Agricultural Intensification as a Strategy for Climate Mitigation in Ghana

An evaluative study of the COCOBOD High Tech Program, rural incomes, and forest resources in the Bia (Juaboso) District of Ghana

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Executive Summary

In Ghana, as in many other tropical landscapes of West Africa, the expansion of extensive low input agriculture has resulted in significant deforestation with concomitant loss of biodiversity and greenhouse gas emissions. Of the many crops grown in Ghana, cocoa has had the largest expansion in area extent and is a strategic crop for the country's development. The story of cocoa in Ghana in recent years is a tale of two very different expansion episodes—the first episode witnessed an increase in the area cultivated by smallholders using extensive cocoa technology and took place in the 90s; the second episode has consisted of intensive cocoa technology adoption by smallholders induced by policy actions and growing land pressures in the decade of the 00s.

During the first expansion of the 90s, cocoa acreage expanded at a 9.1% annual rate mainly at the expense of forest reserves in the Western region. From 1988 to 2010 the extent of cocoa cultivation increased by nearly 1 million ha from a base of 720,000 ha to 1,625,000 ha with 86% of this increase occurring in the decade of the 90s. While the area cultivated was increasing, yields were actually decreasing, dampening overall growth in the industry. Recognizing this pattern of growth as unsustainable, the Ghana Cocoa Marketing Board (COCOBOD) began to implement the first elements of what would become the "High Tech" program of cocoa intensification in 2001. The program is an attempt to shift the cocoa growth paradigm from an extensive low input approach to an intensive approach based on modern agronomic practices and scientific principles. The program encouraged the adoption of intensive technology through substantial fertilizer and pesticide subsidies that were initially targeted to the Western region of Ghana. This region remains the most forested region in the country despite the heavy toll on the region's forests in the 90s. From 2002 to 2010 the Ghana cocoa sector made a remarkable turnaround with yields growing at 5.6% p.a.

In the current debate about climate change, poverty and biodiversity conservation strategies in developing nations, input based agricultural intensification (i.e. land sparing technology) is increasingly considered as a mitigation strategy for biodiversity loss, poverty alleviation, deforestation and carbon emissions (Green et al. 2005, Burney et al. 2010, Gockowski and Sonwa, 2011, Phalan et al.,2011).

A case study of cocoa intensification and the Cocobod High Tech program was conducted by the Sustainable Tree Crops Program of IITA in 2011 to better understand the potential of the intensified perennial tree production systems as a potential tool for addressing rural poverty and climate change mitigation. The objectives of this study include:

1. Quantification of the factors underlying increased cocoa yields and incomes in Bia (Juabeso).
2. Estimation of the rates of deforestation post intensification and the area of deforestation and forest degradation mitigated because of the adoption of intensified land use systems.
3. Analysis of the institutions required for the sustainable intensification of cocoa farming systems.
4. Examination of the characteristics and predictors of households adopting the intensified production of cocoa.
5. Analysis of the economic and environmental tradeoffs between shaded and full sun cocoa.

The analysis is based upon farm level data generated over the last 10 years beginning with a baseline household survey conducted by STCP in 2001 and ending with a household survey in 2011. The main focal points of the survey analysis are changes in the cocoa farming systems over the last 10 years and quantification of the sources of productivity. This is then combined with remote sensing analysis of land-use and land use change (deforestation) for the same 10 year period using satellite images at four separate moments in time for a 1,201 km^2 benchmark of the Bia district of the Western Region. Combining the estimates of deforestation from the remote sensing exercise and the evidence on yield growth from the household survey, an estimate of the avoided deforestation due to higher yields was calculated for the benchmark.

The birth of Cocobod's High Tech program is rooted in the Cocoa Diseases and Pest Control **(**CODAPEC) program designed to assist cocoa farmers with the control of capsid insects and cocoa black pod disease. Assistance is in the form of copper fungicides and insecticides applied by government-sponsored spray gangs at no charge. The program was initiated in 2000/2001 and over the last five years, Cocobod has purchased and distributed fungicides and insecticides valued at nearly US$200 million through the CODAPEC program to the field level. To apply these agro-chemicals, motorized and pneumatic sprayers at a cost of nearly $12 million were procured and distributed to the agro-chemical spray teams hired by Cocobod/CODAPEC.

The other major component of the High Tech program is the subsidized distribution of fertilizers to cocoa farmers initiated in 2003 in the Western region. In 2001 before the purchased and distribution of subsidizied fertilizer had been initiated, less than 3 percent of the cocoa producers in the Western region where using fertilizer. Today over 83% of the farmers in the Western region are applying granular fertilizers.

In order to quantify the impacts of the Ghana high tech program on cocoa yields and income, a survey of 171 randomly selected rural households in the Bia district was conducted. For each household an inventory of all land units belonging to the household was established and questionnaires were developed for all identified land uses. Cocoa production systems were separated into mature bearing cocoa and young cocoa yet to reach the bearing stage. The other major cash crop in the study benchmark was revealed to be oil palm, while the mixed food crop field was mainly subsistence-oriented. Information was gathered on approximately 500 production/land use systems from the 171 households surveyed.

Precise measures of land use change were obtained by remote sensing analysis. By combining the discernible changes in land cover with the household data on the cocoa cropping system and changes to the system over time we were able to estimate the gain in productivity due to the High Tech program.

Almost 100% of the households surveyed grew cocoa; the majority of which were only producing cocoa. From the household survey it was estimated that 83% of all cultivated land was planted to cocoa. Despite this most households were able to meet their caloric needs by including food crops in their cocoa production enterprise particularly where the cocoa had been newly planted or in some cases replanted.

The estimated cocoa yield in 1999/2000 for the Bia district from the STCP baseline was 199 kang per hectare; the estimated yield for 2009/2010 from our household survey was 534 kg per hectare which is more than a twofold increase over the 1999 yield.

In order to separate the effects of the various factors influencing the production of cocoa, a linear regression model was estimated. The model regresses household production of cocoa in 2009/2010 on a range of variables including agrochemical input usage, participation in the mass pesticide spraying program, household inputs of labor, land and capital, demographic variables, farmer field school training participation, current and lagged fertilizer applications, indicators of cocoa varietal differences, and the number of shade trees included in the household's cocoa production system.

According to the model an additional kilogram of fertilizer at a subsidized cost of 0.5 Ghana cedis per kg would generate an additional output of 1.4 kg of cocoa with marginal value of 4.48 GHc. We note that the recommended application rate of 370 kg /ha was much greater than the mean application of farmers who applied at an average rate of 65.8 kg/ha. This along with the regression finding suggests an under allocation of household capital resources to fertilizer and that additional applications would generate greater net profits for the farmer. The role of credit constraints in explaining this under allocation requires further research.

The study revealed that farmers were using two principal types of cacao planting material. The first type are open pollinated unselected plantings directly seeded from the farmers own tree stocks. Referred to as F3 Amazon cacao these are several generations removed from the original F3 introductions of the 1960s and 70s by the Cocoa Research Institute of Ghana and accounted for over 90% of the total bearing acreage. About 8% of the bearing acreage consisted of hybrid seedlings from superior families produced using hand pollination techniques by the 23 Cocobod Seed Production Units scattered across the country. For the representative cocoa farmer the marginal product of another hectare of F3 unselected Amazon cocoa is 242 kg while the marginal product of another hectare of hybrid cocoa is 1344 kg. Both types of cocoa acreage exhibited diminishing marginal returns, which may be due to failures in the labor and capital markets that do not allow larger farms to engage sufficient amounts of these production factors.

The demographic variables of significance were the age of the household head which was negatively related to output in a nonlinear fashion and the household head's educational attainment which had a positive impact on output highlighting the value of youthful energy and education in a rapidly changing agricultural setting. The gender of the producer was not a significant determinant of output.

About 40% of households had food crop fields in addition to cocoa; we tested the impact of food crop cultivation on cocoa output by including the food crop area cultivated. Although the regression coefficient was negative it was not significant. Shade trees did exert a negative influence on cocoa output with each tree decreasing output by an estimated 2.34 kg. For the representative producer with 46 shade trees the effect amounts to a 108 kg decrease in output relative to the full sun scenario. If we consider the current price of cocoa in Ghana this amounts to a decrease of approximately GHc 65 per ha in revenues at the mean level of shade.

The regression model suggests a high return to farmer field school training (FFS). FFS is a relatively knowledge intensive extension tool that has been criticized for being high cost. However in a situation where agricultural technology is rapidly changing, an effective extension service is of crucial importance. This is an area like seedling hybrids and additional fertilizer application where high future payoffs to added investments are likely as less than 6% of the farmers interviewed reported receiving FFS training.

The findings on migration revealed that by the mid-90s nearly all of the stool lands had already been allocated and as a consequence migration slowed considerably in the decade of the 00s. It would seem that new migration would be unlikely unless more land for planting cocoa i.e. forest reserves, were made available. Given this changing demographic and the disappearance of the forest frontier, cocoa farmers must find and exploit remaining opportunities for productivity growth if poverty is to be eliminated and the forest reserves of Bia are to be maintained.

To quantify the impact of increased agricultural intensification on output and yields, the regression model of cocoa production was employed to predict the output that would have resulted, were fertilizer and insecticide inputs applied at the frequencies representative of the year 2000 prior to the high tech program. Besides the changes in fertilizer and insecticide use, we include the fertilizer carryover effect and the farmer field school training impact as neither of these two elements were important in the year 2000.

The cocoa yields in 2010 were three times greater than the predicted yield calculated at 2000 input levels. Nearly all of the mean yield increase which has transpired since the initiation of the High Tech program is attributed to the use of fertilizers which has become quite common in the Western region. It is estimated that the productivity gain from one ton of fertilizer substitutes for 2.84 ha of low input extensive cocoa technology.

Although the impact of FFS training is estimated to have increased producer output by over 1400 kg, only a small proportion of producers benefited from this training provided by the Sustainable Tree Crops Program. The impact of cocoa hybrids was similar to that of farmer field schools training in that although the impact was high, the low adoption resulted in the limited contribution of improved planting materials to the overall increase in yields.

Remote sensing analysis of land use and the transitions between forest and the rural agricultural mosaic were monitored, over a total area of 1,201 square kilometers using 2000 and 2003 Landsat images, a 2006 Spot image, and a 2011 ALOS image.The analysis found that forest land which is comprised 35.5% of the total land area covered by our study in 2000 had declined to 33.5% by 2011. The majority of this deforestation entailed encroachments in the Bia Game Reserve and the Krokosua Hills Forest Reserve. It is interesting to note the near absence of encroachment in the Bia National Park in contrast to the two reserve forests. We surmise that this is due to differences in the level of enforcement by forest wardens.

