over time?</td>
<td>Same / Up / Down</td>
</tr>
<tr>
<td>19a. Why do you think they have changed?</td>
<td></td>
</tr>
<tr>
<td>20. Is pest control a problem?</td>
<td>Y / N</td>
</tr>
<tr>
<td>20a. What kind of pests are the biggest problem?</td>
<td></td>
</tr>
<tr>
<td>21. Are there problems meeting organic certification?</td>
<td></td>
</tr>
<tr>
<td>21a. What kinds of problems are there?</td>
<td>Y / N</td>
</tr>
<tr>
<td>22. Do you plan to expand or reduce production?</td>
<td>Expand / reduce</td>
</tr>
<tr>
<td>22a. Why?</td>
<td></td>
</tr>
</tbody>
</table>

F. Food Availability/ Vulnerability I want to next ask a little about your family's food availability
1. How much do you spend on food per month?

2. How much food each month do you get from hunting or fishing? [number and size/pounds during the dry and wet season]
   - Hunting: | Fishing: |
     - Dry | Wet | Dry |
     - Wet

3. How much of your stored rice and beans were lost due to hurricane Iris?
   - Corn: none / half / all
   - Rice: none / half / all
   - Beans: none / half / all

4. After hurricane Iris how many months were you able to buy food?

5. Did you receive emergency food after hurricane Iris?
   - Y / N

5a. For how long?

6. During the year before the Hurricane, did you run out of stored corn, rice, or beans?
   - [fill columns for each Y]

6a. How many months were you out?

6b. Did your neighbors help with food?

6c. Did you purchase extra?

6d. How much did you purchase? [by month or period]

6e. Where did you purchase it?

6f. How much did pound cost? [calculate if response is in bags]
7. Has there been a time before the hurricane that your family suffered from food shortages?  
   Y / N  
   7a. If yes, why?

8. Since January, for how many months did your household have at least one day without enough to eat? 

9. If you had an extra $25-$30 each month, how much would you spend on food?

G. Off-farm Income and Access to Credit  The next few questions are important to understand different farmers' ability to invest in alternative production and if credit is something farmers are involved in.

<table>
<thead>
<tr>
<th>Type</th>
<th>Annual Amount</th>
<th>2. Do you work with your neighbors on their farms?</th>
<th>2a. How do they compensate you?</th>
<th>2b. How much?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Off-farm labor</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Money</td>
<td>[need to calculate unit per hour/workday]</td>
</tr>
<tr>
<td>b. Rent</td>
<td>Y / N</td>
<td></td>
<td>Food</td>
<td></td>
</tr>
<tr>
<td>c. Remittances [money from family not living on farm]</td>
<td>Y / N</td>
<td>[if no &gt;&gt; 3]</td>
<td>Work for you</td>
<td></td>
</tr>
<tr>
<td>d. Social security</td>
<td>Y / N</td>
<td></td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>e. Other:</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. In the last 12 months have you borrowed money from friends or family that must be paid back?</th>
<th>3a. How often?</th>
<th>3b. How much?</th>
<th>3c. What for?</th>
<th>3d. What is or was the interest rate?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y / N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[if no &gt;&gt; 4]</td>
<td></td>
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<tr>
<td>-------------------------------------------------------------------------</td>
<td>----------------</td>
<td>---------------</td>
<td>---------------</td>
<td>----------------------------------------</td>
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<tr>
<td>In the past 5 years have you borrowed money from friends or family that must be paid back?</td>
<td>Y / N</td>
<td></td>
<td></td>
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<tr>
<td>[if no &gt;&gt; section H]</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>In the last 12 months have you borrowed money from a bank or credit agency?</td>
<td>Y / N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[if no &gt;&gt; section H]</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Have you borrowed money from a bank or credit agency?</td>
<td>Y / N</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>[if no &gt;&gt; section H]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have you received any assistance from the Ministry of Agriculture or other groups with agricultural extension agents in the last 12 months?</td>
<td>Y / N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[if no &gt;&gt; 4]</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Have you ever received any assistance from the Ministry of Agriculture or other groups with agricultural extension agents?</td>
<td>Y / N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2a. How long ago?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Which groups have provided extension assistance in your area?</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>[name the group/Ministry]</td>
<td></td>
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</tr>
<tr>
<td>3a. How many times in the last year have they come to your village?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3b. When was the last time they came?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3c. How often do they visit your farm?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3d. When was the last time they came?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3e. What kind of assistance did they provide?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Do you visit any extension offices if you have questions about your farm? Y / N
   [If no >> wrap up]

<table>
<thead>
<tr>
<th>4a. How often?</th>
<th>4b. When was the last time you visited?</th>
<th>4c. What were you trying to figure out or what problem were you trying to solve?</th>
<th>4d. Did their assistance help solve your problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
</tbody>
</table>

5. In general, what are the problems with your farm you would like assistance with?
6. What form of assistance would be most helpful to you and your family?

I. Wrap-Up (closing thank you and reiteration of the goals of the project and where copies of the paper will be available (TCGA, MAFC, TMCC, CARD, SHI, with Alcaldes, etc.)

Do you have any further comments you feel I should be aware of?

What would be the most helpful thing I could do with this information and my research to help small farmers in Toledo?

I know I have asked a lot of questions I would like to know if you have some for me?

Enumerator Comments:
Crop activities and cost of production questionnaires

**Corn – main crop** (all questions refer to corn planted since January)

1. How many acres of corn did you plant this year (since January)?
2. What varieties do you plant? 3. How many pounds of seed did you plant?
4. What is the typical spacing between plants (inches)? 5. How many seeds per hole?
7. Do you use pesticides/herbicides? Y / N 7a What kind? 7b. How much?
8. How much time did it take to prepare the land for this corn? (man-days*number of days$^{41}$)
9. How much time did it take to plant this corn? (man-days*number of days)
10. How much time did it take to weed this corn? (man-days*number of days)
11. How much time did it take to harvest this corn? (man-days*number of days)
12. How much corn did you harvest this year? (calculate pounds)

