ANALYSIS OF THE FACTORS AFFECTING COCOA YIELDS, PRICES AND BUYER SERVICES IN THE VILLAGES OF SOUBRÉ, CÔTE D'IVOIRE

Kaitlyn Smoot, Borlaug Fellow, ICRAF Soubré

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ANADER	Agence National d'Appui au Developpment Rural
Caistab	La Caisse de stabilisation et de soutien des prix des productions agricoles
Conseil du Café-Cacao	Le Conseil de Régulation, de Stabilisation et de Développment de la Filière Café-Cacao
CDC	Cocoa Development Center
CNRA	Centre National de Recherche Agronomique
CODAPEC	National Cocoa Diseases and Pest Control Program
CSSV	Cocoa Swollen Shoot Virus
ENSEA	Ecole Nationale Superieure de Statistique et d'Economie Appliquée
FFS	Farmer Field School
GVC	Groupements à Vocation Coopérative
HKF	Hassan Kamel Ftouni, large private cocoa buyer
ICRAF	International Center for Research in Agroforestry/World Agroforestry Center
RA	Rainforest Alliance
SIPEF-CI	Société Internantional de Plantation et de Finance Côte d'Ivoire
SATMACI	Société d'Assistance pour la Modernisation de l'Agriculture de la Côte d'Ivoire
V4C	Vision for Change (Mars-ICRAF cocoa project in Côte d'Ivoire)

1: INTRODUCTION

Côte d'Ivoire is the world's largest cocoa producer, exporting 1.24 million tons of cocoa in 2010, or 34% of the world's total (ICCO 2012). Cocoa is cultivated on approximately 2 million hectares in the country by over 1 million smallholder farmers (Assiri et al. 2012) and in 2010 it accounted for 35% of the country's total exports and 12% of total GDP (Kireyev 2010). Thus, cocoa is central to the Ivoirian economy, just as the cocoa production of Côte d'Ivoire is central to the global chocolate market. However, for a combination of reasons, the Ivoirian cocoa industry is on the brink of a crisis, with yields dropping significantly and production threatening not to meet market demand in the near future. This crisis can be averted, and a more sustainable cocoa economy can be established, but it will require efforts which fully take into account the dynamics of cocoa prices and supply.

Though the world chocolate industry is vibrant and growing, raw cocoa bean prices have been declining gradually since the 1980s due to increased buyer concentration and increased bean supply, especially from Asia (Morisset 1998, Kaplinsky 2004, ul Haque 2004, Barrientos et al. 2007). Furthermore, the full world bean price is not earned by most cocoa farmers, due to government export taxes and the market power of intermediaries. UNCTAD (2008) shows a decrease in producer prices as a percentage of the world price over the past decade for every country except for Ghana.

Cocoa production has not dropped over this period, and in fact has increased, despite the price declines. This is due to the fact that cocoa supply is price inelastic, because farmers are loathe to cut down trees in which they have invested time and money (Hattink et al. 1998, Abbott 2007). Also, as long as there was virgin forest land available farmers continued to increase their plantings, taking advantage of initially high yields even without inputs to do the "forest rent" (Ruf 2001, Woods 2004). However, this frontier land it almost completely exhausted, and the only way to maintain, much less increase total cocoa production is to focus on increasing yields (Ruf 2001, Asare 2005). This is a major concern, because yields are low and declining throughout West Africa, particularly in Côte d'Ivoire, where in 2012 they ranged between 200 and 500 tons/ha per year in 2011 (Assiri et al. 2012, FLA 2012), compared to an average of 616 tons/ha from 1990-2005 (Meija 2011).

A number of factors are blamed for yield declines: an increase in disease pressure, aging of cocoa trees, exhaustion of soils, lack of new land to exploit "forest rents," and competition with other crops like rubber (Nkamleu et al. 2007, Assiri et al. 2012, FLA 2012). However, everything ties back to a reluctance of cocoa farmers to invest in replanting aged cocoa, adopting high-yielding varieties, and intensively using inputs, caused in large part by declining prices and rising input costs (Morisset 1998, Kaplinsky 2004, Gibbon and Ponte 2005, Afari-Sefa et al. 2010).

Many chocolate industry players are worried that, based on current declines in yield, there will be a dramatic shortfall between the demand for grindings and cocoa supply in the near future. This has led to the creation of a myriad of initiatives aiming to boost cocoa yields in West Africa, including the African Cocoa Initiative, the Cadbury Cocoa Partnership, and the Nestle Cocoa Plan. Mars Incorporated has initiated its own project, in Côte d'Ivoire. The project is called Vision for Change (V4C) and is being implemented by the World Agroforestry Centre (ICRAF).

The V4C project has set up a network of Cocoa Development Centers (CDCs) throughout the region of Soubré, the most productive cocoa region in Côte d`Ivoire, conducting on-farm research into different cocoa cultivars, rehabilitation of old orchards by grafting, and the effect of fertilizer application and other management practices (ICRAF 2012). In 2013 the project will enter the extension stage, and small local enterprises set up by V4C will supply inputs, improved seedlings, and grafting technology to farmers throughout the region. This initiative is designed on the same model as a successful project initiated in Indonesia by Mars starting in 2003, which increased average cocoa yields from 0.5 to 2.5 tons/ha per year (Pye-Smith 2011). Initial studies of the effects of rehabilitation methods in field trials in Côte d'Ivoire are encouraging, showing an 83% average increase in yields and an average profitability rate of 377% (Assiri et al. 2012).

The research for this report was conducted in the context of the V4C project. Data were collected in cocoa-farming villages throughout the V4C intervention zone, which is centered around Soubré. The report seeks to answer a number of different research questions about the cocoa market in Côte d'Ivoire. First, the data will be analyzed to see how yields, cocoa prices, service provision by buyers, and percent of certified farmers have changed in response to significant market reforms enacted in 2012. Second, regression analysis will be used to determine the effects of several factors, including market variables, on cocoa yields. Third, models will be used to test the effects of several different factors on cocoa prices and services provided by cocoa buyers to farmers. Finally, the factors affecting farmer investment levels and plans for the future of their cocoa land will be analyzed. The conclusion of the report will also include recommendations on how to improve the V4C project model in the future by taking market factors into account.

2: METHODOLOGY

Data for this report were collected in two stages. First, in November 2012, farmer focus group meetings were conducted in thirteen different villages throughout the zone of intervention. At that time several qualitative interviews were also conducted with other cocoa market actors, including representatives of the government's Conseil du Café-Cacao, the ANADER extension service, and several cocoa producer cooperatives, in addition to many V4C personnel. The second stage of the data collection was a randomized quantitative survey of 400 cocoa farming households in 50 villages throughout the zone.

The thirteen focus group villages are listed in Table 2.1 below. In each village three separate focus group meetings were conducted in the course of one day—one with women, one with men aged 18-40, and another with men over 40— with 10-15 participants in each meeting. Questions were posed about the current input and other business services available in the local cocoa market, the number and types of buyers to which farmers sold, how prices and yields have

changed over time, the biggest problems faced by cocoa farmers, and preference rankings of potential project interventions to solve these problems. An effort was made to select villages across a wide geographic area, with different dominant ethnic groups, and to include both villages with ICRAF CDCs and a few without CDCs. One key variable shown in Table 2.1 which we will reference throughout this report is farmer origin: allochtone refers to the native ethnic group in an area, allochtone refers to migrants groups from other regions of Côte d'Ivoire, and allogene refers to foreign migrant groups. Note that a second- or third- generation migrant is still considered allochtone or allogene, even if they were born in the new region.

Table 2.1: Villages for Focus Group Meetings

Village	Prefecture	Dominant ethnic group(s)	Origin(s)
Gbily	Buyo	Bete	autochtone
Raphaelkro*	Buyo	Baoule	allochtone + allogene
Petit-Bondoukou	Oupoyo	Koulongo	allochtone
Gbletia*	Oupoyo	Bakoue	autochtone + allochtone + allogene
Krohon	Meagui	Bakoue + Burkinabe	autochtone + allogene
Kragui	Meagui	Malien + Malike + Burkinabe	allochtone + allogene
Miangobougou*	Meagui	Senefou from Mali	allogene
Takoreagui	Soubré	Baoule + Burkinabe	allogene + allochtone
Koda	Soubré	Kouzie	autochtone
Ottawa	Okrouyo	Baoule + Bete	allochtone + autochtone
Petit-Bouake	Liliyo	Baoule	allochtone
Gnogboyo*	Liliyo	Bete+ Burkinabe	autochtone + allogene
Kipiri	Grand Zattry	Bete	autochtone

Note: Villages marked with a (*) are those without CDCs.

The quantitative survey was conducted in January and February 2013. For the purposes of survey implementation the V4C area of intervention, shown in Figure 2.1 below, was divided into five approximately equal zones, and a different surveyor was assigned to cover each zone. Zone 1 covered the prefecture of Buyo; Zone 2 covered Grand-Zattry and Liliyo, Zone 3 covered Soubré and the southern part of Opouyo, Zone 4 covered southern Opouyo and Meagui, and Zone 5 covered Okrouyo and a small section of the department of Gueyo were ICRAF has recently installed new CDCs. Within each zone 10 villages were selected by the research coordinator, and 8 producer households were interviewed within each village (selected by the surveyors). Villages were selected so as to have variety within the sample along several different variables: geographic location, level of isolation, dominant ethnic group, and exposure to V4C programs.

Figure 2.1: Map of Villages included in the Quantitative Survey

Upon arrival in each village, surveyors first collected some basic data on the village itself, including whether a market was present in the village, the total population (including surrounding camps, to get an estimate of the market size), the presence of producer associations, and the distance from the village to the nearest paved road. Where available, surveyors were given lists of all the households within the village (supplied by researchers from the National School for Statistics and Economics, ENSEA) and selected the 8 households randomly from that list. Where such lists were not available surveyors selected the households themselves, with instructions to choose an approximately representative group based on ethnicity, household location within the village, and membership in producer organizations. In each case the surveyor spoke both with the head of the household (male in the vast majority of cases) and with the head female within the household, since women tend to be the ones who do the shopping, cooking, and marketing of non-cash crops.

This quantitative questionnaire covered basic demographic information and details on cocoa parcels owned, including ages, varieties, land tenure, intercropping patterns, fertilizer and pesticide use, amount of labor, and presence of diseases. All of these data were collected for the cocoa season 2012 only. Additionally, questions were posed on cocoa production and marketing for the 2010, 2011 and 2012 seasons, including total cocoa sold, minimum and maximum price

earned, number and type of buyer to which the farmer sold, and services received. A cocoa season was defined as starting on October 1 of a given year and running through September 30 of the following year. Finally, there was a section of opinion questions which included whether the farmer had already cut down cocoa to plant another crop, whether he intended to farm cocoa on all his current cocoa land in the future, whether he would do rehabilitation methods promoted by V4C, whether he preferred the new fixed price system introduced in 2012, whether he would prefer to be paid for cocoa via bank accounts, and whether he would introduce more intercropping in the future. For all of these questions the farmers were also asked to explain the reason behind their response.

The remainder of this paper is organized as follows. Section 3 provides relevant background information on cocoa marketing in Côte d'Ivoire and a literature review of past studies of topics similar to our three main quantitative research questions. Section 4 outlines the results from the focus group meetings while Section 5 presents the results of some of the qualitative (opinion or motivation) questions from the survey. Section 6 uses summary statistics and graphs to look at time trends of cocoa prices and other marketing variables. Section 7 presents the regression analysis of the determinants of cocoa yields. Section 8 analyzes the determinants of farmgate prices and services, also in regression form, and Section 9 presents regression models of several different measures of future investment in cocoa.

3: LITERATURE REVIEW

3.1 Background on Côte d'Ivoire Cocoa Markets and the 2012 Reforms

From about 1960-1988 the cocoa market in Côte d'Ivoire was regulated by a marketing board known as Caistab which enforced fixed cocoa prices within a given calendar year and ensured that prices were fairly stable across years (Ruf 2009). Caistab also guaranteed bank financing, which increased credit access for several actors in the cocoa industry (mostly buyers and processors) and supplied services to producers including training, road repair, and inputs.

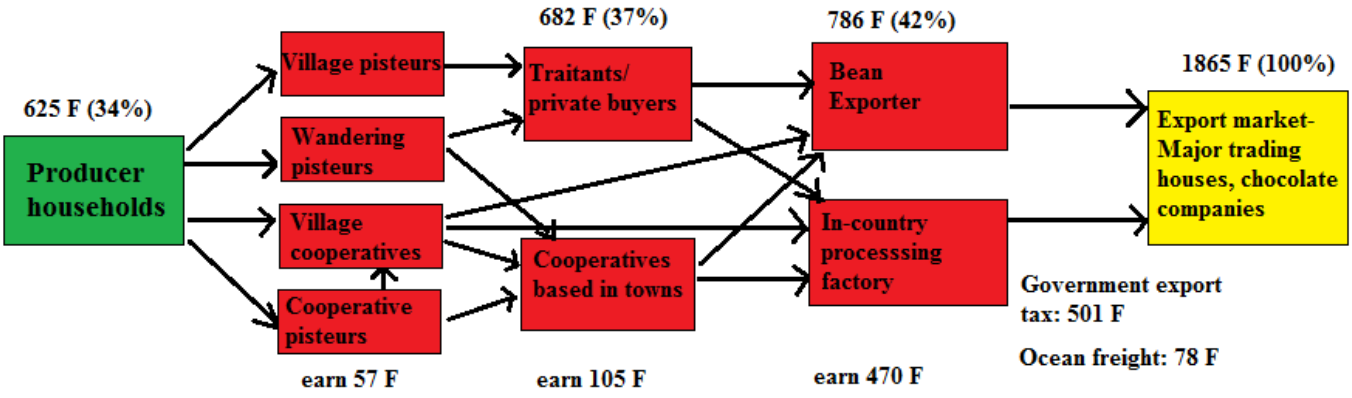
However, when world cocoa prices plummeted in the late 1980s Caistab attempted to counter this by blocking shipments of cocoa for 27 months, hoping that a reduction of world cocoa supplies would raise prices. This period is often referred to as the "cocoa war." Unfortunately, the strategy backfired. Cocoa buyers were able to wait until Caistab gave up and released its supplies, while the domestic consequences were disastrous: the guaranteed-price system fell apart, producers were not paid, and the economy went bankrupt (Losch 2002). Under these circumstances Côte d'Ivoire was forced to cave to pressure by the World Bank to liberalize the cocoa sector. They gradually eased price guarantees throughout the 1990s and devalued the currency in 1994. Liberalization culminated in 1999 when Caistab was fully dismantled.

Though many proponents of liberalization claim that it increases market efficiency and increases producer prices, this has not been the case in Côte d'Ivoire. In fact, average producer prices throughout from 1988-2008 were much lower than during the Caistab period, ranging from 180-500 F per kg in constant 1994 terms, as opposed to 500-900 F in the period before liberalization (Ruf 2009). These prices have dropped not just in real terms, but also as a percentage of world market prices. Before liberalization producer prices averaged about 68% of the world price, but by 2009 they were only 41% of the world price (Williams 2009). This is in contrast to Ghana, where the cocoa industry is still state-controlled and farmers earned 70% of the world price in 2009. Liberalization also greatly increased price volatility within a given year, and spatial differentiation of prices within the same country (ul Haque 2004).

Other consequences of liberalization in Côte d'Ivoire have included a drop in cocoa quality in the absence of a central monitoring mechanism and a dramatic increase in the number and power of private buyers and exporters (Wilcox and Abbott 2004, Fold and Ponte 2008). In Côte d`Ivoire government taxes are only about 30%, but exporters, transporters and other intermediaries, who came to dominate the industry after liberalization, capture a large part of the remaining cocoa revenue. In fact, from 1982 to 1999 the portion of industry revenues earned by intermediaries rose by 71%, to the detriment of both producers (-8%) and the government (-11%) (Bonjean et al. 2001). Figure 3.1 shows a map of the cocoa value chain in Côte d'Ivoire in 2010, with the bean price per kg and the margin earned marked at each stage. The data shown in Figure 3.1 are derived from Abbott (2010). The different intermediaries, shown in red, earned a total of 632 F/kg (34% of the world bean price), about the same proportion as producers.

According to a report by the Nestle Cocoa Program one village-level buyer ("pisteur") purchases from 25-30 farmers, the larger, regional buyers ("traitants") tend to work with 5-6 pisteurs (though the largest work with up to 200), and the export or processing companies work with 20-70 traitants (FLA 2012). That report also showed that about 64% of producers sold with pisteurs in 2011, compared to only 31% who sold with cooperatives and 4% who sold to multiple types of buyers.

Figure 3.1: Map of Cocoa Value Chain, Margins Earned at each Stage



In 2012 Côte d`Ivoire reintroduced a fixed price system, and set the producer price at 60% of the world price. For the first time since 1988 there is a single producer price, of 725 F per kg, enforced throughout the country during a single cocoa season. There is also a set port price of 805 F per kg, which

puts a limit on the profit margins which pisteurs and traitants can earn (Coulibaly 2012). This was done with the intended purpose of reducing revenues earned by middlemen so that some would be driven out of the market, because they were seen as too numerous and powerful (Silue 2012). The 2012 cocoa reforms also created a single, streamlined government agency to oversee the cocoa industry, called the Conseil du Café-Cacao. This body is now charged with enforcing the fixed price system, setting and enforcing quality standards for beans, collecting and analyzing data on cocoa production, and supporting allocation of services to farmers including ANADER Farmer Field Schools (FFSs), distribution of hybrid plants (3,000 ha worth in 2012), road repairs (12,500 km planned for 2012-2013) and small quantities of chemicals (8 fungicide sachets and 1 liter of insecticide) for each planter (Silue 2012).

Another stated objective of the cocoa reforms is to boost the position of cocoa cooperatives in the market, because (especially when UTZ or RA certified) they are seen as the best way to promote quality cocoa (Silue 2012). However, it is not clear whether the reforms help or hurt cooperatives: the Conseil du Café-Cacao preferences distribution of inputs to farmers through cooperatives (and even lends them spray machines for free, which they will not do for individual producers or private buyers), but the decreased profit margins hurt cooperatives as well as private buying companies. The key difference is the fact that cooperatives are farmer-owned and thus earn both profits at the farmgate and for transport to the port. Because of this difference, when the 725 F price was first introduced in October 2012 many private buyers attempted to boycott the market, refusing to buy, and it was cooperative buyers who broke the boycott. Later, private buyers reluctantly started purchasing at the fixed price as well, for fear of losing major market share (Silue 2012). Thus, it seems that cooperatives may be more willing to operate in the new market created by the price reforms and so we may expect to see that they have taken a larger portion of market shares this year. Also, this suggests that the presence of cooperatives can have an influence on the behavior of non-cooperative buyers, another hypothesis worthy of formal empirical investigation.

The first goal of this report is to look at the changes in the cocoa market over time to determine the effects of the 2012 reforms. Is the fixed price being universally enforced? Has the average cocoa price received by producers increased, and has volatility decreased? What are the opinions of the farmers about these price reforms? Have the reforms actually increased the role of cooperatives? Are those cooperatives supplying more support to producers? Have they led to an increase in cocoa quality? These questions will first be explored via graphs in Section 6 and then as part of the regression analysis in Section 8.

3.2 Factors Affecting Cocoa Production

Among the effects outlined above, it will also be interesting to see if the 2012 cocoa market reforms have had any impact on cocoa yields. In order to attempt such estimation, it is crucial to create a model which incorporates all the important yield determinants in order to properly identify the effects of the market reforms. Reardon et al. (1997) is a review of the literature on determinants of agricultural productivity across crops. That report suggests that the most important factors affecting productivity include: use of fertilizer, use of improved seed types, use of animal traction or machinery, investments in soil conservation, farm size and land

tenure, non-cropping income (which can act as a source of investment finance), and well-functioning input and output markets.

There is a sizeable literature which seeks to estimate the determinants of cocoa production specifically, though most of it uses data on Ghana instead of Côte d'Ivoire. Most of the models are based on a Cobb-Douglass production function, with the dependent variable as the log of total production (though a few use yields) and the key continuous independent variables also in log form. The variables which are found to have a significant impact on production or yields in the various studies include: land size, amount of labor, fertilizer inputs, pesticide inputs, use of machinery, type of cocoa variety, age of cocoa trees, extension services, rainfall, household size, farmer age, education level, gender, and dummy variable for regions or soil types (Evenson and Mwabu 1998, Owens et al. 2003, Teal and Vigneri 2004, Edwin and Masters 2005, Zeitlin 2005, Teal et al. 2006, Vigneri 2008, Vigneri and Santos 2008, Gockowski et al. 2010, Aneani 2011). A number of similar studies model the factors which impact the technical efficiency of cocoa farms using much the same combination of independent variables (Leonard 1997, Binam et al. 2003, Amos 2007, Nkamleu et al. 2010, Richman 2010).

Though results vary by study, several common trends can be observed. First, in many cases fertilizer use was found to be the most significant determinant of yields. A 10% increase in fertilizer was found to result production increases between 14% and 54% (Teal et al. 2006, Vigneri 2008, Aneani 2011). However, many models omitted tree variety as a variable, and this could arguably have a higher effect. Edwin and Masters (2005), for example, found that planting an improved cocoa hybrid increased yields by 42% while applying an additional 50 kg bag of fertilizer increased yields by 19%. By comparison with the effects of fertilizer, a 10% increase in pesticide use was found to increase yields by 16-36%, a 10% increase in labor increased yields by 15%, and a 10% increase in farm assets including machinery increased yields by 5-11% (Vigneri 2008). Input use was incorporated into models via several different methods: some used log continuous variables of use per hectare, others used dummy variables of whether the input was used at any quantity or not, and some included both of these types of variables.

Research on a variety of agricultural products suggest that farm yields decline by about 20% as farm size doubles (Carter 1984). This is partially due to a reduction in shirking on smaller farms, since supervision of labor is easier and owner-operators are more motivated to work, since they gain all the benefits of their labor. Vigneri (2008) looked at the farm size-yield relationship specifically for Ghanaian cocoa and found that doubling farm size would decrease yields by between 20%-45%, depending on the model specification used (OLS or fixed effects). For similar reasons land tenure is expected to impact yields: based on moral hazard, an owner-operator is more likely to invest more time and resources into his plantation than a sharecropper or paid laborer, a result supported by some empirical research on cocoa (Gockowski et al. 2010). However, Freud et al. (1996) actually found that sharecroppers in Ghana and Côte d'Ivoire had 25% and 40% higher cocoa yields, respectively, than landowners. The authors suggested that this is because Ivoirian sharecroppers are able to select the best plots when negotiating their contracts. These two studies used different combinations of independent variables, so it is possible that one was influenced by omitted variable bias.

Several past papers have found a significant effect of extension services on agricultural production, modeling it as a knowledge factor which can impact the use of inputs and good agricultural practices (Feder and Slade 1985, Owens et al. 2003). A few studies have shown a significant effect of extension on cocoa production or efficiency in particular (Romani 2003, Barrientos et al. 2007, Oguntade et al. 2012). Romani (2003) specifically tested the effect of ANADER extension in Côte d'Ivoire and found that it increased yields by 30%. On the other hand, Deaton and Benjamin (1988) found no significant impact of extension on cocoa production in Côte d'Ivoire. This insignificant result may be related to their use of the availability of extension at the village level, rather than individual participation, as the key independent variable.

Several studies also discuss the effect of marketing factors on cocoa production. For example, Bonjean et al. (2001), for example, say that the structure of the local purchasing market can significantly affect yields via the provision of inputs and services. A single state or private (but state-regulated) monopoly buyer is more likely to supply quality inputs to farmers because of the likelihood of reaping the benefits in terms of production later, and also because optimal application of pesticides and quality monitoring of inputs are more easily accomplished by a single institution.

Several Ghanaian studies included the number of LBCs to which farmers sold their beans as an independent variable in order to estimate the effect of non-price competition (supply of credit and other services to producers) among buyers on cocoa production (Zeitlin 2005, Teal et al. 2006, Vigneri and Santos 2008). However, this could have been measured more directly by including number of buyer services as a variable. Also, it would be interesting to look at the effect of the number of type of buyers on actual price competition. Though this was not possible in the Ghanaian context, where the government strictly enforces a single price, it is possible in Côte d'Ivoire using data before 2012.

A number of studies have attempted to estimate the price elasticity of supply of cocoa, within specific countries and at a global level. However, this has proven difficult because for many years prices were administered by the government, so there was no price variation within cross-section studies, and the ratio of cocoa price to its biggest competitor (until recently) was generally constant even across years, so time-series estimations were also difficult (Deaton and Benjamin 1993). Existing estimates suggest that short-run supply is price inelastic but that supply is somewhat elastic in the long-term (Bond 1983, Godoy 1992, Trivedi and Akayama 1992). One of the most recent elasticity studies, Abdulai and Reider (1995), found that cocoa supply was inelastic in both the short and long term, but still more responsive to price than previously believed: a 10% increase in price was found to cause a 3% increase in output in the short-run and a 7.2% increase in cocoa output in the long-run.

Where prices are found to affect cocoa yields, it is via an effect on farmer investment and input use. When prices are low farmers neglect their plantations, investing in few inputs and labor, which can even decrease production in the short-run, and in the longer-run higher prices stimulate new planting and new entrants even to the point of causing oversupply (Bonjean et al. 2001,Woods 2004). Woods (2004) concluded that prices are thus a factor affecting production but the relationship is not linear. Input use and yields are much higher in Indonesian cocoa compared to Ivoirian cocoa (Meija 2011), and this may be related to the fact that producer prices are also much higher, though trees also tend to be younger and rainfall is higher, so no definite conclusions can be made.

Meija (2011) preformed regressions on the determinants of cocoa yields in four West African companies which included producer price as a potential factor. Results for Côte d'Ivoire showed that rainfall had a significant positive effect on yields, though with a diminishing marginal effect, and that market reforms in the 1980s and 1995 both had a positive impact on yields, but no other variables were significant (Meija 2011). In the same paper a pooled regression of panel data on all four countries found that cocoa producer price, lagged yield, and a time trend all positively and significantly correlated with yields. However, the magnitude of the estimated effect of price was very small: a 10% increase in price lead to an increase in yields of only 4 kg/ha.

A study of 800 cocoa farms in Côte d'Ivoire found that over 50% of producers had less than 5 hectares, 30% of trees were over 20 years old, and over 70% of mature plantations were grown in full sun (Assiri et al. 2009). Weeding as only done 2-3 times per year on average, insecticide application only 1-2 times per year, and fertilizer rarely applied. CNRA recommends 4-6 weedings per year, 2 treatments with fertilizer (around 520 kg per ha per year), and 4 pesticide treatment per year, for a total of about 4 liters per ha per year (Ismael et al. 2005), so observed maintenance was far below these guidelines. Given the proven importance of inputs, tree age, and maintenance (proxied by labor) on cocoa production, it is thus not surprising that yields in Côte d'Ivoire are only 260-560 kg/ha (Assiri et al. 2009).

The second goal of this report is to determine if these same characteristics are observed for our sample of producers, and to quantify the relative impacts of the different identified factors on yields. We are particularly interested in isolating the effect of farmgate cocoa prices and buyer services on yields.

3.3 Factors Affecting Farmgate Prices and Buyer Services

Farmgate prices and availability of services like input support might have a significant impact on cocoa yields, as discussed above, and this will be tested empirically for the current sample. But what factors affect the level of farmgate prices and services allocated by buyers? How are these two variables related to one another, and to other factors like buyer competition, buyer type, and individual producer characteristics?

Many models look at the determinants of world cocoa prices including global supply, demand for grindings, stocks, and liberalization policies (Shamsudin et al. 1992, McIntire and Varangis 1999, ul Haque 2004, Lloyd 2006). However, this is not of direct interest to our report. Instead, we are interested in the determinants of variation in farmgate prices across villages and farmers at a given time, when world prices are constant. Few models of this type were found in the literature, and those that exist were mostly conducted in other West African countries but not Côte d'Ivoire.

For example, Ajetomobi (2011) investigated spatial price differentiation in cocoa markets in Nigeria and found that a high number of separate buyers in an area increased the likelihood that farmers would receive the national market price. Several studies in the past have looked at factors affecting the marketing services provided to farmers. Calkins and Ngo (2005) found that cocoa cooperative members in Ghana received fairer weight and quality evaluations on beans, as well as superior marketing and

transport services. A number of other studies in Ghana concluded that a higher number of buyers in a given region increased farmer welfare by decreasing cheating and stimulating LBCs to offer scholarships, inputs on credit, and other services in order to attract and retain farmer business (Varangis and Schreiber 2001, ul Haque 2004, Teal et al. 2006, Vigneri and Santos 2008).