It is estimated that 11,173 households were operating in the Bia benchmark in 2011 with an estimated total of 640.2 km^2 planted to cocoa, of which 564.2 km^2 was mature and bearing at an average yield of 535 kg per ha with the total 2010 production from the study benchmark estimated at 30,186 tons. Dividing the 2010 output by the 2000 yield gives an estimate of the cultivated area that would have

been required if using the technology of 2000. The estimate of 1,517 km², exceeds the total area of the Bia benchmark. Therefore even if all the remaining forest estimated at 402 km² in 2011 were converted to extensive cocoa, this level of output could not have been achieved with the technology of 2000. From a REDD+ policy perspective, the 402 km^2 of remaining forest represents a significant global asset of carbon which we argue is an indirect outcome of the Ghana High Tech program.

The intensification of the cocoa farming systems in the Bia benchmark resulted in positive income growth and is necessary to ensure the environmental integrity of the landscape. It is however not sufficient on its own to guarantee the conservation of closed canopy forest and must be accompanied by proscriptive land-use policies for national parks and forest reserves with firm enforcement.

Global value streams from tropical forest assets should be used to support sustainable intensification and forest protection. Determining the monetary value of these climate change assets and rewarding cocoa growing communities for their maintenance is the logical next step in this analysis. This requires measuring and quantifying the average carbon stock for both the rural mosaic and the closed canopy forest. It will also necessitate the monitoring of land use change through the use of remote sensing and the monitoring of land use productivity through a random representative sampling design. We did not have the resources to extend this study in this direction, but for illustrative purposes assume that the average difference in carbon between the rural agricultural mosaic and tropical forests is 120 t CO_2/ha. Under this assumptions the stock of avoided carbon emissions in our benchmark area would amount to 4,800,000 tons C or 17,600,00 t CO_2-eq which at the 2010 voluntary OTC market price of $6/t has an asset value of $105,600,000. A meager 3% return on this asset (think of a natural capital bond) would generate approximately $3 million annually in financial resources for maintaining this carbon stock. A portion of these resources could be reinvested in the public goods (research, extension and public awareness) needed to support the sustainable intensification of tree crop systems. Another portion should be used to protect and conserve forests assets which still witnessed the conversion of 2,400 ha in the last 10 years despite the positive achievements in productivity.

Two competing cocoa technology systems were distinguished—an intensified system based on agrochemical input usage and an extensive production system based on biomass conversion into plant nutrients. Producers with smaller land holdings were more likely to adopt the intensified system then were larger producers who opted for an extensive technology system characterized by relatively low capital and labor investments on a per unit area basis. The largest 25% of landowners accounted for 50% of total output produced with 57% of the total cacao tree stock resource. Yields were significantly lower among large farmers. These findings suggest that climate change mitigation packages for agricultural intensification will find wider acceptance among land-constrained producers especially if credit constraints are not binding. However, the greatest impact on deforestation is most likely to occur from interventions targeting the extensive land use practices of the largest farmers.

If mitigation is a principal objective then addressing the intensification constraints among large producers is necessary for achieving significant impact. For larger landowners, labor rather than land is the principal constraint. In response, they are implementing an extensive technology which economizes labor and capital rather than an intensive technology system which demands more of these factors. The

difference in terms of labor endowments per hectare between the lower and upper tail quartiles of the farm size distribution is fourfold.

The fact that fertilizer use was estimated to have accounted for 87% of the increase in mean yields begs the question: "Why not just increase fertilizer use among large producers?" Unfortunately, the answer is not simple; increasing land productivity through additions of fertilizer will only occur if large farmers are able to mobilize additional labor and capital resources to get the cocoa off the tree and in the bag. If the farmer is unable to harvest all that is produced because of labor constraints then clearly the producer will not produce more. Capital readily substitutes for labor and one strategy for intensifying production among larger producers would be to increase capital inputs particularly in the realm of local rural transport, and postharvest processing.

On the other hand agricultural intensification appears to be a good fit when poverty reduction is principal objective. In our study sample the lowest income class had a lower adoption rate of fertilizers and significantly lower size of landholding. Reductions in poverty will require improving the access of the poor to productive factors including land resources, farmer training, improved planting materials and fertilizers. The regression analysis confirmed the positive impact of these factors on cocoa production and incomes. What begins to emerge is a pathway out of poverty based on the increased usage of fertilizer, increases in farm size, the adoption of hybrid cocoa varieties and increases in the farmer's stock of knowledge.

Six institutional challenges to creating such a pathway have been identified:

1. *Delivering agrochemical inputs.* Much greater effort is needed to build sustainable input delivery systems. The distribution of fertilizers through government agents crowds out the private sector.
2. *Efficient real estate markets.* A modern land tenure system would permit small but efficient producers the means of expanding their operation by buying out inefficient producers. Evolution in customary land tenure institutions may be headed in this direction as discussed in appendix A.
3. *Efficient inheritance institutions.*The recent change from a matrilineal to an officially patrilineal system (though bilinial in practice) is impacting the structure of farming in Ghana. Land that historically remained intact over the generations is now inherited by the biological children of the married couple. This fragmentization limits the options of the farming enterprise and is often coincident with emerging land markets.
4. *Producing and delivering improved planting materials.* As the Cocobod looks to develop future sources of productivity growth, addressing the low adoption of improved hybrids that are four times more productive than the open pollinated F3 Amazon variety typically used by farmers is an obvious target
5. *Generating innovations and innovation delivery systems.* Research is woefully underfunded and when innovations are generated they often sit on the shelf and do not get out to the farmer as extension services are as poorly funded as research, if not worse.

6. *Addressing credit market failures.* Credit constraints are one of the likely reasons underlying the sub optimal use of fertilizers. Interlinked credit arrangements with licensed buying companies offers an intermediate institutional innovation that has proven effective for broadening smallholder access to essential inputs. In terms of future productivity gains, increasing fertilizer use is still a viable strategy for increasing productivity with plenty of room for further expansion given that only 9% of producers were applying fertilizers at the recommended rate of 370 kg/ha.

In the last 10 years there's been a remarkable adoption of agrochemical intensification in the cocoa sector of the Western region of Ghana. Farmers recognize the value and indeed the necessity of applying inputs. Ghana has shown that such a strategy is viable among smallholders however the institutions for delivering these inputs are still largely state-based with questionable long run sustainability. Developing private sector institutions for the delivery of inputs should be a major focus of the development agenda. Currently the institutions supporting intensification are all targeted to the cocoa sector. The high tech program has proven technically that cocoa yields can be increased with major positive impacts on both poverty and the environment achieved. However, much of the success has been driven by the high price of cocoa since the mid 2000s. Markets are volatile and input markets and farmers need to be flexible and able to respond to changing incentives. Smart subsidies for the use of fertilizers need to be designed so that the private sector is fully engaged and participating in the distribution and sale of these inputs. Having a viable agricultural input sector is one of the best ways for farmers to adapt to a changing climate and volatile markets.

The potential productivity gains from the adoption of hybrid cocoa are substantial and could easily double current yields just as the use of fertilizers did in the decade of the 00s. As the industry develops and modernizes one would expect to see specialization and economies of scale impacting in this critical segment of the sector. To date state-sponsored seed gardens have by and large failed to deliver the best varieties to farmers in the quantity and form desired by farmers. Ultimately for institutional sustainability, the multiplication and propagation of improved planting material should lie with the private sector and not the public sector. The principal role of the public sector is to develop the improved varieties and adapt them with farmers.

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Introduction

In Ghana, as in many other tropical landscapes of West Africa, the expansion of extensive low input agriculture is an important agent of deforestation (Norris *et al.* 2010, Gockowski and Sonwa, 2011). Ghana in the last 23 years has increased cocoa production in impressive fashion growing from a base of 300,000 tons in the late 1980s to slightly over 1 million tons in 2010/11. This impressive output growth is in fact a tale of two very different expansion episodes—the first expansion was due to an increase in area cultivated and took place in the 90s; the second expansion was due to agricultural intensification that was induced by policy and growing land pressures in the decade of the 00s.

Growth in the Ghanaian cocoa sector in the 1990s was driven by an unprecedented expansion of traditional low input cocoa technology. Cocoa acreage expanded at a 9.1% annual rate mainly at the expense of forest reserves, while yields declined annually by 4.5% slowing output growth to 4.6% p.a (figure 1, panel b). In the last 23 years the extent of cocoa cultivation in Ghana has increased by 1 million ha from a base of 700,000 ha to 1,700,000 ha with nearly all of this increase occurring in the decade of the 90s. Widespread deforestation and forest degradation was associated with this area expansion which was mainly the result of smallholders.

Recognizing this pattern of growth as unsustainable, the Ghana Cocoa Marketing Board (COCOBOD) began to implement the first elements of what would become the "High Tech" program of cocoa intensification in 2001[1]. The program is an attempt to shift the cocoa growth paradigm from an extensive to an intensive approach based on modern agronomic practices and scientific principles. This program was initially targeted to the Western region of Ghana which at that time was the region with the largest forest remnants. From 2002 to 2010 the Ghana cocoa sector made a remarkable turnaround with yields growing at 5.6% p.a. in contrast to the previous decade (figure 1).

In the current debate about climate change and biodiversity conservation strategies, input based agricultural intensification (i.e. land sparing technology) is presented as a mitigation strategy for biodiversity loss, deforestation and carbon emissions (Green et al. 2005, Burney et al. 2010, Gockowski and Sonwa, 2011, Phalan et al.,2011). Forest carbon is protected through cross-sectoral agricultural interventions that are not strictly related to forest management. The impact of agricultural intensification on carbon balance and biodiversity is assumed to depend on the magnitude and the extent of three potential outcomes of technical change in production:

(1) the amount of deforestation avoided following the adoption of higher yielding land sparing cocoa technology,
(2) the increase of carbon and biodiversity in agricultural landscapes through the promotion of shaded, biodiverse cocoa agroforestry that are higher yielding as well as more bio diverse than traditional extensive systems
(3) additions to climate emissions from the increased use of agrochemical inputs.

1 Mayaux et al. (2004) estimate that in 2000 there was only 1,193,000 ha of dense forest remaining in Ghana

As documented in Burney et al., 2010 and Phalan et al., 2011, empirical evidence suggests that the carbon and biodiversity conserved through avoided deforestation is much greater than the additional carbon emitted or biodiversity loss associated with agricultural intensification. The second outcome represents an intermediate intensification technology that trades off some avoided deforestation (relative to the full sun alternative) in exchange for carbon stock and biodiversity enhancements. The cocoa-mixed tropical timber associations proposed by Gockowski and Sonwa (2011) are examples of such potential intermediate technologies.

Study Objectives

1. Quantify the factors underlying increased cocoa yields and incomes in Bia (Juabeso).
2. Estimate the rates of deforestation post intensification and calculate the area of deforestation and forest degradation avoided because of higher cocoa yields.
3. Analyze the institutions required for the sustainable intensification of cocoa farming systems.
4. Examine the characteristics and predictors of households adopting the intensified production of cocoa.
5. Analyze the economic and environmental tradeoffs between shaded and full sun cocoa.
6. Analyze the institutions and policies required to implement a full land sparing strategy.