**Matambre – second corn crop** (all questions will refer to plans for current crop)

1. How many acres of corn did or will you plant? 2. How many pounds of seed did or will you plant?
3. Are the varieties, spacing, and number of seeds per hole the same as first corn crop? Y / N
   If no explain.
4. Do you use fertilizer? Y / N 6a What kind? 6b. How much?
5. Do you use pesticides/herbicides? Y / N 7a What kind? 7b. How much?
6. How much time did or will it take to prepare the land for this corn? (man-days*number of days)
7. How much time did or will it take to plant this corn? (man-days*number of days)
8. How much time did or will it take to weed this corn? (man-days*number of days)
9. How much time did or will it take to harvest this corn? (man-days*number of days)
10. What is the typical harvest for matambre corn? (calculate pounds per amount planted)

---

$^{41}$ Discuss labor input of women and youth and calculate the number of children/women days that equal a man-day. Make sure this calculation is included in each of the subsequent labor questions in the questionnaire.
**Rice** (all questions refer to rice planted since January)

1. How many acres of rice did you plant this year (since January)?

2. What varieties do you plant?  
3. How many pounds of seed did you plant?

4. What is the typical spacing between plants (inches)?  
5. How many seeds per hole?

6. Do you use fertilizer? Y / N  
6a What kind?  
6b. How much?

7. Do you use pesticides/herbicides? Y / N  
7a What kind?  
7b. How much?

8. How much time did it take to prepare the land for this rice?  
   (man-days*number of days)

9. How much time did it take to plant this rice?  
   (man-days*number of days)

10. How much time did it take to weed (or spary) this rice?  
    (man-days*number of days)

11. How much time did it take to harvest this rice?  
    (man-days*number of days)

12. How much time did it take to thresh the rice?  
    (man-days*number of days)

13. How much rice did you harvest this year? (calculate pounds)

**Beans - Black** (all questions will refer to ‘dry season’ beans planted since January)

1. How many acres of beans did you plant this year (since January)?

2. What varieties do you plant?  
3. How many pounds of seed did you plant?

4. What is the typical spacing between plants (inches)?  
5. How many seeds per hole?

6. Do you use fertilizer? Y / N  
6a What kind?  
6b. How much?

7. Do you use pesticides/herbicides? Y / N  
7a What kind?  
7b. How much?

8. How much time did it take to prepare the land for the beans?  
   (man-days*number of days)

9. How much time did it take to plant the beans?  
   (man-days*number of days)

10. How much time did it take to weed (or spray) the beans?  
    (man-days*number of days)

11. How much time did it take to harvest the beans?  
    (man-days*number of days)

12. How much time did it take to clean and prepare the beans for storage?  
    (man-days*number of days)

13. How much corn did you harvest this year? (calculate pounds)
### Key informants and contact organization

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization/occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wendell Parham</td>
<td>CEO Ministry of Sugar, labor and industry</td>
</tr>
<tr>
<td>Harry Parham</td>
<td>Retired – MAFC</td>
</tr>
<tr>
<td>Mr. Gusman</td>
<td>Director of Immigration</td>
</tr>
<tr>
<td>Rick August</td>
<td>Help For Progress</td>
</tr>
<tr>
<td>Wallace Mahler</td>
<td>District Agricultural Officer - Toledo</td>
</tr>
<tr>
<td>Robert Griffith</td>
<td>Central Statistical Office – Cayo</td>
</tr>
<tr>
<td>Carl Tindell</td>
<td>Central Statistical Office – Toledo</td>
</tr>
<tr>
<td>Jose Castellanos and Bautista</td>
<td>Planning and Policy Unit - MAFC</td>
</tr>
<tr>
<td>Alfredo and Yvon Villoria</td>
<td>Dem Dats Doin (private consultants)</td>
</tr>
<tr>
<td>Mr. Cal</td>
<td>Land Information Center – Belmopan</td>
</tr>
<tr>
<td>Juan Ferguson</td>
<td>Land Valuation</td>
</tr>
<tr>
<td>Mr. Contraris</td>
<td>Land Information Center</td>
</tr>
<tr>
<td>Neva Quewell (re-assigned); Glen Avilez - director</td>
<td>Central Statistical Office – Belmopan</td>
</tr>
<tr>
<td>Cresencio Cho</td>
<td>Toledo Cacao Growers Association— administrative officer</td>
</tr>
<tr>
<td>Christopher Nesbitt</td>
<td>Green and Black’s Belize country liaison</td>
</tr>
<tr>
<td>Mr. Cal</td>
<td>Chairman of TCGA</td>
</tr>
<tr>
<td>Ignacio Ash</td>
<td>Cacao ext. agent - Sarstoon and Temash Institute of Indigenous Management (SATIIM)</td>
</tr>
<tr>
<td>John McGill (formerly w/ ESTAP) and Joanna Monk</td>
<td>Sarstoon and Temash Institute of Indigenous Management (SATIIM)</td>
</tr>
<tr>
<td>Will Mahia</td>
<td>Director - Toledo Institute of Development and the Environment (TIDE)</td>
</tr>
<tr>
<td>Pablo Mis</td>
<td>SAGE (liaises closely with Toledo Maya Cultural Council)</td>
</tr>
<tr>
<td>‘Doc‘</td>
<td>Toledo Institute of Development and the Environment (TIDE)</td>
</tr>
<tr>
<td>Jak Viafranco</td>
<td>Lands Department – Toledo</td>
</tr>
<tr>
<td>Mr. Vasquez</td>
<td>Lands Department - Toledo</td>
</tr>
<tr>
<td>Norman</td>
<td>Community Mobilizer - Community Initiated Agriculture and Rural Development (CARD)</td>
</tr>
<tr>
<td>Kenneth Gale</td>
<td>Asst. Coordinator, Technical Marketing Service Unit – CARD</td>
</tr>
<tr>
<td>Maria Edeso</td>
<td>Information and Analysis – CARD</td>
</tr>
<tr>
<td>Javier Garcia</td>
<td>Acting Director – CARD</td>
</tr>
<tr>
<td>Felix Tzul</td>
<td>Belize Farmers Registry (ag. Census) – MAFC</td>
</tr>
<tr>
<td>Candido Chun – San Antonio</td>
<td>Sustainable Harvest International</td>
</tr>
<tr>
<td>Reyes Chun – San Antonio</td>
<td>TEA Guest House</td>
</tr>
<tr>
<td>Reyes Bol – San Antonio</td>
<td>Hilltop Hotel/cacao farmer</td>
</tr>
<tr>
<td>Erineo Bolon – San Antonio</td>
<td>MAFC Extension</td>
</tr>
<tr>
<td>Juan Chun – San Antonio</td>
<td>Did Census Work</td>
</tr>
<tr>
<td>Jim Bardalis</td>
<td>Director Belize Marketing Board and Rice Mill</td>
</tr>
<tr>
<td>Pedro Che</td>
<td>President of Toledo Maya Cultural Council</td>
</tr>
<tr>
<td>Ms. Tejul</td>
<td>TMCC Executive Board</td>
</tr>
<tr>
<td>Assad Magana</td>
<td>Rural Financial Services – lending component</td>
</tr>
<tr>
<td>Ms. Yanira Hernandez</td>
<td>CARD project</td>
</tr>
<tr>
<td>Auxibio Sho</td>
<td>Dept. of Forestry – Machaco satian</td>
</tr>
<tr>
<td>Marvin Blades</td>
<td>MAFC extension agent: in charge of cacao</td>
</tr>
<tr>
<td></td>
<td>MAFC extension agent, Toledo</td>
</tr>
</tbody>
</table>
An example of questions sent in advance to key informants