English (2008) conducted an empirical study of the effects of various factors on cocoa farmgate prices in Liberia, including: world prices and quality discounts, transport factors (distance to major markets, whether farmer pays the transport costs, whether the farmer owns a vehicle for transporting cocoa), market information and resources (cell phone ownership, sources of market information, access to credit, membership in an association), farm characteristics (household size, experience, education, cocoa as a proportion of revenues), season of sale (wet or dry), and location (dummies for different countries, proximity to major buying centers).

Results of English (2008) showed that the most significant factors which positively influenced farmgate price were the world cocoa price and membership in a farmer organization, while lower quality, distance to the border, receiving a loan from a buyer, obtaining market information mostly from other farmers, proximity to a large buying center, and selling in the wet season all had significant negative correlations with price. This suggests a number of variables which should be included in our models of farmgate prices though it is not a complete list, because it omits a number of variables which have theoretical importance to farmgate price, notably the type and number of buyers in a given area, the population of an area, and total cocoa production of the household, which are basic representative variables of demand and supply.

English (2008) also suggest that there are trade-offs between price and provision of buyer services such as credit, an idea which has been discussed by a number of other researchers (Ruf and Yoddang 1998, Bonjean et al. 2001, Poulton et al. 2004, Jones and Gibbon 2011). That is, while a higher number of buyers is likely to stimulate price competition and lead to higher farmgate prices, is should have the opposite effect on service provision. In the situation of a local monopoly, or where the buyer has enforceable contracts with suppliers, they gain the full benefit from the services they provide, whereas in regions with high buyer competition service benefits care not excludable. Ruf and Yoddang (1998) cite this as one of the major reasons for a significant drop in the provision of credit by buyers following liberalization in Côte d'Ivoire. This is in contrast to the situation in Ghana, where a larger number of buyers tended to increase service provision, because prices are fixed and so the buyers engage in service provision as a form of non-price competition (Zeitlin 2005, Laven 2007, Vigneri and Santos 2008).

Kamden et al. (2010) estimated the effect of various factors on producer prices for several different agricultural products in Cameroon. Results showed that variables which significantly increase producer prices include: distance from the producer's house to the point of sale, number of separate sales made by the producer during the season, number of approved buyers in the village, a dummy for sales made at a time other than the start of the school year and by a producer who did not take credit from a specific buyers, total income of the producer, degree of reliance on cocoa for income, selling with a cooperative, selling with an approved buyer instead of an unregistered pisteur, and selling during the

season of abundance. Age, world cocoa price two weeks previously, and distance between the point of sale and the port were significantly negatively correlated.

These results confirmed the hypothesis that producers have lower market power, and thus face lower prices, when they sell at the start of the school year (because a high number of producers are in acute financial need at that time, because of school fees) and when they obtain credit from a buyer (and are thus tied to selling with that particular buyer). The results also showed that those who sell to cooperatives earn a higher price, but that the presence of cooperatives does not lead to higher prices for those in the same region who sell with private buyers.

The model used in this report to test the determinants of farmgate prices and service provision in Côte d'Ivoire will be derived primarily from English (2008) and Kamden et al. (2010) and will include individual and village level variables, some of which will be fixed and some which will vary over the three year period. We hypothesize that there will be a positive correlation between both dependent variables (prices and services) and proximity to major roads, quality of village access paths, the presence of cooperative buyers, a dummy for the 2012 reforms, and the percent of revenue derived from cocoa. We also expect to see a positive correlation between the number of buyers in an area and price, but a negative correlation for services (though this may change in 2012). Finally, we expect to see a negative relationship between buyer services and competition in 2010 and 2011.

3.4 Factors Affecting Farmer Willingness to Invest in, Rehabilitate, or Replant Cocoa

One final, related question which this report seeks to answer is: what factors affect the future willingness of farmers to farm cocoa and invest in higher yields? It is related because general profitability of cocoa (a function of farmgate prices, input costs, and expected production) are expected to have a major impact on farmer attitudes about the future. Also, the relationship between the price and yield variables is largely determined by the former's effect on investment in farm inputs and planting. We plan to investigate this separately and more formally in order to better elucidate this relationship and to identify other factors which influence investment decisions besides market conditions. This is especially of interest and importance to the V4C project, of which the goal is to increase cocoa yields by spreading the adoption of cocoa rehabilitation methods (especially replanting and grafting). Understanding which farmer characteristics, market factors, and other elements make adoption of investment in rehabilitation more likely could help V4C to better target its extension efforts in the future.

Past research supports the importance of finding methods to stimulate investment in the cocoa sector. For example, Binam et al. (2008) estimated the gap between actual and potential cocoa yields (the latter based on optimal input use) in several West African countries. The study concluded that Côte d'Ivoire and Ghana had the highest yield gaps, of 260 kg/has and 460 kg/ha respectively, and that these gaps could be closed with investment in extension, credit availability, and infrastructure. Another crucial reason to pay attention to investment decisions is to better understand why a growing number of farmers are cutting down their cocoa and replacing it with other crops, especially rubber. If this motivation is understood then V4C and other initiatives which seek to avert cocoa production declines can better target their efforts.

There is a wide literature on agricultural technology adoption in general. Prokopy et al. (2008) conducted a review of 55 different adoption studies and found that a few factors which continually surface as significant are: education level, amount of capital, income, farm size, access to information about the relevant new practices, attitudes toward the new practices, environmental awareness, and utilization of social networks. A number of classic papers explore the influence of social learning on technology adoption (Besley and Case 1993, Conley and Udry 2001, Acemoglu et al. 2008) though this has not been studied much in cocoa.

A sizeable literature also exists on technology adoption in cocoa specifically. Freud et al. (1996) found that farm scale and origin were the most important determinants of pesticide use in cocoa in in Côte d'Ivoire and Ghana, while education and age did not have a significant effect. Barrientos et al. (2007) reported that the adoption of fertilizer and improved cocoa varieties in Ghana was affected by the cost of labor, the cost of other inputs, land tenure, gender of the farmer, migration status, and farmer age. Several studies investigated farmer investment in agrichemical use on cocoa in Nigeria and found that the most significant factors affecting adoption were household size, education, farm size, number of extension agent visitations, input cost, cocoa output, total number of previous adopter in an area, number of agrichemical stores in an area, and cooperative membership (Akinola 1986, Agbeniyi et al. 2010, Onwumere and Alamba 2010).

Nkamleu et al. (2007) found that education, being a member of a producer organization, receiving cash credit, having a higher total land area, living in the Southwest region, and being a foreign immigrant (allogene) were positively correlated with chemical input expenditure in Ivoirian cocoa farms. Being native to an area (autochtone), living in the Eastern region (the newest cocoa frontier), managing a higher number of separate parcels, higher tree age, and a higher number of adults in the household correlated negatively with chemical expenditures. Ordonez and Patricia (2011) estimated the determinants of adoption of rehabilitation techniques (pruning, integrated pest management, and fertilizer application) on cocoa farms in Ecuador. Results showed five significant factors affecting adoption: gender, availability of family labor, additional source of income, past pruning practices, and high disease incidence.

In addition to understanding the determinants of investment in cocoa, it is important to understand the factors cause farmers to abandon it. Ruf (2013) discussed the fact that in the Bas Sassandra region (which includes Soubré) cocoa has already gradually replaced coffee over the past several decades, and now rubber is replacing cocoa in many areas. Ruf (2013) cited a myriad of reasons for this, including the fact that export taxes on rubber or only 2% compared to 30% for cocoa, that the soils of the region were not particularly well-suited to cocoa in the first place and the region only supported major production for a period because of high "forest rents," that as soils become degraded and acidic rubber succeeds on them with minimal inputs far better than replanted cocoa, that the rubber industry provides comparatively more supports and services to producers, and that the producer revenue to labor cost ratio is much higher for cocoa than rubber.

No study has yet attempted to empirically estimate the factors which make farmers more likely or less likely to cut down their cocoa and switch to rubber in Côte d'Ivoire. This study will attempt to do so, in

addition to estimating the factors which affect investment in inputs, rehabilitation efforts, and plans for continued cocoa cultivation. It is hypothesized that the same underlying factors will be significant determinants of all measures of investment. The variables used in the various adoption studies cited above will be used to generate the model for this report.

4: QUALITATIVE RESULTS FROM FOCUS GROUPS

4.1 Basic Data on Focus Group Villages

The focus group meetings in the thirteen villages revealed several commonalities and differences in terms of cocoa value chain structure, other important crops, marketing, and problems facing producers. These observations were later used to develop the quantiative survey questionnaire.

4.1.1 Production Features of Cocoa and Other Major Crops

In all villages surveyed except for Ottawa, cocoa was listed as the most important crop. In Ottawa, which is located 7 km from the SIPEF-CI palm oil processing factory, cocoa takes second place to palm. In all villages the other most frequently listed important crops were: rubber, rice, maize, manioc, plantains, yams, vegetable crops, and peanuts. Coffee was brought up by several of the male groups as important, but after some discussion the groups tended to agree that coffee had mostly disappeared by this point in time. Even where some land was still under coffee cultivation, as in Raphaelkro, in recent years producers have not bothered to harvest the coffee due to low prices and the labor-intensive nature of harvest. Men tend to dominate cultivation of cash crops like cocoa, palm oil, rubber, and coffee while women tend to cultivate vegetable crops, peanuts, manioc, yams, and plantains. Men and women both participated in the cultivation of rice and maize.

The average cocoa farm size across the villages was 5.9 ha, though this varied dramatically by locality. The smallest cocoa parcels were in Ottawa, averaging 2.6 ha; average land sized farmed was 5.6 ha, but a larger portion of the land tended to be in oil palm. The largest land size was 11.95 ha, found in Krohon, a village of autochtones, several of which were very large land-owners. On average trees tended to be around 30 years old, though the range was from 9 years in Raphaelkro to 42 years in Kragui and Petit-Bouaké. Every single locality reported yield declines in recent years, regardless of age. Thus, while aging may be a key factor in yield declines, it is clearly not the only problem. In Raphaelkro, for example, farmers say that even their recent re-plantings have failed, and they blame diseases and depleted soil nutrients.

4.1.2 Marketing Structures

In most of the villages women act as the main traders of crops other than cocoa, selling their own produce locally or to nearby markets (frequently transporting the goods on foot), as well as selling goods from elsewhere, such as clothing and packaged food, in the local market. In most villages women process manioc into products like attiké, plakali, and congoné, for consumption and sale, and in some villages women made palm soap (Kragui, Gnoboyo, Ottowa). In Ottowa there was extensive palm oil production, because of the abundance of palm trees in the village. Several women earned income as hairdressers, or restaurateurs. The older men tended to have no sources of income apart from production of cash crops, while the younger men were the most active in alternative professions. Focus group participants included masons, plumbers, hairdressers, paid agricultural labor, technicians (trained rubber grafters or pesticide applicators for certified cocoa coopertives), charcoal producers, and mechanics. However, almost all of the young men said that the largest part of their income was still earned from agricultural production.

Most of the villages had a few cocoa stores located in the village itself, either operated by private companies or by a registered cooperative, but producers also sold widely to itinerant pisteurs who came to the village at different points throughout the season and purchased cocoa directly from their trucks, paying in cash. Where itinerant pisteurs were present they were described as being too many to enumerate. Producers described how both the itinerant pisteurs and those with stores in the village centers would take their trucks out to the cocoa fields themselves and assist with transport of harvested beans back to the village for fermentation and drying. In this case the farmer was then obliged to sell their beans to the pisteur who had helped them with transport, after the cocoa was done drying. Pisteurs also attracted patronage by offering small cash advances to farmers in need. For the most part farmers who purchased with itinerant pisteurs did not have long-term agreements with any one person, but sold to many different buyers even in the course of one season. Long-term informal agreements based on relationships and trust were more common for the pisteurs based in a given village.

All of the focus group farmers reported receiving the fixed 725 F/kg price in 2012, and most said that they preferred the new fixed-price system to the former liberal system.Their reasons were that the price is higher on average, cheating by buyers is less common, and there are incentives to sell higher quality beans, which they believe will help to raise prices in the future. Only in Krohon did farmers say that the liberal pricing system was better, and that is because last year the price which they received about 900 f/kg, much higher than the average across villages and much closer to the 1000f/kg official government minimum price that year which was widely not respected. This price difference is likely because Krohon is located directly on a major paved road, 70 km from San Pedro, so there is much more competition between buyers for their beans, and a higher flow of information which reduces the possibility of cheating.

4.1.3 Cooperatives

Cocoa cooperatives have been gaining in popularity lately mostly because of the promise of premiums, which seemed to be a universal 50 f per kilogram to the farmers. Some cooperatives provided additional benefits, like subsidized pesticides and fertilizer or sponsoring a local Farmer Field School (FFS). These FFSs are run by ANADER, but financed by cooperatives or other organizations. The V4C project, for example, also sponsors a number of FFSs. In the cases where cooperatives are well-established and headquarted in the village (notably Petit-Bondoukou, Kragui, Raphaelkro, Petit-Bouaké, and Gbletia) many producers are dues paying members, certifications have been in place for several years, and benefits are higher.

In many other villages the producers are aware of cooperatives, and pisteurs working for the cooperatives come to the village to make purchases, but very few locals are dues-paying members. Many just sell to the cooperative without joining, so they receive almost no benefits. In many cases producers reported that they do not join the cooperatives (which entails a commitment to sell) because they have much smaller fleets of trucks and thus are less able to help with transport from the field to village, and because many cooperatives pay for cocoa weeks or even months after initial sale. Pisteurs, especially those working for very large private traitants have the financial backing to come to villages more frequently and to pay cash-on-hand, and thus they tend to outcompete the coopertives.

The most important single traitant in the study area is HKF, a private Lebanese buyer headquarted in Soubré which has begun training and a providing the RA certification to farmers. Many producers actually mistakenly think that HKF is a cooperative. Even many of the officially registered cooperatives in Côte d'Ivoire, certified or not, are actually for-profit companies without producer ownership (made possible because the cooperative law is not very strict), so many farmers do not understand the principles and benefits of genuine cooperatives.

The cooperative in Petit-Bondoukou, which is genuinely owned by the farmers, has been producing high quality cocoa for so long that while most villages reported seeing prices of between 500-700 f/kg in the 2011 season, the price was consistently 800 f/kg or higher in Petit-Bondoukou. This year under the fixed price 725 f/kg the cooperative does not have a pricing advantage as in the past. Nevertheless, even the farmers in Petit-Bondoukou said that preferred the fixed-price system, because it has increased cocoa quality in the country, which they believe with help Côte d'Ivoire to attract a higher world price in the long-run.

4.2 History of Cocoa Yields and Prices

The groups of older male farmers were asked to describe the history of cocoa yields and prices in their village over the past 40-50 years. The history described was much the same across all of the villages. They talked about how in the 1960s and 1970s the government (through Caistab) enforced a single-price system within a given season and provided a number of

supports, including training and supply of cocoa germplasm (through the SATMACI extension organization). Almost all of the farmers talked positively about the support received from SATMACI, and mentioned that they even gave cash prizes to the most successful farmers. After liberalization in the 1990s all that government support disappeared, and for a long period no credit, training, and input support services were available from any institutions. This has begun to change again over the past 2-5 years, as cooperatives financed by the major exporters and ANADER agents supported by V4C or another initiative have increased the availability of training and other services.

Farmers in many of the different villages, when asked about the presence of cooperatives, said that they had a local chapter of the national GVC cooperative in their village from about 1970-1985. These were generally set up by the government to facilitate bulk cocoa sales (so they were not genuine farmer-owned associations), but farmers in the focus groups said that they were generally positive and provided a 55 F/kg bonus at the end of the year to all members. Men in Miangobougou described how their GVC branch fell apart in the late 1980s because of high costs of bringing cocoa to the port. They said that their delivery trucks were forced to wait for days and days near the port and went bankrupt paying for parking there. It is likely that this was during the "cocoa war," though the farmers did not specifically mention this term and weren't even certain which year this occurred.

During the Caistab period prices in nominal terms were lower than currently, starting at 200 F/kg early in the period and rising to 400 F/kg by the late 1970s, but each focus group agreed that these prices were higher than today's prices in terms of purchasing power. In the village of Kipiri, for example, they said that a bag of rice which now costs 19,000 F used to cost 3,500 F. The groups described how prices dropped substantially at the end of the 1980s, to as low as 50 F/kg at one point in 1989 (likely due to the "cocoa war"). Prices from 1990-2011 were highly volatile, shifting between 200-1000 F/kg within a single season, while prices for other goods rose substantially at the same time. Many focus groups mentioned how prices were high during the 2002 season, at about 1000 F/kg, but they have not seen such high prices since that time. Prices were the lowest in recent times in 2011, during the crisis, ranging from 300-650 F/kg.

At the same time, farmers describe dramatic drops in cocoa yields. In the 1960s and 1970s cocoa yields were high, as most of the cocoa was planted on virgin forest land and disease pressure was low. Over time, as cocoa orchards have aged, pest and disease pressures have increased, and soils have become depleted, so the cocoa requires more and more inputs to sustain the same yields. Yields declines have become particularly acute over the past 3-4 years. In some cases farmers say that they have increased input use or tried to replant their cocoa but they even then the cocoa will no longer succeed in their areas.

Meanwhile, inputs, especially fertilizer, are very expensive and there are relatively few support services (no government fertilizer subsidy, few buyers or institutions that will supply inputs on credit, etc.), and many farmers cannot afford them. The combination of lower real

cocoa output prices, the increased need for inputs to counter falling yields, and the higher prices of inputs, means that overall profitability of cocoa has declined substantially. In some villages farmers still think cocoa is profitable, though less than in the past, but in some villages they say that it is no longer profitable at all. In those cases farmers are hoping that rehabilitation or other interventions will return cocoa to profitability, but if this does not occur they are likely to abandon cocoa and switch to a crop like rubber or a locally profitable staple like corn or rice.

4.3 Comparison of cocoa, rubber and oil palm cultivation

Figure 4.1 below shows the disadvantages and advantages identified by farmers in the various focus groups for cultivation of cocoa compared to the two other principal cash crops in the Soubré region. In the regions around the SIPEF-CI palm oil factory farmers identified more benefits of palm oil when compared to cocoa, and the same was the case for rubber throughout the region, but especially in less remote villages. These two crops are preferred by farmers because they require fewer inputs, have higher/more reliable yields per hectare under current conditions, and have highly organized value chains which include reliable, quality input supplies, provision of training and other services, and contract structures with large buyers who pay through bank accounts and thus facilitate loan access.

However, farmers also cited a number of advantages that are unique to cocoa which encourage them to retain the crop despite the perceived benefits of other crops. Farmers have grown cocoa for their entire lives and do not want to give it up, because they are familiar with the crop and know it to have been profitable in the past. Thus, if yield declines can be arrested they will happily continue to cultivate cocoa. Farmers also like the fact that cocoa can be intercropped with food crops (plantains, corn, fruit trees, cassava), and that some profits can generally be earned on cocoa even on a small amount of land.

By contrast, rubber is only profitable if done on a larger scale because of the high costs of paying grafters and tappers, and it has high start-up costs, so it is not accessible to all farmers. Furthermore, adoption of rubber and oil palm cropping is significantly affected by networking affects, so farmers in areas with early adopters are more likely to plant the crop themselves. In villages where no nearby plantations farmers are more hesitant to try out the crop. Thus, if the V4C and other initiative wish to slow the trend of cocoa replacement with rubber they could try to prioritize support for rehabilitation activities in the villages where rubber has already gained a foothold (especially in the villages closer to main roads, and among farmers with larger plots of land).

Table 4.1: Advantages and Disadvantages of Different Cash Crops

	Cocoa	Rubber	Oil Palm
Advantages	*can be intercropped with food crops *familiar, farmers have knowledge and are reticent to eliminate *was profitable in the past, the hope is it could be again *ICRAF and other initiatives are offering support now *those with large cocoa fields an get access to loans *labor intensive, so provides jobs for many people *main harvest corresponds with start of school year, good for paying fees	*can succeed on land where cocoa fails *yields higher than cocoa *high price *monthly harvest, income *paid through bank account, like "functionary," so can get bank loans *harder to steal money earned on for rubber sales *well organized value-chain, a lot of support from buyers *good extension services, frequent visits *1 ha = 1 million CFA revenue/ year (?), equivalent to 10 ha cocoa	*can sell with SIPEF-CI factory or locally *can consume within household as well *many different uses, including making oil, soap, palm wine *more resistant to diseases than cocoa *Those in Ottawa near factory get many benefits: road repair, school construction, bonus payments, input support, bank account payments and loans.
Disadvantages	*yields declining *soil can no longer support high yields, even replanting fails *affected by many diseases *requires many inputs to succeed *poor quality and high prices of inputs on the market *value chain poorly organized with too many intermediaries *labor intensive (which can be a problem where labor is in short supply, expensive) *only 2 major harvests per year, so income irregular	*cannot be intercropped *requires more land (2-3 ha+) to be cost effective *expensive start-up costs (60,000 F/ha) *complicated, can hurt trees if not done well (grafting, tapping) *some villages don't have much information or experience with the crop, as reticent to plant	*cannot be intercropped *must pay for expensive transport to SIPEF-CI factory *requires complex physical work *main services only available in SIPEF-CI area, not elsewhere *some villages don't have much information or experience with the crop, as reticent to plant

4.4 Farmer Future Plans for Cocoa

When asked about their future plans for their cocoa land, farmers in most villages (both with and without CDCs) said that they wanted to continue farming cocoa, but in some areas this was becoming harder and harder. None of the farmers were planning to sell their land, the vast majority said that they wanted to try out either replanting (where trees were dead or diseased) or grafting (where trees were still viable but aging). However, many were still awaiting the results of the ICRAF experiments and said that their decision on rehabilitation depended on the level of support which will be available in the future. A minority (small but vocal) of farmers were planning to cut down all or part of their cocoa to replace with rubber, staple crops like corn or cassava or rice, or palm oil.

Groups in several villages, including Kipiri, Gbiliy, and Krohon (which are all located near major roads or town centers), said that many cocoa farmers in the village have already started to replace their cocoa with rubber, and some of them had been planning to replace all of their cocoa until the arrival of V4C. Information received from ICRAF technicians and preliminary observations of demonstration plots have given them hope that cocoa yield declines can be reversed. Although extension of the rehabilitation services has not yet started, they are now more willing to delay destruction of their cocoa in hopes that they can successfully rehabilitate in the future.

In Kipiri the focus group participants said that community projects sponsored by Mars and implemented in partnership with the community development wing of V4C are encouraging them to be patient, tiding them over as they wait for results of ICRAF's rehabilitation experiments. They know that in order to receive funding and assistance with these project they have to commit to continue growing cocoa, and the promise of projects make cocoa cultivation seem more profitable and worthwhile to them on balance.

In those areas where other cash crops have already gained a foothold most farmers who already have the additional crops, or want to plant them in the future, said that they still did not want to completely eliminate their cocoa crop. Several farmers hope to maintain productive, separate cocoa and rubber plantations, or cocoa and palm oil, or all three crops. In Kipiri the focus group of young men had a long discussion about the possibility of actually intercropping cocoa and rubber, a practice with which several farmers in that area are currently experimenting. It may thus be very fruitful for V4C and other initiatives to encourage complementarity between these crops and perhaps even to fund research on intercropping between them, rather than simply trying to discourage rubber planting.

One young planter in Krohon says that he used proceeds from his 3 ha of rubber to perform an experiment on 1 of his 4 hectares of cocoa. He implemented all the recommended agricultural practices, including high fertilizer, fungicide and pesticide use, for one year to see the effects. He reported that he saw such large yield increases that he completely recouped the inputs costs and made extra profits; now he wants to intensify cultivation on all four of his cocoa hectares. This example could be used as a model to encourage other farmers to invest in their cocoa, perhaps also using money earned from the sale of other cash crops.

4.5 Farmer Identification of Needs and Project Priorities

After discussing the history and problems facing the cocoa industry, the farmers in the focus groups were asked to list suggested projects which they believed would help to overcome these problems and revitalize the cocoa industry. In almost all cases the suggested projects fell into one of five general categories, as outlined in Table 4.1. After the group listed their suggestions I explained these different categories and where their suggestions fit in, and introduced a few extra

project suggestions where they had omitted a given category. Then I asked them to work together to rank the five categories in order of priority, imagining that we might only be able to assist with one or two types of projects. A score was calculated, as shown in Table 4.1, wherein a category received a "5" each time it was ranked as first priority, a "4" if it was ranked as the second priority, etc. and the individual scores in all focus groups were added together.

Table 4.1: Focus Group Rankings of Project Priorities

Project/Intervention Category	Total Score	Number of Top Rankings
Inputs Support Programs: *fertilizer subsidies *input stores in villages *credit structures to finance inputs	61	1st: 10, 2nd: 0
Introduction of New Technologies *grafting *replanting with improved varieties *intercropping methods *research on key yield constraints in each area, best fertilizers, etc.	49	1st: 2, 2nd: 8
Marketing Interventions *creating of more and stronger farmer cooperatives *maintain and increase fixed price *direct contracts between cooperatives and MARS, or at least big exporting companies	36	1st: 0, 2nd: 4
Community Projects *infrastructure, including water pumps, electrification, road repair, school and clinic construction *other production projects besides cocoa, especially rice, vegetable crops, aquaculture, and livestock	33	1st: 2, 2nd: 0
Training in Well-known GAPs *more Farmer Field Schools *extension agents permanently stationed in villages	29	1st: 1, 2nd: 1

Results show that by far the farmers are most interested in input supports. They consider the high cost of inputs, especially fertilizer, to be the major constraint to cocoa yields and profitability. This suggests that if inputs were more affordable (perhaps even provided for free, as is done in Ghana with the CODAPEC spraying program) then farmers would use them much more intensively, which would go a long way to reversing yield declines. The introduction of new technologies, above all the V4C rehabilitation package (grafting or replanting), is the clear second priority for planters. Farmers in the CDC villages have already started to see the effects of replanting and grafting on yields and are very eager to gain access to these technologies,

especially grafting. However, inputs are both a crucial component of these packages and can increase yields of cocoa that is not grafted or replanted (due to lack of resources or another reason) which is why the farmers tended to prioritize inputs over these new technologies.

Market interventions are generally considered to be the third priority, closely followed by community projects. The different groups have very different opinions on these two topics. Some planters were passionate that methods to guarantee reliable, high cocoa prices were one of the top priorities. One farmer in Ottawa argued, and convinced the other group members, that a large, powerful cocoa cooperative union was needed to ensure that prices remain high, and that high prices were the key to profitable cocoa. He also argued that with higher prices the farmers would be able to take care of all the other projects on their own: pay for grafting, inputs, improved varieties, and community projects. Similar ideas came out in several of the other focus groups. Interestingly, those groups which ranked market interventions highly also tended to rank community projects as the lowest priority, accepting the idea that if cocoa was highly profitable again they could easily finance such projects on their own.

Support for community projects is generally the fourth-ranked priority. As previously noted it is very close behind market interventions, but the groups that ranked this highly generally tended to place a lower emphasis on the market factor. A major reason for interest in these projects is because they result in the most immediate, tangible benefit, especially where the V4C project is currently working. Support for inputs, grafting, and other planned interventions have not yet started in any of the CDC villages, but community projects have already started in locations. Thus, producers perceive that these projects are on a shorter time-scale of implementation, and since they want to receive benefits as soon as possible they list these as a high priority. It is worth repeating that one producer in Kipiri made the explicit statement that supporting these community project in the short-term, while promising to help with the (more important but complex) issue of increasing cocoa yields in the future has been a good strategy on the part of the V4C project, because it has kept them interested in the project while waiting for the extension phase of rehabilitation methods.

Training and extension services related to already-known methods (good agricultural practices, pruning, input use, integrated pest control, etc.) were ranked as the last priority not because they are not important, but because such training is already available to many of the communities surveyed. Farmers feel that they already have some idea of what needs to be done to improve yields, but they lack the means (to buy fertilizer, for example) and so assistance with these means needs to come before additional training programs.

4.6 Focus Group Conclusions, Implications for Quantitative Survey

These focus group meetings generated a number of observations and hypotheses to be investigated during quantitative survey phase of this project. Producers universally confirmed that yields of cocoa have dropped over time. Farmers themselves cited input use, especially fertilizer as a key limiting factor affecting yields. Other factors cited were aging trees, the low availability of improved varieties, depleted soils, low shade, and climate change. Our regression analyses will enable us to identify the relative impact of each of these factors on cocoa yields.