We begin the investigation of productivity growth in the Ghana cocoa sector by looking back retrospectively at cocoa agronomic practices and productivity levels in the year 2000[2] which is then complemented by a 2011 field survey of rural households. These databases are subjected to various multivariate analyses of cocoa productivity. The institutions surrounding agricultural intensification are investigated through key informant interviews including village elders, farmers, market agents, and government officials. Finally an anthropologist was engaged for ten days in a village in the Bia district learning about perceptions and norms relative to land tenure, inheritance, sharecropping, and other local customs. The main focal points of the analysis are changes in the cocoa farming systems over the last 10 years and quantification of the sources of productivity. This is then combined with remote sensing analysis of land-use and land use change (deforestation) for the same 10 year period using satellite images at four separate moments in time for a 1,201 km^2 quadrat of the Bia district of the Western Region. Combining the estimates of deforestation and the evidence on yield growth, an estimate of the avoided deforestation due to higher yields was calculated.

Study Area

The selected site in the Juaboso District encompasses the Bia National Park- Krokosua Hills biodiversity hotspot which is one of the most important forest remnants in the Western region of Ghana (figure 2).

[2] A baseline survey in 2001 conducted by the IITA Sustainable Tree Crop Program interviewed over 400 cocoa farmers in the Juabeso district. The Bia district was subsequently created out of the northern reaches of the Juabeso in 2001 when the survey was carried out as it was administratively part of the Juabeso district

This area is also at the center of the recent cocoa expansion and protected areas have been encroached upon by illegal logging and the expansion of cocoa and other agricultural crops.

The Western region currently accounts for more than 60% of Ghana's total cocoa production and this district is the most productive in the Western region (Cocobod, unpublished data).

The District has a surface area of 1,924 km^2 and a population of approximately 150,000 which has been growing at 3.5% per annum as compared to national (2.7%) and regional (3.2%) average rates. The high growth rate reflects immigration into this region by cocoa settlers. The district is ethnically diverse: the Sefwis who are indigenous and belong to the Akan ethnic group form 52.4% of the district's population whilst settlers account for 48.6% of the population. The largest group among the settlers are the Brongs (25.5%) followed by Ashanti's (8.4%). Migrant farmers own over 65% of the cocoa farms in the district where traditional land management is in the control of the traditional rulers, family heads and land owners. Slightly more than half of the district's cocoa producers farm on lands bought from traditional rulers and lineage heads. Due to the high demand for cocoa land there are incidences of fraud and improper transfer of land in the district. This has led to numerous court cases involving land acquisition as well as encroachment on forest reserves.

Originally, there were three forest reserves in the district—Bodi, Bia-Torya, and Krokosua Hills—today only two reserves remain as ecological islands of forest in a sea of full sun and low shade cocoa farms.The Bia National Park and the Krokosua Hills reserve, account for 28% of the land area in the District. Inadequate and poorly motivated staff, lack of equipment and shortage of funds result in low levels of forest protection and control. Poaching, illegal logging and agricultural encroachment continue to erode the forest cover. The forest reserves are currently being logged by forest concessionaries. Recently, a combined team of military and forestry officials destroyed more than 1,000 ha of cocoa in the Krokosua Hills forest reserve. This forest reserve is currently exploited by logging concessions.

More than 60% of the district residents lack access to potable water and the district has a poorly developed road network with only 20 kilometers of tarred roads and only one trunk road Juaboso – Dwenease (Sefwi Wiawso District) linking it to the rest of the country. Despite the fact that the district is the largest producer of cocoa among all the districts in Ghana today, poverty levels are still high.

Disaggregated statistics on poverty are difficult to come by in Ghana. An alternative proxy measure is child nutritional status, as measured by the DHS public health survey. At the regional level the nutritional status of children gives a broad indication of poverty. Analyzing the data from the 2008 DHS, we find only a slight difference between the region and the rest of the country in terms of these proxy measures of poverty and hunger. For the country as a whole 28% of children under the age of five were stunted, 9% were wasted, and 14% were underweight. By comparison, in the Western region these percentages were all slightly lower at 27%, 5.6%, and 10.3% respectively. Although regional data were not available over time, the trend in the nutritional status of children was improving for the country as a whole. For instance in 2003 thirty-five percent of children under five were stunted.

An Overview of the Cocobod High Tech Program

Over the last ten years, Ghana's Cocoa Marketing Board, also known as Cocobod[3], has undertaken the High Tech Program (HTP) whose intention was to reverse the decline in yields and to increase production to one million tons of beans annually. To encourage intensified production, two supporting policy actions in the early part of the decade of the 2000s were undertaken—the first involved a commitment to pay producers 70% of the net fob price which when implemented nearly doubled the official producer price; the second, involved the liberalization of internal cocoa markets which has led to the vertical integration of cocoa buyers in the provision of cocoa inputs and producer credit (see below).

The high tech program started in 2001 with the Cocoa Diseases and Pest Control **(**CODAPEC) program designed to assist cocoa farmers with the control of capsid insects and cocoa black pod disease. The program divides the country into zones of intervention one region for black pod control, another region where farmers are assisted in controlling capsid sucking bugs and the third region where farmers are assisted with both of these pests control issues. Assistance is in the form of copper fungicides and insecticide applied by government-sponsored spray gangs at no charge. The program norms are two sprays of insecticide and three sprays of fungicides per farm. It should be pointed out that this is not generally adequate for effective control; and the farmer is expected to purchase pesticides from private agents to complete the control. The use of agrochemicals to control these pests is a key element in achieving higher yields but the effectiveness of the program is ambiguous. The program has been plagued by numerous institutional failures and is large and unwieldy with over sixty thousand employees.

From 2005 to 2010, Cocobod purchased nearly $39 million worth of fungicides and insecticides annually which were distributed through the CODAPEC program to the field level (table 3). Over 90 percent of these expenditures were on insecticides suggesting that capsids are a more significant problem than cocoa blackpod disease. The CODAPEC program is charged with physically applying the pesticides purchased by Cocobod on farmers' fields at no charge excepting fuel for operating the motorized sprayers. To apply these agro-chemicals, a total of 25,318 motorized sprayers at a cost of $9.7 million were procured and distributed to the agro-chemical spray teams by Cocobod/CODAPEC along with 35,000 pneumatic sprayers at a cost of $1.6 million.

The subsidized distribution of fertilizers to cocoa farmers is the other major component of the High Tech program. In 2003 COCOBOD initiated the program in the Western region. At that time, fertilizer was being used by less than 3 percent of the cocoa producers in said region (IITA unpublished data). Almost all the crop balances in Ghana show a nutrient deficit in terms of the quantities of plant nutrients applied and the quantities removed or lost (FAO, 2004). Kudos to COCOBOD for recognizing soil nutrient depletion as one of the critical natural resource issues facing Ghana and for demonstrating the benefits of fertilizers on yields and soil restoration.

[3] Cocoa production in Ghana is regulated by the Cocoa Marketing Board (COCOBOD).

Dry fertilizers once purchased by Cocobod are distributed principally by two types of agencies—the first set of public or quasi-public agents are employed either by the GoG or agencies and parastatals affiliated with the Cocobod. The principal distributing agents are the District officers of the Ministry of Agriculture, the purchasing clerks of the Produce Buying Company and the agents of the Cocoa Input Company who are charged with distributing these fertilizers at a heavily subsidized price. Distribution by the private sector involves village-based purchasing clerks employed by the various Licensed Buying Companies and agents of the Cocoa Abrabopa farmer association which is supported by a major agroenterprise involved in the importation and distribution of agrochemicals. In 2006/07, the share of public sector partners in the distribution of fertilizer was 88% versus 12% for the private sector. More recently in 2009/10 the share of the private sector partners had risen to 37% (table 5). Most of the increased activity of the private sector appears to be occurring in the Western region among LBCs. STCP staff involved in the recent household survey in the Western Region reported repeated instances of LBC purchasing clerks competing with one another to supply fertilizer on credit against the future sale of the borrower's cocoa to the clerk supplying.

Another important component of the high tech package is the use of selected hybrid varieties developed by the breeding program of the Cocoa Research Institute of Ghana (CRIG). F1 hybrid crosses are produced through hand pollination by more than twenty Seed Production Units (SPUs) located across the cocoa growing regions of Ghana. The SPUs sell F1 hybrid cocoa pods to farmers at a subsidized price. There is no private sector involvement in production and distribution of improved planting material with the exception of agents employed by the SPUs who occasionally produce seedlings and then sell them to farmers wishing to establish a farm or replant an existing farm.

Methodological elements of the study

The study draws on agricultural economics, landscape ecology, remote sensing, and anthropology. Agricultural productivity was the focus of a randomized cluster survey of 171 rural households in 17 villages. A sampling frame, listing all the villages in Bia District was used to randomly select villages. When the village was well laid-out it was divided into four quadrants and every other household selected until a sample of 10 was reached. If there were more than two households in a house we treated them as if they are from a single household. There were a few instances where the total number of households did not total to ten, in which case all households were interviewed.

Our interest was to understand the processes of land acquisition and land use from the time of settlement to the present. In pre-survey discussions with farmers it was revealed that land was typically acquired in discrete units often separated by several kilometers and then developed into a cocoa farm or alternative agricultural use. For each household an inventory of all land units belonging to the household was established and questionnaires were developed for all identified land uses (appendix B). Cocoa production systems were separated into productive mature bearing cocoa and young cocoa yet to reach the bearing stage. The other major cash crop in the study benchmark was oil palm, while the mixed food crop field was mainly subsistence-oriented. Information was gathered on approximately 500 cropping/land use systems.

In addition to the quantitative survey, a qualitative anthropological description of village norms and cultural institutions pertaining to the issues at hand was conducted over the course of ten days and nights. Based on the results of this multidisciplinary study as described in this report, and an in-depth literature review, the anthropological study will enter into a second phase.

Precise measures of land use change were obtained by remote sensing analysis. By combining the discernible changes in land cover between four time steps with the household data on the cocoa cropping system and changes to the system over time we were able to estimate the gain in productivity due to the High Tech program. We then apply a "what if" analysis (in similar fashion to Burnley et al. 2010) to examine the level of deforestation that would have occurred had yields remained at their 1999/2000 assuming the same level of output. While we did not measure of carbon levels, estimates can be made through recourse to ASB methodology about assessment of carbon stock in land use units (Hairiah et al. 2009) and other technical literature.