10 October 2002

Dear Commissioner Cansino:

I am doing agricultural policy and development work in the Toledo Uplands regarding agricultural land use and the adoption of alternative agricultural practices. The idea was first developed about five years ago while working on a commodity study of cocoa with the Ministry of Agriculture and IIICA and will continue with cocoa as the main focus. Land tenure is one component that greatly affects the adoption of different production systems so it is important that I understand and analyze the characteristics of these arrangements in the Western Toledo region—an area containing leased, owned, GOB, and Maya Reservation lands. I thank you in advance for your assistance and hope that your office can provide the data requested below.

The target areas for the data request are the following villages: San Miguel, San Pedro Columbia, San Antonio, San Jose, Santa Cruz, Crique Jute, Na Lum Ca, Santa Elena, Pueblo Viejo. It is important that data is sorted by village where possible and in aggregate for the Toledo district.

I am looking to analyze a time series of data going back at least five years (but ten if data is computerized and easily accessible). The request came primarily from reviewing the ESTAP report on lands, discussions I have had with Mr. Vasquez and Mr. Viafranco here, the MAFC, and with farmers and other stakeholders in the region.

The key pieces of data that I have not located are:

1) The number of requests for lease land and the number granted each year by residents from the above villages and Toledo district as a whole;
2) Requests to buy land in the district (again sorted by village and Toledo district);
3) A summary of any parcels (particularly agricultural) laid out or given directly to farmers or groups each year;
4) A review of the cost of leasing land and how they change throughout the district;
5) A method for calculating land values in the district (i.e., agricultural land is valued at X dollars vs. seafront valued at X more dollars);
6) Estimate of the number of leases and/or owned parcels held by residents in above villages (I know some are reservation and some are not, but farmers seem to hold some leases and ownership);
7) Summary of how the lands commission is formed or legislation regarding their operations;
8) Description or legislation detailing Location Tickets and how they work;
9) And any comments or ideas you have regarding Toledo Upland land tenure arrangements.

It would be great to receive the information by beginning of November, however I understand that some data and information may be easier to compile than others and that a different Department may hold others. Please let me know your assessment of the request and send any comments or questions to me and I will address them immediately.

Thank you,

Travis P. Marcotte
## Appendix 5: Input/output tables for selected crops

### Main Season Corn KO (farm size: __ acres)

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased Inputs</td>
<td>Amount</td>
<td>BES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seed (pounds)</td>
<td>15</td>
<td>$4.00</td>
<td>$4.00</td>
<td>$4.00</td>
<td>$4.00</td>
<td>$4.00</td>
<td>$4.00</td>
</tr>
<tr>
<td>fertilizer</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>pesticides</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Land Input</td>
<td>Rental rate (farm acres/rental rate)</td>
<td>0</td>
<td>$1.00</td>
<td>$1.00</td>
<td>$1.00</td>
<td>$1.00</td>
<td>$1.00</td>
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<tr>
<td>Labor Inputs (per-day/ wage)</td>
<td>11</td>
<td>$191.70</td>
<td>$191.70</td>
<td>$191.70</td>
<td>$191.70</td>
<td>$191.70</td>
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<tr>
<td>System Output</td>
<td>Revenue</td>
<td>Corn</td>
<td>740</td>
<td>740</td>
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<tr>
<td>Yield 1</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rent paid for shed</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Revenue</td>
<td>$241.50</td>
<td>$241.50</td>
<td>$241.50</td>
<td>$241.50</td>
<td>$241.50</td>
<td>$241.50</td>
</tr>
<tr>
<td></td>
<td>Rent paid for shed</td>
<td>$75.00</td>
<td>$75.00</td>
<td>$75.00</td>
<td>$75.00</td>
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<tr>
<td>Total labor (per-days and cost)</td>
<td>275</td>
<td>$4,042.50</td>
<td>$4,042.50</td>
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<td>$4,042.50</td>
<td>$4,042.50</td>
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<tr>
<td>Return to land (BES/acre)</td>
<td>$9.05</td>
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<td>$9.05</td>
<td>$9.05</td>
<td>$9.05</td>
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### Second Season Corn (maize/cornoff) KO (farm size: __ acres)

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
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<th>5</th>
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<td>Purchased Inputs</td>
<td>Amount</td>
<td>BES</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>seed (pounds)</td>
<td>15</td>
<td>$3.75</td>
<td>$3.75</td>
<td>$3.75</td>
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<td>$0.00</td>
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<tr>
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<td>$1.25</td>
<td>$1.25</td>
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<td>$1.25</td>
</tr>
<tr>
<td>Land Input</td>
<td>Rental rate (farm acres/rental rate)</td>
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<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
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</tr>
<tr>
<td>Labor Inputs (per-day/ wage)</td>
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<td>$271.76</td>
<td>$271.76</td>
<td>$271.76</td>
<td>$271.76</td>
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<tr>
<td>System Output</td>
<td>Revenue</td>
<td>Corn</td>
<td>650</td>
<td>650</td>
<td>650</td>
<td>650</td>
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<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>Yield 1</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Rent paid for shed</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Rent paid for shed for corn and</td>
<td>($22.76)</td>
<td>($24.44)</td>
<td>($24.44)</td>
<td>($24.44)</td>
<td>($24.44)</td>
<td>($24.44)</td>
</tr>
<tr>
<td>Total labor (per-days and cost)</td>
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<td>$191.50</td>
<td>$191.50</td>
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<td>$191.50</td>
</tr>
<tr>
<td>Return to labor (BES/day)</td>
<td>$11.15</td>
<td>$11.15</td>
<td>$11.15</td>
<td>$11.15</td>
<td>$11.15</td>
<td>$11.15</td>
<td>$11.15</td>
</tr>
</tbody>
</table>
### Uploaded File 1 (Table): Purchased Rice Inputs (prices include taxes)