While farms did not explicitly cite low prices as a reason for yield declines, they did universally complain about the lower profitability of cocoa over time and they ranked projects to improve prices as the number three priority. This supports our hypothesized link between prices and investment, and thus yields, which we will test empirically. We will also test the impact on prices of marketing structures, many of which came up for discussion in the focus groups. Results showed that the number of cocoa buyers, the relative importance of cocoa, the number and strength of cooperatives, and the average size of fields varied substantially by village, as did prices in 2010 and 2011. This suggests fertile ground for price regression analysis.

The sharp difference which was observed between those villages which preferred the liberalized price system to the 2012 fixed price system (the correlation observed with distance to the paved road) is very interesting. This suggests that in a liberalized market cheating is widespread but most severe in isolated areas, and that the most accessible villages earn the highest prices in such an environment. This observation was a major factor in the choice of the level of village isolation as a key variable in design of the quantitative survey. It is hypothesized that distance of the village to the road will be negatively correlated with average price in 2010 and 2011, though uncorrelated in 2012. Also, we expect that the more remote villages will show an average price increase from 2010 to 2012, while the opposite will be the case in less remote villages.

Results of the focus groups also suggested that the level of farmer investment and their plans for the future of their cocoa depend on the general cocoa price levels in the village, location of the village, availability of services (especially credit), level of means (size of land, other revenue), and exposure to the V4C rehabilitation program. These relationships will also be investigated in the quantitative analysis.

The key results of this section which will not be investigated further are those in Table 4.1. Those results suggest that the best ways to promote cocoa sustainability are first to provide input support to cocoa communities, and second, to spread access to the technologies of grafting and replanting with improved cocoa varieties. All of the projects listed in Table 4.1 were considered important and useful by the producers, but these are the top priorities.

5: QUALITATIVE RESULTS FROM FORMAL SURVEY

This section presents some of the demographic data collected in the survey of the 400 cocoa producers as well as the results of the various qualitative (attitude and motivation) questions.

5.1 Demographics

Figure 5.1 shows the breakdown of the sample by origin. The largest portion (51%) of the sample were allochtone, most of which were Baoule, while 33% were allogene (mostly Burkinabe) and only 16% were autochtone. Figure 5.2 shows the breakdown of the sample by ethnicity, which confirms that the largest group sampled were Baoule and the second largest was Burkinabe. It also shows that among autochtones Bete were the most numerous.

Figure 5.1: Origins of Sampled Households

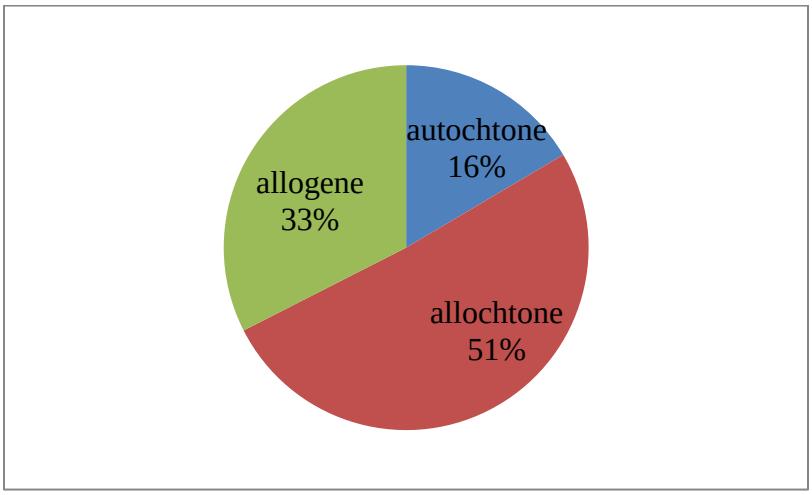


Figure 5.2: Ethnicity of Sampled Households

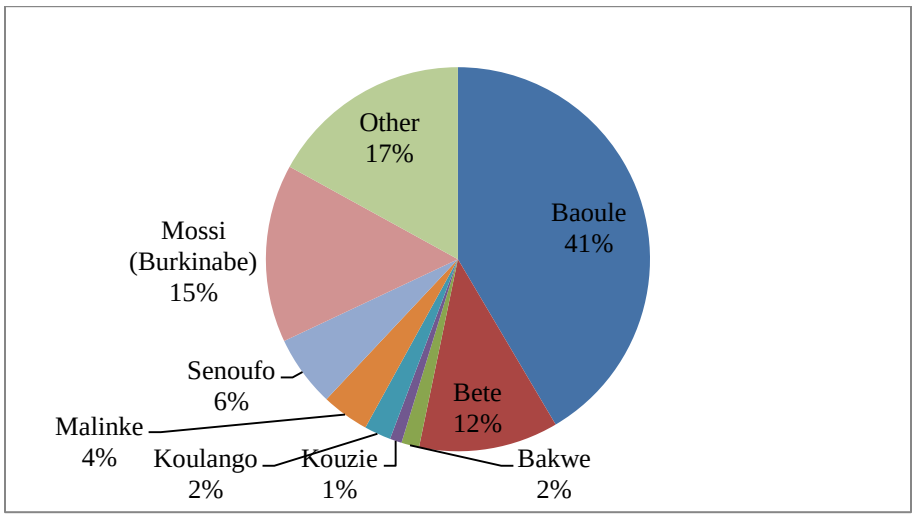


Figure 5.3 shows the breakdown of the sample by nationality. The largest part of the sample is Ivoirian, as one would expect, but a very large number, 24%, are Burkinabe. The only other significant foreign population is Malians, with 7%. Thus, when we talk about the allogene population this is almost synonymous with Burkinabes. Figure 5.4 shows the breakdown of the sample by education level of the household head, which was measured as a categorical variable. The vast majority, 61%, of sampled farmers had received no education, with 22% attended at least some years of primary school, 10% attended lower secondary school, and 5% attended upper secondary school.

Figure 5.3: Nationality of Sampled Households

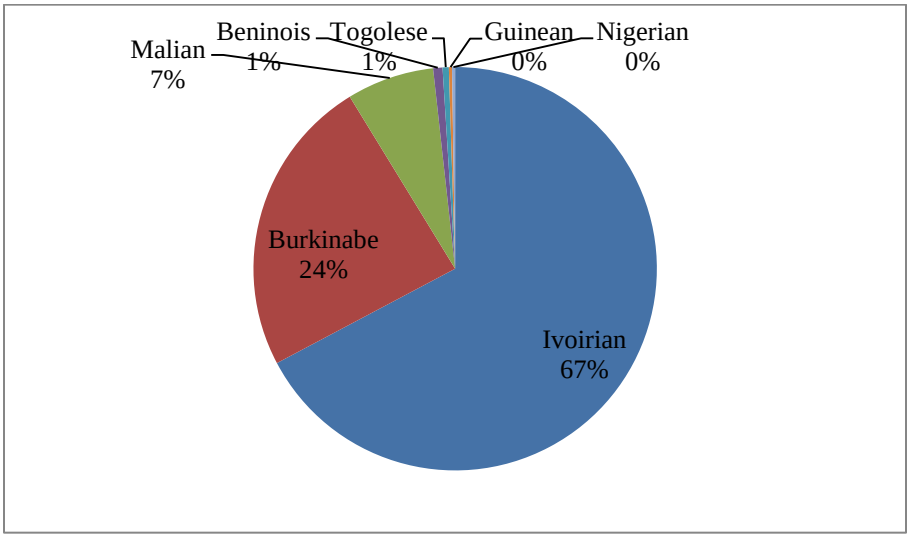
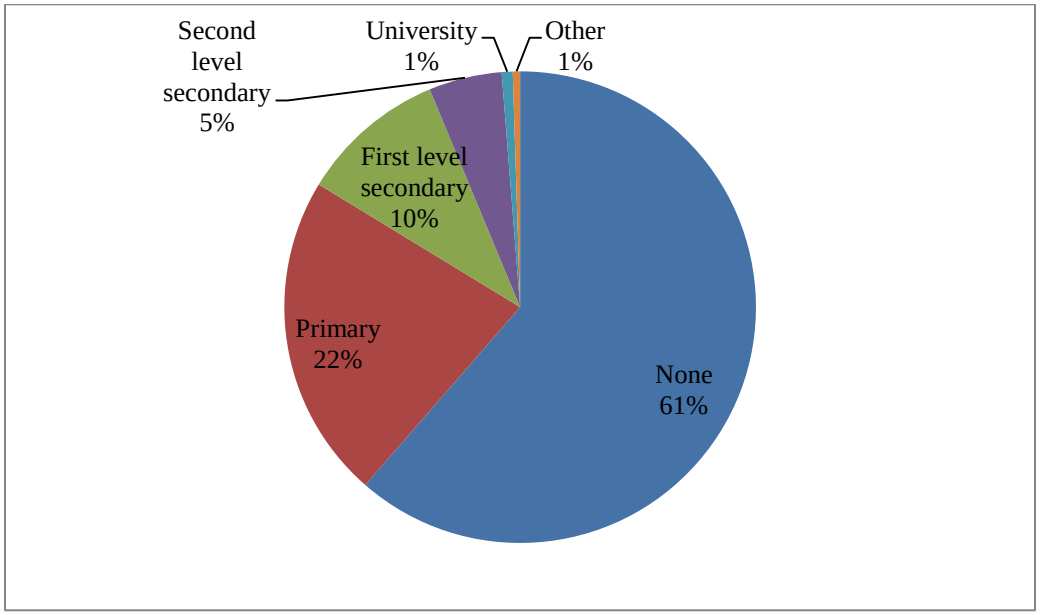


Figure 5.4: Education Level of Household Head for the Sample



5.2 Cooperatives and Extension Services

This section presents the results of qualitative questions about producer associations and extension services. First, those farmers who said that they were not members of a producer cooperative were asked to explain their reasons for not joining. Figure 5.5 displays the results of this question. Respondents could list multiple reasons, so the total of all responses shown in the table is larger than the 228 farmers who were not members. By far the most common reason cited was the lack of a cooperative in the village where the farmer lived. However, this is likely to be overestimate: if cooperatives were set up in those villages, some of these farmers would still not join, for other reasons which they may not have fully considered yet.

The second most common reason for not joining a cooperative was lack of trust. Several farmers said that cooperatives had come to their villages in the past, collected dues while making lots of promises, then cheated people of their money. Others said that they did not trust certain factions within their village and thus could not work together with them in a cooperative. Both of these situations are captured in the same category. Almost 20 farmers reported that they didn't join an association because of the delay between sale and payment, and an equal number said they couldn't sell with a coop because they have a contract with another buyer (most HKF). Unreliable transport by cooperatives, high member fees and lack of eligibility for cooperative membership were not significant reasons for failure to join a cooperative, though observations in during the initial focus group meetings suggested that they might be.

Figure 5.5: Reported Reasons for Not Joining a Cooperative

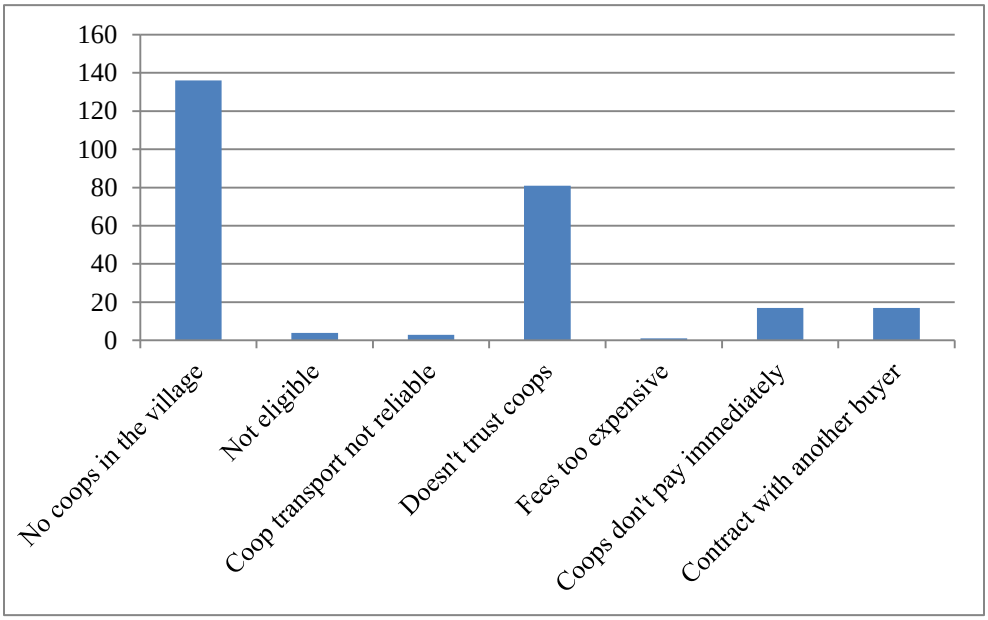
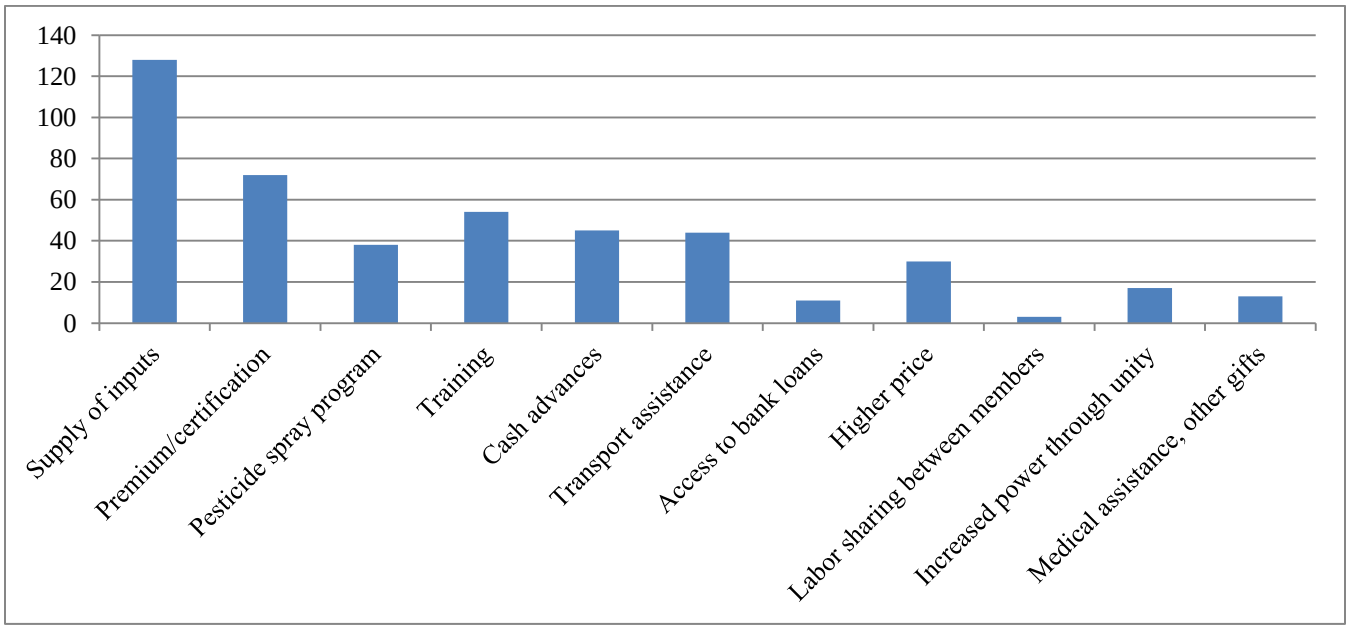


Figure 5.6 shows the benefits of cooperative membership as cited by those who said that they were members. There may be some overlap between this question and the question on

services provided by buyers when that buyer is a cooperative. The difference is that in this question the list of potential benefits was wider than just the provision services, and that this was an open-ended question in which choices were not read to the respondents to prompt them (as was done in the case of buyer and general services to generate a comprehensive list). The choices were not listed for this question in order to get a picture of what the producers consider the most important cooperative benefits.

The most commonly cited benefit was supply of inputs. Other fairly common benefits included provision of a certification premium, training, cash advances, and transport assistance. Only a small number of members said that the cooperative increased producer power via unity, provided access to bank loans, or facilitated labor sharing between members. In fact, because it is not standard for cocoa buyers of any type to pay through bank accounts, as is done in the rubber and palm oil industries, it was somewhat surprising to see that about 10 farmers have been paid by their cooperative through a bank account and thus gained access to credit.

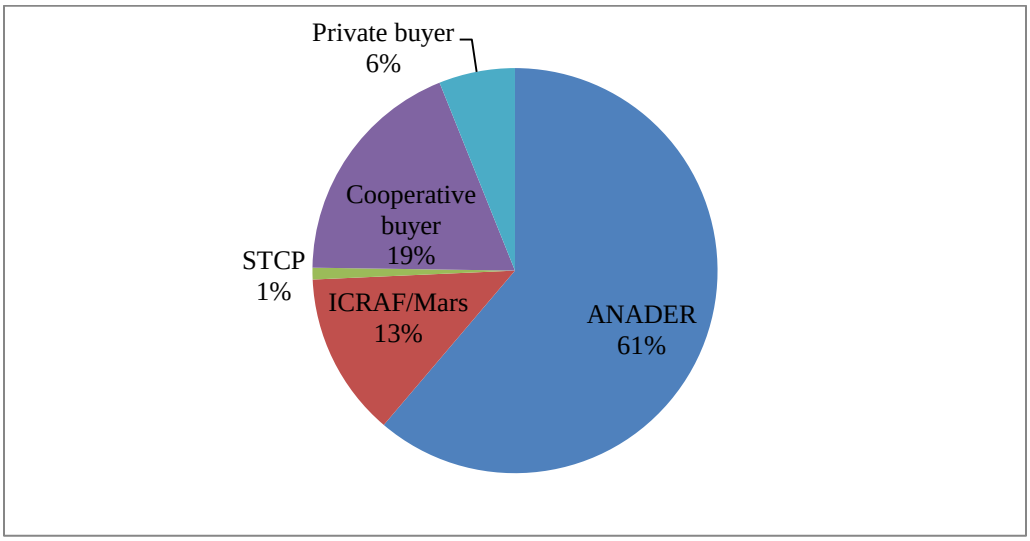
Figure 5.6: Benefits of Cooperative Membership



Another question on the survey asked whether a farmer participated in training or extension services, and if he did, from which organization(s). Figure 5.7 displays the results. ANADER is by far the most common source of training, though interestingly 19% said that the training was provided by their cooperative buyer and 6% from a private buyer. It is possible that some of these trainings were also run by ANADER staff, but were organized and financed by the cited actors. This is very likely the case for those who said ICRAF/Mars ran their trainings, since almost all ICRAF-facilitated trainings are implemented by ANADER partners. Some of the farmers may be those who work directly with ICRAF technicians in CDC maintenance, however,

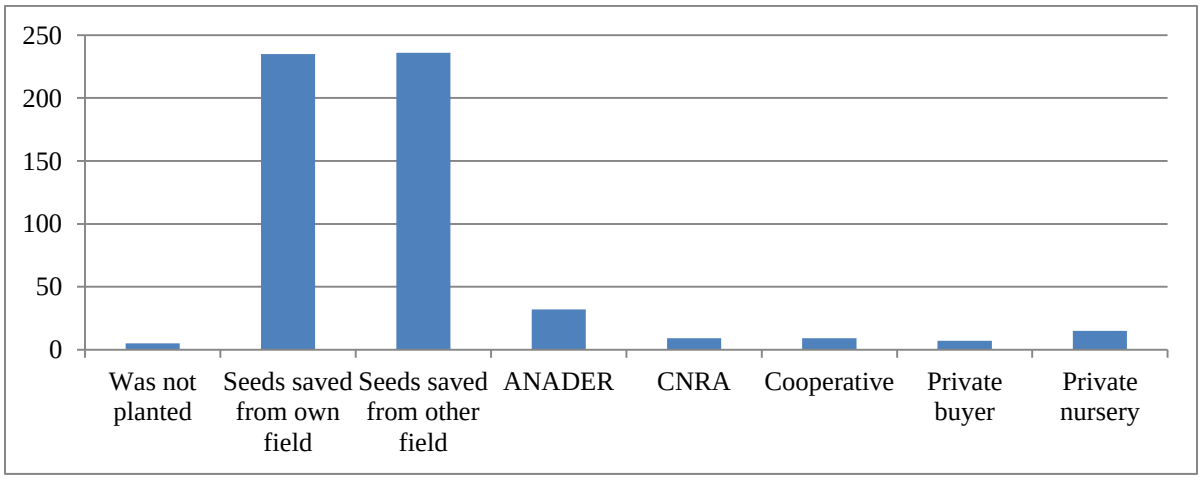
in which case they do receive direct ICRAF extension services. Unfortunately, we cannot distinguish between these two scenarios with the given data.

Figure 5.7: Organization Running Training/Extension Received by Farmers in Sample



Farmers were also asked about the source of any cocoa seeds or seedlings which they used for replanting. Figure 5.8 shows the results. The vast majority said that they used seed saved either from their own field or from a neighboring field, most of which was also acquired for free. About 40 people said that they acquired improved seedlings from ANADER agents, and much smaller numbers bought germplasm from a private nursery, from a buyer, or directly from CNRA. From this data it appears that cooperatives are not any more likely to supply improved seeds to their members that private buyers are to their suppliers, though this could be tested more rigorously. Even if this is true, it might change in the future as the quantity of improved seed available on the market increases.

Figure 5.8: Source of Cocoa Germplasm

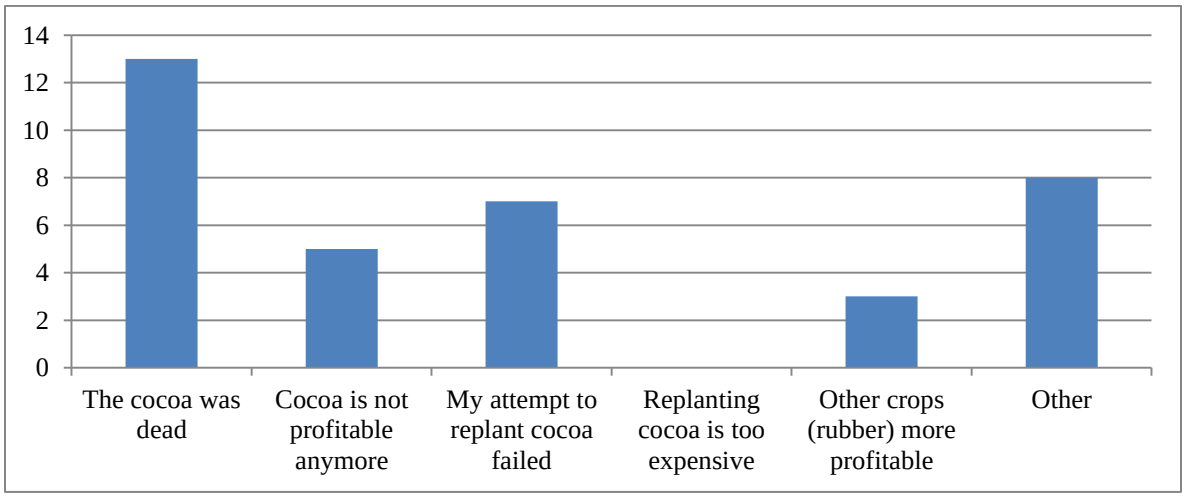


5.3 Farmer Opinions and Future Plans

As one part of the survey farmers were asked a serious of questions about their opinions on certain aspects of the cocoa market as well as their plans regarding the future of their cocoa. The first questions was actually about past practice, but was directly relevant to aggregate future production trends. The question was whether or not the farmer had already cut down a portion of their cocoa to plant another crop. Only 6% of the sample had done so, and almost 100% of those farmers had replaced their cocoa with rubber.

Figure 5.9 shows the reasons which these farmers cited in their decision to replace cocoa with rubber. The main reason cited was "the cocoa was dead," though of course this doesn't elucidate why it could not just be replanted. Unfortunately, follow-up questions were not posed when this response was given. A sizeable number of farmers did specify other reasons for cutting their cocoa, which included the relatively high cost of cocoa maintenance and the presence of CSSV. Seven different farmers said that they initially tried to replant cocoa, but it failed, so they switched to other crops. Interestingly, no farmers said that the expense of replanting cocoa was a factor, possibly because planting rubber is even more expensive. In fact, it is likely that wealthier farmers are the first to replace some cocoa with rubber, because they can afford the investment.

Figure 5.9: Reasons for Cutting down Cocoa and Replacing with Another Crop



Farmers were also asked whether they plan to keep 100% of their current cocoa land under cocoa cultivation in the next decade. Then, all respondents were asked a follow-up question on the reasons why they did or did not plan to keep 100% of their cocoa. Figure 5.10 and Figure 5.11 show the results. By far the highest number of farmers said that they planned to keep all their cocoa land (84%) and the main reason was because the crop is still profitable. They are familiar with cocoa and have been earning their livelihoods from it for so long that they will continue to farm it as long as they feel they are earning some profits, as opposed to venturing into unfamiliar, potentially risky crops.

Figure 5.10: Why planning to keep all current cocoa area under cocoa in future

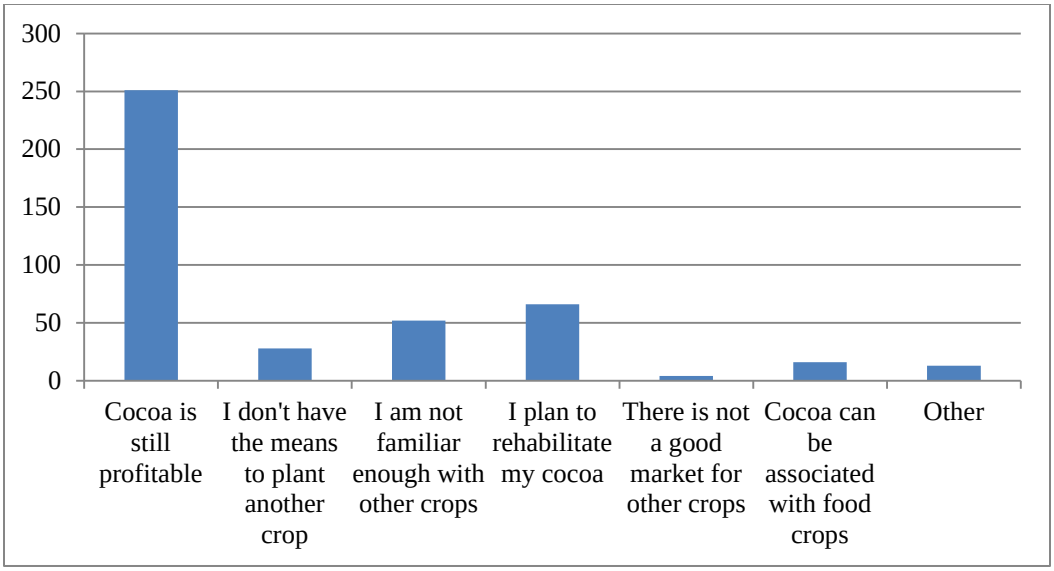
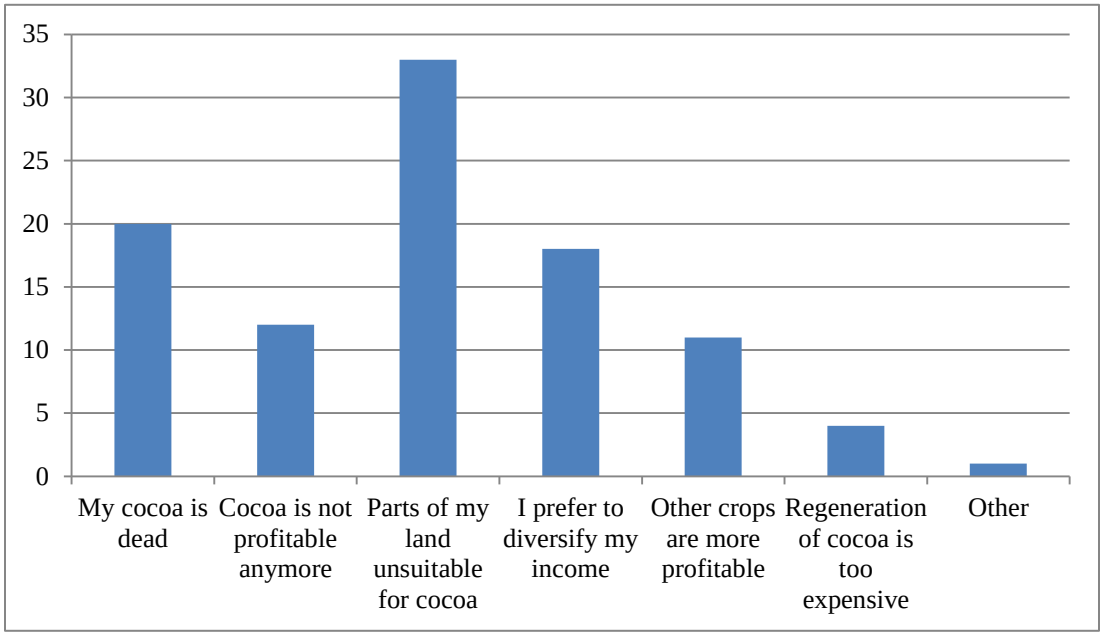


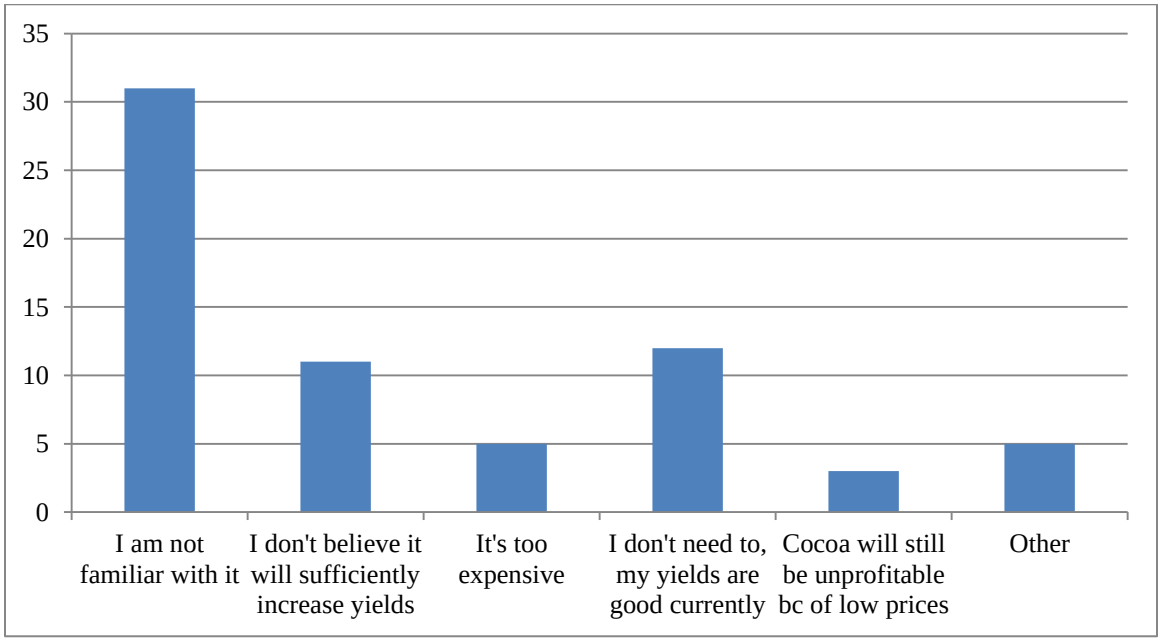
Figure 5.11: Why not planning to keep all current cocoa area under cocoa in future



Far fewer farmers (16%) plan to replace at least a portion of their cocoa in the future, and among those planning to do so the main reason cited was that certain portions of the land are not suitable for cocoa. Twenty farmers said it was because “my cocoa is dead” without going into more detail about why they would not replant. A significant portion of farmers mentioned the desire to diversify their income, and the relatively low profitability of cocoa was another key factor.