Survey Results

As we were interested in understanding land use and land use change over time, the subject of our analysis is the ensemble of all land parcels belonging to the household head. Separate questionnaires were implemented for each land parcel depending on the particular use to which it was employed. As such a household with four separate parcels would complete four questionnaires. Land use specific questionnaires were developed for mature cocoa, young cocoa, other cash crops, and food crops. In addition to these field-specific questionnaires, there was a household specific questionnaire which gathered information pertinent to all land uses. In total, data was gathered from 171 households whom generously participated in the survey and provided information on 260 mature cocoa farms (defined as already in production), 60 young cocoa farms (4 years or less), 56 other cash crop farms and 74 food crop farms for a total of 450 agricultural plots. In addition, 26 fallow plots and 23 on farm forest lots were enumerated resulting in a final total of 499 land use observations distributed over 171 household observations.

Land use and intensification trajectories in Bia District

We are interested in developing an empirical understanding of the interactions through time of land use change, land tenure institutions and agricultural intensification.

Current land use in Bia District

The two major land uses in the Bia district consist of private smallholder agricultural enterprise and publicly owned forest lands subject to multiple uses. The latter include gazetted forest reserves such as Krokosua Hills where private logging is permitted under long term concession and the Bia national park (77km^2) where neither logging nor exploitation of natural resources is allowed. Logging and hunting is allowed in the Bia Resource Reserve (277 km^2), adjacent to the park.

Agricultural enterprise is synonymous with cocoa as nearly all households engaged in its production (table 1). For about one-quarter of the households interviewed this was the only agricultural land-use cited. Cocoa was the only cropping system reported by a majority of households. The next most

frequent land use was the food crop field followed by oil palm systems. Surprisingly few farmers had land that was in fallow or secondary forest. The majority of cocoa farmers in the Western region are commercially oriented and fully engaged in a cocoa boom with little concern for diversification. This is clearly seen in acreage data by land use, where cocoa accounts for 83% of all cultivated land. Only two in every five households had a food crop field which suggests a relatively high dependency on food markets among rural households. While markets are important for food security in the Bia district, most households are still able to meet most of their caloric needs by including food crops in their cocoa production enterprises particularly the young cocoa fields which are almost universally intercropped with food crops (mainly cassava, cocoyam and plantain). Overall, the mean estimate of the proportion of purchased food in total household food consumption was 37%. Market dependency was highest among the smallest landowners who are purchasing 55% of their food consumption from the market.

Land Distribution, Intensification, and Yields

The distribution of total farm size among the sample households was positively skewed with the median household farming just under 5 ha and the mean farm size just over 7 ha (table 2 and figure 3). The cropping intensity was defined as the total area in production divided by the total farm area and showed little variation over farm size; all quartiles were above 90%. The high cropping intensity among even the largest land owners suggests that a "use it or lose it" tenure norm for stool lands may be at play (see discussion of land tenure in appendix A).

While there is little difference in the cropping intensity, the largest producers have a significantly lower average cocoa yield per hectare and are in pursuing on the whole a more extensive production strategy relative to smaller farmers (table 3). The lower yields of the largest landowners are correlated with lower applications of fertilizer, fungicide, insecticide and labor inputs per ha of cultivated mature cocoa. Herbicides are the only purchased input where the application among large producers exceeds the overall mean. This latter result reflects the labor saving nature of herbicide use when compared to manual weed control.

Quartile IV farmers control 57% of the agricultural land in production and had an average farm size of 17 ha. They also account for nearly 50% of cocoa output. On a per hectare basis we see that the smaller producers are employing on average between 2x and 4x more labor and three times as much capital per ha as are the largest producers.

Poverty and intensification

In this section, the relationship between cocoa income (as a proxy for household income) and agricultural intensification is considered. Poverty is difficult to measure in semi-subsistence economies such as our own where most households still produce the majority of food consumed. Unfortunately, with a one-time visit, we were unable to accurately determine the value of this consumption and instead focus on the income generated from cocoa. As we have seen cocoa accounts for the lion's share of agricultural enterprise in the Western region and therefore offers a reasonable proxy for household income. If we define poverty as per capita cocoa income of less than two dollars per day then 64% of our sample households were living in poverty as so defined. Alternatively, if we define poverty as less than one dollar per day, the percentage of our sample living below the poverty line falls to 39%. As we are

not accounting for all the economic activity of the household these figures likely represent an upper bound on poverty as so defined.

To further develop our understanding of poverty in the Bia district we analyze differences in various factors beginning with an analysis of variation in the intensity of agrochemical use per hectare across the cocoa income distribution of our sample population. Focusing on households earning less than $1 per day in cocoa income, i.e. the first two quintiles of our income distribution, we find that these households had a significantly lower adoption rate (56% versus 84%) than the ? among the rest of the income distribution (P=.0006) and lower mean application rates of agrochemicals per ha (figure 4., panel b). Overall, insecticide adoption among the poor was higher than fertilizer adoption although again the frequency of non adoption among the lower income classes (15%) was significantly higher than among non-poor (5.2%, p=.062). In terms of the intensity of use as measured by the number of liters applied per ha the differences seen across the cocoa income distribution were not statistically significant (figure X., panel a). This pattern of lower agrochemical use among the lower income classes was repeated for fungicides where 43% of the very poor (defined as quintile 1) had applied fungicides versus 62% among the rest of the income distribution (Chi-test, P=.096).

As expected, a strong positive association existed between per capita income and cocoa area in production with a correlation coefficient of 0.51. The mean area in production among the highest income quintile was 5.5 times greater than among producers in the lowest income class. This disparity in land holdings accounts for a good deal of the variation in cocoa income. There was also a positive correlation between yields and per capita income (rho =.35).

Land tenure and intensification

Land tenure was one of the principal focuses of our anthropological investigation and was also treated in the household field survey. Preliminary findings from the qualitative case study of one cocoa community, composed of both indigenous and migrant populations, confirm that there continue to be manifest differences in land tenure arrangements between 'citizen' and migrant (cocoa) farmers. However, any historical paperless arrangement with the stool and/or indigenous family heads has always entailed some level of insecurity. This insecurity counts for both the customary arrangements migrants have made with the stool and/or individual citizens, as well as for the citizens' and their negotiated rights over stool and/or family lands. Much of this insecurity however can be countered relatively easily, by investing in personal relations and through your general standing within society. A second important security element is the cocoa crop itself. As long as one continues to farm his or her crop(s) it is virtually unheard of that you would be denied of your right to the produce. This effectively turns the act of planting cocoa into a renewable land use right for about 40 years.

The customary land tenure system is embedded within the national official land tenure system and most of the chiefs appear to be seen as credible arbitrators. However, especially for privately acquired lands, land ownership papers are rapidly becoming the norm. The most cited document is the farm plan that is given out by official surveyors, generally through the Stool Lands Office. Not only does it provide a ready proof of ownership that doesn't depend on local witnesses and has validity beyond the stool's sphere of influence, it renders yearly taxation more transparent and provides a way of using the land as collateral.

It therefore seems that land titling (though officially the farm plan document does not necessarily has that status) has a number of drivers that makes it essential in the eyes of many farmers nowadays. Whereas for migrants, managing cocoa farms has always been about accumulation of private lands, the still matrilineal Akan are however rapidly moving towards more private, individualistic ownership arrangements. Although the customary matrilineal system is held in high appreciation by the Akan, it seems most nuclear family heads are actively preparing for patrilineal inheritance, to each of their biological children. Farmers no longer want to depend on the men in the maternal family to take care of their nuclear family after they pass on. Akan men feel increasingly related to their own biological children and want the best for them and their childrens' biological mother (or father) after their death, thereby disfavouring their 'own' sisters' children.

This drastic rupture with the customary matrilineal inheritance system results in more and more family lands not reverting back to the men in the maternal blood line (mothers' brothers in general) thereby in fact transferring from one matrilineal blood line to another. This effectively seems to discontinue most of the matrilineal inheritance system over the course of one or two generations. All farmers within the community will be forced to change at the same time. If not, some of them will inherit twice and others not at all, causing social unrest. Certainly there will be winners and losers. An added result of this development is the fragmentation of lands that formerly would remain whole over the generations and would remain under family control.

A number of events are anticipated to be witnessed more frequently because of these developments. More children with private ownership of smaller patches of land could result in more (emergency) sales of land, including cocoa farms. It seems that the monetary needs of farmers have constantly been on the rise in the last decades with increased expenditure on modern medicine, education and consumer (durable) goods. With land for cash crops becoming increasingly scarce and fragmented, intensification seems the more logical course of action for more and more farmers. Land titling and increased private land ownership also could be an important impetus for new financial arrangements, whereby land can be used as collateral. Each of the hypotheses in this paragraph is the object of further research in the second stage of the qualitative study.

From the both the qualitative and quantitative evidence above, intensification at the household level appears to be driven by increasing land scarcity much in line with the writings of Esther Boserup (1965). In the field survey, farmers were asked how and when each plot of land was acquired. If we assume that the 8% of fields for which the date of acquisition was unknown were acquired prior to 1980, then seventy-six percent of agricultural lands enumerated in 2011 had already been acquired by 1980 (table 5.). By the start of the new millennium, this percentage had grown to 94 percent.

We also note a shift in the way land was acquired beginning in the 1970s (Table 6). Prior to the 1970s land was almost always obtained from the local chief (stool lands), either purchased or simply allocated by the chief in exchange for some symbolic payment. In the 1970s land transfers grew increasingly individualistic. Producers who had acquired stool land would either sell a proportion of land to another farmer or more commonly, negotiate with migrant workers to develop forest land acquired from the stool into a cocoa farm. Once the farm was completed and in production, the land would be equally

divided (Abunu) between the worker and the landowner. In essence the laborer paid for the farm with his labor over a period of 5 to 6 years until cocoa began to produce. Overall, approximately one in every seven farms in 2011 was acquired in such a fashion, many by landless settlers. By the 1970s, the availability of stool lands grew increasingly rare and land transfers between individuals became increasingly common, especially among migrants. Cocoa farmers who are part of the original settler families continue to depend on family and stool lands though this configuration is evolving now that the customary matrilineal inheritance system is under pressure from the official patrilineal inheritance system Ghana has put into law since two decades now. In the most recent decade, 70% of land transactions were between individuals, representing a complete reversal from earlier days (appendix A).

An indication of the security of tenure arrangements is given by the proportion of titled lands by mode of acquisition (table 7). A higher proportion of titled land is supposed as indicating a less secure means of land acquisition vis-à-vis local tenure institutions. If our supposition is correct then land purchases appear to be relatively less secure than lands acquired from the stool in the local tenure system. There was no relationship between titled land and current fertilizer use (see also appendix A.).

The adoption dynamics of intensification in the 00s

To determine the effect of cocoa intensification on deforestation requires some definition and indication of the intensification adoption process through time. We define intensification as the increase in the use of inputs per unit area of land. In this definition inputs may include agrochemical inputs such as pesticides and fertilizers as well as farmer knowledge on integrated natural resource management including integrated pest and soil fertility management. It also includes the learning and knowledge embodied in improved planting materials. Measuring and quantifying farmer knowledge is more difficult than measuring and quantifying farmer use of inputs. So choosing the path of least resistance we begin with inputs.