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<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased Inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>land (hectares)</td>
<td>24</td>
<td>$7.20</td>
<td>$7.20</td>
<td>$7.20</td>
<td>$7.20</td>
<td>$7.20</td>
</tr>
<tr>
<td>fertilizer</td>
<td>0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>pesticides</td>
<td>1.5</td>
<td>$15.00</td>
<td>$15.00</td>
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<td>$15.00</td>
</tr>
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</table>

### Uploaded File 1 (Table): Land Input

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rental rate (per acre/total rate)</td>
<td></td>
<td>0</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Labor inputs (per day*total wage)</td>
<td>20</td>
<td>$294.00</td>
<td>$294.00</td>
<td>$294.00</td>
<td>$294.00</td>
<td>$294.00</td>
</tr>
<tr>
<td>Transport costs (bus/truck to WB)</td>
<td></td>
<td>$22.88</td>
<td>$22.88</td>
<td>$22.88</td>
<td>$22.88</td>
<td>$22.88</td>
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</table>

### Uploaded File 1 (Table): System Output

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pounds of harvested rice</td>
<td>1,144</td>
<td>1,144</td>
<td>1,144</td>
<td>1,144</td>
<td>1,144</td>
<td>1,144</td>
</tr>
<tr>
<td>Revolutions</td>
<td>$255.41</td>
<td>$255.41</td>
<td>$255.41</td>
<td>$255.41</td>
<td>$255.41</td>
<td>$255.41</td>
</tr>
<tr>
<td>Benefits-costs discounted to yr 1</td>
<td>$(73.67)</td>
<td>$(73.67)</td>
<td>$(73.67)</td>
<td>$(73.67)</td>
<td>$(73.67)</td>
<td>$(73.67)</td>
</tr>
<tr>
<td>Benefits-costs discounted to yr 1</td>
<td>$(681.78)</td>
<td>$(681.78)</td>
<td>$(681.78)</td>
<td>$(681.78)</td>
<td>$(681.78)</td>
<td>$(681.78)</td>
</tr>
</tbody>
</table>

### Uploaded File 1 (Table): Total labor (per day and cost)

<table>
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<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice: Yield 1</td>
<td>$7,350.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice: Yield 2</td>
<td></td>
<td>$2,112.70</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>NPV of system</td>
<td>$(797.82)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Returns to labor (USD/day)</td>
<td>$117.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Returns to land (USD/acre)</td>
<td>$(152.66)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

### Uploaded File 2 (Table): Black Beans Inputs (prices include taxes)

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<tr>
<th>Year</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased Inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seed (pounds)</td>
<td>49</td>
<td>$48.00</td>
<td>$48.00</td>
<td>$48.00</td>
<td>$48.00</td>
<td>$48.00</td>
</tr>
<tr>
<td>fertilizer</td>
<td>0</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>pesticides</td>
<td>0</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
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### Uploaded File 2 (Table): System Output

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pounds of dried beans</td>
<td>928</td>
<td>928</td>
<td>928</td>
<td>928</td>
<td>928</td>
<td>928</td>
</tr>
<tr>
<td>Revolutions</td>
<td>$538.24</td>
<td>$538.24</td>
<td>$538.24</td>
<td>$538.24</td>
<td>$538.24</td>
<td>$538.24</td>
</tr>
<tr>
<td>Benefits-costs</td>
<td>$154.48</td>
<td>$154.48</td>
<td>$154.48</td>
<td>$154.48</td>
<td>$154.48</td>
<td>$154.48</td>
</tr>
<tr>
<td>Benefits-costs discounted to yr 1</td>
<td>$157.93</td>
<td>$157.93</td>
<td>$157.93</td>
<td>$157.93</td>
<td>$157.93</td>
<td>$157.93</td>
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### Uploaded File 2 (Table): Black Beans: Yield 1

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice: Yield 1</td>
<td>$7,200.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice: Yield 2</td>
<td></td>
<td>$1,214.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV of system</td>
<td>$1,214.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Returns to labor (USD/day)</td>
<td>$32.42</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Returns to land (USD/acre)</td>
<td>$16.84</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Year</td>
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<td>3</td>
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<td>5</td>
<td>6</td>
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<tr>
<td>------</td>
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<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td><strong>Purchased Inputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed (4 per acre)</td>
<td>$30</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Pesticides</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Land Input</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rental rate (per acre/rental rate)</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Labor Inputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fission days/yr (est in yr 1)</td>
<td>425</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Labor costs (per day/weight)</td>
<td>$205.25</td>
<td>$140.25</td>
<td>$140.25</td>
<td>$140.25</td>
<td>$140.25</td>
<td>$140.25</td>
</tr>
<tr>
<td>Transport costs (due to ECOA)</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
</tr>
<tr>
<td><strong>Yield 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Revenues</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Yield 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Revenues</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

| Cash: Yield 1 | 399.3 | $1,829.71 |
| Cash: Yield 2 | 399.3 | $1,829.71 |
| NPV of system | $(495.85) | $1,437.42 |
| Returns to labor (522/yr) | $133.99 | $25.16 |
| Returns to land (3324/yr) | $(119.90) | $1,437.42 |
Appendix 6: Rice purchases by the Belize Marketing Board from sample villages

![Bar chart showing rice purchases by the Belize Marketing Board from 1997 to 2001 for villages San Miguel, San Antonio, Santa Cruz, and San Jose.](chart.png)

**Milpa Rice Purchased by BMB - pounds**
source: Belize Marketing Board (2002)
Appendix 7: PCA results and analyses for non-cacao growers and cacao-growers