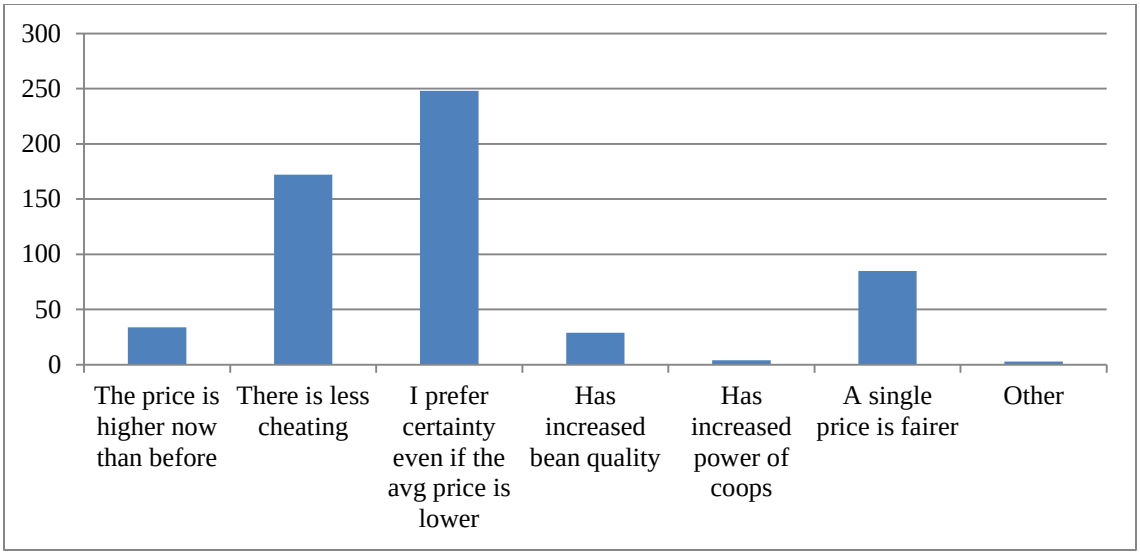
In the survey, farmers were also asked specifically whether they planned to rehabilitate part of all of their cocoa land in the future. Approximately 84% reported that they planned to do so. Those 16% that said they were not planning to rehabilitate were asked to explain why, and Figure 5.12 shows the results. The primary reported reason was lack of awareness of rehabilitation. This is encouraging, since it suggests that spreading information about rehabilitation might increase the likelihood of future adoption. However, about 36% of the farmers shown in Figure 5.12 were aware of rehabilitation and were skeptical of its benefits, either because they felt it would not help to increase yields adequately or because market factors (low cocoa prices, high input prices) would still pose a significant problem. Thus, spreading awareness of rehabilitation might not be enough to induce widespread adoption.

Figure 5.12: Why not planning to do cocoa rehabilitation



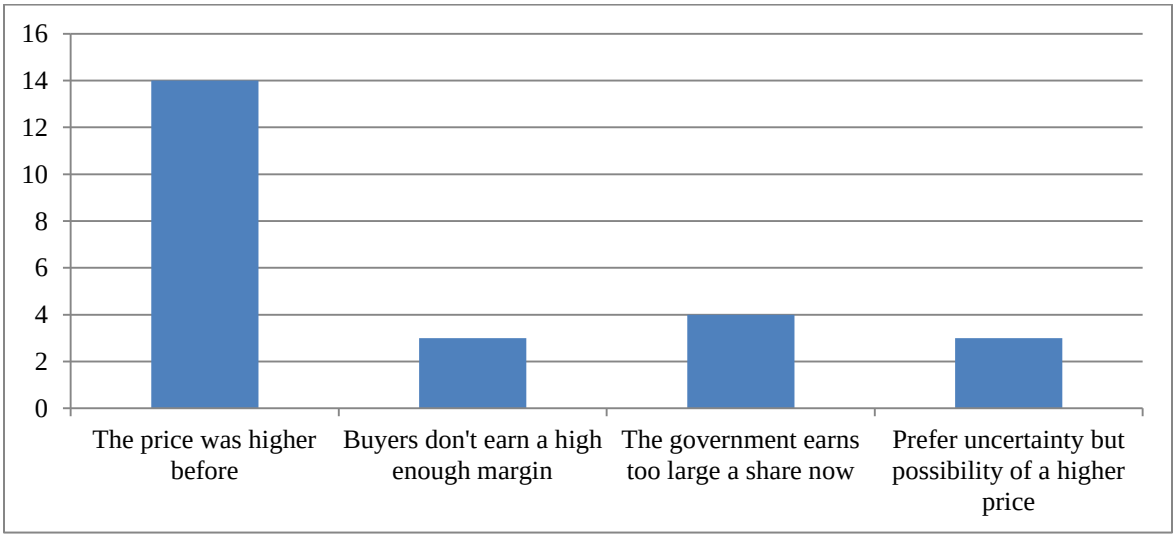
Farmers were also asked about their opinions of the 2012 price reforms. About 96% of respondents preferred the new, fixed price system over the liberalized price system. Figure 5.13 shows the reasons cited for preferring the fixed price system. Figure 5.14 shows the reasons cited by the 4% of farmers in the sample who preferred the old system. By far the main reason why farmers prefer the fixed price is the security of knowing what the price will be all season even if the average price is lower. A large number of farmers also said that they prefer the fixed price system because it leadsto less cheating by buyers, and that in general a system in which all farmers earn the same price is fairer. A relatively small number said they prefer the system because the average price is higher now their area or that it has increased bean quality (though this is a widely cited motivation for the reforms).

Figure 5.13: Reasons why farmers prefer the new, fixed cocoa price system



Among the 4% of farmers who preferred the old price system, the major reason was that they earned higher prices under the old system. Some also feel that the system disadvantages buyers too much (these people may be cooperative leaders or local pisteurs, in addition to farmers) or perceive that now the government earns a higher portion of cocoa revenues, which is unfair.

Figure 5.14: Reasons why farmers prefer the old, liberalized price system

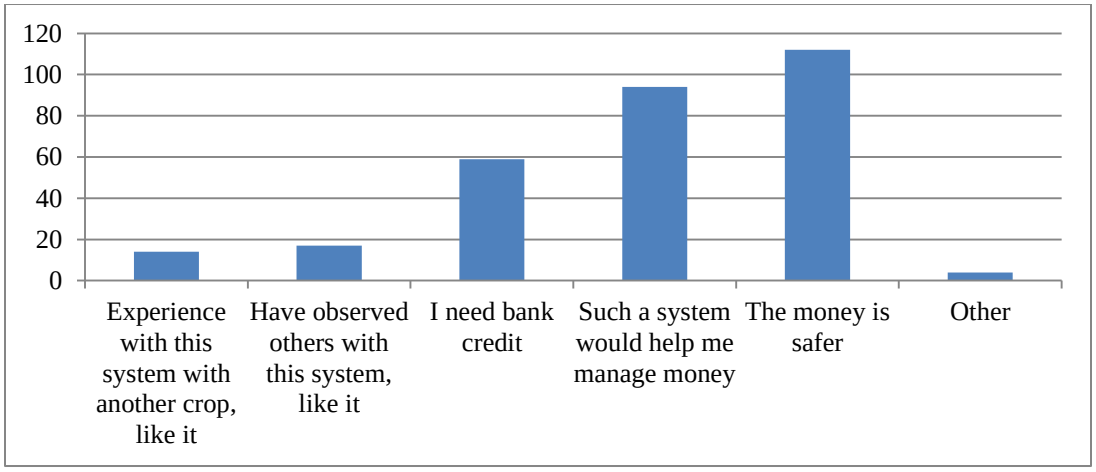


Farmers were also asked whether they would be interested in a system in which buyers paid them via bank accounts, as is done in the rubber and palm oil industries, instead of in cash. In these cases farmers set up an account with a microfinance organization and because of the regularity of payments into their bank account, which serves as a sort of guarantee, they can take loans of up to two times the amount of money in their account immediately and of up to 5 times the amount within a few months (Diby 2012). The interest rate is 10% and the repayment period

is one year. Individuals who open accounts and are not paid regularly by one of these industries can also get loans, but they can never receive more than two times the amount in their account, they must wait for longer periods, and their receipt of such loans is less certain.

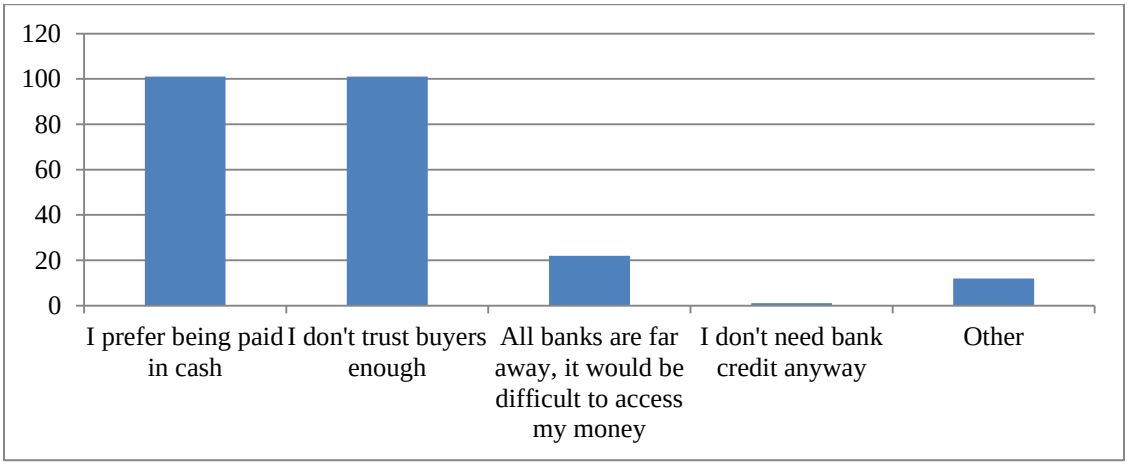
Surprisingly (based on an expectation that farmers always prefer cash, as seen in past research in Ghana), over half of farmers (54%) said that they would prefer to be paid via direct deposit into a bank account. Figure 5.15 shows the reasons cited for this preference, and Figure 5.16 shows the reasons cited for farmers who did not want to be paid through a bank account.

Figure 5.15: Reasons why farmers want to be paid via bank accounts



The primary reason for the interest in bank accounts is a perceived increase in security of money. A large number of respondents also thought that it would help them to better manage their money across the year. We expected that the desire for bank credit would be the primary motivation for preferring this system, and that experience or observation of its use in the rubber and palm industries would increase interest, but these reasons were cited by only 20% and 11% of respondents, respectively.

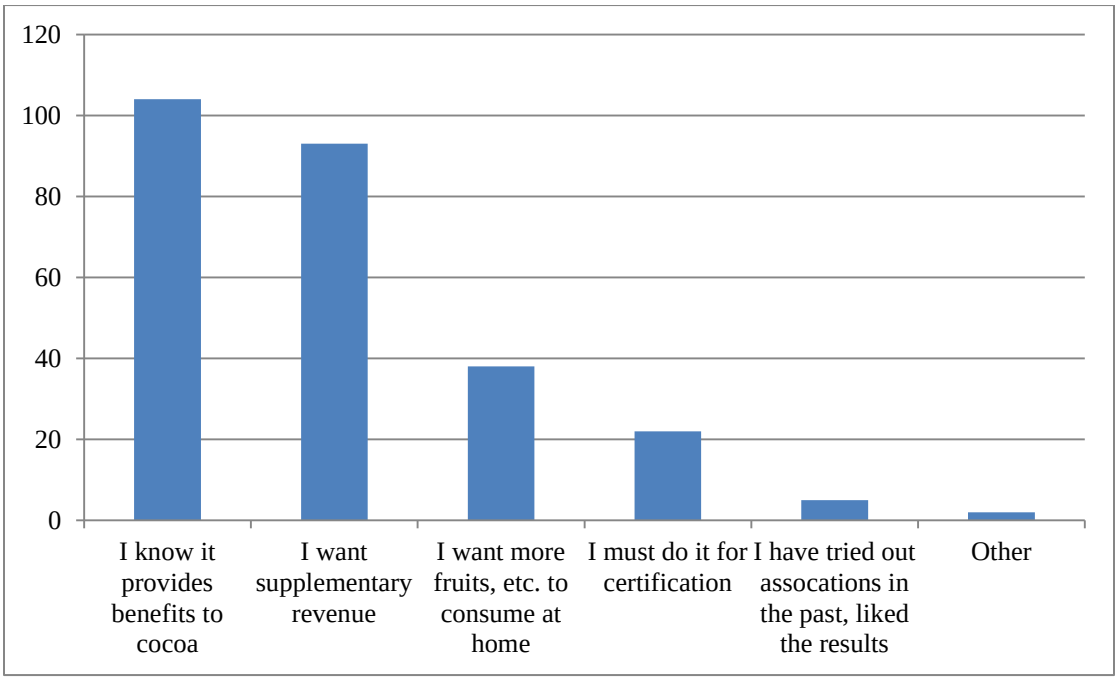
Figure 5.16: Reasons why farmers do not want to be paid via bank accounts



Among those who did not want to be paid via bank account, an equal number of farmers cited their preference for cash and the fact that they do not trust the cocoa buyers enough to accept that form of payment. Interestingly, a relatively low number of farmers cited the distance of banks from their villages as a major obstacle, perhaps because of the ability to link a bank account to an Orange Money (or similar) account to access and manage money via cell phone. A priori it was expected that this would be a major constraint, so it is encouraging that in fact it is not. In fact 24% of sampled farmers already reported having a bank account (though none were paid for their cocoa that way), even some of those farmers live in the more remote villages.

Finally, farmers were asked about their intention to plant more alternative tree species in their cocoa orchards in the future. Promotion of such intercropping is one priority of ICRAF and is also one goal of certification programs and of ANADER extension agents, because intercropping has been shown to increase the long-term sustainability of the cocoa system. About 51% of farmers in the sample said that they planned to intercrop more trees in the future, for the reasons listed in Figure 5.16. The reasons why farmers were not planning to intercrop more trees in the future (49% of the sample) are shown in Figure 5.17.

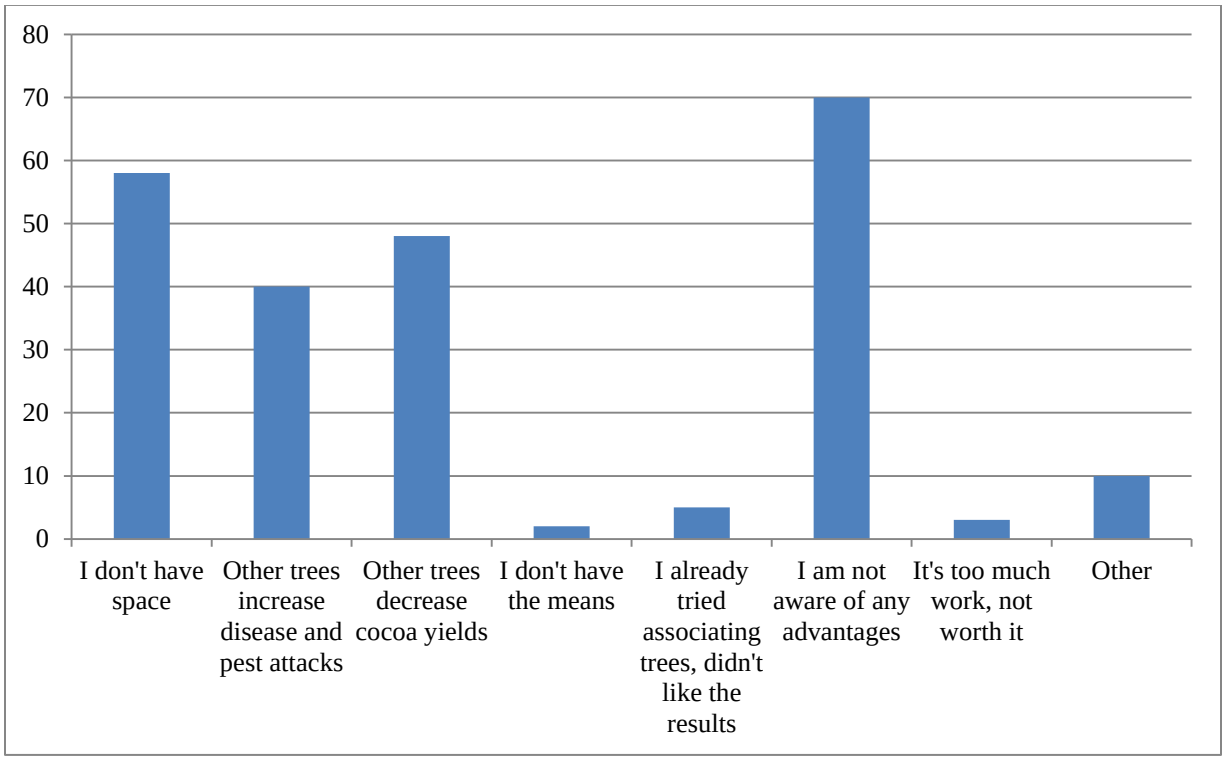
Figure 5.17: Why planning to intercrop other trees with cocoa in the future



The top two reasons for interest in intercropping were: awareness of benefits to cocoa, likely due to past trainings, and desire to earn supplementary revenue by intercropping with another economic crop. Though proportionally less important, several farmers also said that they want to intercrop in order to have more products for household consumption, and other said they are required to intercrop as part of their cocoa certification program.

The top reason cited by farmers not planning to intercrop in the future was that they were not aware of any advantages of intercropping, likely because they had never received training on the topic. The three other major reasons reported were: lack of space, a belief that intercropping decreases cocoa yields, and a belief that intercropping increases diseases and pest attacks. There are indeed some tree species that can harm cocoa if intercropped, and so these farmers may have first-hand experience with such species. However, it is now widely believed by most researchers that intercropping with the best species and with the optimal spacing will help cocoa, so the farmer beliefs shown in Figure 5.18 may be a lingering consequence of the misinformation disseminated in the past by the SATMACI extension service, which said that cocoa should be grown in full sun. New training programs to explain how intercropping can be done right and improve long-term cocoa yields should thus have a major impact on the 49% of farmers who are currently predisposed against intercropping.

Figure 5.18: Why not planning to intercrop other trees with cocoa in the future



5.4 Summary and Conclusions

These results lead to a number of conclusions which are relevant for the cocoa market and V4C operations in and of themselves, and also several conclusions which can be used to further define the empirical models which will be used in the subsequent sections of this report.

First, the fact that 51% of the sample is allochtone (41% Baoule), 33% allogene (24% Burkinabe) and only 16% autochtone (12% Bete) indicates that autochtone cocoa farmers are

less numerous in the Soubré region. If efforts are targeted at separate ethnic groups then the most fruitful groups to target (in order to reach more farmers) are in fact Baoule and Burkinabe populations. Also, in terms of the regression analysis which will be performed the origin variable can be used in place of ethnicity and nationality because it generally is a proxy for the three dominant groups. Second, the fact that 61% of the population received no education and there are relatively few producers among each of the separate remaining levels suggests that perhaps the best way to include education in regressions is as a dummy variable, with 1= education of some type and 0 = no education.

Results on cocoa cooperatives in this section confirm the observations from the focus groups that many people do not join cooperatives because of a lack of trust. The primary reason for not joining a cooperative, however, was because no cooperative was present in the village. This section does not indicate the reasons behind the absence of cooperatives in a village, though this could be investigated empirically using logit regression analysis. Cooperative members cited a myriad of benefits of membership, which suggests that members may receive higher services than non-members received from their buyers (whether cooperative or private). This will also be tested further, in Section 8.

Information on the organizations providing extension services show than ANADER is the primary source of these services. But it also suggests that private and cooperative buyers both play a role in providing extension, the latter more than the former. Results also show that relatively few planters use improved seeds, which was expected given past studies of Côte d'Ivoire. Unfortunately, this means that there is little variation on this factor in the data, so in yield regressions improved variety may not appear statistically significant, even though it is a key factor affecting yields in reality.

With regard to farmer attitudes and plans, results show than only a small group of farmers has already cut their cocoa to replace it with another crop or intend to do so in the future, and that most are interested in rehabilitating their cocoa plantations in the future. Those farmers who have chosen to cut down and replace cocoa seem to be driven more by "push" factors (poor cocoa yields and dying cocoa), instead of "pull" factors (high rubber profits and appealing aspects of this industry). This should be encouraging to the V4C project, since it shows that the best way to maintain cocoa area is to find and disseminate methods to increase yields, as is the current V4C project plan.

However, the proponents of cocoa should not be lulled into a false sense of security. Adoption of rubber seems to be affected by income level and proximity to other rubber planters, and thus adoption may increase as social networks spread awareness of the crop and incomes improve. It is possible that rubber adoption in the country is in its early stages and, following the traditional S-curve, will soon enter a period of exponential increase. Whatever the case, rather than trying to avert rubber adoption the V4C project could try to encourage (and perhaps even

support) farmers to adopt rubber, but only on a portion of their land and in a way that is economically complimentary to cocoa production.

Results show that rehabilitation technologies are in high demand, and the primary reason for lack of interest in rehabilitation is lack of awareness, with as more trainings and demonstrations are provided we would expect even more farmers to become interested. However, intention to adopt and actual adoption is not the same thing, so it is crucial for V4C to follow-up with interested farmers by making grafting, improved germplasm, fertilizer and other inputs widely available and affordable. The goal of the CVC model is to do just that, but these findings confirm just how crucial this mission is.

Further results show that 96% of the sample prefers the 2012 fixed price system, primarily because they prefer to have price certainty and feel that it has decreased cheating. Both of these factors allow farmers to make investments in inputs with less risk and thus could have an impact on yields in the following year, though this cannot be investigated with the current data. The 4% of the sample which preferred the old system mostly did so because they earned a higher price previously, which confirms the hypothesis generated from the focus groups. It simply remains to be seen in the empirical model whether the level of isolation of the village affects the price level in 2010-2011. Overall, this suggests that the 2012 reforms had generally positive effects on the welfare of the majority of farmers and that the system should be maintained in the future, though of course the fixed price level should be increased each year.

Half the sample liked the idea of being paid for cocoa via bank accounts, because this would increase the security of their money and help them to manage their finances. It would also increase access to bank credit, which would facilitate investments in inputs and could thus have a positive impact on yields. Credit is always one of the most limiting factors in agricultural contexts, but the successful examples of the rubber and oil palm industries have shown that payment through bank accounts can overcome credit limit problems. V4C has no component to promote payment through bank accounts, but it could consider adding this to their program in the future. Many of the 46% of farmers who did not want to be paid via bank account said that they did not trust their buyers. If V4C helped to established direct contracts between farmer cooperatives and large export companies (or even Mars itself) then this would overcome issues of farmer distrust of pisteurs and could create a structure much like that in the rubber industry.

The results on intercropping show that training has a significant effect on farmer attitudes and plans to adopt this method (and agricultural methods more generally). Revenue and household consumption considerations were also important, suggesting that as intercropping is promoted an emphasis should be places on species with economically viable products. As V4C widens its emphasis on intercropping it ought to do more research into and promotion of these types of species.

6: QUANTITATIVE RESULTS: TIME TRENDS

This section investigates changes in various cocoa marketing variables over the past three years, from 2010-2012, in order to determine if the 2012 market reforms have had the expected results. Based on qualitative observations and the goals of the reforms, we expect to see a drop in yields, a decrease in price volatility combined with an increase in average price, an increase in cooperative market share, an increase in buyer services, an increase in certified farmers, and an increase in bean quality in 2012.

6.1 Production and Price Trends

Figure 6.1 below shows that total production per farm household has declined steadily over the past three years, and so have yields. The former declined by 26.7% and the latter by 24.6%. Yields were calculated by dividing reported production by mature acres of cocoa in the given year. Farmers were only asked to report current farmed land, but they also reported the years that their cocoa was planted by parcel, and this was used to calculate the mature area for each year. Cocoa area calculated in this way may have errors; for example if a farmer purchased land between 2010 and 2012 this will not be reflected. Thus, the yield trend over time shown in Figure 6.1 is not wholly accurate, but it gives a good general idea.