Producers were asked to give the first year in which they used fertilizers, insecticides, and fungicides and the last year. Combining this with the date of farm establishment allows us to plot the adoption over time of agrochemical use for producing cocoa farms. As seen in figure 5, agrochemical intensification has progressed steadily over the last 10 years. In 1999 the majority of households were still using minimal levels of input with the exception of insecticide where a quarter of producers were utilizing.

Migration and intensification

For over 100 years, cocoa producers in Ghana have migrated to the forest frontier to convert forest lands to cocoa. Overall, 88.3% of the cocoa producing households interviewed were non-indigenous settlers, with nearly three quarters already settled by the mid-1990s (table 8). The largest proportion was from the neighboring region of Brong Ahafo, followed by Ashanti and Western region. Roughly four in every five settlers came from a cocoa producing region (table 9). Of the 151 settler households, 78 had migrated themselves, while 73 were headed by the offspring of the original settlers. What is perhaps unique about Ghana is the willingness of the local indigenous people to accept settlers. A clue as to why this may be can be found in the historical account of the first settlers in the village case study of appendix A. The original settlement by a Sefwi clan was only three generations ago, which means in some sense that all members of the community are immigrants. Perhaps it is this perception which leads

to the acceptance of other settlers from other regions of Ghana. Clearly sharing and participating in the local customs of the Akan people is important for successful integration (appendix A.).

A wide variety of previous employments were being pursued by the 78 settlers with nearly half of the settlers possessing previous agricultural experience (table 10). In 2006, the arrival of new settlers diminished significantly relative to the three previous decades. Clearly the slowing of immigration was impacted by the lack of off-reserve forest lands for conversion to cocoa farms either from the stool or among individual farmers (appendix A).

The majority of settlers with farming experience prior to migration to Bia, did so on their own lands while a minority worked on the farms of others as caretakers in exchange for a share of the output. A substantial portion indicated that they were students prior to migration. When we examine the education attainments for this student subgroup of settlers all attained a primary education and 82.4% continued with some secondary education, although none achieved the A-level certificate.

Among those farming prior to migration, roughly four out of ten indicated growing cocoa while two out of every three grew food crops. The lands farmed prior to migration mostly reverted to extended family members upon the departure of the settler.

Cocoa varieties in farmers fields

One of the most important determinants of productivity is the quality of the farmer's tree stock. Quality is a function of genetics, the biophysical environment, and because of the biological lags inherent in perennial crops, the age of the cocoa tree. In principle, all of these parameters affect the yield potential.

Three types of cocoa are distinguished by the cocoa farmers in the Bia district. Amelonado,a Forastero cocoa native to the lower Amazon basin, gained its nickname Tetteh Quarshie from the itinerant cocoa worker who introduced it to Ghana upon his return from Fernando Po in the 1890s . In the mid-forties it was estimated that over 90% of the trees in Ghana were of Amelonado type (Edwins and Master 2005). The second type of cocoa distinguished is Amazonian cocoa with Peruvian origins sometimes referred to as F3 Amazon or Upper Amazon (UA) cocoa. First introduced in open-pollinated multiplication plots in the 1950s, F3 Amazon has a shorter lag prior to bearing (2 to 3 years) and is higher yielding as compared to the TQ variety. This varietal type especially when grown with low shade and no fertilizer maintains its peak yield for a shorter period of time than TQ. The third varietal type distinguished is improved "hybrid" cocoa based on bi-parental crosses among and between upper Amazonian, local Amelanado, and Trinitario cocoa parents. Upper Amazonian hybrids with tolerance to cocoa swollen shoot disease[4] gave impetus to their widespread production and distribution (Edwin and Masters 2005). Hybrids developed by CRIG are produced using mass hand pollination techniques by the Seed Production Units (SPUs) of the Cocobod and distributed as ripe pods to farmers who pick up the pods at 23 locations throughout the cocoa belt of which only three were in the Western region.

[44] A viral disease spread by a whitefly that has until recently been fairly dormant. Some pathologists blame a warming of the climate for recently reported upturn in CSSD incidence

Farmers with bearing farms were asked to give the relative proportions of these varieties in each cocoa farm. F3 Amazon trees were found on the majority of farms and accounted for the major portion of bearing cocoa acreage (Table 11). There has been to date a relatively low adoption of hybrid cocoa with approximately 1 in every six producers reporting mature hybrid tree stocks in production and less than 1 in every 12 hectares planted to hybrids (Table 11). As the Western region was really the last cocoa region to be developed, very little TQ cocoa is found here. Hybrid cocoa was more common on recently planted young cocoa farms not yet bearing.

In all, more than one in every 3 farmers had a recently planted cocoa farm with the majority creating new farms as opposed to replanting (table 11). While the frequency of farmers replanting old farms was lower, the average size of replanted farms was 2.5 times greater than that of newly created farms so that in terms of total area, 46% of the area in young cocoa was replanted old cocoa (figure 6). This is significant as some industry observers have questioned the willingness of cocoa farmers to replant old farms and advocate instead the introduction of grafting with improved clones for the rehabilitation of old farms.

Another way in which farmers improve the quality of their tree stocks is through the replacement of dead trees in the cocoa farm. At the time of the interview, slightly over half of all producers with bearing cocoa had replaced dead trees in the last 12 months. The use of Amazon/Amelonado from the farmer's own tree stocks was cited by two in every three producers versus a much reduced frequency of producers citing the use of hybrids or a combination of the two (table 12.). The farms among those replacing dead trees had a significantly greater mean tree age than those where trees were not replaced (mean difference = 4 years, prob<.001).

Waiting for the tree to die before replacing it is a second best strategy for the poor who lack access to credit for the costly undertaking of replanting. Replacement of a dead tree reflects the farmer's unwillingness to forego even the meager income of a senescing tree. As a consequence of this strategy the farmer's tree stock becomes a heterogeneous mix of various age classes such that in a plantation established 30 years ago one can find young trees not yet bearing. For a modern and productive cocoa enterprise the conventional wisdom holds that replanting should occur by the age of 25 which is when the biological productivity of the tree declines. However with the heterogenous mix of age cohorts common to most small holder farms, the productivity decline is less pronounced at this age, thereby reducing the likelihood that the producer will replant.

Overall one in every three farmers had a young cocoa farm that was not yet bearing at the time of the interview. Slightly over one quarter of the young farms that were not yet producing were old cocoa farms that had been replanted with the remainder consisting of new cocoa farms. It is interesting to consider the type of land use to create new cocoa farms. In general across the West Africa farmers prefer to plant cocoa on forest land. But in the case of the 43 new cocoa farms in our sample only half were planted on forest lands, the rest were planted on fallow land. This along with the significantly smaller field size of new farms relative to bearing cocoa is a clear indication of the disappearance of the forest frontier (figure 6.) and the impossibility to further encroach into the reserves and national park land.

In the future for growth to continue farmers will need to intensify their existing fields and improve the quality of the tree stock. The latter shall require the replanting of old cocoa farms with improved planting materials. As seen in figure 7 over a third of the tree acreage was established 26 years ago or more and would normally be targeted for replanting.

A multivariate regression model of cocoa production

In order to separate the effects of the various factors influencing the farmer's level of intensification, we estimate a linear regression model using the data collected from 171 households on their farming systems. After cleaning and editing the data we were left with 170 observations. Our model measures *inter alia* the impact of inputs, the mass spraying program of the Cocoa Marketing Board, household quantities of labor, land and capital, demographic variables of the household head, the effect of farmer field school training, residual effects of fertilizer application, varietal differences, and the impact of shade on the household's total production of cocoa marketed in 2009/2010 (table 13).[5]

The variables pertaining to fertilizer application were measured as kilograms of dry fertilizer equivalent applied in the 2009/2010 season. For the two most common types of fertilizer, Asaase Wura and Cocofeed, this simply entailed multiplying the number of bags applied per unit area by weight of the bag. For the liquid fertilizer, SIDALCO (NPK 10 -- 10 -- 10), the dry weight equivalent was calculated by multiplying the volume of fertilizer applied in liters by the specific density of the liquid. Residual effects of fertilizer applications were captured by a fertilizer carryover index which was simply the sum of the years in which fertilizer had been applied for the four previous years weighted by the field size.

For the various pesticides, the sum total of insecticides, herbicides, and fungicides were distinguished and measured in terms of either liter bottles, (insecticides, herbicides), or in packets of fungicide. We also capture the effect of the Cocoa Marketing Board's mass spraying program which in the Bia district only entailed the application of fungicides by measuring the number of times the farmer's field was sprayed with fungicides by the marketing board's mass spray gangs. In principle this program is supposed to apply fungicide three times during the season with the expectation that the farmer augments the free fungicide application with his own efforts.

A measure of capital employed in cocoa farming was constructed from a household inventory of selected durable goods multiplied by their relative values to create a household capital index. These goods included items such as bicycles, machetes, sprayers, drying mats, ladders, pruning instruments etc.

The land variables measured cocoa harvest area for three varietal groupings—Amelonado, Amazonian, and hybrid F1 varietal crosses. The first two as we have seen are generally propagated by farmers themselves using their own selections from tree stocks on farm. The hybrid varieties are propagated by Seed Production Units of the COCOBOD using mass hand pollination techniques. Hybrid seed pods generally yielding between 20 and 25 F1 seedlings are sold at the gate of the SPU to farmers at a heavily

[5] The official cocoa marketing year runs from October 1, to September 30th. Many farmers reported on multiple cocoa fields

subsidized price. To account for nonlinear size effects, quadratic terms were included in the model specification for Amazonian and hybrid cocoa. As farmers in Ghana measure land in acre units we maintained this measure in the model.

A dummy variable captures whether or not the producer received farmer field school training provided by the Sustainable Tree Crops Program in a five year program from 2006 to 2011. Other producer variables include the age, age-squared, and gender as well as their educational attainment. Educational attainment was measured on a cardinal scale of 1 to 10 with the expectation that more education will have a positive effect on production.

Finally, to capture village level fixed effects, we included dummy variables for the 17 villages surveyed with a value of one if the producer lived in that village and zero otherwise.

OLS regression results

The model variance was corrected using White's efficient estimation procedure (robust option in *STATA* statistical software). The results are reported in Table 13. Overall the model had an R^2 of .704 and excluding the village dummy variables, 11 of the remaining 18 variables were significant at normally accepted levels.

Fertilizer and insecticide were positive and significant but fungicides and herbicides had negative coefficients with that of the later significant. Although it is conceivable that the improper application of herbicides could reduce yields, in a well maintained cocoa farm with a closed canopy, weeds are usually not an issue and herbicides would not be necessary. An alternative interpretation of this result is that the use of herbicides is signaling a weed-choked cocoa farm with low productivity. Furthermore, as we saw in the section on poverty and intensification, only 0.17 liters/ha of herbicide was applied on average, which is unlikely to give more than localized control.