**Total Variance Explained - non-cacao growers (n=87)**

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
<th>Rotation Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
<td>Cumulative</td>
</tr>
<tr>
<td>3</td>
<td>1.921</td>
<td>8.352</td>
<td>44.752</td>
</tr>
<tr>
<td>4</td>
<td>1.723</td>
<td>7.491</td>
<td>52.242</td>
</tr>
<tr>
<td>5</td>
<td>1.578</td>
<td>6.862</td>
<td>59.104</td>
</tr>
<tr>
<td>6</td>
<td>1.370</td>
<td>5.956</td>
<td>65.061</td>
</tr>
<tr>
<td>7</td>
<td>1.299</td>
<td>5.647</td>
<td>70.707</td>
</tr>
<tr>
<td>8</td>
<td>1.051</td>
<td>4.568</td>
<td>75.275</td>
</tr>
<tr>
<td>9</td>
<td>1.024</td>
<td>4.453</td>
<td>79.728</td>
</tr>
<tr>
<td>10-23</td>
<td>20.272</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.

a Only cases for which Do you grow cacao? = no are used in the analysis phase.

**Rotated Component Matrix - non-cacao growers (n=87)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Component</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Current age of farmer</td>
<td></td>
<td>-1.176</td>
<td>0.117</td>
<td>0.699</td>
<td>-0.417</td>
<td>-0.148</td>
<td>0.314</td>
<td></td>
</tr>
<tr>
<td>B. How many years of school has farmer completed</td>
<td></td>
<td>-1.134</td>
<td>-0.881</td>
<td>-1.169</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Number of family members living on farm</td>
<td></td>
<td>0.183</td>
<td>0.186</td>
<td>0.293</td>
<td>-0.126</td>
<td>0.162</td>
<td>0.115</td>
<td>0.687</td>
</tr>
<tr>
<td>D. How much land have you been farming this year?</td>
<td></td>
<td>0.517</td>
<td>0.411</td>
<td>0.150</td>
<td>0.189</td>
<td>0.438</td>
<td>0.195</td>
<td></td>
</tr>
<tr>
<td>E. How much do you spend on food each month?</td>
<td></td>
<td></td>
<td>-0.222</td>
<td>-0.138</td>
<td>0.840</td>
<td></td>
<td></td>
<td>0.174</td>
</tr>
<tr>
<td>F. If you had an extra $25-30 each month, how much would you spend on food?</td>
<td></td>
<td>0.358</td>
<td>-0.267</td>
<td>-0.255</td>
<td>-0.157</td>
<td>0.277</td>
<td>0.450</td>
<td>-0.246</td>
</tr>
<tr>
<td>G. Will you be trying to get more land in the next 5 years?</td>
<td></td>
<td>0.122</td>
<td>0.312</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.804</td>
</tr>
<tr>
<td>H. Have you received any assistance from extension agents in the last 12 months?</td>
<td></td>
<td></td>
<td></td>
<td>-0.146</td>
<td>0.135</td>
<td>0.858</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Overall land tenure security</td>
<td></td>
<td>-1.172</td>
<td></td>
<td></td>
<td>-0.496</td>
<td>0.626</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. Does farmer get help from neighbors?</td>
<td></td>
<td>-0.277</td>
<td></td>
<td></td>
<td>-0.557</td>
<td>0.396</td>
<td></td>
<td>0.313</td>
</tr>
<tr>
<td>K. Total on farm income (crops)</td>
<td></td>
<td>0.811</td>
<td>0.470</td>
<td>0.234</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. How much money did you receive from off-farm labor in the last 12 months</td>
<td></td>
<td>-0.132</td>
<td></td>
<td>0.401</td>
<td>-0.306</td>
<td></td>
<td>-0.173</td>
<td>0.675</td>
</tr>
<tr>
<td>M. Number of man days hired since January</td>
<td></td>
<td>0.134</td>
<td></td>
<td></td>
<td></td>
<td>0.897</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. How much bush did you clear in the last 12 months?</td>
<td></td>
<td>0.646</td>
<td>0.352</td>
<td>0.428</td>
<td></td>
<td></td>
<td>0.236</td>
<td>0.168</td>
</tr>
<tr>
<td>O. How long has it been fallow? (age of regrowth)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.103</td>
<td>0.828</td>
</tr>
<tr>
<td>P. How many acres are grown on the plot? (corn)</td>
<td></td>
<td>0.747</td>
<td></td>
<td></td>
<td>0.230</td>
<td>0.233</td>
<td></td>
<td>0.341</td>
</tr>
<tr>
<td>Q. How many acres are grown on the plot? (matahambre)</td>
<td></td>
<td>0.414</td>
<td>0.759</td>
<td></td>
<td>-0.169</td>
<td></td>
<td></td>
<td>0.200</td>
</tr>
<tr>
<td>R. How many acres are grown on the plot? (rice)</td>
<td></td>
<td>0.165</td>
<td></td>
<td></td>
<td>0.930</td>
<td></td>
<td></td>
<td>0.113</td>
</tr>
<tr>
<td>S. How many acres are grown on the plot? (black beans)</td>
<td></td>
<td>0.847</td>
<td>0.103</td>
<td>0.208</td>
<td></td>
<td>0.130</td>
<td></td>
<td>-0.169</td>
</tr>
<tr>
<td>T. How many acres are grown on the plot? (na na na na na na na na na)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Interpretation of rotated component matrix - non-cacao growers (n=87)