Figure 6.1: Cocoa Production and Yields, Over Time

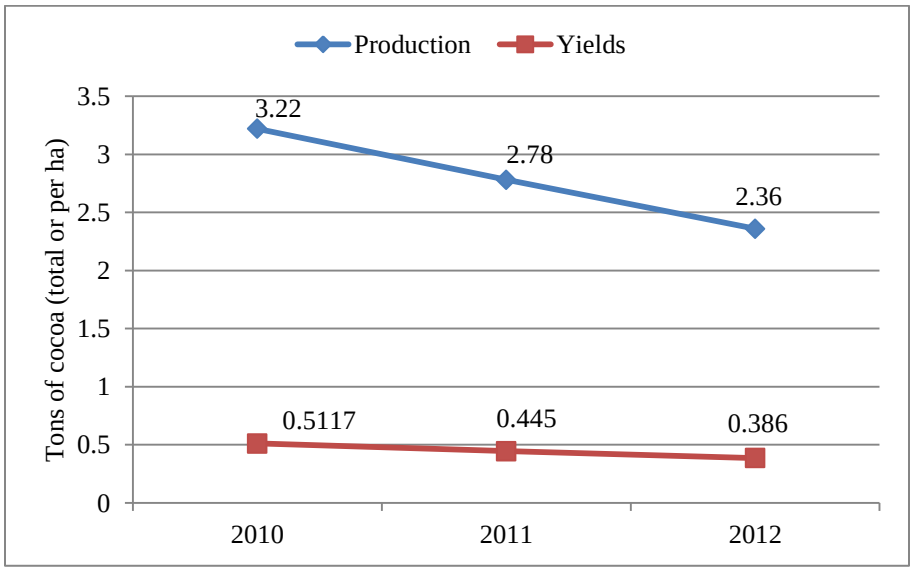


Figure 6.2 shows the average minimum and maximum cocoa prices in the sample plotted over time. The largest gap between the two prices was in 2010 (192 F/kg). Both the minimum and maximum prices dropped in 2011, in large part due to the political crisis, though the gap between them reduced somewhat (165 F/kg). In 2012 there was a dramatic difference, with the

minimum and maximum prices both equal to 725 F. This represented a dramatic increase in the minimum price with regard to both 2010 (by 22%) and 2011 (by 33%). It represented a slight increase with regard to maximum price in 2011 (by 2%), but a decrease with regard to the maximum price in 2010 (by 8%). Figure 6.3 presents the same data but divided by level of isolation (distance from the nearest paved road). The trends are roughly the same for all the different isolation levels, except at the degree to which the maximum price in 2012 exceeds that in 2012 is less for the most isolated villages and the drop in the minimum price in 2011 was the least dramatic for the most isolated villages.

Figure 6.2: Minimum and Maximum Cocoa Prices, Over Time

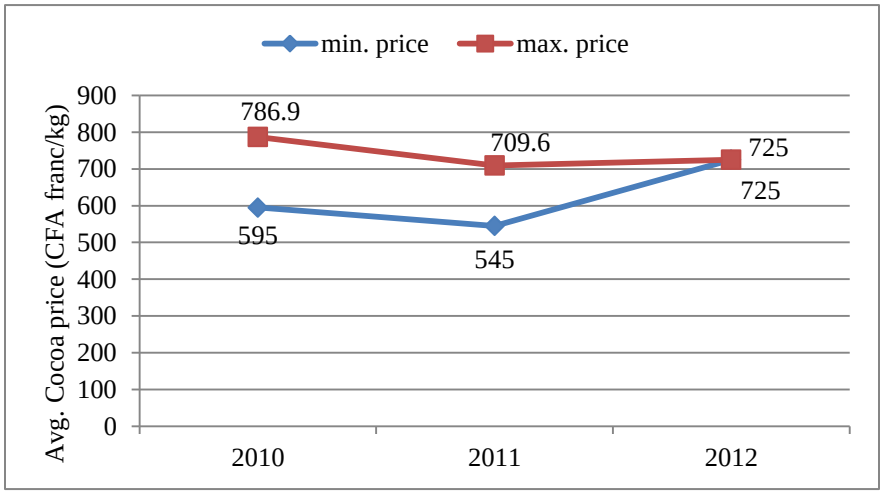
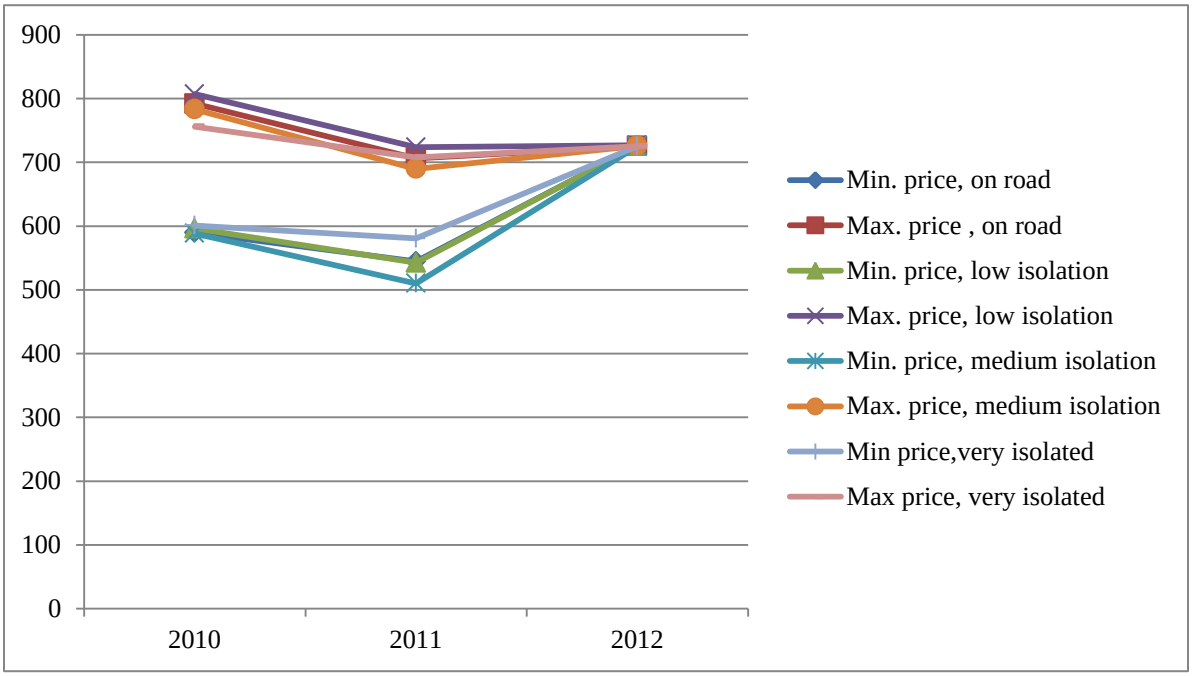
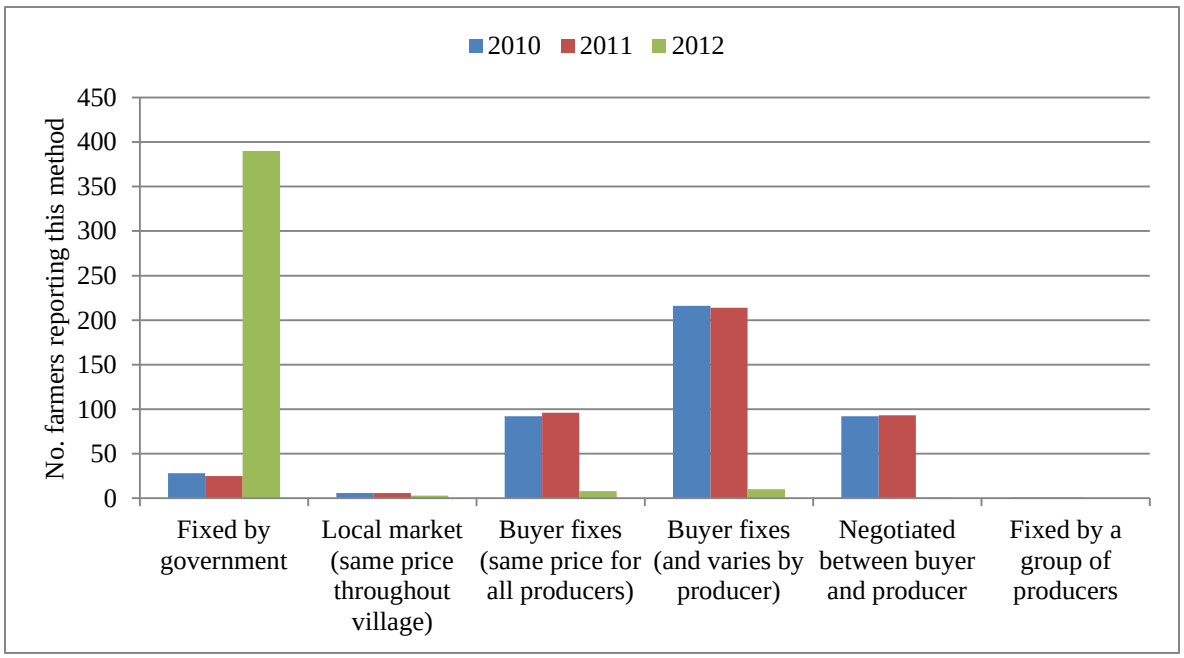


Figure 6.3: Min. and Max. Prices by Village Level of Isolation, Over Time



Farmers were also asked how cocoa prices were determined in each of the three years of study. Figure 6.4 shows their responses and indicates that prices were determined in much the same ways in 2010 and 2011, mostly by buyers. In the majority of cases those buyers had so much market power that they could pay a different price to producer even within the same village. A smaller number of farmers said the price was negotiated between buyers and sellers, and a very small number said it was fixed by the government (nominally there was always a set government price, but it was not enforced). In 2012 almost 100% of the sample said that prices were fixed by the government. Together with the price data, this shows that the 2012 price reforms are being strictly enforced and have had a major impact on the market.

Figure 6.4: How Cocoa Prices Determined in Different Years



6.2 Trends in Buyers and Buyer Services

Figure 6.5 shows the types of buyers with which farmers sold their cocoa in the different years. As in Figure 6.4, we see very small differences in the responses between 2010 and 2011, but several significant differences between those years and 2012. Though pisteurs based in the village and itinerant pisteurs are still the top two types of buyers in 2012, the proportion of producers who sold to both those groups dropped by a sizeable margin in 2012. At the same time those selling with cooperatives based in the village or elsewhere, and those selling directly with a large traitant increased significantly. This is very likely a result of the reforms, and may indicate that the Conseil du Café-Cacao strategy of driving some of the intermediaries from the market by reducing their potential profits has succeeded. These findings also seem to support the argument that the reforms are helping to boost cooperative market share.

Figure 6.5: Cocoa Buyer Type in Different Years

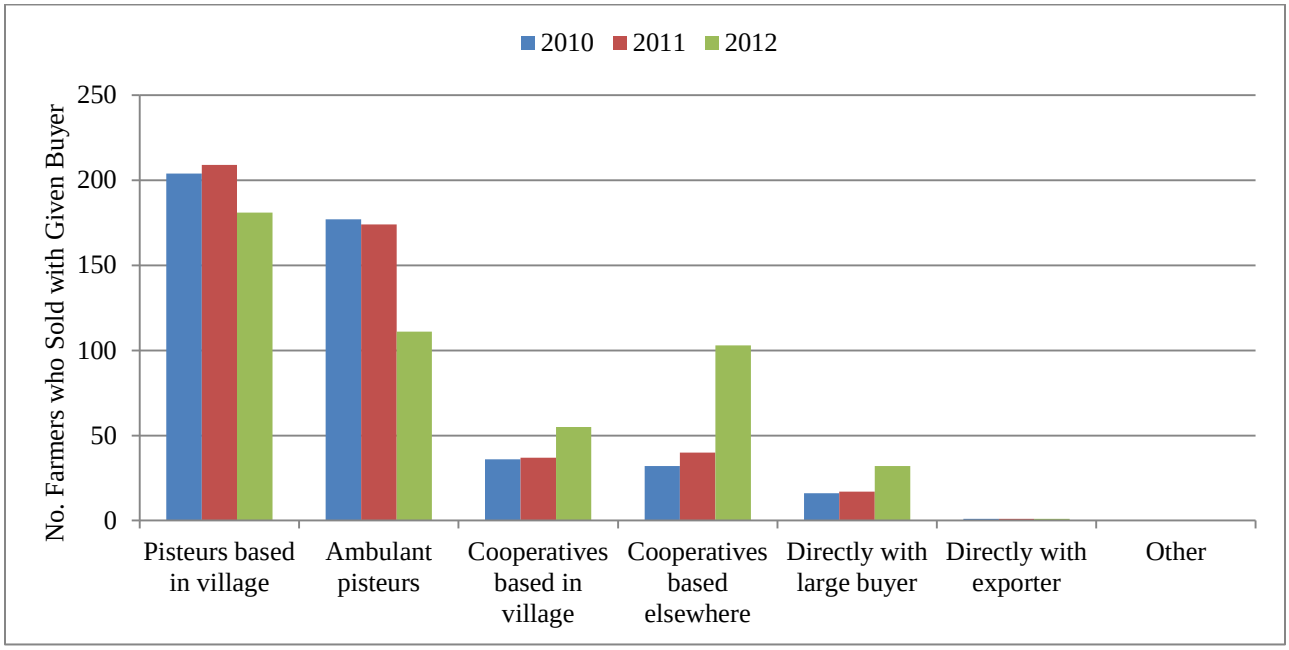
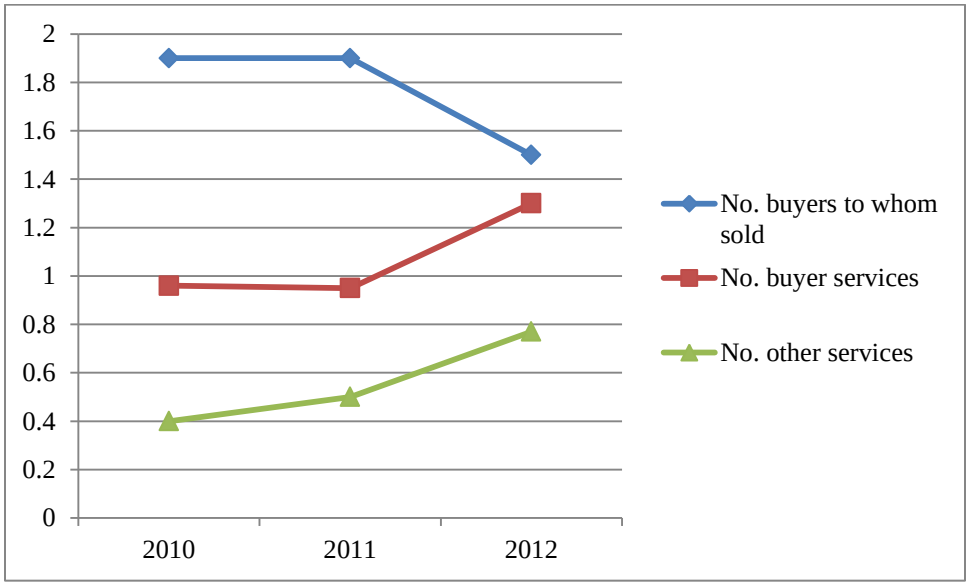


Figure 6.6 shows the average number of different buyers with which producers sold their cocoa in a given season, as well as the average total number of services that they received from these buyers and from other sources (the government, NGOs, etc.). The results show that in 2010 and 2011 farmers generally sold with two different buyers and received only one service, but in 2012 a large number of farmers reduced the number of buyers with whom they sold, and those buyers provided a higher number of services.

Figure 6.6: Average Number of Buyers and Number of Services Provided in Different Years



This seems to support the hypothesis that when there are fewer buyers in a market and producers have higher loyalty to a single buyer they are more likely to provide more services. Interestingly, services from other sources increased both in 2011 and in even more so in 2012, though the overall level was lower than for buyer services in both years.

Figure 6.7 shows the specific buyer services which farmers reported receiving in the three different years. Receipt of all the different services was much the same between 2010 and 2011 then increased significantly in 2012. The increase was most dramatic for input assistance and the second most dramatic for training. Assistance with transport from the fields to the village was the most common service provided across all three year, but there was only a proportionately small increase in this service in 2012.

Figure 6.7: Buyer Services Received in Different Years

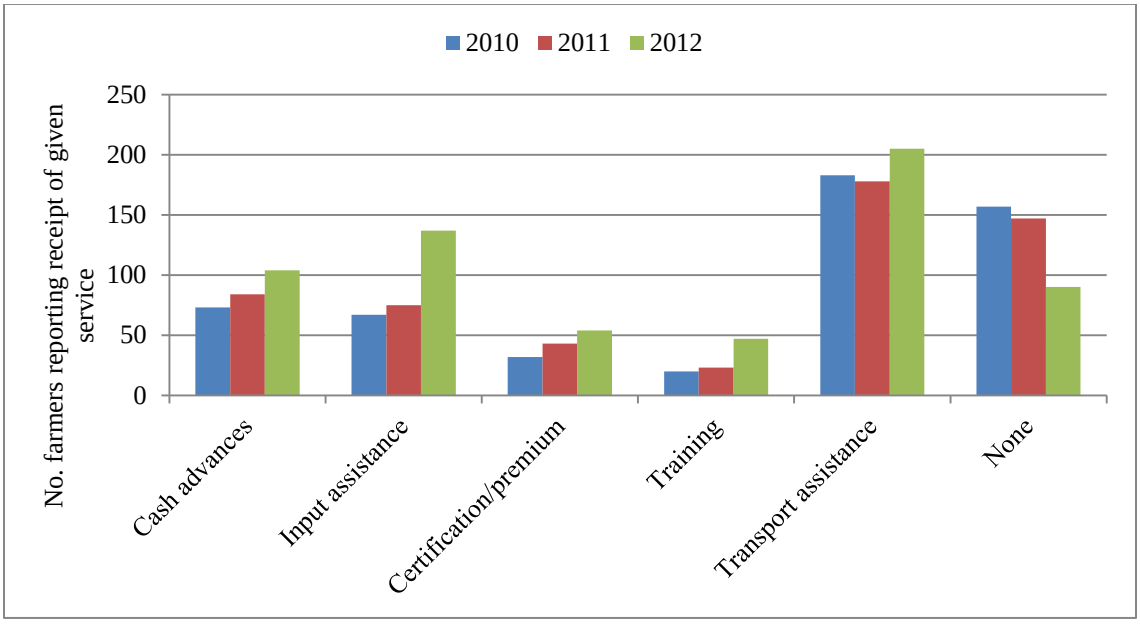


Figure 6.8 shows the reasons which farmers listed for choosing the particular buyer(s) to whom they sold in a given year. There are clear trends in these different motivations over time. In 2012 the number of buyers chosen because they provided the best services increased dramatically and became the most important reason for buyer choice. With each year the proximity of the buyer became a less important factor, and of course earning the highest price was less of a consideration in 2012 since almost all buyers paid the same 725 F/kg. The graph also shows that in 2012 a slightly larger number of farmers chose buyers in order to earn premiums and because they had signed formal contracts with their buyer.

Figure 6.9 shows the services received by farmers from sources other than buyers over the period. Results show a notable increase in road repair and community projects, largely reflecting activities of the ICRAF community development program but also road repair efforts

by the Conseil du Café-Cacao. Training from other sources, probably ANADER FFSs sponsored by an organization other than a buyer, have also increased slightly over time.

Figure 6.8: Reasons by Buyers Chosen in Different Years

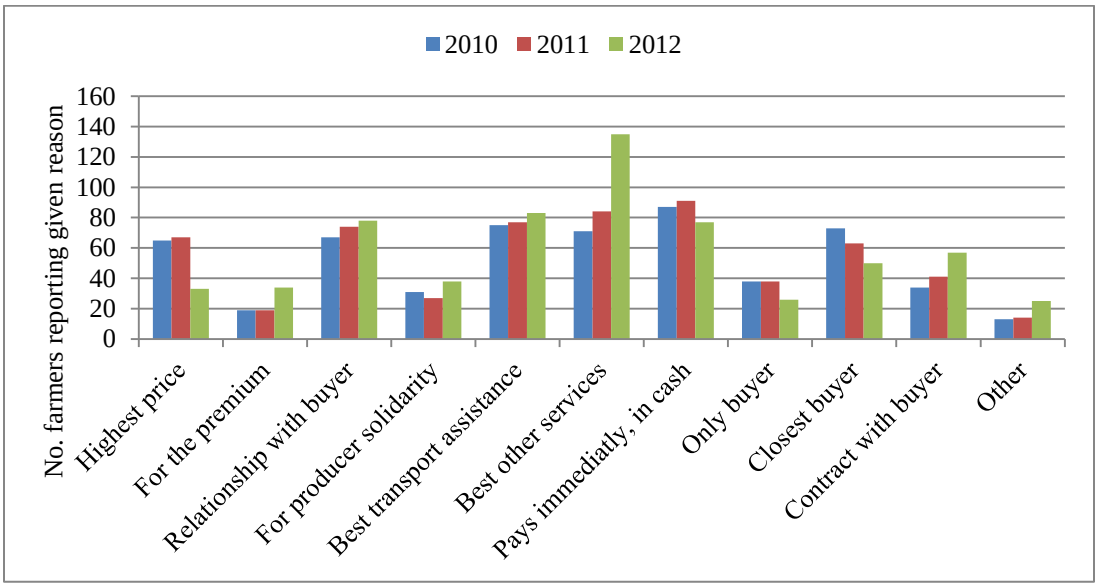
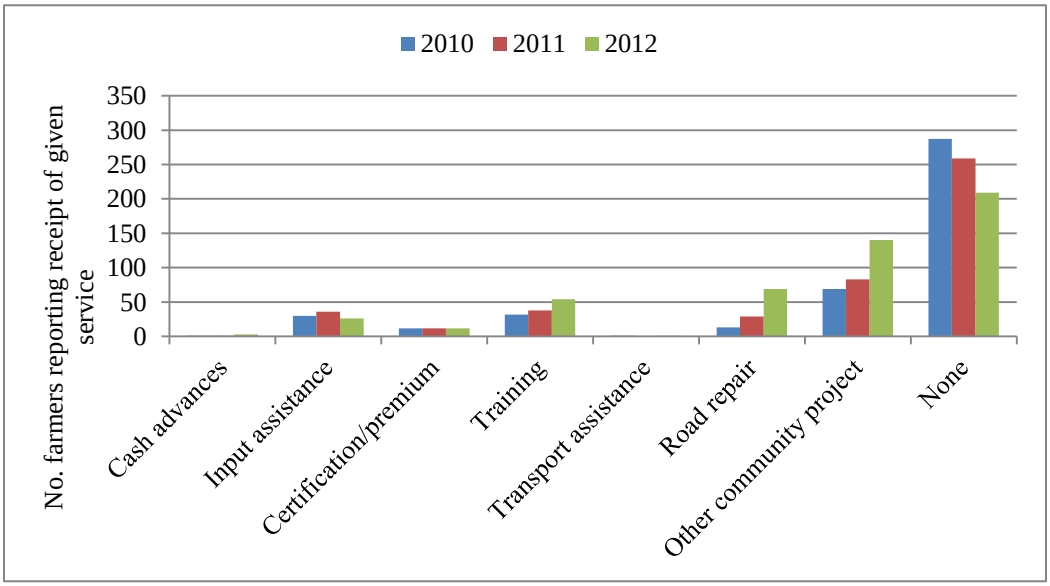


Figure 6.9: Services from Sources Other than Buyers in Different Years

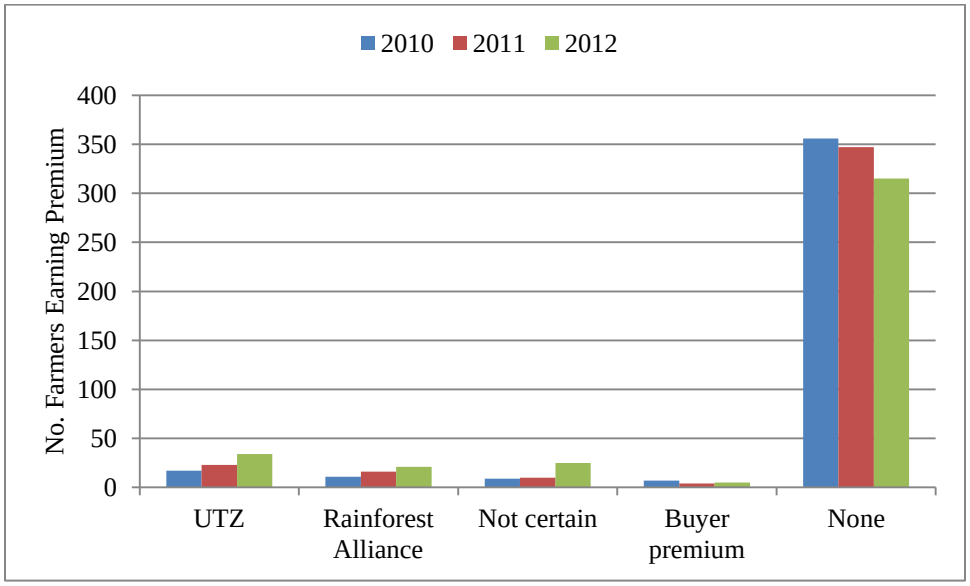


6.3 Certifications, Bean Quality, and Market Satisfaction Trends

As shown in Figure 6.10, the number of farmers earning premiums has increased each year of the period, though non-certified farmers still far outnumber certified farmers, with only 21%

certified in 2012. UTZ was the top certification in all three years, followed by RA. None of the farmers in this sample reported being Fair Trade certified. Interestingly, several farmers each year (particularly in 2012) said that they received a premium but were not sure what program they were enrolled in. This might mean that they are not in fact certified, but are being paid a bonus by one of the certified buyers anyway, perhaps because they have high quality cocoa. It could also mean that the farmer is certified but lacks information about the program. In both cases this is somewhat worrisome for the integrity of certification. It seems unlikely that a farmer who does not even know the name of his certification is familiar with and implementing all its standards, and if a cooperative is paying farmers a bonus for cocoa grown under non-certified conditions then this both decreases the incentive of farmers to become certified in the future and raises the risk that certified and non-certified cocoa are being mixed together after purchase.

Figure 6.10: Premiums Earned in Different Years

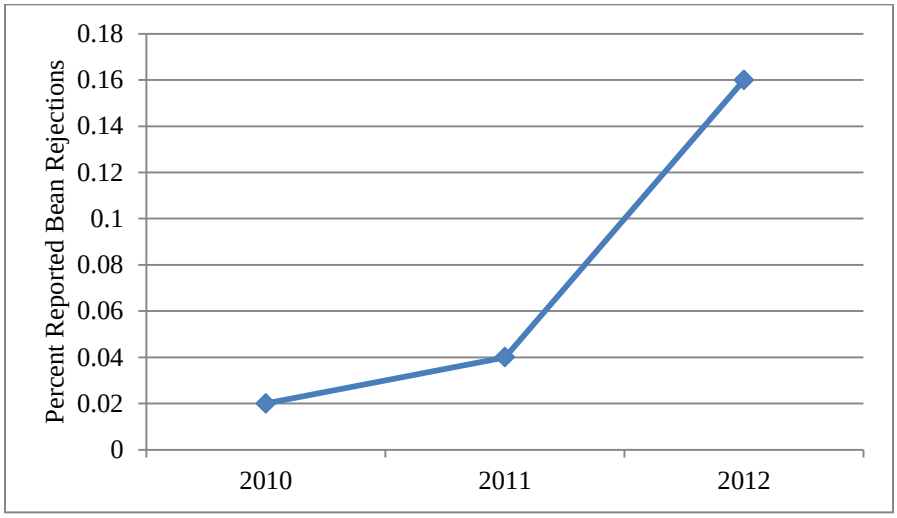


Because emphasis had been placed on increasing the quality of cocoa in the past year or so, and because improving quality was one major objective of the 2012 reforms, it was expected that farmers would report a higher amount of bean rejections in 2012 than in the past years. That is, at the factory level traitants are being pressured to delivery higher quality beans (more thoroughly dried and fermented, better sorted), and so we would expect them in turn to pressure pisteurs who would then pressure farmers to deliver high quality beans. In the past pisteurs rushed farmers to sell their beans quickly and purchased everything, even poorly dried or fermented beans, putting an emphasis on quantity over quality.

Figure 6.11 shows that there was in fact an increase in the average percent of beans rejected; however, the levels are not very significant, because all are far under 1%. The vast majority of producers reported zero bean rejections in all three years. These results are not likely to be truly representative of the trends in quality, however, which are probably more evident in

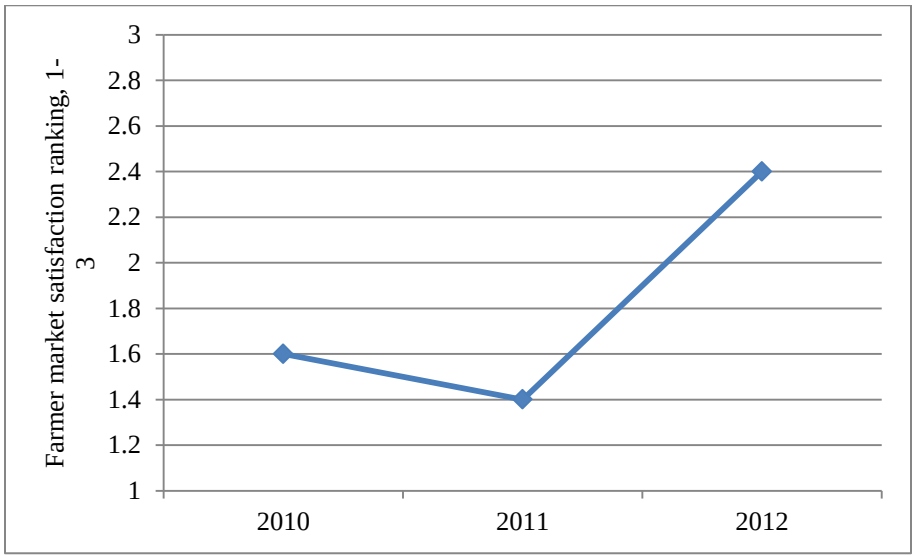
rejections at the port level and in the percentage of beans which farmers are pressured into selling before the recommended fermentation and drying periods of elapsed. It would have been more fruitful to ask these questions of the farmers, but unfortunately this was not considered until it was too late.