According to the model an additional kilogram of fertilizer would generate an additional output of 1.4 kg of cocoa. At a subsidized price of 0.5 Ghana cedis per kg in 2009 the marginal cost of fertilizer was considerably below the value of the additional (marginal) product generated equal to 4.48 GHc suggesting an underallocation of fertilizer use. The recommended application rate is 150 kg per acre (=370 kg /ha) whereas farmers in our sample applied at an average rate of 65.8 kg/ha confirming that there is still slack in the use of fertilizer and potential gains await higher levels of use. A quadratic term was not significant, which was interpreted as an indication of the lack of diminishing returns at the current use levels. In addition to the response to fertilizer applied in the current year there is also a large residual effect from fertilizer applied in previous years.

The acreage variables for the different cocoa varieties were generally significant. The magnitude of the coefficient on hybrid cocoa was more than four times that of the F3 Amazon variety. The lower yields of large farms seen in table 3 of the section on land distribution and intensification are reflected in the negative coefficients of the quadratic terms for Acres_Amazon and Acres_HYB. The productivity per acre diminishes as farms grow larger. For the representative cocoa farmer the marginal product of another land unit is 98 kg per acre for Amazon cocoa and 544 kg per acre for hybrid cocoa equivalent in metric units to 242 kg per ha and 1344 kg per ha. Diminishing marginal returns maybe due to rigidities in

the labor and capital markets which do not allow larger farms to engage sufficient amounts of these production factors (Table 3).

Labor and capital inputs in our model were also significant positive determinants of output. The mean worker in our model contributed 202 kg of output. The mean ratio of land to labor was 2.9 acres per worker. An additional cedis of capital generated 1 kg of cocoa at the value of 3.2 Ghana cedis.

The demographic variables of significance were the age of the household head which was negatively related to output in a nonlinear fashion and the household head's educational attainment which had a positive impact on output highlighting the value of youthful energy and education in a rapidly changing agricultural setting. The gender of the producer was not a significant determinant of output.

About 40% of households had food crop fields in addition to cocoa; we tested the impact of food crop cultivation on cocoa output by including the area cultivated. Although the regression coefficient was negative it was not significant. Shade trees did exert a negative influence on cocoa output with each tree decreasing output by an estimated 2.34 kg. For the representative producer with 46 shade trees the effect amounts to a 108 kg decrease in output relative to the full sun scenario. If we consider the current price of cocoa in Ghana this amounts to a decrease of approximately GHc 65 per ha in revenues due to competition at the mean level of shade. In certain instances farmers deliberately include timber or fruit trees in their cocoa plantations because of the secondary income that these provide.

To quantify the impact of increased agricultural intensification on output and yields, the regression model of cocoa production was employed to predict the output that would have resulted, were fertilizer and insecticide inputs applied at the frequencies representative of the year 2000 prior to the high tech program (table 14). Besides the changes in fertilizer and insecticide use, we include the fertilizer carryover effect and the farmer field school training impact as neither of these two elements were in play in the year 2000. The point estimates for the levels of insecticides and fertilizers are based on the adoption rates obtained in the 2001 STCP baseline survey.

The cocoa yields in 2010 were three times greater than the predicted yield calculated at 2000 input levels (table 14). Nearly all of the yield increase which has transpired since the initiation of the HT program is attributed to the use of fertilizers which has become quite common in the Western region. Although the impact of FFS training is estimated to have increased producer output by over 1400 kg, only a small proportion of producers benefited from this training provided by the Sustainable Tree Crops Program.

Intensification and Deforestation

Remote sensing analysis of land use and land use change was conducted using four images covering a total area of 1,201 square kilometers in the Bia district of the Western region. Landsat images were obtained for 2000 and 2003, and a 2006 SPOT image and a 2011 ALOS image completed the satellite imagery used in the analysis. Using these four images we monitored the transitions between forest and the rural agricultural mosaic. We have not yet completed to analyze the transitions within the rural agricultural mosaic but with the acquisition of new ground control points we are continuing the effort. However given results from the field survey of households which indicate that 80% of agricultural land

use is for the production of cocoa, we feel justified in discussing changes in the rural agricultural mosaic as a proxy for changes in cocoa cultivation.

Analysis of the 2000 Landsat image found that forest land comprised 35.5% of the total land area covered by our study (figure 8 and table 15). This proportion had declined to 33.5% by 2011. The majority of this deforestation entails encroachments on the Bia Game Reserve and the Krokosua Hills Forest Reserve. It is interesting to note the near absence of encroachment in the Bia National Park in contrast to the two reserve forests. We surmise that this is due to differences in the level of enforcement by forest wardens.

Taking the average farm size from table 2 and dividing it into the area of the agricultural mosaic in 2011 from table 15, we estimate the number of farm households operating in our geographical unit at 11,173. Using the estimates on cropping systems reported in table 1 an estimated total of 64,021 ha of land was planted to cocoa, of which 56,423 ha were bearing at an average yield of 535 kg per ha. Thus the total production from our geographical unit is estimated at 30,186 tons.

In 2000 the average yields for Juabeso, which at that time included the Bia district of Ghana, were equal to 199 kilograms per ha (IITA unpublished data). An estimate of the avoided deforestation resulting from the interventions of the High Tech program is calculated by dividing the total production of 30,186 tons by the 2000 yield of 199 kg per ha giving a figure of 151,700 ha. This figure exceeds the total area of the Bia benchmark implying that even if all the existing forest were converted to cocoa, this level of output could not have been achieved with the technology of 2000. From a REDD+ perspective, the 40,000+ ha of remaining Bia forest that avoided deforestation represents a significant stock of carbon.

Figure 9. presents the actual deforestation by periods. Relative to the existing forest the annual rate of deforestation over the 11 years of analysis was 218 ha p.a. or 0.5%p.a. which is actually quite low compared to the country rate usually cited as 2% per annum.

Discussion

The near tripling of cocoa yields which occurred in the last 10 years in the Bia district would have avoided the deforestation of 151,700 ha. That is to say the 2010 output could not have been produced with the extensive technology of 2000. The 40,000 ha of forest remaining in the Bia district is a global public asset for climate change mitigation and biodiversity conservation that would not exist had there been no technical change in the farming technology. The value streams from this asset should be used to support sustainable intensification of the cocoa farming systems while reinforcing the control of forest reserves to reduce encroachment. Determining the monetary value of this asset and rewarding cocoa growing communities for its maintenance appears to be a feasible next step. This will require measuring and quantifying the average carbon stock for both the rural mosaic and the closed canopy forest. It will also necessitate the monitoring of land use change through the use of remote sensing.

We did not have the resources to determine these parameters, but for illustrative purposes assume that the average difference in carbon between the rural agricultural mosaic and tropical forests is 120 t CO_2/ha. Under these assumptions the stock of avoided carbon emissions in our geographical unit would be equal to 4,800,000 tons C or 17,600,00 t CO_2 which at the 2010 voluntary OTC market price of $6/t amounts to an asset value of $105,600,000. If we assume a 3% return on this asset, the annual return would be approximately $3 million for maintaining this carbon stock. While these are just illustrative, it goes to show that the monetary stake for the district budget is very significant . A portion of these resources could be reinvested in the public goods needed to support the sustainable intensification. In the last 10 years approximately 2,400 ha of forest were converted.

As seen in figure 8 the majority of the deforestation occurred in the Krokosua Hills Forest Reserve and the Bia Game Reserve. However, in the Bia National Park, there was very little encroachment by cocoa farmers, presumably due to better enforcement. The impact of forest zonation, of policy regulating forest management and access and the costs for conservation should be part of the assessments about trade-offs in cross sectoral land use planning. Bringing the level of enforcement of the reserves up to the level of the Bia National Park is another potential use of REDD funds.

The impact on emission of the conversion trajectories in the intensification process remains an open question. More information is needed in terms of the amount of carbon stocked in the fallow and in the cocoa farm classes to assess the carbon balance of change dynamics in the study area.

Similarly the impact of intensification on the ecological resilience of the agricultural matrix should be assessed and landscape management designs to maintain the connectivity and conduit functions across the matrix promoted to reduce the impact of the increased isolation of the two biodiversity hot spots.

The main contribution of the study has been a detailed analysis of actual and potential sources of growth in cocoa productivity. This analysis should prove useful for the planning of future interventions in intensification based mitigation strategies. The study develops a clear body of evidence about the production factors with significant impact on cocoa incomes and yields in the last ten years in the Bia District. Most of the growth in yields is attributed to the rapid adoption of mineral fertilizer which grew from 2.6% of households in 2000 to 75% of households in 2011. In 2011 fertilizers were applied to 85%

of the mature bearing cocoa in 2010. The regression model estimates that the increased use of fertilizer was responsible for approximately 87% of the overall increase in yields.

Two competing technology systems were distinguished—an intensified system based on agrochemical inputs and an extensive production system based on biomass conversion into plant nutrients. Producers with smaller land holdings were more likely to adopt the intensified system versus larger producers who were more likely to have adopted the extensive technology system characterized by relatively low capital and labor investments on a per unit area basis. The largest 25% of landowners accounted for 50% of total output produced with 57% of the total cocoa tree stock resource. Yields were significantly lower among large farmers. These findings suggest that climate change mitigation packages for agricultural intensification will find wider acceptance among land-constrained producers especially if credit constraints are not binding. However, the greatest impact on deforestation is through the land use practices of the largest farmers.

If mitigation is a principal objective then addressing the intensification constraints among large producers is necessary for achieving impact. For larger landowners, labor rather than land is the principal constraint. In response, they are implementing an extensive technology which economizes labor and capital rather than an intensive technology system which demands more of these factors. The difference in terms of labor endowments per hectare between the lower and upper tail quartiles of the farm size distribution is fourfold. The fact that fertilizer use was estimated to have accounted for 87% of the yield gain begs the question: "Why not just increase fertilizer use among large producers?" Unfortunately, the answer is not simple; increasing land productivity through additions of fertilizer will only occur if large farmers are able to mobilize additional resources to get the cocoa off the tree and in the bag. It is estimated that over 60% of the labor demand for cocoa occurs during the harvest season (Abenyega and Gockowski, 2002). Interventions are needed to address labor constraints during the harvest season for an intensification strategy for large farmers. If the farmer is unable to harvest all that is produced because of labor constraints then clearly the producer will not produce more. Capital readily substitutes for labor and one strategy for intensifying production among larger producers would be to increase capital inputs particularly in the realm of local rural transport and postharvest processing.

On the other hand agricultural intensification appears to be a good fit when poverty reduction is principal objective. In our sample the lowest income class had a lower adoption rate of fertilizers and significantly lower size of landholding. Reductions in poverty will require improving the access of the poor to productive factors including land resources, farmer training, improved planting materials and fertilizers. The regression analysis confirmed the positive impact of these factors on cocoa production and incomes. What begins to emerge is a pathway out of poverty based on the increased usage of fertilizer, increases in farm size, the adoption of hybrid cocoa varieties and increases in the farmer's stock of knowledge.