<table>
<thead>
<tr>
<th>Component</th>
<th>% of Variance</th>
<th>Variables that load heavily (values&gt;0.4)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18.863</td>
<td>D, K, N, P, Q, S, U, X</td>
<td>Eight variables indicate a clear association between increasing farm size, on-farm income and the production and sale of corn, matahambre, and black beans among non-cacao growers. This component also hints to younger, less educated farmers and negative correlation to hiring workers. A desire to spend more money on food also loads just under 0.4 (.358).</td>
</tr>
<tr>
<td>2</td>
<td>10.108</td>
<td>D, K, Q, V</td>
<td>These four variables related to farm size, on-farm income (mostly from matahambre) and production of matahambre all load heavily on this component. This group may also be seeking more land in the future, not working with neighbors or working off-farm.</td>
</tr>
<tr>
<td>3</td>
<td>9.813</td>
<td>N, R, W</td>
<td>This component clearly correlates with clearing land and rice production and marketing. There is also a family size relationship and a desire to purchase more food if money allowed. This component also correlates with land insecurity (rice production and land insecurity were significant issues in Santa Cruz as seen earlier).</td>
</tr>
<tr>
<td>4</td>
<td>9.183</td>
<td>E, I, L, M</td>
<td>This component is clearly off-farm workers that spend a lot on food, hire labor, and do not work with their neighbors. There is also a negative relationship with matahambre production and rice revenues.</td>
</tr>
<tr>
<td>5</td>
<td>7.071</td>
<td>A, B</td>
<td>Again, older farmers tend to be less educated than younger farmers, work off-farm less, receive less support from extension and grow primarily corn for consumption. There is also a desire to spend more money on food is possible.</td>
</tr>
<tr>
<td>6</td>
<td>7.050</td>
<td>A, F, G, I</td>
<td>These four components highlight younger farmers with insecure land rights and will seek more land in the future. There is a high loading on the need for more money for food. This grouping also correlates slightly with less education.</td>
</tr>
<tr>
<td>7</td>
<td>6.261</td>
<td>H, I</td>
<td>These two variables account for farmers who are visited by extension and have more secure land.</td>
</tr>
<tr>
<td>8</td>
<td>5.844</td>
<td>C, D, L</td>
<td>This component is a unique mix of larger families farming more land, yet receiving income from off-farm work. There is no significant loading for on-farm income suggesting production is for home consumption.</td>
</tr>
<tr>
<td>9</td>
<td>5.535</td>
<td>O</td>
<td>The variance in this component is linked primarily with the length of time land is left fallow. There is some positive loading on farmer age and acres of corn grown.</td>
</tr>
</tbody>
</table>
### Total Variance Explained - cacao growers (n=33)\(^{42}\)

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
<th>Rotation Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
<td>Cumulative %</td>
</tr>
<tr>
<td>2</td>
<td>3.129</td>
<td>12.515</td>
<td>33.201</td>
</tr>
<tr>
<td>3</td>
<td>2.562</td>
<td>10.250</td>
<td>43.451</td>
</tr>
<tr>
<td>4</td>
<td>2.268</td>
<td>9.073</td>
<td>52.524</td>
</tr>
<tr>
<td>5</td>
<td>1.828</td>
<td>7.311</td>
<td>59.834</td>
</tr>
<tr>
<td>6</td>
<td>1.708</td>
<td>6.832</td>
<td>66.666</td>
</tr>
<tr>
<td>7</td>
<td>1.342</td>
<td>5.368</td>
<td>72.034</td>
</tr>
<tr>
<td>8</td>
<td>1.292</td>
<td>5.166</td>
<td>77.200</td>
</tr>
<tr>
<td>9</td>
<td>1.098</td>
<td>4.394</td>
<td>81.594</td>
</tr>
<tr>
<td>10-25</td>
<td>18.406</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.

a Only cases for which Do you grow cacao? = yes are used in the analysis phase.

### Rotated Component Matrix - cacao growers (n=33)

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Current age of farmer</td>
<td>-.262</td>
<td>-.243</td>
<td>-.733</td>
<td>-.148</td>
<td>.345</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. How many years of school has farmer completed</td>
<td>.354</td>
<td>.197</td>
<td>.674</td>
<td></td>
<td>.255</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Number of family members living on farm</td>
<td></td>
<td></td>
<td>.881</td>
<td>-.127</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. How much land have you been farming this year?</td>
<td>.306</td>
<td>.517</td>
<td>.659</td>
<td></td>
<td>.124</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. How much do you spend on food each month?</td>
<td>.325</td>
<td>-.102</td>
<td>.420</td>
<td>.552</td>
<td>-.197</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. If you had an extra $25-30 each month, how much would you spend on food?</td>
<td>.200</td>
<td>-.608</td>
<td>.121</td>
<td>.270</td>
<td>-.457</td>
<td>-.115</td>
<td>-.191</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. Will you be trying to get more land in the next 5 years?</td>
<td>.202</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.134</td>
<td>.889</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. Have you received any assistance from extension agents in the last 12 months?</td>
<td>-.300</td>
<td>.125</td>
<td>.291</td>
<td>.488</td>
<td>.227</td>
<td>.327</td>
<td>.202</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Overall land tenure security</td>
<td>.414</td>
<td></td>
<td></td>
<td></td>
<td>.481</td>
<td>.449</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. Does farmer get help from neighbors?</td>
<td>.183</td>
<td>.390</td>
<td>.261</td>
<td>.427</td>
<td>.581</td>
<td>.121</td>
<td>-.204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K. Total on farm income (crops)</td>
<td>.142</td>
<td>.885</td>
<td>.156</td>
<td>.177</td>
<td>-.142</td>
<td>.132</td>
<td>.122</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. How much money did you receive from off-farm labor in the last 12 months</td>
<td>-.245</td>
<td>-.128</td>
<td>.126</td>
<td>.844</td>
<td>-.120</td>
<td>.148</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. Number of man days hired since January</td>
<td>.149</td>
<td>-.195</td>
<td></td>
<td>.873</td>
<td>-.116</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. How much bush did you clear in the last 12 months?</td>
<td>.142</td>
<td>.816</td>
<td>.112</td>
<td>.145</td>
<td>-.100</td>
<td>-.129</td>
<td>-.154</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O. How long has it been fallow? (age of regrowth)</td>
<td>.164</td>
<td>.140</td>
<td></td>
<td>-.273</td>
<td>-.783</td>
<td>.211</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. How many acres are grown on the plot? (corn)</td>
<td>.103</td>
<td>.103</td>
<td>.820</td>
<td>.291</td>
<td>.115</td>
<td>-.158</td>
<td>.200</td>
<td>-.172</td>
<td></td>
</tr>
</tbody>
</table>