Figure 6.11: Percent Cocoa Beans Rejected in Different Years



Farmers were also asked to rank their satisfaction with the cocoa marketing opportunities available to them in each year, on a 1-3 scale where 1 represented "dissatisfied/highly dissatisfied," 2 was "neutral" and 3 was "satisfied/highly satisfied." Each individual interpreted the question in his or her own way, so it is not a very objective measure. However, it is still interesting to see the general trends. Figure 6.12 shows the mean satisfaction level for each year.

Figure 6.12: Average Cocoa Market Satisfaction in Different Years



The results of Figure 6.12 show that satisfaction was low to neutral in 2010, dipped in 2011, and rose substantially in 2012. This is not surprising, considering that prices dropped significantly in 2011 due to the crisis and increased again in 2012. However, the degree of increase in satisfaction in 2012 is higher than the increase in average prices, which suggests that the other changes seen in 2012 (the decrease in price volatility and the increase in buyer services) were appreciated by many farmers.

6.4 Summary and Conclusions

Overall, this section has shown that there are substantial differences in market conditions between the 2010 and 2011 marketing years when compared to 2012. This may or may not be a result of the 2012 price reforms, because a large portion of the 2010 and 2011 cocoa seasons were affected by the post-election political crisis in Côte d'Ivoire. It would have been better to also collect data on previous years to truly isolate the effects of the reforms from the election crisis. However, given anecdotal evidence from the focus groups, it seems that at least some of the 2010-2011 versus 2012 differences are due to the reforms.

Price volatility has dropped dramatically, the proportion of producers selling with cooperatives has increased, farmers are selling with fewer (often just one) buyer within a given season, more farmers are receiving certification premiums, and service provision has increased. Though the average maximum price earned by farmers decreased from 2010 to 2012 (and might have decreased even more if earlier years were compared to 2012), the minimum and average prices earned have increased. The only initial hypothesis not supported firmly by these data is that reforms should have increased quality of cocoa sold. All these results, combined with the fact that 96% of sampled farmers prefer the fixed price system, suggests that the reforms have had a positive effect on farmer welfare and seem to have achieved their objectives.

7: QUANTITATIVE RESULTS: DETERMINANTS OF COCOA YIELDS

Section 7.1 below will outline the model of the determinants of cocoa yields, which is based on theory from the literature discussed in Section 3.2. Section 7.2 will present the summary statistics for relevant variables and section 7.3 will present the results of the basic regression plus several robustness checks. Section 7.4 is a discussion of these results.

7.1 Model for Determinants of Yield

Based on the literature, important determinants of cocoa yields which must be included in the model are: hectares of mature cocoa, labor, fertilizer inputs, pesticide inputs, age of trees, variety of cocoa, gender of the farmer, age of the farmer, education level of the farmer, origin of the

farmer, the presence of diseases, access to training/extension services, services received from buyers and other sources, and the farmgate price of cocoa. Ideally rainfall and access to machinery (for pesticide spraying) would also be included, but data was not directly collected on these variables in our survey. However, this is not a serious problem. An indicator variable for zone or village should help to control for differences in rainfall and other climate factors. With regard to machinery, any farmer that sprays pesticides necessarily used a spray machine. Whether he owned or rented the machine should not have a direct effect on yields; any significant correlation between machine ownership and yields found in the literature was likely due to the fact that both are positively correlated with wealth.

In order to take wealth into account we can include total land area owned, non-agricultural revenue, and/or whether the farmer has a bank account. Membership in a cooperative is also correlated with access to spray machines, through the cooperative spraying program. However, instead of including cooperative membership and other marketing factors like the total number of buyers in an area in the model, these factors are viewed as determinants of cocoa prices and number of buyer services, which are the direct means by which market structure variables are expected to impact investment and thus yields. Lagged cocoa prices and current services are thus included in the model, but all other marketing variables, including the level of isolation of the market, are not included and instead will be used as independent variables in the models of prices and services in Section 8.

The yield determinant model used is as follows:

(7.1) $\ln(\text{cocoa yield } 2012) = \beta_0 + \beta_1 \ln(mature\ cocoa\ acres) + \beta_2 \ln(labor) + \beta_3 \ln(pesticide\ per\ ha) + \beta_4 \ln(fertilizer\ per\ ha) + \beta_5(avg\ tree\ age) + \beta_6(avg\ tree\ age)^2 + \beta_7\,(CSSV\ present) + \beta_8(other\ diseases\ severe) + \beta_9(hybrid\ seed) + \beta_{10}(extension) + \beta_{11}\,(no.buyer\ services) + \beta_{12} \ln(avg.cocoa\ price\ 2011) + \beta_{13} \ln(avg.cocoa\ price\ 2010) + \beta_{14}\,(farmer\ age) + \beta_{15}(farmer\ age)^2 + \beta_{16}\,(origin) + \beta_{17}\,(gender) + \beta_{18}\,(educated) + \beta_{19}\,(bank\ account) + \beta_{20}(non-ag\ revenue) + \varepsilon$

Both the levels and squares of tree age and farmer age are included because we expect to see quadratic relationship between these variables and yields (at first yields should increase with age, but with diminishing returns, and after a certain threshold yields should decrease). Education is included as a dummy variable which takes the value of 1 if the head of household received any schooling at all, while origin is an indicator variable with autochtone as the base category. Labor is measured in man-hours per week used for regular upkeep of the cocoa farm (not during harvest). The frequency of weeding is also omitted from the model because it measures essentially the same thing as labor. The factors of production and the dependent variable are all in log form because we assume a Cobb-Douglas production function. Prices are also in log form, so that the coefficients represent the price elasticity of supply. All data is provided for the 2012 season except for cocoa prices, for which two lagged prices are included. This structure was chosen investment decisions which affect cocoa yields are made before the

current season and thus should be affected by past revenue and price expectations based on past prices, not current prices. Also there was almost no variation in prices in 2012 because of the fixed price system.

7.2 Summary Statistics

Table 7.1 presents the summary statistics for the variables included in the regression model, plus a few additional variables with values of interest but which are not directly included in the regression model (fertilizer and pesticide use dummies, household size, number of weedings per year, 2012 prices). Continuous variables are shown at the top and dummy variables at the bottom, with only mean (percentage with a value = 1) and standard deviation displayed.

Table 7.1: Summary Statistics for Yield Model Variables

	Mean	Standard deviation	Median	Min	Max
cocoa yield (tons)	0.386	0.294	0.333	0.018	2.28
cocoa hectares	6.45	6.23	5	0	50
farmer age	49	12.6	50	21	88
labor (man hours/week)	98.3	70.4	84	0	432
fertilizer (kg/ha)	146.9	248.8	0	0	2000
pesticides (liters/ha)	1.3	1.2	1	0	10.9
weeding frequency per year	2.5	0.7	3	0	7
avg. cocoa age	22.9	10.2	24.3	0.3	75.6
no. buyer services	1.3	1	1	0	4
cocoa price avg. (F/kg) 2010	690	146.4	700	250	1100
cocoa price avg. (F/kg)2011	627.3	109.4	625	250	1100
cocoa price avg. (F/kg)2012	725.5	4.7	725	700	787.5
total hectares	9.4	8.2	7	1	57.5
household size	12.3	7	11	1	40
fertilizer use	0.43	0.5			
Pesticide use	0.9	0.31			
male	0.98	0.14			
non-agricultural revenue	0.15	0.36			
bank account	0.24	0.43			
extension	0.43	0.5			
hybrid cocoa	0.21	0.41			
CSSV	0.32	0.47			
Other diseases	0.68	0.47			
educated	0.38	0.49			
autochtone	0.165	0.37			
allochtone	0.51	0.5			
allogene	0.325	0.47			
cooperative member	0.43	0.5			

Table 7.1 shows that the mean cocoa yield is 386 kg/ha, though some farmers have yields has high as 2.28 tons/ha and others as low as 18 kg/ha (farmers whose cocoa was not yet mature). The average land area under mature cocoa was 6.45 ha, though it ranged from 0 to 50 ha. As much as 90% of farmers used some level of pesticide, with a mean application rate of 1.3 liter/ha per year, but only 43% of the sample used fertilizer, with a mean application rate of 147 kg/ha. The mean weeding frequency was only 2.5 times per year. These levels are far below the CNRA recommendations of 520 kg/ha of fertilizer, 4 liters/ha of pesticide and 4-6 times weeding per year (Ismael et al. 2005). In fact, further examination of the data shows that only 2% of farmer do the recommended amount of weeding, only 4.3% use the recommended amount of fertilizer, and only 7% use the recommended amount of pesticide.

There is a sizeable amount of variation in the sample for almost all variables. The variable with the least variation is gender, given that 98% of the sampled farmers were male. The data was cleaned of obvious errors and outliers, which is confirmed by the fact that the median and mean values of the continuous variables are similar and that the minimum and maximum values for all variables are reasonable. It is worth noting that for all of the input variables which were log transformed in the model, the zero values were first changed to 0.001.

7.3 Yield Regression Results and Discussion

The equation 7.1 yield model was first regressed in OLS form. Another specification was run which included indicator variables for each of the five zones, to account somewhat for differences in rainfall and soil type. A third specification was run with indicator variables for each village, to completely control for all ecological and market differences across villages.

Table 7.2: Yield Regression Results

	OLS	OLS, zone indicators	OLS, village indicators	2SLS	2SLS, zone indicators	2SLS, village indicators
ln(ha mature cocoa)	-0.231 (0.067)***	-0.231 (0.076)***	-0.284 (0.086)***	-0.51 (0.154)***	-0.593 (0.157)***	-0.568 (0.137)***
ln(labor, man hours)	0.052 (0.047)_	0.066 (0.072)_	0.06 (0.077)_	0.561 (0.269)**	0.728 (0.278)***	0.591 (0.227)***
ln(pesticide per ha)	0.059 (0.018)***	0.065 (0.021)***	0.015 (0.007)**	0.063 (0.023)***	0.078 (0.025)***	0.053 (0.019)***
ln (fertilizer per ha)	0.023 (0.007)***	0.018 (0.006)***	0.015 (0.007)**	0.02 (0.006)***	0.013 (0.007)*	0.013 (0.006)***
avg. cocoa age	-0.009 (0.012)_	-0.007 (0.012)_	0.004 (0.016)_	-0.007 (0.012)_	-0.01 (0.013)_	-0.001 (0.016)_
(avg. cocoa age)^2	0 (0.00)_	0 (0.00)_	0 (0.00)_	0.0003 (0.0002)_	-0.01 (0.013)_	0 (0.00)_
CSSV	-0.068 (0.084)_	-0.023 (0.099)_	0 (0.115)_	-0.003 (0.101)_	0.043 (0.101)_	0.104 (0.114)_

other diseases	-0.004 (0.083)_	0.072 (0.08)_	-0.037 (0.082)_	-0.031 (0.101)_	0.05 (0.119)_	-0.02 (0.103)_
hybrid seed	-0.012 (0.099)_	-0.143 (0.09)_	-0.05 (0.103)_	0.021 (0.104)_	-0.108 (0.101)_	0 (0.1)_
extension	-0.021 (0.086)_	0.039 (0.083)_	0.111 (0.111)_	-0.004 (0.083)_	0.009 (0.086)_	0.147 (0.104)_
no. buyer services	0.046 (0.041)_	0.063 (0.04)_	0.057 (0.054)_	-0.0003 (0.05)_	0.01 (0.058)_	-0.058 (0.084)_
ln(avg.price 2011)	0.687 (0.228)***	0.513 (0.221)**	0.324 (0.256)_	0.85 (0.25)***	0.723 (0.256)***	0.482 (0.262)*
ln(avg. price 2010)	0.128 (0.176)_	0.032 (0.195)_	-0.046 (0.207)_	0.072 (0.213)_	-0.097 (0.23)_	-0.174 (0.23)_
farmer age	0.023 (0.020)_	0.017 (0.022)_	0.028 (0.022)_	0.002 (0.029)_	-0.011 (0.03)_	-0.002 (0.026)_
(farmer age)^2	0 (0.00)_	0 (0.00)_	0 (0.00)_	0 (0.00)_	0.0001 (0.0003)_	0 (0.00)_
origin 2- allochtone	-0.064 (0.12)_	-0.04 (0.128)_	-0.037 (0.183)_	-0.089 (0.131)_	-0.071 (0.131)_	0.082 (0.215)_
origin 3- allogene	0.183 (0.135)_	0.139 (0.134)_	0.204 (0.165)_	0.117 (0.157)_	0.053 (0.187)_	0.229 (0.218)_
male	0.465 (0.262)*	0.443 (0.201)**	0.522 (0.284)*	0.369 (0.249)_	0.336 (0.225)_	0.336 (0.23)_
educated	-0.035 (0.092)_	-0.006 (0.092)_	-0.04 (0.095)_	0.018 (0.1)_	0.057 (0.1)_	0.013 (0.093)_
bank account	0.203 (0.097)**	0.236 (0.085)***	0.186 (0.104)_	0.235 (0.099)**	0.253 (0.093)***	0.161 (0.105)_
non-ag. revenue	0.049 (0.108)_	0.126 (0.099)_	0.045 (0.102)_	0.025 (0.102)_	0.114 (0.112)_	-0.036 (0.134)_
surveyor 2		-0.213 (0.125)*			-0.093 (0.197)_	
surveyor 3		-0.422 (0.133)***			-0.472 (0.133)***	
surveyor 4		0.115 (0.123)_			0.335 (0.154)**	
surveyor 5		0.208 (0.14)_			0.171 (0.144)_	
constant	-7.36 (1.68)***	-5.569 (1.652)***	-4.115 (01.994)**	-9.195 (2.1)***	-7.572 (2.016)***	-5.386 (2.082)_
Observations	365	365	365	364	364	364
R-squared	0.208	0.276	0.448			0.25
Root MSE	0.717	0.69	0.659	0.807	0.846	0.689

Heteroskedasticity-robust standard errors are shown in parenthesis, followed by degree of significance, with * =90% significance, **= 95%, ***= 99%

All the different input variables and cocoa prices were tested for endogeneity using several different instruments, but the Breush-Pagan test indicated significant endogeneity only for amount of labor. This was thus controlled for by preforming a two stage least squares regression with household size as the instrument for labor. Interestingly, using this specification labor is found to have a significant effect on yields, in contrast to the OLS regressions. The 2SLS model is also run with zone and village indicators.

Results of all the models show essentially the same significant variables, though the coefficients vary in magnitude. Cocoa area is always significantly negatively correlated with yields, as was expected based on the literature. The OLS estimates suggest that a 10% increase in land size should decrease yields by about 23-28%, while the 2SLS (preferred) specification suggests that it should decrease yields by 51-59%.

Pesticide and fertilizer use also significantly increase yields, though by less than was found in the literature. A 10% increase in fertilizer use increases yields by 1-2% and a 10% increase in pesticides increases yields by 2-8%. Based on the literature, we expected fertilizer to have a higher marginal effect on yields than pesticides and other variables, but this was not found to be the case. This could mean that fertilizer is less important in Côte d'Ivoire, or that there were not enough fertilizer users in the sample to provide an accurate estimate. Labor was only found to be significant in the 2SLS models, wherein a 10% increase in labor hours was found to increase yields by 56-73%. This seems to suggest that of all the inputs examined labor has the highest marginal effect on yields in Côte d'Ivoire.

As predicted, cocoa price in the previous season (though not two seasons in the past) did have an effect on yields, and a Breush-Pagan test (using numerous village market level variables as instruments) indicated that there were no endogeneity concerns. Only the OLS model with village indicator variables did not yield a significant result for this variable, likely because variation of price within each village was not high enough to see a significant effect. Within the five other models, a 10% increase in price in 2011 lead to an increase in yields between 42% and 85% in the following season. This indicates a much higher price elasticity of supply than was found in past literature. It is possible that the response was larger for this period than on average for cocoa in Côte d'Ivoire because of the political crisis. That is, the regions with the highest level of unrest were completely cut off from the market (and thus had the lowest prices) and in those areas farmers may have completely neglected cocoa maintenance due to lack of security, causing their cocoa yields to drop in the following season. Some anecdotal evidence from the focus groups supports this narrative.

In all specifications except for the two with village indicators having a bank account lead to a significant increase in yields. This may represent access to credit which is used to make investments in the farm other than the inputs already included in the regression. It could also be endogenous, since it is necessary to have a minimum amount of money to open a bank account (and for those with more money the transactions costs are more worthwhile) those farmers with

higher production are more likely to open an account. However, when a Breush-Pagan test was performed using total land, percent revenue earned from cocoa, and distance to the main road as instruments endogeneity was found not to be a problem.

Male cocoa farmers were found to have significantly higher yields than females in the OLS, but not the 2SLS regressions. However, considering that only 2% of the sample was female (8 farmers), this is not necessarily indicative of broader trends. Also, in the specifications with zone indicators it was found that zone 3 significantly lower yields when compared with zone 1 for both OLS and 2SLS, while zone 2 had significantly lower yields under OLS only and zone 4 had significantly higher yields under 2SLS only.

No other variables were found to have a significant relationship with yields. It was particularly surprising that cocoa age was not found to have an effect in any of the models tested, and that the sign of the level and square variables on age were the opposite of what was expected. The presence of hybrid seed also showed no effect on yields, surprisingly. This is likely because the nature of this variable as a dummy (whether the farmers had planted any hybrid seed at all) inherently makes it weak, since it will equal 1 both for a farmer with 4 hectares of hybrid cocoa and for a farmer with only 10 hybrid trees. We should have asked each farmer how many acres of hybrid cocoa they have, but this was not done, unfortunately.

7.4 Conclusions

Thus results confirm theory and past empirical studies which suggest a significant positive relationship between cocoa yields and the factors of production including labor, fertilizer, and pesticide use. It also confirms the inverse land size-yield relationship found elsewhere. However, the hypothesis, based on past findings, that fertilizer would have the highest marginal effect on yields was not supported. Actually, the variable which had the highest effect on yields was the average price received for cocoa in the previous year. This seems to indicate that even in the short-run cocoa farmers in Côte d'Ivoire are highly sensitive to price, reducing their investments in cocoa maintenance when prices are low. This cannot be confirmed without time series data on yields, inputs and the various control variables in addition to prices. Such research should be done in the future. However, the result is robust to multiple model specifications, and tests of endogeneity showed that lagged prices are not endogenous to current yields. Thus, it is fair to conclude that V4C or any other institution interested in increasing cocoa yields should pay attention not only to traditional variables like extension and fertilizer use, but also to local market conditions and prices.

8: QUANTITATIVE RESULTS: DETERMINANTS OF COCOA FARMGATE PRICES AND BUYERS SERVICES

Given the importance of farmgate prices on yields, as shown in Section 7, and the importance of both prices and services available to producers on their welfare, it is crucial to understand the determinants of these two variables. Section 8.1 outlines the model which will be used to study this question, Section 8.2 provides summary statistics of the relevant variables, Section 8.3 shows the results of the base regression and several robustness tests, and Section 8.4 is a discussion and conclusion based on these results.

8.1 Model for Determinants of Farmgate Price and Buyer Services

Our model of farmgate prices and buyer services includes a number of factors which were found to be important based on past empirical literature (English 2008, Kamden et al. 2010): the number of buyers in a given region, the type(s) of buyer with whom a producer sells, membership in a farmer association, the presence of cooperatives in a region, distance to major roads, quality of access roads/paths, farmer age, and the portion of income earned from cocoa.

Receipt of credit or other services from a specific buyer was also found to be significant in the literature, so we also include it as an independent variable in some model specifications. However, we believe that buyer services are also determined by the same factors which determine prices, so because of possible endogeneity we run specifications that omit it as an explanatory variable. In fact, we run a complete section of regressions wherein the number of services supplied is the dependent variable, regressed on the same set of factors as prices.

We also add several variables which have not been included in past studies but which seem theoretically relevant. The population of the village and its surrounding camps and the average cocoa production in the village will be included as proxies of total local cocoa supply. We also include the number of different buyers to whom the farmer actually sold his or her produce and the number of years since the path leading to the village was repaired.

Several other factors from the literature are omitted from our model. World price is not included, for example, because over the course of each season in question the average world price was the same for all of the farmers in the sample. We are merely interested in the variation of local farmgate prices across villages and farmers at a given world price level. Several past models also looked at the effect of time of sale (during wet or dry season, at the start of the school year or another time) and the frequency of sales in a season on price (English 2008, Kamden et al. 2010), but we did not collect data on these variables. English (2008) also looked at source of market information as a factor influencing price, but we did not collect data on this variable either. We include extension as a factor in order to partially account for this, since Farmer Field Schools include some information on prices and marketing.

The data collected is in cross-section form. However, data on several of the variables were collected for each of the three years from 2010-2012 (farmers were asked to recall to values for previous years) and so the data can be reorganized to resemble a panel, but with constant values for the other variables. In the regression model shown below those variables which vary from year to year are marked with a "t" subscript, and all others are constant across the three years. Setting up the data this way is inferior when compared to using a true panel data set (because many of the variables treated as constant here also may, in fact, vary over time). Due to time constraints and the suspected unreliability of recall data we did not try to collect a separate value for each variable for all three years.

In order to best analyze the data in this limited form, we ran three different types of models on farmgate prices. The first (equation 1 below) included all of the individual-level variables which vary over time plus a few of the constant individual regressors, but included an indicator variable for village in order to hold all of the geographic and market factors constant. The second model (shown in equation 2) used the mean cocoa price at the village level as the dependent variable and included only village-level variables as regressors, in order to more clearly identify the effects of geography. Finally, a combined model (shown in equation 3) was run, which included both the village-level and individual-level regressors in the same equation to test their relative impacts on individual average cocoa price.

Variations were run on each model, as will be seen in the results section. For example, in some cases year was included as an indicator variable in order to more clearly identify the effect of policies and world prices in a given year, while specifications were also run without year so that the effects of time variance within the other variables (number of buyers, type of buyer) could be more fully captured. Models following 8.2 were also run with and without the zone indicator variable, since there is not a clear theory on whether we would expect to see price differences across the five large zones.

Finally, we ran models which included the number of buyer services earned as a regressor, in order to explicitly look at the correlation between the two, but we also left this variable out of other specifications, since we consider it an endogenous variables simultaneously determined by the same factors affecting prices. We include an entire separate section with these regressions on buyer services. The analogous equations for the determination of buyer services are not shown here, but they are the same as equations 8-3 below except that the cocoa price and number of buyer services variables are reversed in the model.

The three base models that we used for cocoa price (and buyer service provision) are:

(1) $individual\ avg.cocoa\ price_t = \beta_0 + \beta_1\ (no.buyers\ with\ whom\ sold)_t + \beta_2(buyer\ type)_t + \beta_3(coop\ member) + \beta_4(\%\ income\ from\ cocoa) + \beta_5\ (numb.buyer\ services)_t + \beta_6\ (farmer\ age) + \beta_7(year) + \beta_8(village) + \varepsilon$

(2) $village\ avg.cocoa\ price_t = \beta_0 + \beta_1\ (village\ population) + \beta_2(distance\ to\ road) + \beta_3(path\ quality) + \beta_4(years\ since\ path\ fixed) + \beta_5\ (no.cocoa\ stores) + \beta_6\ (no.coops) + \beta_7\ (mean\ village\ production) + \beta_8(training\ in\ village) + \beta_9(dominant\ village\ ethnicity) + \beta_{10}(year) + \beta_{10}(zone) + \varepsilon$

(3) $individual\ avg.cocoa\ price_t = \beta_0 + \beta_1\ (no.buyers\ with\ whom\ sold)_t + \beta_2(buyer\ type)_t + \beta_3(coop\ member) + \beta_4(\%\ income\ from\ cocoa) + \beta_5\ (numb.buyer\ services)_t + \beta_6\ (farmer\ age) + \beta_7\ (village\ population) + \beta_8(distance\ to\ road) + \beta_9(path\ quality) + \beta_{10}(years\ since\ path\ fixed) + \beta_{11}\ (no.cocoa\ stores) + \beta_{12}\ (no.coops) + \beta_{13}\ (mean\ village\ production) + \beta_{14}(training\ in\ village) + \beta_{15}(dominant\ village\ ethnicity) + \beta_{16}(year) + \varepsilon$

Table 8.1 shows the summary statistics for the variables included in these models, with continuous variables shown at the top and dummy variables shown at the bottom.

8.2 Summary Statistics

Table 8.1 shows the summary statistics for the variables included in these models, with continuous variables shown at the top and dummy variables shown at the bottom.

Table 8.1: Summary Statistics for Farmgate Price and Buyers Services Regressions

	Mean	Standard deviation	Median	Min	Max
individual cocoa price avg.	680.69	113.02	725	250	1100
no. buyers services received	1.063	1.024	1	0	5
no. buyers w/ whom sold	1.79	1.22	1	1	12
Distance to main road	24.7	25.7	15	0	100
Years since repair	9.2	11.2	4	0	45
Road quality	2.9	1.2	3	1	5
village population	3,948	3,547	3,000	110	15,000
no. cocoa stores in village	4.1	6.5	3	0	40
no. cooperatives in village	1.1	1.2	1	0	4
farmer age	49	12.6	50	21	88
mean village production	2.533	1.433	2.257	0.402	6.6
mean village cocoa price	680.46	38.24	685.1	558.33	760.12
revenue from cocoa (%)	88.36	19.98	100	0	100
cocoa training in village	0.62	0.49			
dominant Baoule village	0.4	0.49			
dominant Bete village	0.114	0.319			
dominant Mossi village	0.267	0.443			
dominant Other ethnicity village	0.218	0.413			
sold w/ pisteurs in village	0.469	0.5			
sold w/ ambulant pisteurs	0.256	0.437			
sold w/ cooperatives in village	0.076	0.264			
sold w/ cooperative elsewhere	0.104	0.306			
sold directly w/ traitants	0.038	0.192			

8.3 Farmgate Price Regression Results

Table 8.2 below shows the results of the model shown in equation (8.1), with four slightly different specifications. Table 8.3 shows the results of the equation (8.2) models and Table 8.4 shows the results of the equation (8.3) models.

Table 8.2: Regressions on Avg. Individual Cocoa Price, Controlling for Village-level Factors

	Model 1	**Model 2**	**Model 3**	**Model 4**
no. buyers w/ whom sold	-7.028 (2.87)**	-10.437 (3.117)***	-7.272 (2.847)**	-11.137 (3.096)***
buyer 2- itinerant pisteurs	0.606 (9.958)_	-1.391 (10.585)_	-0.349 (9.97)_	-3.644 (10.62)_
buyer 3 - village coops	24.584 (16.944)_	32.667 (17.492)_	26.86 (17.001)_	38.151 (17.576)**
buyer 4 -coops elsewhere	16.312 (9.425)*	32.914 (10.197)***	18.437 (9.506)*	38.487 (10.219)***
buyer 5 - direct to traitants	28.475 (17.98)_	37.346 (18.304)**	28.262 (18.048)_	37.289 (18.52)**
coop member	-11.61 (8.891)_	-16.01 (9.396)*	-10.078 (8.712)_	-12.777 (9.289)_
% revenue from cocoa	-0.186 (0.189)_	-0.21 (0.211)_	-0.173 (0.189)_	-0.183 (0.209)_
no. buyer services	5.112 (3.873)_	11.194 (4.089)***		
farmer age	-0.36 (0.272)_	-0.334 (0.296)_	-0.38 (0.272)_	-0.378 (0.297)_
2011	-64.098 (8.624)***		-64.258 (8.621)***	
2012	27.78 (7.543)***		28.925 (7.485)***	
constant	758.139 (26.95)***	755.17 (27.239)***	760.944 (26.905)***	753.974 (29.465)***
Observations	1173	1173	1173	1173
R-squared	0.263	0.262	0.262	0.148
Root MSE	100.3	100.38	100.33	107.69

Heteroskedasticity-robust standard errors are shown in parenthesis, followed by degree of significance, with * =90% significance, **= 95%, ***= 99%

The results of Table 8.2 show that, when village-level factors are all controlled for, the factors which have a significant impact on the cocoa prices received by farmers are: the number of buyers with whom the farmer sold their cocoa (contrary to expectations the correlation is negative, meaning that farmers earn a higher price if they sell with fewer buyers per season) and selling with cooperatives based outside the village (positive correlation). The models with year included as a variable show that prices were significantly lower in 2011 and significantly higher

in 2012 when compared with 2010. Number of buyer services was correlated with cocoa prices, rather than negatively correlated as hypothesized, though this is only the case when year is not included as a variable, meaning that both buyer services and price changed in tandem over time. Selling directly to large traitants and selling with village cooperatives also only had an effect (positive) on prices when year was not included. The latter also was only significant when number of buyer services was not included. That is, cooperatives and other buyers supplying the same number of services in the same year did not offer significantly different cocoa prices.