The greatest challenge in creating such a pathway will be to develop sustainable institutions for:

7. *Delivering agrochemical inputs.* Much greater effort is needed to build sustainable input delivery systems. The distribution of fertilizers through government agents crowds out the

private sector. The same situation is found in the pesticide market where reports of agrochemicals dealers being jailed for selling CODAPEC pesticides were common. Policies that facilitate competition and encourage private investment are needed. The problem with sector specific policies such as the HT program lies in the brake on diversification it engenders at the household level. In principle the inputs imported by Cocobod are only to be used on cocoa, which can hinder diversification by the household into alternative crops. One of the principal findings of this study was the lack of diversification in smallholder strategies.

8. *Efficient real estate marketsand inheritance institutions.* Land tenure institutions are fundamental for transforming the rural sector and building a pathway out of poverty while maintaining the competiveness of Ghanaian cocoa in the global market. A modern land tenure system would permit small but efficient producers the means of expanding their operation by buying out inefficient producers. Evolution in customary land tenure institutions may be headed in this direction as discussed above and in appendix A. Most land in the district is no longer controlled by the stool but has evolved into a pattern of individual ownership. As described in appendix A land titling has become an important objective for most cocoa farmers. The "Abunu" labor contract, in which the laborer who develops a cocoa farm receives 50% of the land after 5 years, is an institutional innovation that can provide the poorest of the poor with the assets to escape chronic poverty. Anthropological investigation uncovered changes in land tenure over time. The mode of land acquisition has shifted from relatively large acquisitions of stool lands obtained in exchange for symbolic gifts, to Abunu contractual arrangements and land sales between individuals with titling. Evolution in land tenure institutions is sine qua non for sustainable intensification. Unless the more efficient farmers are able to increase their scale of operation, smallholder agriculture will find it difficult to modernize.
9. *Efficient inheritance institutions.*The recent change from a matrilineal to an officially patrilineal system (though bilinial in practice) isimpacting the structure of farming in Ghana.Land that historically remained intact over the generations, as it would always revert back to the control of the (men of the) maternal blood line is now inherited by the biological children of the married couple. This fragmentization limits the options of the farming enterprise and is often coincident with emerging land markets in which we will see normal land sales, but also other kinds of transactions like land as collateral for credit, renting of lands and emergency sales of land by the poorest. This fragmentisation of lands may also proof to be a driver of intensification, as for many farmer that may be the only remaining option as extensive farming becomes impossible in the absence of more lands.
10. *Producing and delivering improved planting materials.* As the Cocobod looks to develop future sources of productivity growth the low adoption of improved hybrids would seem to be an obvious target. The regression model estimated that the marginal product of another acre of hybrid cocoa was 544 kg as compared to 98 kg for farmers' ll varieties. With less than 7% of bearing cocoa planted to hybrids there is still much room for improvement on this front especially given that over a third of the tree stocks are over 25 years of age. Among the institutional issues facing the broader diffusion of cocoa hybrids and clonal grafts is the lack of a viable business model. Producers are often unaware of the superior performance of hybrids

which limits their demand. Extension efforts should include professionalizing and training farmers interested in specializing in the commercial production of improved planting material.

11. *Generating innovations and innovation delivery systems.* Research is woefully underfunded and when innovations are generated they often sit on the shelf and do not get out to the farmer as extension services are as poorly funded as research, if not worse.

Enhancing forest conservation effort in national parks and the sustainable management of resources in the forest reserves. The study shows that forest management and the endorsement of protection policies reduces the risk of agricultural encroachment in remnants forest of highly populated and intensively cultivated areas, closing the deforestation frontier.

It is an open question whether the lack of diversification which characterizes the cocoa sector in the Bia district is the result of farmers feeling secure due to the Cocobod interventions or rather farmers feeling as though they had no other choice but to produce cocoa. Nearly all households were engaged in cocoa farming and over 80% of agricultural lands were planted to cocoa. This specialization raises a food entitlement risk, particularly for those with smaller land holdings who have a high dependency on food markets. Global cocoa markets are highly volatile and although the Cocobod provides a guaranteed price, their capacity to maintain the panterritorial price at its current level in the face of weakening global demand is worrisome. Another potential concern is a cedis appreciation due to the discovery of oil in Ghana which would put more downward pressure on price. Over a quarter of all households were found to be only producing cocoa, these households will certainly be in difficult economic straits when and if cocoa prices begin to decline.

There is also a debate about how best to rejuvenate aging tree stocks owned by producers with high subjective discount rates. Poor farmers can be extremely reluctant to replant an old farm that is still producing, even if the yields are abysmal. As an alternative, the tree may be grafted with an improved scion on either a chupon[6], or side grafted with the advantage that the old tree may continue to produce while the producer waits for the graft to begin bearing (typically within 12 to 18 months) before destroying the old tree in favor of the graft.

Current practice among smallholders is to plant new farms or replant old farms using open pollinated local Amazonian seeds which are planted at high density in April and May along with food crops. Farmers plant cocoa at an initial high density to ensure rapid canopy closure. Once the cocoa canopy is closed, weeds cannot develop. It is not uncommon for farmers to plant at double the recommended density just to control weeds. The farmer has a ready supply of Amazonian seed from existing trees available at no cost. For cash-strapped smallholders this is a strong incentive for choosing unimproved planting material over hybrids.

Alternatively, to create a farm with hybrids seedlings, the farmer first of all must travel at his own cost to the seed garden production unit to pay for pods pollinated by hand. If he is lucky and succeeds in acquiring pods these are then transported back to his residence where they are then planted in a

[6] A chupon is a sucker on the cocoa tree

nursery and watered during the five-month dry season. Although the price of pods is subsidized, cash constraints keep some producers from participating. Subsidies do not appear to be adequate incentive for farmers to adopt relative to the other transaction costs. Labor constraints for producing seedlings are often onerous for the producer particularly if there is not a source of water close to the nursery or if the nursery is located at a distance to the intended planting site. When farmers were asked why their hybrid usage was low, it was pointed out that the Seed Production Units are often quite distant; and hybrid pods are typically only available from November until late January which means farmers are obliged to manage a dry season nursery.

In terms of future productivity gains, increasing fertilizer use is still a viable strategy for increasing productivity with plenty of room for further expansion given that only 9% of producers were applying fertilizers at the recommended rate of 370 kg/ha. The marginal return to fertilizer was GHc 3.88 per kg while the cost was GHc 0.60 per kg of fertilizer which suggests an under allocation of fertilizer inputs.

In recent years, internal cocoa marketing agents have been involved in non price market competition with many making fertilizers available on credit through their networks of purchasing clerks. The purchasing clerk typically lives in the same village and is able to overcome the problem of information asymmetry faced by formal financial institutions. His local knowledge of the client's cocoa growing operations acts as collateral for the purchase of fertilizers. The typical transaction involves payment of half of the fertilizer cost upon delivery, with the remainder deducted from the producer's sale. When the high tech program began, 80% of fertilizers were distributed through government agents; today 80% are being distributed by cocoa buyers at several times the volumes in the mid-2000s. A similar institutional innovation has been observed for the distribution and sale of fungicides in Cameroon and Nigeria (Gockowski, et al., 2009). Interlinked credit is seen as an intermediate institutional innovation of the informal sector which hopefully will ultimately transition into full financial intermediation by the formal banking sector.

The regression model suggests a higher return to farmer field school training (FFS). FFS is a relatively knowledge intensive extension tool that has been criticized for being high cost (Federer et al., 2004; Muilerman and David, 2011). However in a situation where agricultural technology is rapidly changing, an effective extension service is of crucial importance. This is another area where high future payoffs to added investments are likely with less than 6% of the farmers interviewed reporting FFS training.

The findings on migration revealed that by the mid-90s nearly all of the stool lands had already been allocated and as a consequence migration slowed considerably in the decade of the 00s. Approximately half of household heads interviewed were second-generation immigrants. It would seem that new migration would be unlikely unless more land for planting cocoa i.e. forest reserves, were made available. Given this changing demographic and the disappearance of the forest frontier, cocoa farmers must find and exploit remaining opportunities for productivity growth if poverty is to be eliminated and the forest reserves of Bia are to be maintained.

Concluding remarks

In the last 10 years there's been a remarkable adoption of agrochemical intensification in the cocoa sector of the Western region of Ghana. Farmers recognize the value and indeed the necessity of applying inputs. Ghana has shown that such a strategy is viable among smallholders however the institutions for delivering these inputs are still largely state-based with questionable long run sustainability. Developing private sector institutions for the delivery of inputs should be a major focus of the development agenda. Currently the institutions supporting intensification are all targeted to the cocoa sector. The high tech program has proven technically that cocoa yields can be increased with major impacts on both poverty and the environment achieved. However, much of the success has been driven by the high price of cocoa since the mid 2000s. Markets are volatile and input markets and farmers need to be flexible and able to respond to changing incentives. Smart subsidies for the use of fertilizers need to be designed so that the private sector is fully engaged and participating in the distribution and sale of these inputs. Having a viable agricultural input sector is one of the best ways for farmers to adapt to a changing climate.

Norman Borlaug, who won the Nobel Peace Prize for his work on the genetics of wheat, would always point out that the green revolution involved improved genetics and fertilizer in combination. In Ghana there is good news and bad news. The good news is that smallholders have adopted the use of fertilizers at least in the Western region, the bad news is they are applying these inputs to largely un-improved cocoa tree stock and the mechanism for distributing improved planting material is cumbersome. With regards to the tree stock the regression model revealed nearly a fourfold difference between farmer's local tree stock and improved hybrid material. Despite this substantial benefit, less than 7% of the mature cocoa acreage was planted in hybrid. The Ghana cocoa sector is on the verge of a green revolution in cocoa productivity if it can solve the institutional issues surrounding the production and distribution of improved planting materials.

The potential productivity gains from the adoption of hybrid cocoa are substantial and could easily double current yields just as the use of fertilizers did in the decade of the 00s. As the industry develops and modernizes one would expect to see specialization and economies of scale impacting in this critical segment of the sector. To date state-sponsored seed gardens have by and large failed to deliver the best varieties to farmers in the quantity and form desired by farmers. Ultimately for institutional sustainability, the multiplication and propagation of improved planting material should lie with the private sector and not the public sector. The principal role of the public sector is to develop the improved varieties and test them with farmers. It should not be engaged in the annual production and distribution of cocoa seedlings and hybrid seed pods which ultimately can be completed by the private sector in a more efficient and cost-effective manner.