\(^{42}\) Although SPSS will conduct a PCA analysis on a small set of cases (n=33) it is important to note that the Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.149. Low sampling adequacy suggests that PCA is not the best statistical method for this sample (most likely because it is too small), however to compare cacao growers with non-growers and the entire sample the results are presented and discussed with this in mind.
<table>
<thead>
<tr>
<th>Component</th>
<th>% of Var.</th>
<th>Variables that load heavily (values &gt; 0.4)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.490</td>
<td>I, R, V, W</td>
<td>Component 1 loads high on the production of rice and matahambre and has correlated revenues from their sale. It also loads high on land security. Interestingly, cacao production itself does not account for variance within this component.</td>
</tr>
<tr>
<td>2</td>
<td>11.132</td>
<td>K, T, Y</td>
<td>Three variables load the highest on component 2: on farm income, cacao acreage, and cacao revenues. There was also moderate loading on level of education and size of farm in this component.</td>
</tr>
<tr>
<td>3</td>
<td>10.893</td>
<td>D, F, N, P, Q</td>
<td>This component suggests a grouping of growers with cacao, but primarily subsistence farmers growing corn and matahambre for home consumption on large acreages. This group does not indicate a need for money to be spent on food and tends to work with neighbors.</td>
</tr>
<tr>
<td>4</td>
<td>10.215</td>
<td>D, H, S, X</td>
<td>Farm size, assistance from extension, and black bean production for sale load high on this component. Cacao revenues are moderately, yet negatively related to this component indicating cacao growers who are investing more heavily in, and benefiting more from black beans.</td>
</tr>
<tr>
<td>5</td>
<td>9.625</td>
<td>A, B, C, J,</td>
<td>Age and education are again inversely related with larger families among younger farmers. It seems that among cacao growers, larger families tend to work more with neighbors.</td>
</tr>
<tr>
<td>6</td>
<td>8.915</td>
<td>E, F, L, M</td>
<td>Off-farm work is key to farmers spending more on food (while simultaneously indicating they wouldn’t need more money for food) and hiring labor. Among crop acreages, rice is the only positively loaded variable and may be where labor is being invested.</td>
</tr>
<tr>
<td>7</td>
<td>6.320</td>
<td>E, J, Q, U</td>
<td>Corn production for sale loads heaviest in this component. In this small sample size this loading may be picking up very few farmers that do not work with neighbors and grow only main season corn (and not matahambre) for sale.</td>
</tr>
<tr>
<td>8</td>
<td>6.281</td>
<td>I, O</td>
<td>Secure land and short fallow periods correlate with farmers using nitrogen-fixing crops and are farming permanent plots. There is also a moderate and negative loading on black bean sales.</td>
</tr>
<tr>
<td>9</td>
<td>5.723</td>
<td>G, I</td>
<td>Farmers with secure land and an interest in getting more load heavily.</td>
</tr>
</tbody>
</table>
## Appendix 8: Cacao-Grower Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Pearson Corr.</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How long have you been growing cacao?</strong></td>
<td>1.062</td>
<td>.750</td>
</tr>
<tr>
<td>Current age of farmer</td>
<td>.274</td>
<td>.841</td>
</tr>
<tr>
<td>Did you already know how to grow cacao when you started?</td>
<td>.150</td>
<td>.001</td>
</tr>
<tr>
<td>Did your parents grow cacao?</td>
<td>.274</td>
<td>.001</td>
</tr>
<tr>
<td>Did your grandparents grow cacao?</td>
<td>-.150</td>
<td>.001</td>
</tr>
<tr>
<td>Have you borrowed money to invest in cacao?</td>
<td>.110</td>
<td>.569</td>
</tr>
<tr>
<td>How many years of school has farmer completed?</td>
<td>-.601</td>
<td>.001</td>
</tr>
<tr>
<td>Number of family members living on farm</td>
<td>-.497</td>
<td>.990</td>
</tr>
<tr>
<td>Number of family members living on farm (2)</td>
<td>-.102</td>
<td>.900</td>
</tr>
<tr>
<td>How many acres are grown on the plot? (cacao)</td>
<td>.095</td>
<td>.740</td>
</tr>
<tr>
<td>Is the tenure secure or not secure?</td>
<td>-.146</td>
<td>.292</td>
</tr>
</tbody>
</table>

**Notes:**
- **P-value** less than 0.05 indicates a significant correlation.
- **Correlation Coefficient** (r) indicates the strength and direction of the linear relationship between two variables.
- **Sig.** represents the significance level of the correlation coefficient.

- Positive correlations indicate that as one variable increases, the other variable also tends to increase.
- Negative correlations indicate that as one variable increases, the other variable tends to decrease.

**Correlation Table:**

| How long have you been growing cacao? | -245          | .297 |
| Did you already know how to grow cacao when you started? | -297          | .118 |
| Did your parents grow cacao?          | -.471         | .010 |
| Did your grandparents grow cacao?     | -.271         | .011 |
| Have you borrowed money to invest in cacao? | -.131        | .497 |
| How many years of school has farmer completed? | .151          | .592 |
| Number of family members living on farm | -.519         | .002 |
| Number of family members living on farm (2) | -.122         | .002 |
| How many acres are grown on the plot? (cacao) | -.205        | .118 |
| Is the tenure secure or not secure?    | -.184         | .868 |

**Correlation Calculation:**

- **Pearson Correlation Coefficient** is used to measure the strength and direction of the linear relationship between two variables.
- **Significance Level (Sig.)** indicates whether the correlation is statistically significant.

**Correlation Interpretation:**

- A correlation coefficient close to 1 or -1 indicates a strong linear relationship.
- A coefficient close to 0 indicates little to no linear relationship.

**Conclusion:**

By analyzing the correlation matrix, we can infer that:

- There is a strong negative correlation between the number of years of school completed and the number of family members living on the farm.
- A weak positive correlation exists between the number of family members living on the farm and the number of family members living on the farm (2).