Table 8.3: Regressions on Mean Village Cocoa Prices

	Model 1: no zone indicator	**Model 2: w/ zone indicator**
village population	0.001 (0.0005)*	0.002 (0.001)***
distance to paved road	0.152 (0.058)***	0.252 (0.105)**
road quality	-4.435 (1.403)***	-3.854 (1.358)***
years since road fixed	-0.116 (0.125)_	0.041 (0.119)_
no. cocoa stores	-0.866 (0.341)**	-1.932 (0.429)***
no. coops	3.847 (1.175)***	4.136 (1.221)***
mean village production	3.643 (1.175)***	4.418 (0.82)***
FFS/training in village	5.675 (2.438)**	6.566 (3.504)*
dominant ethnicity- Baoule	-27.971 (2.839)***	-20.638 (2.92)***
dominant ethnicity- Bete	15.554 (3.665)***	25.845 (4.169)***
dominant ethnicity- Mossi	-24.812 (3.764)***	-12.816 (4.378)***
2011	0.116 (2.591)_	-0.041 (2.497)_
2012	0.232 (2.6)_	-0.082 -2.505
zone 2		-5.358 (6.257)_
zone 3		-17.252 (5.4)***
zone 4		7.967 (6.646)_
zone 5		15.539 (6.31)_
constant	689.218 (6.81)***	670.844 (10.14)***
Observations	1008	1008
R-squared	0.218	0.277
Root MSE	33.546	32.324

Heteroskedasticity-robust standard errors are shown in parenthesis, followed by degree of significance, with * =90% significance, **= 95%, ***= 99%

Table 8.3 shows only the effects of village-level variables on price, using the mean cocoa price for each of the 50 villages as the dependent variable, rather than individual farmer price. All the factors included in the regression are found to be significant, both with and without inclusion of the zone indicator variable, except for the number of years since the road was repaired and the year itself. This is very interesting considering the large magnitude and significance of the year in the individual-level price regressions in Table 8.2. This result seems to indicate that variation between village-level prices is affected more by geographic factors than changes in the world price and politics with time, and that the price reforms of 2012 had a greater impact on intra-village rather than inter-village prices.

A higher population and higher average village production both corresponded with higher prices. This is contrary to one theory, which suggests that prices should be lower in areas of higher supply. However, there is a more active market in those areas, perhaps with more visits by pisteurs per year. We did not explicitly measure transaction frequency, which was found to be significant in other studies, and so it is possible that this variable is being captured here. The number of cooperatives in a village, the presence of training programs for cocoa farmers, and having a dominant native (Bete) ethnicity also increases average village prices. These findings are all consistent with theory: farmer-owned cooperatives have an incentive to offer higher prices, and this might then influence the prices of all buyers in the area; training programs increase market information of farmers; and native groups are expected to have more political influence and relationships with buyers, giving them more leverage to negotiate higher prices.

However, more remote villages (farther from paved roads and with lower road quality) were found to have higher prices, completely contrary to expectations. It is possible that this is a result of controlling for dominant ethnicity, because several of the villages located on major roads were also Bete villages. Also, contrary to theory on the positive effects of buyer competition, the number of cocoa stores located in a village was found to be negatively correlated to prices. That is, where there are only 1-2 dominant buyers as opposed to many different small, competing buyers, prices tend to be higher. When zone was included as a variable, only zone 3 (Soubre) was found to have significantly different average prices, lower than those in zone 1 (Buyo) which is also surprising considering that Buyo is more remote from the final markets in Abidjan and San Pedro than Soubre.

Table 8.4 shows the individual cocoa price regressed on a combination of village-level and individual-level factors, as outlined in equation 8.3. Prices were again found to be significantly higher in 2012 and lower in 2011. Older farmers were found to receive lower prices, in contrast to the Table 8.2 regressions where age was insignficant. The number of buyer services was positively correlated with prices both when year was included and when it was not, in contrast to the Table 8.2 results, suggesting that buyers which paid higher prices may also have supplied more services, and that this may not have only been a function of time trends.

Table 8.4: Regression on Individual Avg. Cocoa Price, Combined Model

	Model 1	Model 2	Model 3	Model 4
no. buyers w/ whom sold	-1.269 (2.974)_	-4.109 (3.196)_	-1.303 (2.96)_	-4.319 (3.181)_
buyer 2- itinerant pisteurs	11.544 (8.94)_	8.536 (9.454)_	10.138 (8.927)_	5.848 (9.442)_
buyer 3 - village coops	30.696 (14.553)**	36.24 (15.022)**	34.265 (14.456)**	42.874 (14.83)***
buyer 4 -coops elsewhere	15.501 (9.136)*	30.665 (10.121)***	19.396 (9.08)**	38.429 (9.952)***
buyer 5 - direct to traitants	4.696 (18.495)_	11.079 (19.632)_	5.705 (18.482)_	13.214 (19.68)_
coop member	-16.482 (9.457)*	-21.476 (9.971)**	-13.702 (9.155)_	-16.8 (9.766)*
% revenue from cocoa	-0.253 (0.195)_	-0.272 (0.211)_	-0.237 (0.194)_	-0.245 (0.201)_
no. buyer services	7.062 (3.687)*	12.29 (4.073)***		
farmer age	-0.567 (0.277)**	-0.54 (0.295)*	-0.593 (0.278)**	-0.584 (0.296)**
2011	-60.889 (9.966)***		-61.128 (9.975)***	
2012	31.231 (8.326)***		32.919 (8.327)***	
village population	0 (0.001)_	0 (0.002)_	0 (0.001)_	0 (0.002)_
distance to paved road	0.148 (0.191)_	0.109 (0.202)_	0.208 (0.191)_	0.213 (0.201)_
road quality	-2.478 (4.405)_	-2.364 (4.788)_	-2.327 (4.442)_	-2.072 (4.856)_
years since road fixed	-0.039 (0.339)_	0.181 (0.366)_	-0.105 (0.335)_	0.079 (0.362)_
no. cocoa stores	0.443 (1.194)_	0.679 (1.25)_	4.226 (4.167)_	1.051 (1.222)_
no. coops	4.8 (4.159)_	4.376 (4.353)_	4.226 (4.167)_	3.325 (2.983)_
mean village production	3.666 (2.79)_	2.994 (2.984)_	3.884 (2.792)_	-22.902 (9.478)**
FFS/training in village	1.104 (7.919)_	2.693 (8.435)_	4.229 (7.73)_	2.653 (8.254)_
dominant ethnicity- Baoule	-25.991 (11.263)***	-25.529 (9.38)***	-23.581 (9.24)**	-22.902 (9.478)**
dominant ethnicity- Bete	8.862 (14.874)_	6.565 (15.843)_	13.941 (14.62)_	15.532 (15.603)_
dominant ethnicity- Mossi	-29.991 (11.263)***	-29.786 (11.985)**	-29 (11.327)**	-27.99 (12.074)**
constant	739.401 (31.3)***	733.477 (33.287)***	739.723 (31.28)***	735.024 (33.237)***
Observations	986	986	986	986
R-squared	0.167	0.057	0.164	0.048
Root MSE	104.1	110.54	104.12	110.97

Heteroskedasticity-robust standard errors are shown in parenthesis, followed by degree of significance, with * =90% significance, **= 95%, ***= 99%

Selling with a cooperative (based in the village or elsewhere) is found to be positively correlated with higher cocoa prices, but we find no spill-over effects of cooperatives to others in the village who do not sell with the cooperative. We also find a negative impact of being a cooperative member once buyer type is controlled for. This seems to indicate that even non-members who sell with a cooperative earn a higher price, and that joining officially does not help farmers to earn more (when the premium is excluded). This could indicate either than farmers facing lower prices are more likely to join a cooperative, or perhaps that members receive more benefits and are thus willing to accept lower prices.

Interestingly, a number of variables which were significant in the two separate regression models are not significant in this combined model. For example, the only village-level factor which still is found to impact price is the dominant village ethnicity (higher for Baoule and Mossi villages when compared to other ethnicities, but not significant for Bete villages). This suggests that individual market decisions and characteristics have a higher impact on the price received by a given farmer than geographic factors.

Tests of multicollinearity were performed on all of the models and no significant multicolliearity was found. With regard to endogeneity, an argument could be made that several of the variables might be endogenous. For example, farmers who receive higher prices might be more likely to join a cooperative; on the other hand, farmers facing lower prices may be more motivated to join a cooperative. Villages which earn higher average cocoa prices may be more likely to afford road repairs or to finance a FFS. Village mean production may be influenced by prices, which encourage investment.

Unfortunately, good instruments to test and control for endogeneity of these variables do not exist in our collected data. However, none of these variables should be of major concern. Only 1 out of 259 non-members reported dues as a barrier to joining a cooperative, and a single variate regression shows no significant difference in cocoa price for cooperative members and non-members. It is the national government (via the Conseil du Café-Cacao), buyers and NGOs which finance road repairs and FFSs, and not the local government in almost all cases, so village prices are less likely to influence road quality and training.

Percent of revenue which comes from cocoa may also be endogenous, since those who earn a higher price may decide to focus a greater proportion of their time and resources on cocoa cultivation than other crops or activities. This latter variable is the only one for which we have a reasonable instrument in our data set, namely the number of hectares of non-cocoa land. Testing this variable with the Breush-Pagan test shows that there is not, in fact, significant endogeneity.

8.4 Buyer Services Regression Results

Table 8.5, 8.6 and 8.7 present the analogous results of the regressions with buyer services as the dependent variable. All the same factors as those included in the price regressions are expected

to be relevant because both of these variables reflect resources expended by the cocoa buyers, and the same factors which would cause them to pay a higher price for cocoa are likely to influence their decision to pay for service provision.

We hypothesized, a priori, that in some cases a factor will exert the same influence on prices and services (farmer age, dominant ethnicity, level of isolation of the village, year) while other should exert an opposite influence. For example, as discussed by many studies in the literature, the level of competition in a given area is expected to raise prices but to lower service provision, since services are non-excludable and thus yield a lower marginal benefit to buyers when there are many competitors (Ruf and Yoddang 1998, Bonjean et al. 2001, Poulton et al. 2004, Jones and Gibbon 2011). We thus expected to see an inverse relationship between service provision and cocoa prices. Contrary to expections, the results of the price regressions demonstrated that this was not the case, and in fact higher service provision is correlated with higher cocoa prices, even when the effect of different years is controlled for. However, those results also showed that prices were negatively correlated with buyer competition. Thus, we still expect to see a negative correlation between service provision and buyer competition.

Table 8.5: Regressions on No. Buyer Services Received, Controlling for Village-level Factors

	Model 1	**Model 2**	**Model 3**	**Model 4**
no. buyers w/ whom sold	-0.046 (0.022)**	-0.056 (0.023)**	-0.048 (0.022)**	-0.063 (0.022)***
buyer 2- itinerant pisteurs	-0.187 (0.07)***	-0.199 (0.071)***	-0.194 (0.07)***	-0.208 (0.071)***
buyer 3 - village coops	0.438 (0.138)***	0.469 (0.138)***	0.452 (0.139)***	0.497 (0.14)***
buyer 4 -coops elsewhere	0.411 (0.098)***	0.476 (0.097)***	0.422 (0.098)***	0.502 (0.096)***
buyer 5 - direct to traitants	-0.05 (0.127)_	-0.026 (0.129)_	-0.042 (0.0127)_	-0.006 (0.129)_
coop member	0.303 (0.073)***	0.296 (0.074)***	0.291 (0.072)***	0.277 (0.073)***
% revenue from cocoa	0.003 (0.001)*	0.003 (0.001)*	0.002 (0.001)*	0.002 (0.001)*
avg. cocoa price	0.0003 (0.0002)_	0.001 (0.0002)***		
farmer age	-0.004 (0.002)_	-0.004 (0.002)*	-0.004 (0.002)**	-0.004 (0.002)**
2011	-0.013 (0.055)_		-0.024 (0.053)_	
2012	0.216 (0.057)***		0.226 (0.056)***	
constant	0.331 (0.0258)_	0.21 (0.252)_	0.571 (0.19)***	0.656 (0.188)***
Observations	1173	1173	1184	1184
R-squared	0.496	0.487	0.495	0.484
Root MSE	0.751	0.756	0.751	0.758

Heteroskedasticity-robust standard errors are shown in parenthesis, followed by degree of significance, with * =90% significance, **= 95%, ***= 99%

The results of Table 8.5 confirm this hypothesized negative relationship between number of buyers and number of services provided. Results also show a positive correlation between average cocoa price and services, but only in the model without year indicators, supporting the theory that the correlation is just based on the fact that both variables increase in 2012.

Selling with ambulant pisteurs (as opposed to village-based pisteurs) also resulted in fewer services, and so did increased farmer age. Significant positive coefficients were found for selling with cooperatives (based in the village or elsewhere) when compared to selling with pisteurs, percent of revenue earned from cocoa, the year 2012, and being a cooperative member. This latter was significant even controlling for selling to a cooperative, indicating that members do get more benefits than non-member patrons in terms of services, though the opposite was found for prices. Perhaps the inverse relationship which we expected to see between prices and services only holds for cooperative members.

The regressions of village-level factors on the mean number of services received in each village, with results displayed in Table 8.6, shows that village population is negatively correlated with service provision, though the magnitude of the effect is small. This is consistent with the theory that with higher population supply is higher and thus buyers are less obligated to offer services in order to obtain adequate supplies. However, this is contradicted by the fact that mean village cocoa production is positively correlated with service provision. This latter could be endogenous, though because we are looking at services and production in the same year this is less likely.

The number of years since the path in the village was repaired and having Mossi (which are Burkinabe, so allogenes) as the dominant ethnicity are both also negatively correlated with services. This is consistent with expectations, since farmers in more remote villages and foreign farmers are expected to have lower power in the market. Distance to the main paved road is positively correlated with average services received, however, which contradicts the theory that remote villages have lower market power and thus should be relatively neglected by buyers, though the positive correlation with road quality supports this theory. It is possible that distance to paved road is not a good representation of village isolation, since in some cases the main road through a region is not paved, as is the case in Buyo (zone 1).

The number of total cocoa stores and specifically the number of cooperative buyers in a village are both positively correlated with service provision, which seems to suggest a positive effect of buyer competition on service provision. Thus, the original theory that price would be negatively correlated and services would be positively correlated with buyer competition seems to be completely reversed. The reasons for this are unclear.

Villages with a dominant native (Bete) ethnic group, those with FFS groups. These variables could be the result of increased market information (and thus power), since farmers who have received training and those who are native to an area should have higher access to

market information. All zones were found to have significantly higher service provision when compared to zone 1 (Buyo), though the reasons for this are not clear. In fact, there are several active cooperative in the Buyo area, so a priori we would have expected to see higher service provision in this zone. In fact, a simple regression of village mean services on the zone indicator only shows that zone 1 villages receive significantly higher services than zone 3 and 5 villages, and there is no significant difference between zones 1, 2 and 4. Thus, this finding is related to the inclusion of other variables, though no multicollinearity problems were detected.

Table 8.6: Regressions on Village Mean No. Buyer Services

	w/out zone indicator	**w/ zone indicator**
village population	-0.00002 (0.000004)***	-0.00004 (0.000004)***
distance to paved road	0.008 (0.001)***	0.013 (0.001)***
road quality	0.007 (0.018)_	0.07 (0.016)***
years since road fixed	-0.01 (0.001)***	-0.01 (0.001)***
no. cocoa stores	0.023 (0.004)***	0.021 (0.005)***
no. coops	0.088 (0.011)***	0.104 (0.013)***
mean village production	0.092 (0.008)***	0.072 (0.01)***
FFS/training in village	0.505 (0.031)***	0.634 (0.047)***
dominant ethnicity- Baoule	0.055 (0.0034)_	-0.059 (0.042)_
dominant ethnicity- Bete	0.763 (0.088)***	0.523 (0.072)***
dominant ethnicity- Mossi	0.097 (0.038)**	-0.059 (0.042)_
2011	0.01 (0.032)_	0.01 (0.03)_
2012	0.02 (0.032)_	0.02 (0.03)_
zone 2		0.665 (0.075)***
zone 3		0.25 (0.041)***
zone 4		0.25 (0.062)***
zone 5		0.197 (0.063)***
constant	0.137 (0.07)*	-0.291 (0.104)***
Observations	1008	1008
R-squared	0.546	0.598
Root MSE	0.414	0.39

Heteroskedasticity-robust standard errors are shown in parenthesis, followed by degree of significance, with * =90% significance, **= 95%, ***= 99%

Table 8.7: Regression on No. Buyer Services Received, Combined Model

	Model 1	Model 2	Model 3	Model 4
no. buyers w/ whom sold	-0.004	-0.039	-0.005	-0.017
	(0.023)_	(0.022)*	(0.023)_	(0.023)_
buyer 2- itinerant pisteurs	-0.204	-0.18	-0.201	-0.221
	(0.067)***	(0.067)***	(0.066)***	(0.067)***
buyer 3 - village coops	0.49	0.451	0.522	0.554
	(0.125)***	(0.123)***	(0.124)***	(0.124)***
buyer 4 -coops elsewhere	0.543	0.565	0.552	0.63
	(0.112)***	(0.11)***	(0.11)***	(0.108)***
buyer 5 - direct to traitants	0.14	0.08	0.145	0.178
	(0.141)_	(0.145)_	(0.14)_	(0.143)_
coop member	0.4	0.45	0.378	0.363
	(0.07)***	(0.071)***	(0.069)***	(0.071)***
% revenue from cocoa	0.002	0.002	0.002	0.002
	(0.001)_	(0.001)_	(0.001)*	(0.001)*
avg. cocoa price	0.004	0.0008		
	(0.0003)*	(0.0002)***		
farmer age	-0.003	-0.002	-0.003	-0.004
	(0.002)_	(0.002)_	(0.002)*	(0.002)*
2011	-0.006		-0.024	
	(0.066)_		(0.064)_	
2012	0.224		0.246	
	(0.07)***		(0.069)***	
village population	0	0.001	0	0
	(0.0)_	(0.011)_	(0.0)_	(0.00)_
distance to paved road	0.008	0.059	0.009	0.009
	(0.001)***	(0.011)***	(0.001)***	(0.001)***
road quality	0.022	-0.002	0.023	0.027
	(0.036)_	(0.003)***	(0.037)_	(0.037)_
years since road fixed	-0.009	-0.01	-0.009	-0.008
	(0.002)***	(0.003)***	(0.002)***	(0.002)***
no. cocoa stores	0.028	0.047	0.029	0.031
	(0.01)***	(0.01)***	(0.01)***	(0.01)***
no. coops	-0.083	-0.11	-0.075	-0.079
	(0.031)***	(0.032)***	(0.031)**	(0.031)**
mean village production	0.029	0.002	0.031	0.03
	(0.022)_	(0.022)_	(0.022)_	(0.022)_
FFS/training in village	0.441	0.342	0.451	0.444
	(0.065)***	(0.064)***	(0.065)***	(0.065)***
dominant ethnicity- Baoule	0.224	0.207	0.208	0.207
	(0.079)***	(0.081)**	(0.079)***	(0.079)***
dominant ethnicity- Bete	0.713	0.505	0.719	0.73
	(0.134)***	(0.129)***	(0.135)***	(0.135)***
dominant ethnicity- Mossi	0.154	0.13	0.136	0.139
	(0.094)_	(0.095)_	(0.093)_	(0.094)_
constant	-0.29	-0.141	0.025	0.104
	(0.29)_	(0.327)_	(0.231)_	(0.231)_
Observations	986	986	995	995
R-squared	0.322	0.309	0.32	0.307
Root MSE	0.833	0.84	0.834	0.841

Table 8.7 shows the results of the combined model of buyer services. Selling to ambulant pisteurs and time since the village path was repaired are negatively correlated to services, as is the number of cooperatives in a village, though it was positive in the village-level model and is also positively correlated to individual services in a single variable regression. Apparently when all factors are controlled for, higher competition between cooperatives does lead to decreased service provision, as per our original theory of non-excludable benefits.

The factors which were positively correlated with buyers services in this combined model included: selling to a cooperative (based in the village or elsewhere), being a cooperative member, the year 2012, distance to the nearest paved road, number of cocoa stores in the village, training in the village, and dominance of any of the three major ethnicities (though Bete villages had the highest coefficients, followed by Baoule). Cocoa prices were again found to be positively correlated with services, though the magnitude of the correlation was very small, especially in the model without year indicators. Percent revenue earned from cocoa was relevant only in the regression where cocoa price was not included and the magnitude was also very small.

8.4 Discussion and Conclusions of Farmgate Price and Buyer Service Models

These six sets of regressions show that overall, farmgate prices and the number of buyer services are positively correlated with one another, despite past studies which found the opposite. This is partially due to the increase in both of these variables with time, but the correlation was found even when year was controlled for, so this is clearly not the only factor. Another element is that cooperatives tend to provide higher services and also a higher price, but the relationship existed even though buyer type was controlled for. Clearly the dynamics of buyer competition in the Ivoirian cocoa market are more complicated than basic theory would indicate.

In regression on individual-level variables only, both prices and services were found to be negatively correlated with the number of buyers to whom a producer sold her cocoa. This indicates that farmers are better off choosing one buyer and sticking with them. Also, selling with cooperatives, as opposed to pisteurs, was consistently found to be correlated with higher prices and higher service provision. Results suggest that farmers should especially avoid selling with ambulant pisteurs: although they don't pay significantly lower prices, they do offer much fewer services. The various models also clearly indicate that, controlling for all other factors, both average prices and buyer services were significantly higher in 2012, which seems to indicate a positive effect of the 2012 reforms. Of course, the end of the political crisis in 2011 may also account for these increases.

There is also a clear result that villages with a majority Bete (local or autochtone) population receive higher benefits when compared to villages dominated by the Baoule, Mossi and other ethnicities. The Baoule seem to have an intermediate level of service provision and prices and Mossi have the lowest. This seems to suggest that the local population has the highest

market power, perhaps due to political influence, while the foreign population has the least. This indicates high market inefficiency, particularly since the Baoule and Mossi represent much higher proportions of the total population than the Bete.

Conclusions on the other factors analyzed in these regressions are less clear. One key hypothesis of this report was that more remote villages would be disadvantaged in the market, but this does not appear to be the case. The distance from the village to the nearest paved road was actually found to be positively correlated with prices and service provision, though it is possible that this variable is not identified properly, since in some regions the main roads are not paved and a disproportionate number of Bete villages (which were found to have higher prices and services) are on main roads. Road quality (as ranked on a subjective 1-5 scale) was found to be positively correlated with services and negative correlated with prices, and the number of years since the road was fixed (another proxy for bad quality) was negatively correlated with both dependent variables. On balance, this suggests that hard-to-access villages do receive lower prices and fewer services, but it is impossible to make any firm conclusions because of the contradictory evidence.

It is also difficult to make firm conclusions about the effect of buyer competition at the village level. A higher number of total cocoa stores and of cooperatives specifically are positively correlated with services in the village-level model, while number of stores is positively correlated and number of coops is negatively correlated with services in the combined model. At the same time, number of coops is positively correlated and number of total stores is negatively correlated with prices at the village-level, and neither is significant in the combined model. These results might suggest that there is in fact a trade-off between the price paid and service provision which is based on buyer competition, but that this trade-off is different for cooperative versus non-cooperative buyers. That is, perhaps private buyer competition in an area leads to higher service provision but lower prices (perhaps because it means that are more likely to stick to the fixed price and then engage in non-price competition), while competition between cooperatives increases prices but decreases service provision (because of the original non-excludable benefits theory).

These results suggest a few policy recommendations. Since farmgate prices have been found to significantly impact yields, it is in the interest of V4C, the government, and other organizations which seek to increase yields, to find ways them. With that goal in mind, this analysis suggests that the number one way to do so is to promote strong cooperatives in the villages, perhaps even single dominant cooperative buyers in an area. It also suggests that the 2012 price reforms have had a positive effect on the market and should be perpetuated in the future. Finally, allochtone and allogene villages should be given particular focus, since currently they face disproportionately low prices and service provision, despite making up the vast majority of cocoa producers. Efforts should probably also be directed at more remote villages, and increased road repairs should be a major priority, even though the data did not show as much of a price and service disadvantage for remote villages as was expected.

9: QUANTITATIVE RESULTS: DETERMINANTS OF FUTURE PLANS FOR COCOA

This section seeks to estimate the effects of various factors on farmer investment in cocoa in the past and plans for the future of their cocoa. Section 9.1 outlines the model which will be used to test these variables, Section 9.2 presents summary statistics of the relevant variables, Section 9.3 presents the results, and Section 9.4 is a discussion and conclusion based on these results.

9.1 Regression Model on Cocoa Future Plans and Investment

The literature on adoption models in general and specifically for cocoa technologies suggest a list of factors which should be included in our models of cocoa investment. These include: farmer education, farmer age, level of assets and credit (which we proxy with bank accounts and non-agricultural revenue), total farm size, mature cocoa area, number of separate parcels under the farmer's management, household size (a proxy for labor availability), cocoa output in past years, disease prevalence, ethnic origin, and tree age. The costs of various technologies in a given area are also important factors, as is the number of suppliers of those technologies. Unfortunately we did not collect data on these variables, but we will attempt to take input costs and markets into account by including a zone dummy, a dummy for the presence of a market in the village, and three variables for level of isolation of the village (distance from the village to the main road, quality of the access path, years since the path was repaired).

It is also important to look at sources of information on cocoa rehabilitation and alternative crops that could be used to replace cocoa, including social learning. We will include variables on the number of farmers in a given village who have planted crops other than cocoa, participation in training/extension, and whether the village is a part of V4C activities (either a village hosting a CDC or another ICRAF village without a CDC, leaving non-ICRAF villages as the base case). We also want to look at the effect of prices and buyer services available to farmers on their future cocoa investment. The general model is shown in equation 9.1.

(9.1) $$future\ cocoa\ investment = \beta_0 + \beta_1\, educated + \beta_2 extension + \beta_3 coop\ member + \beta_4 CDC village + \beta_5 ICRAF\ nonCDC\ village + \beta_6\, nonag\ revenue + \beta_7 \ln(total\ land) + \beta_8 \ln(ha\ mature\ cocoa) + \beta_9\, farmer\ age + \beta_{10}(farmer\ age)^2 + \beta_{11} bankaccount + \beta_{12} \ln(no.parcels) + \beta_{13} \ln(household\ size) + \beta_{14} \ln(cocoa\ production\ 2010) + \beta_{15}\, CSSV + \beta_{16} other\ diseases + \beta_{17} origin + \beta_{18}\, avg.cocoa\ age + \beta_{19}\, (avg.\ cocoa\ age)^2 + \beta_{20} \ln(no.villagers\ with\ other\ cash\ crops) + \beta_{21} \ln(distance\ to\ paved\ road) + \beta_{22} \ln(path\ quality) + \beta_{22} \ln(years\ since\ path\ fixed) + \beta_{23}\, market\ in\ village + \beta_{24} \ln(cocoa\ price\ 2010) + \beta_{25} \ln(cocoa\ price\ 2011) + \beta_{26} \ln(no.buyer\ services) + \beta_{27} zone + \varepsilon$$

We use four separate dependent variables to represent future cocoa investment. One is a dummy for whether farmers planned to keep 100% of their cocoa land under cocoa cultivation for at least the next decade. Another is a dummy for whether they plan to undertake rehabilitation of cocoa. A third is a dummy for whether farmers have cut down cocoa and

replaced it with another crop in the past. A fourth is an investment index measure. Dummy variables for input use greater than the median for the sample (displayed in Table 9.1) were created for fertilizer, labor, pesticides and weeding, and the sum of these dummies was added with the dummy for hybrid seed use to generate the investment index. The determinants of the first three dependent variables described here are estimated using logit regressions, while determinants of the investment index are estimated using an OLS regression. All continuous variables are log transformed to simplify interpretation of the results except for age variables.