These findings suggest that there are relationships between educational attainment, family structure, and other factors that could influence cacao production and management. Further analysis could explore these relationships to inform strategies for improving cultivation practices and extending support to cacao growers.
<table>
<thead>
<tr>
<th></th>
<th>Sig</th>
<th>.469 .466</th>
<th>.140 .839</th>
<th>.439</th>
<th>.308</th>
<th>.512 .429 .323</th>
<th>.000 .825</th>
<th>.108 .706 .570</th>
<th>.801</th>
<th>.588</th>
<th>.633</th>
<th>.126 .785 .309</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall land tenure security</strong></td>
<td>Pearson Corr</td>
<td>-.103 -.236</td>
<td>.306 -.045</td>
<td>.125</td>
<td>.145</td>
<td>.026 .172 .089 .894**</td>
<td>.000 .040</td>
<td>.367 .039 .024</td>
<td>-.019</td>
<td>.058</td>
<td>-.042 .093 .062 -.169</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.596 .218</td>
<td>.106 .815</td>
<td>.518</td>
<td>.122</td>
<td>.884 .338 .624</td>
<td>.000</td>
<td>.826</td>
<td>.050 .827 .896</td>
<td>.924</td>
<td>.747</td>
<td>.818 .607 .733 .382</td>
</tr>
<tr>
<td><strong>How much bush did you clear in the last 12 months?</strong></td>
<td>Pearson Corr</td>
<td>.003 .002</td>
<td>-.062 -.089</td>
<td>.249</td>
<td>-.338</td>
<td>.078 .268 .121</td>
<td>-.041 .040</td>
<td>1 .188</td>
<td>.261 .409</td>
<td>.137</td>
<td>.004</td>
<td>.127 .091 .202 -.041</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.988 .993</td>
<td>.748 .644</td>
<td>.192</td>
<td>.054</td>
<td>.664 .132 .504</td>
<td>.825 .826</td>
<td>.328</td>
<td>.143 .018</td>
<td>.478</td>
<td>.985</td>
<td>.481 .614 .260 .835</td>
</tr>
<tr>
<td><strong>Did you get training when you began growing?</strong></td>
<td>Pearson Corr</td>
<td>-.327 -.181</td>
<td>.054 .169</td>
<td>.154</td>
<td>-.351</td>
<td>.229 .194 .260</td>
<td>.316 .367 .188</td>
<td>1</td>
<td>-.057 -.110</td>
<td>.183</td>
<td>-.102</td>
<td>.183 .034 .198 .466</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.083 .349</td>
<td>.859 .382</td>
<td>.427</td>
<td>.190</td>
<td>.232 .313 .173</td>
<td>.108 .050</td>
<td>.328</td>
<td>.768</td>
<td>.571</td>
<td>.342</td>
<td>.598</td>
</tr>
<tr>
<td><strong>Have you received any assistance from extension agents in the last 12 months?</strong></td>
<td>Pearson Corr</td>
<td>-.016 .065</td>
<td>-.249 -.035</td>
<td>.348</td>
<td>-.108</td>
<td>.180 .265 .073</td>
<td>-.071 -.039</td>
<td>.261</td>
<td>-.057</td>
<td>1</td>
<td>.424</td>
<td>.236</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.933 .739</td>
<td>.192 .856</td>
<td>.064</td>
<td>.148</td>
<td>.317 .136 .688</td>
<td>.706 .827</td>
<td>.143</td>
<td>.768</td>
<td>.014</td>
<td>.218</td>
<td>.785</td>
</tr>
<tr>
<td><strong>Do you visit any extension offices?</strong></td>
<td>Pearson Corr</td>
<td>.076 .083</td>
<td>.029 .072 .533**</td>
<td>-.70</td>
<td>.70</td>
<td>.218</td>
<td>.231 .029</td>
<td>.106</td>
<td>.024</td>
<td>.490**</td>
<td>-.110</td>
<td>.424*</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.696 .667</td>
<td>.881 .709</td>
<td>.003</td>
<td>.344</td>
<td>.223</td>
<td>.196</td>
<td>.872</td>
<td>.570</td>
<td>.896</td>
<td>.018</td>
<td>.571</td>
</tr>
<tr>
<td><strong>Before hurricane Iris, what was the Pearson Correlation with the most cacao you sold in one year?</strong></td>
<td>Pearson Corr</td>
<td>.247 .304</td>
<td>-.010 -.049</td>
<td>.130</td>
<td>.823</td>
<td>.296</td>
<td>.011</td>
<td>.668</td>
<td>.051</td>
<td>.019</td>
<td>.137</td>
<td>.183</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.196 .109</td>
<td>.958</td>
<td>.800</td>
<td>.503</td>
<td>.159</td>
<td>.118</td>
<td>.955</td>
<td>.000</td>
<td>.801</td>
<td>.924</td>
<td>.478</td>
</tr>
<tr>
<td><strong>Cacao yield (output/acreage)</strong></td>
<td>Pearson Corr</td>
<td>.140 .292</td>
<td>-.070</td>
<td>.211</td>
<td>.083</td>
<td>.047</td>
<td>.289</td>
<td>.039</td>
<td>.038</td>
<td>.101</td>
<td>.058</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.468</td>
<td>.124</td>
<td>.717</td>
<td>.271</td>
<td>.669</td>
<td>.795</td>
<td>.103</td>
<td>.830</td>
<td>.835</td>
<td>.588</td>
<td>.747</td>
</tr>
<tr>
<td><strong>Cacao revenues (amount sold * price)</strong></td>
<td>Pearson Corr</td>
<td>.247</td>
<td>.304</td>
<td>-.010</td>
<td>.049</td>
<td>.130</td>
<td>.018</td>
<td>.310</td>
<td>.009</td>
<td>.682</td>
<td>-.089</td>
<td>.042</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.196</td>
<td>.109</td>
<td>.958</td>
<td>.800</td>
<td>.503</td>
<td>.923</td>
<td>.079</td>
<td>.959</td>
<td>.000</td>
<td>.633</td>
<td>.818</td>
</tr>
<tr>
<td><strong>How much money did you receive from off-farm labor in the last 12 months?</strong></td>
<td>Pearson Corr</td>
<td>-.277</td>
<td>.260</td>
<td>-.251</td>
<td>.330</td>
<td>.086</td>
<td>.147</td>
<td>-.021</td>
<td>-.050</td>
<td>.235</td>
<td>.281</td>
<td>.093</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.146</td>
<td>.173</td>
<td>.189</td>
<td>.063</td>
<td>.657</td>
<td>.16</td>
<td>.908</td>
<td>.783</td>
<td>.188</td>
<td>.126</td>
<td>.607</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.500</td>
<td>.267</td>
<td>.739</td>
<td>.408</td>
<td>.452</td>
<td>.250</td>
<td>.024</td>
<td>.512</td>
<td>.000</td>
<td>.785</td>
<td>.733</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>.908</td>
<td>.486</td>
<td>.102</td>
<td>.428</td>
<td>.275</td>
<td>.136</td>
<td>.007</td>
<td>.089</td>
<td>.817</td>
<td>.309</td>
<td>.382</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).