9.2 Summary Statistics

Table 9.1 shows the summary statistics for the variables which are included in these regressions. Some of these are repeated from earlier sections to facilitate reading.

Table 9.1: Summary Statistics for Future Cocoa Investment Regression Variables

	Mean	Std. dev.	Median	Min	Max
cocoa production 2010	3.22	3.62	2	0	35
number parcels	1.9	0.97	2	1	4
total land area	9.4	8.2	7	1	57.5
mature cocoa area	6.45	6.23	5	0	50
no. farmers in village w/ other cash crops	1.45	1.71	1	0	8
farmer age	49	12.6	50	21	88
avg. cocoa age	22.9	10.2	24.3	0.3	75.6
fertilizer per ha	146.9	248.8	0	0	2000
pesticides per ha	1.3	1.2	1	0	10.9
weeding per year	2.5	0.7	3	0	7
labor per ha	17.2	14.1	13.9	0	144
investment index	2.03	0.83	2	1	4
distance to paved road	24.7	25.7	15	0	100
village path quality	2.9	1.2	3	1	5
years since path fixed	9.2	11.2	4	0	45
avg. cocoa price 2010	690	146.4	700	250	1100
avg. cocoa price 2011	627.3	109.4	625	250	1100
no. buyer services 2012	1.3	1	1	0	4
CDC village	0.26	0.44			
ICRAF, non –CDC villages	0.2	0.4			
destroyed cocoa in past	0.058	0.23			
plan to keep all cocoa	0.842	0.37			
plan to regenerate	0.842	0.37			
coop member	0.43	0.5			
bank account	0.24	0.43			
extension	0.43	0.5			
CSSV	0.32	0.47			
other diseases	0.68	0.47			
educated	0.38	0.49			
autochtone	0.165	0.37			
allochtone	0.51	0.5			
allogene	0.325	0.47			
hybrid seed	0.21	0.41			

9.3 Results of Future Cocoa Investment Regressions

Table 9.2 shows the results of the regressions on the four different dependent variables, each run on the full model from equation (9.1) and on the same equation but without the zone indicator variables. Results which were found to be significant are highlighted in blue.

Table 9.2: Future Cocoa Investment Regression Results

	Cocoa replaced in past		Plan to keep all cocoa		Plan to rehabilitate		Investment Index	
educated	-0.364 (0.539)	-0.072 (0.614)	0.126 (0.464)	-0.064 (0.434)	-0.168 (0.424)	-0.257 (0.425)	-0.055 (0.056)	-0.037 (0.056)
farmer age	0.123 (0.149)	0.182 (0.188)	-0.421 (0.157)***	-0.373 (0.152)**	-0.071 (0.111)	-0.065 (0.112)	0.033 (0.012)***	0.030 (0.012)**
(farmer age)^2	-0.002 (0.001)	-0.002 (0.002)	0.004 (0.002)***	0.004 (0.002)**	0.001 (0.001)	0.001 (0.001)	-0.0003 (0.000)***	-0.0003 (0.000)**
extension	-0.455 (0.591)	-0.477 (0.759)	0.634 (0.428)	0.576 (0.398)	0.622 (0.429)	0.600 (0.422)	0.100 (0.051)*	0.114 (0.052)**
coop member	-0.177 (0.675)	-0.248 (0.709)	-0.008 (0.455)	0.077 (0.419)	0.578 (0.443)	0.524 (0.471)	-0.015 (0.052)	-0.010 (0.054)
ICRAF village	1.134 (0.697)	1.370 (0.967)	-0.896 (0.576)	-0.721 (0.515)	0.969 (0.589)	0.421 (0.601)	-0.130 (0.069)*	-0.067 (0.079)
CDC village	-1.463 (0.697)**	-1.540 (0.774)**	0.088 (0.464)	0.168 (0.418)	-0.258 (0.416)	-0.328 (0.456)	0.059 (0.052)	0.067 (0.053)
non-ag. revenue	0.852 (0.756)	1.054 (0.989)	1.289 (0.609)**	0.968 (0.587)*	0.013 (0.532)	0.160 (0.549)	0.027 (0.060)	0.029 (0.059)
ln(ha total land)	-0.040 (0.710)	-0.284 (0.765)	0.634 (0.538)	0.469 (0.636)	0.071 (0.604)	0.255 (0.611)	-0.110 (0.055)**	-0.103 (0.056)*
ln(ha mature cocoa)	0.971 (0.783)	1.091 (0.869)	-1.579 (0.636)**	-1.217 (0.700)*	-0.046 (0.595)	-0.082 (0.595)	-0.112 (0.063)	-0.136 (0.063)**
bank account	2.035 (0.735)***	2.109 (0.826)**	-0.296 (0.457)	-0.062 (0.439)	-0.567 (0.498)	-0.745 (0.511)	0.011 (0.059)	0.013 (0.061)
ln(number of parcels)	0.367 (0.661)	1.091 (1.248)	0.266 (0.589)	-0.337 (0.503)	0.519 (0.533)	0.695 (0.564)	-0.012 (0.058)	0.021 (0.064)
ln(household size)	-0.077 (0.641)	-0.164 (0.625)	0.318 (0.379)	0.262 (0.316)	0.128 (0.330)	0.077 (0.349)	0.047 (0.042)	0.050 (0.043)
ln(cocoa prod. 2010)	-0.397 (0.302)	-0.384 (0.313)	0.012 (0.212)	0.031 (0.201)	0.029 (0.185)	-0.026 (0.196)	0.050 (0.029)*	0.049 (0.030)*
CSSV	0.457 (0.558)	1.357 (0.758)*	0.067 (0.394)	-0.418 (0.376)	1.125 (0.463)**	0.910 (0.512)*	-0.006 (0.050)	0.061 (0.055)
other diseases	-0.796 (0.567)	-0.660 (0.599)	-1.118 (0.493)**	-1.383 (0.482)***	0.428 (0.411)	0.261 (0.451)	-0.061 (0.049)	-0.035 (0.050)
origin 2- allochtone	1.834 (1.051)*	1.640 (1.182)	1.539 (0.721)**	1.107 (0.629)*	-0.300 (0.550)	-0.321 (0.786)	0.032 (0.073)	-0.114 (0.084)
origin 3- allogene	0.600 (1.288)	1.881 (1.709)	2.001 (0.752)***	1.874 (0.664)***	-0.866 (0.581)	-0.914 (0.610)	0.162 (0.073)**	0.094 (0.072)
ln(dist. to road)	-0.311 (0.121)***	-0.473 (0.206)**	0.114 (0.085)	0.109 (0.066)*	0.073 (0.061)	0.046 (0.076)	-0.001 (0.008)	-0.002 (0.009)
ln(path quality)	0.004 (1.320)	-0.680 (2.563)	0.325 (0.514)	0.350 (0.496)	0.757 (0.519)	0.957 (0.535)*	-0.108 (0.059)*	-0.126 (0.060)**
ln(yrs since path fixed)	-0.169 (0.090)*	-0.103 (0.128)	0.055 (0.063)	0.079 (0.055)	-0.004 (0.055)	-0.007 (0.065)	0.003 (0.008)	0.005 (0.009)
market in village	-0.035 (0.672)	0.902 (0.944)	0.885 (0.465)*	0.555 (0.395)	0.780 (0.422)*	0.784 (0.454)*	0.043 (0.052)	0.057 (0.060)

avg. cocoa age	0.135 (0.140)	0.128 (0.171)	-0.013 (0.089)	-0.025 (0.094)	0.115 (0.068)*	0.119 (0.072)*	-0.004 (0.007)	0.002 (0.008)
(avg. cocoa age)^2	-0.003 (0.003)	-0.003 (0.004)	0.002 (0.002)	0.001 (0.002)	-0.001 (0.001)	-0.001 (0.001)	0.000 (0.000)	-0.000 (0.000)
ln(villagers w/oth. crops)	-0.267 (0.107)**	-0.296 (0.115)***	0.013 (0.062)	0.034 (0.052)	0.000 (0.055)	0.007 (0.061)	0.025 (0.007)***	0.021 (0.008)***
ln (cocoa price 2010)	1.325 (1.538)	1.406 (1.787)	1.714 (0.787)**	1.299 (0.774)*	-0.826 (0.871)	-0.723 (0.943)	-0.063 (0.102)	-0.027 (0.107)
ln(cocoa price 2011)	0.206 (1.919)	0.024 (2.408)	0.159 (0.983)	1.042 (0.891)	-0.182 (0.998)	-0.437 (1.075)	0.074 (0.144)	0.004 (0.143)
ln (no. buyer services)	0.204 (0.215)	0.252 (0.320)	-0.122 (0.080)	-0.119 (0.075)	-0.018 (0.067)	-0.025 (0.065)	0.000 (0.008)	0.001 (0.008)
zone 2		-1.600 (2.379)	-1.292 (0.808)			-0.911 (0.591)		0.026 (0.072)
zone 3		0.430 (1.383)	-0.081 (0.923)			-1.014 (0.748)		0.138 (0.104)
zone 4		0.980 (1.407)	1.216 (0.937)			-0.335 (0.875)		0.011 (0.108)
zone 5		-0.504 (2.821)	0.681 (0.935)			-1.193 (0.755)		0.154 (0.080)*
constant	-19.020 (14.153)	-20.306 (22.493)	-2.912 (8.546)	-5.741 (8.256)	6.005 (8.579)	7.481 (9.395)	0.211 (1.042)	0.337 (1.048)
Observations	322	322	322	322	322	322	322	322
(Pseudo) R-squared	0.297	0.338	0.181	0.221	0.197	0.208	0.24	0.26
Log likelihood/ Root MSE	-48.78	-45.96	-112.49	-107.04	-114.32	-112.69	0.388	0.384

Heteroskedasticity-robust standard errors are shown in parenthesis, followed by degree of significance, with * =90% significance, **= 95%, ***= 99%

Results from Table 9.1 show that the significant determinants vary widely across each of the four different dependent variables studied. With regard to replacing cocoa in the past with another crop (mostly rubber), farmers in CDC villages were significantly less likely to have done so. This may indicate that the presence of a CDC increases farmer interest in rehabilitating cocoa and has thus reduced the frequency of cutting down cocoa. On the other hand, it may be that villages were chosen as CDC locations which had a higher dominance of cocoa farming, so the coefficient may be biased by endogeneity. Farmers in villages farther from the main road were also less likely to have cut down cocoa, which fits with expectations, since rubber planting is more heavily concentrated along major roads (due to ease of access for transportation to processing factories and because these farmers are wealthier). In one specification the number of years since the village access path was repaired was also found to be significantly negatively correlated with replacing cocoa, which is likely true for the same reasons.

Strangely, it was found that farmers living in villages with a higher number of farmers growing cash crops other than cocoa were *less* likely to have cut down their cocoa and replaced it with something else. We expected to see a positive correlation between these variables, since adoption of a new crop or technology is often prompted by observation of a neighbor who previously adopted (Conley and Udry 2001). This unexpected result may be accounted for by the fact that in villages with a high number of people with other cash crops farmers have access to more land and are more likely to have planted rubber or palm oil on forest land or a fallow instead of cutting down cocoa in order to plant it.

Farmers with bank accounts were much more likely to have replaced their cocoa. This could indicate that having credit access, and thus a higher degree of means, increases the likelihood of cutting down cocoa and replacing it. However, it could also be endogenous, since those who produce rubber are then paid through bank accounts. The risk of endogeneity is lessened, however, by the fact that most of the farmers in the study who had planted rubber and only done so in the past several years and were thus not producing and selling it yet. In the specification which included zone indicators the presence of CSSV was highly correlated with replacing cocoa, which fits with expectations, since replacing diseased cocoa trees is one strategy to deal with the negative effects of CSSV. Finally, in the specification without zone indicators it appears that allochtone farmers are more likely to have replaced their cocoa.

An even higher number of variables were found to be significantly correlated with a farmer's stated plan to keep all current cocoa area under cocoa for the next decade. Farmer age and its square were significantly correlated, indicating a U-shaped relationship between the variables. It seems that as farmers get older (and thus see the problems with cocoa yield) they are less likely to want to keep all their cocoa, but that this trend reverses for very old farmers (perhaps because they have grown cocoa for so long that they are reluctant to give it up). Having a higher non-agricultural revenue, being allochtone or allogene (as opposed to a native, autochtone), living farther away from the main road, having a market in one's village, and receiving a higher cocoa price in 2010 were also correlated with a higher likelihood of continuing to cultivate all one's cocoa land in the future. Having a higher number of hectares of cocoa and having severe disease problems was negatively correlated with this likelihood. The signs of all these significant variables fit with theory except for higher non-agricultural revenue. Those with more revenue, just like those with bank accounts, were expected to have more resources to fund replacement of cocoa with crops like rubber. The fact that this is not the case indicates that perhaps these farmers are instead planning to use their extra resources to invest in cocoa inputs and rehabilitation.

The third dependent variable is the likelihood of a farmer planning to rehabilitate his cocoa. There are few significant variables in this case; non-agricultural revenue, for example, has no significant effect, so the explanation made in the previous paragraph cannot be tested. The presence of CSSV and increased cocoa tree age both significantly increase the likelihood of planning to rehabilitate, which is logical because disease prevalence and aging trees are two of the main factors which necessitate rehabilitation. Those farmers in villages with higher quality access paths and with markets (and thus better access to inputs) are more likely to be interested in rehabilitation, possibly because prices for the needed inputs are lower in these villages. No other variables were found to be significant, however, not even the presence of CDCs or other ICRAF programs, which we expected would have a significant effect since ICRAF is the main organization promoting the idea of rehabilitation. This lack of significance may be due to measurement or specification errors, or it may indicate that knowledge of rehabilitation has spread via word-of-mouth or ANADER extension agents to places outside ICRAF villages.

Finally, the level of current investment in cocoa (as measured by the investment index) is significantly positively correlated with participation in extension programs, cocoa production in 2010, being allogene, living in zone 5, and living in a village with a higher number of farmers who grow alternative cas h crops. Farmer age has a quadratic relationship to investment: it increases with increasing age but the rate of increase decreases marginally, and very old farmers have lower levels of investment. Investment was found to be negatively correlated with living in a village with ICRAF activities but no CDC, having a higher amount of total land and specifically a higher amount of cocoa, and living in a village with higher quality access paths.

The positive effect of extension on investment supports expectations, as does the result for farmer age. The positive correlation between investment in 2012 and production in 2010 may suppor the hypothesis that good yields in the past encourage investment in the future. On the other hand, it could be endogenous, because investment in 2012 may just follow the same pattern as investment over the past several years, and higher investment in the past may have increased production in 2012. Allogene farmers may have been more likely to invest in cocoa because they migrated from their home countries to Côte d'Ivoire explicitly to farm cocoa, so they may be more motivated to intensify production and may have greater financial means to do so than native farmers.

It is logical that those farmers with a greater land area generally had lower investment index scores, since part of that index is based on input levels per hectare. That is, those with higher land areas find it more difficult to intensively cultivate their cocoa. This supports the argument that smaller farms have higher yields because of higher intensification of labor and other input use. The negative correlation between villages with ICRAF programs and investment is unexpected, but may be a coincidence related to other features of those villages and probably does not indicate any type of causation. It could also be due to endogeneity, if ICRAF targeted villages with a high level of need.

The positive correlation with zone 5 (which has a great deal of palm oil cultivation) and with the number of villagers who grow cash crops other than cocoa suggests that perhaps diversification into other crops helps to finance and thus increase investment in and intensification of the cocoa parcels which remain. If this is the case, it is an encouraging result which supports the idea that cocoa and rubber or cocoa and palm oil do not have to be competitors but can be grown in ways that complement one another.

9.4 Discussion and Conclusions of Future Cocoa Investment Models

These regressions generally show that V4C program interventions, in CDC villages and elsewhere, have not yet had a significant effect on farmer investment levels or on future plans of their cocoa farms. We did not even see an increased intention to adopt rehabilitation in CDC

villages, as we expected. The only significant result related to V4C programs was that fewer farmers in CDC villages have cut down their cocoa and replaced it with rubber or other trees in the past several years. This may or may not be a result of V4C programs, though qualitative evidence from the focus group meetings does suggest that the V4C is partially responsible for decreasing replacement of cocoa.

With regard to another village-level variable, the number of people in the village growing rubber or cocoa, this was found to be correlated with higher investment in cocoa and with a lower probability of having cut down cocoa in the past. Though both of these results are unexpected as first glance, they may indicate that where farmers have diversified incomes they are better able to afford to invest in their cocoa and less likely to replace it. This suggests that encouraging some level of diversification into other cash crops could be beneficial and would not likely result in a full replacement of cocoa by these other crops.

Farmer age was found to be significant for two different outcome variables, exhibiting a U-shaped relationship with the likelihood of keeping all one's cocoa and an inverse-U relationship with the level of investment in cocoa. The presence of severe disease was found significant for three different outcomes: CSSV makes farmers more likely to replace their cocoa and to be interested in cocoa rehabilitation, while other severe diseases make farmers less likely to keep all their cocoa in the future. Ethnic origin also was found to be a significant factor for several measures of future investment: allochtones were more likely to have replaced some of their cocoa in the past, but were also more likely to want to keep all of their remaining cocoa in the future, while allogenes were more likely to have higher investments and to keep cocoa in the future. This suggests that migrants are more interested in investing in cocoa or other crops than native populations, perhaps because they have higher financial means for making investments and/or are more motivated to do the work to make their cocoa systems profitable, since they migrated a long distance specifically to farm cocoa.

The effects of village isolation and market factors are less clearly demonstrated by the results but still seem important. Farmers living in more isolated villages were less likely to have already replaced some of their cocoa and were more likely to keep all their remaining cocoa in the future. This is probably because less information about new crops, and less support in terms of input and training for these crops, has permeated to the isolated villages. Villages with local markets had more farmers interested in keeping all their cocoa and rehabilitating it in the future, and villages with higher quality paths were also more interested in rehabilitation. All these results indicate support for the hypothesis that better paths should lead to more developed markets and information access, thus stimulating investment. However, farmers in villages with better paths were also less likely to invest in their cocoa, which contradicts this hypothesis.

We expected to see a significant correlation between cocoa prices and investment, since this is the mechanism by which we believe that prices affect yields, as we showed in Section 7. However, with these regressions we did not in fact find a significant relationship between cocoa

prices in 2010 or 2011 and the investment index. The only outcome variable which was significantly correlated with price was the likelihood of keeping cocoa in the future. This indicates that farmers feel more confident in cocoa and feel less of a need to diversify when they receive a higher price. The number of buyer services was not found to be significantly correlated with any of the outcome variables, though this is less surprising than the case of prices, because we also did not find a significant correlation between buyer services and yields.

Having non-agricultural revenue made farmers more likely to keep all their cocoa land in the future, perhaps because their income is already diversified and so they do not need to switch to other crops in order to reduce their income risk. Also, they may be intending to use their non-agricultural revenue to invest in cocoa rehabilitation. By contrast, those farmers with access to bank accounts were more likely to have cut down and replaced cocoa in the past. It is curious that such different results were found for these two variables (both wealth proxies), for which we expected to find the same correlations.

For the most part, the results also found no significant influence of household size, the number of separate parcels cultivated, education, cocoa production in 2010, cocoa prices in 2011, years since the village access path was repaired, number of buyer services, or the separate geographic zone dummies on all the measures of investment. The results did show a significant influence of extension services on investment levels, but not on any of the other measures of future plans for cocoa. Likewise, cocoa production in 2010 was correlated with investment in 2012 (which may or may not be causal) but not with any other dependent variables. Farmers with more land were less likely to have high investment per hectare, but land size was not correlated with any other outcome variables. Increased cocoa age correlated with a higher interest in rehabilitation, as expected, but it was also not significantly correlated with any other outcomes.

Unfortunately, the dependent variables used for these regressions are all somewhat weak. A farmer's statement of his intention to rehabilitate or to keep his cocoa is inherently flawed because the farmer may not be telling the truth (if they want V4C to think that they plan to continue only in cocoa in order to gain benefits) or they may not follow through with their stated intentions in the future for yet-to-be-encountered reasons. The investment index is also flawed because it assigns arbitrary weights to each of the inputs which make up the index. It would have been more informative to run regressions looking at the adoption of each individual input, and the data is available to do so, but this was not done in order to save time and space. There are many possibilities of further research to improve this section, including running these separate input adoption regressions and collecting follow-up data with the same farmers later to see if they actually did keep all of their cocoa and/or adopt rehabilitation methods.

10: CONCLUSION

This report used qualitative analysis of farmer focus group meetings, graphical analysis and summary statistics of opinion questions and time trends, and three different groups of regression models to analyze the local market for cocoa in Soubré, Côte d'Ivoire. First we looked at market trends over time and the results of open-ended questions to farmers about cocoa markets to understand the effects of the 2012 price reforms. Then we analyzed the determinants of cocoa yields using a comprehensive regression model. Finding that cocoa farmgate price in the previous year had a major impact on yields, we ran regressions on the determinants of price. Finally, we used regression analysis to more explicitly look at the determinants of farmer investment in cocoa and their plans for the future of their cocoa. These results as a whole support several policy recommendations for the V4C project and for other initiatives which seek to increase cocoa production in Côte d'Ivoire.

Analysis of time trends confirmed that the 2012 cocoa market reforms have significantly impacted the cocoa marketing at the farm level, and mostly had their intended effects. All farmers in the focus groups and the surveys reported receiving the 725F/kg fixed price, except for a few who received higher price. Price volatility dropped dramatically, going from a gap between minimum and maximum average price of 192 F/kg and 165 F/kg in 2010 and 2011 to a gap of essentially zero in 2012. The overall minimum and average cocoa prices dropped in 2011 but then rose significantly in 2012, to levels higher even than in 2010, though the 2012 maximum price was lower than that in 2010. The vast majority of farmers surveyed (96%) preferred this fixed price system because of the price certainty.

The time trend analysis also showed an increase in 2012 of sales to cooperatives instead of private pisteurs, an increase in services received from buyers (especially input support and training), a decrease in the number of individual buyers with whom producers sold their cocoa, an increase in certified farmers, a slight increase in bean rejections (a proxy for bean quality in the final market), and an overall improvement in farmer satisfaction with the market. These results suggest that the 2012 reforms have improved farmgate price, increased the power of cooperatives, drove some intermediaries out of the market, improved bean quality (though evidence for this result is the weakest), and increased support to farmers, all of which were goals of the reforms.

Results of the focus groups and time trend analysis also showed that cocoa yields have been falling over time. The suggested causes for this included aging trees, depleted soil, low input use, disease pressure, and low incentives to invest in cocoa due to prices. Regression analysis was used to isolate and compare the effects of these different factors. In order, the most important determinants of yield were found to be: labor use (a 10% increase led to a 56-73% increase in yields), cocoa price earned in the previous year (a 10% increase led to a 48-85% increase in yields), gender (male farmers had 44-52% higher yields than female farmers, though

this was insignificant when labor was accounted for), total land area (a 10% increase led to a 23-29% decrease in yields), having a bank account (increased yields by 20-25%), use of pesticide (an increase of 10% led to a 1.5-7.8% yield increase), and use of fertilizer (an increase of 10% led to a 1.5-2.3% yield increase). All of the signs on these variables were in line with expectations from the literature review, though the magnitude of the effect of fertilizer and pesticide was expected to be much higher, and the lagged price had much higher effect than anticipated.

In contrast to past findings, our results suggest that the supply of cocoa is actually quite price elastic in the short-run (1 year time frame only). This result may be biased due to a problem with the model specification, but it is possible that the result is accurate. Farmers facing very low prices may have invested very little labor and other inputs in cocoa maintenance or perhaps not even have harvested it all. Whether we believe the magnitude of the estimated coefficients or not, the significance of price in all six model specifications and even after several robustness checks suggests that farmgate price is not a factor which organizations seeking to increase cocoa yields can ignore.

Our regressions on the determinants of farmgate price showed that several factors have a clear significant impact, though for others the relationship is less clear. For example, farmers earned significantly higher prices if they sold with cooperatives instead of private pisteurs and if they sold with a small number of buyers within a given season instead of many different buyers. A positive relationship was also observed between farmgate prices and the services provided by buyers, even when year was controlled for. Essentially, the results suggest that farmers who sell with a single cooperative are more likely to earn higher prices and improved services, and that these types of arrangements have increased in 2012.

Prices were also found to be significantly higher in Bete villages when compared with Baoule and Mossi villages, which is an indication of market inefficiency, especially considering that the Baoule and Mossi make up the majority of the cocoa farming population and are proportionally more interested in keeping their cocoa. Weaker results include a general inverse correlation between village isolation and price and between the number of different buyers in a village and price (though an increase in services). The results did not support hypotheses from the literature that buyer competition would increase farmgate prices and farmer welfare. The best policy recommendation to promote higher prices is to promote formation of strong local cooperative buyers.

Our last set of regressions, on the future investment in cocoa, did not yield very clear results, though a few general trends were suggested. First, V4C programs seemed to have no significant impact on farmer attitudes toward the future of cocoa, even regarding the likelihood of rehabilitation. However, this may have been due to the fact that interest in rehabilitation was so high (84% of the sample), so there was little variation in the sample. Disease pressure had a major impact on farmer plans to rehabilitate or replace cocoa, as did migration status

(allochtones and allogenes were more interested in keeping all their cocoa in the future, compared to autochtones) and the price received for cocoa in 2010 had a significant positive impact on the likelihood to continue cultivating only cocoa. Farmers in more isolated villages were generally less likely to have replaced their cocoa in the past or to plan to do so in the future, and the same was the case of farmers with lower credit access.

This seems to indicate that in many cases farmers who stick exclusively with cocoa do so because they have no other choice. This is not necessarily a positive thing for the future of the cocoa industry. In fact, results of both the focus groups and the regression suggest that farmers are better off, and better able to invest in rehabilitating and intensifying their cocoa, when they have outside revenue, and that includes revenue from alternative cash crops. Almost no farmers said that they wanted to replace their cocoa completely, even those who had already cut down some of it to plant rubber. In focus group meeting several farmers reported using higher profits from rubber sales and credit (which is easier to acquire because rubber buyers pay through bank accounts) to invest in cocoa inputs and improve yields. Rather than working hard to avoid it, organizations concerned with cocoa production might consider assisting farmers to diversify into rubber and other crops, since evidence shows that these can be economically complementary.

There are several recommendations which emerge from these results, for the V4C project and for other initiatives which are interesting in increasing cocoa production and the sustainability of the cocoa communities of Côte d'Ivoire. First, the most important element in creating a sustainable cocoa economy according to farmers is increased support in acquisition of inputs. This could include schemes to subsidize fertilizer, composting initiatives, higher supplies of input on credit, and wider coverage of cooperative spraying programs. Second, rehabilitation methods like grafting are of very high interest to farmers in the study, and they want access to these technologies as soon as possible. Many of them say that the hope of rehabilitation is one of the key factors that has preventing them from abandoning their cocoa.

Third, it is crucial to consider the prices which farmers are facing. Providing training, access to fertilizer and other inputs, and technologies like hybrid seed and grafting will go nowhere if the farmers believe that it is not profitable to make investments in their cocoa. Short of providing free or heavily subsidized inputs the best way to stimulate investment in inputs and new technologies is to promote structural changes which create stable, higher cocoa prices in all villages. One way to do this is to support and continue the new government policies initiated in 2012, particularly the fixed price system. Another is to support formation of strong local cooperatives. One method of doing this would be for Mars and other major industry players to sign direct contracts with these cooperatives, guaranteeing them access to financing and stable sales, so that they can continue to serve farmers. Special efforts should also be made to target specific at-risk groups of farmers who face lower than average prices, including both internal and foreign migrants and those living in more isolated villages.

Besides focusing on ways to increase prices, there is also room to increase credit availability and thus investment in inputs by promoting payment of cocoa through bank accounts. This is much more palatable to farmers and more efficient when they are organized into cooperatives, especially if those cooperatives contract with a single large buyer (a traitant or even directly with an exporter). Finally, initiatives like V4C can help to promote and facilitate diversification of cocoa farmers into other crops, even rubber, since this will increase the stability of their income, could improve their credit access, and might help them to increase their investments in intensified cocoa production on their remaining land.

In sum, there is a lot of hope for the cocoa industry in Côte d'Ivoire, but it is crucial not to ignore price and market dynamics when designing interventions.

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