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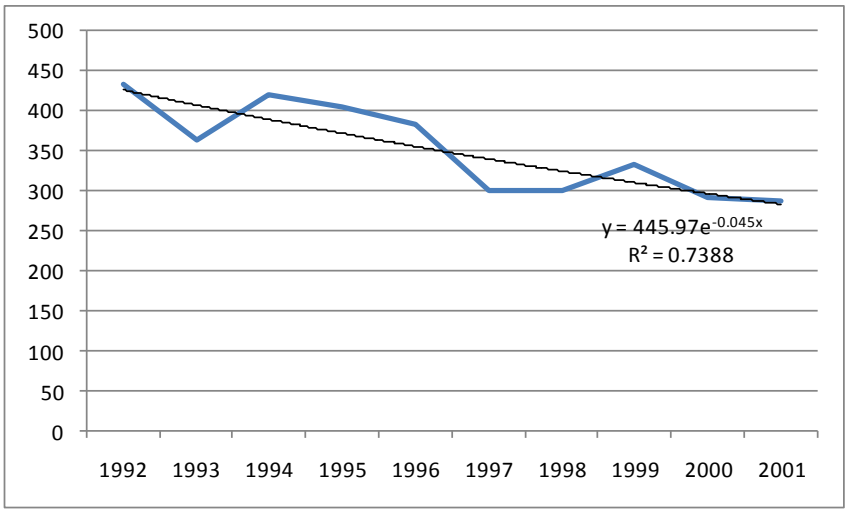
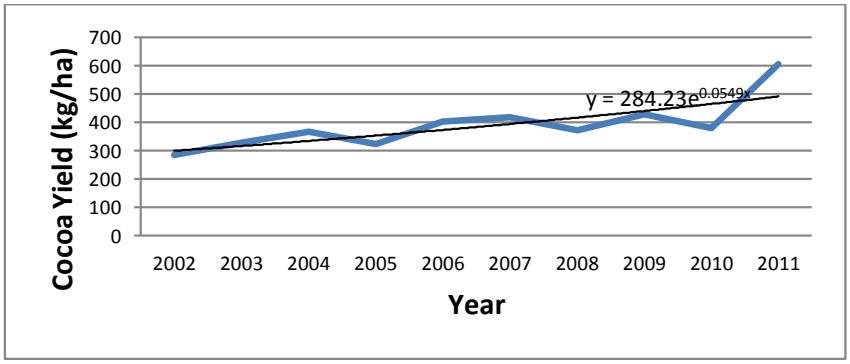
Figures



(a)



(b)

Figure 1. A comparison of Ghana cocoa yield trends from 1992 to 2001 and 2002 to 2011
Source: FAOSTAT, accessed on line 8/12/2011

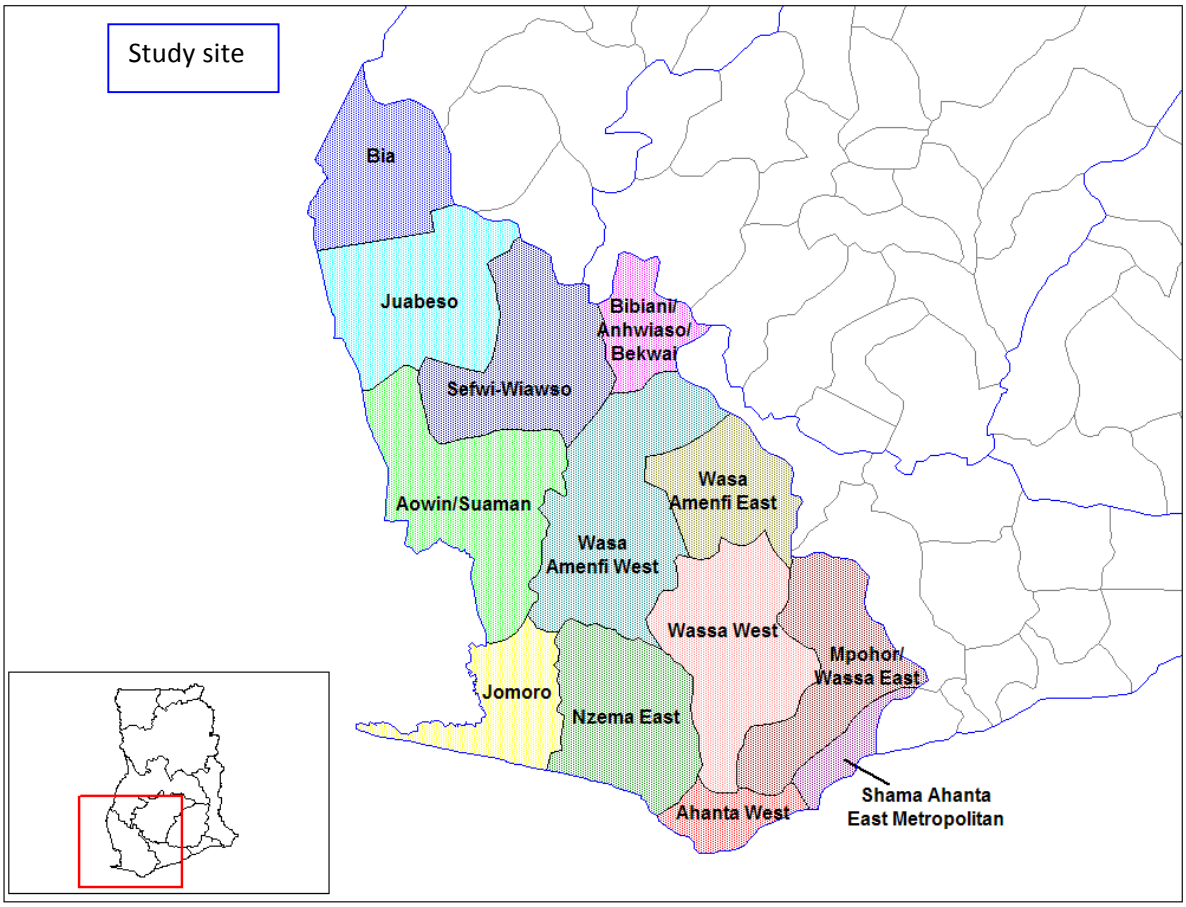


Figure 2. The administrative districts of the Western Region of Ghana

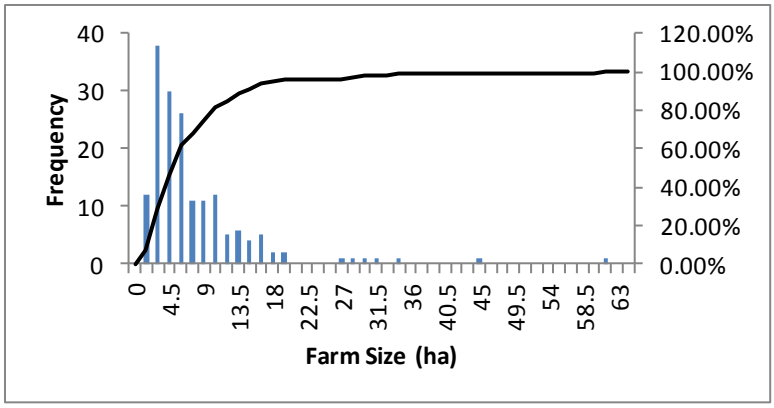


Figure 3. Positively skewed distribution of farm size, Bia District

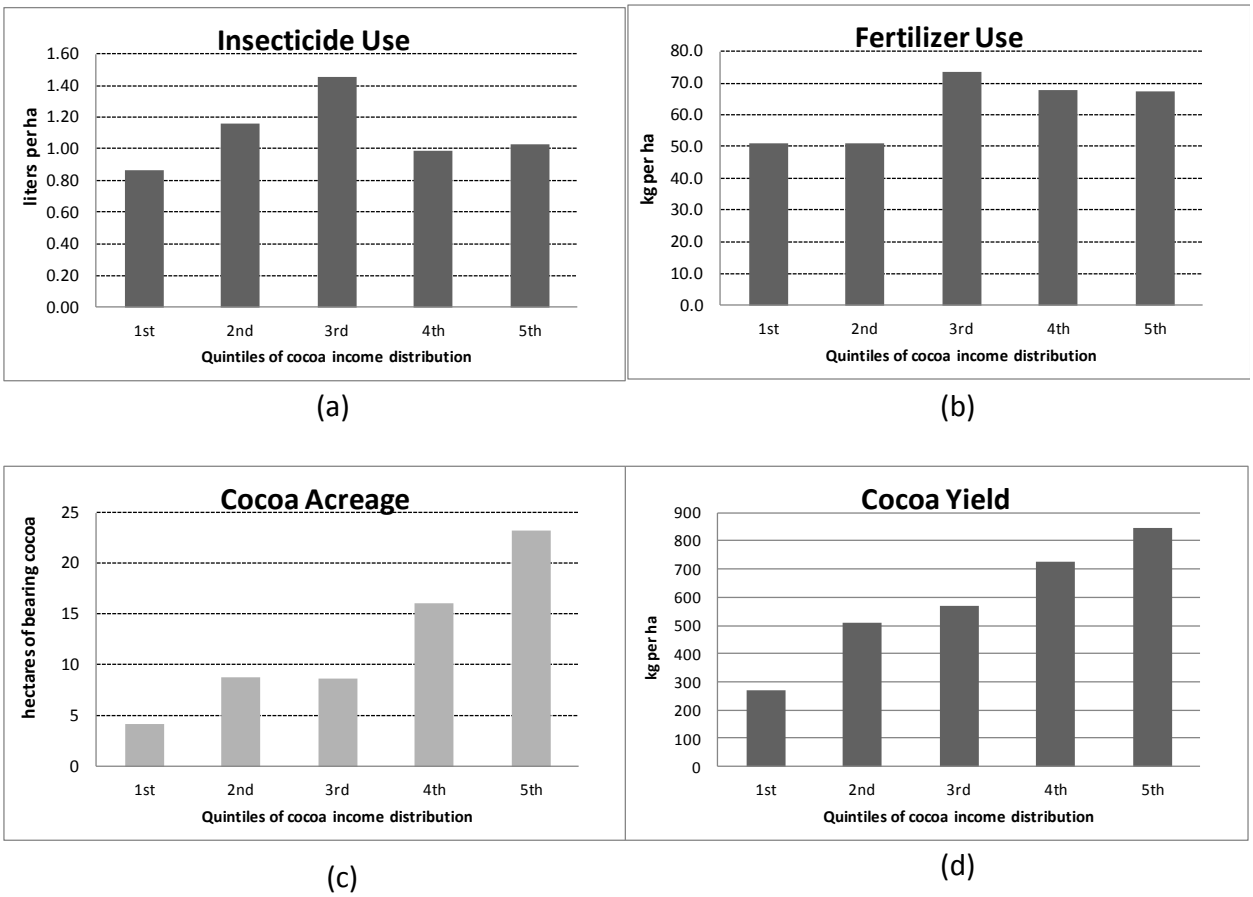


Figure 4. Input use and cocoa yields by level of household income.

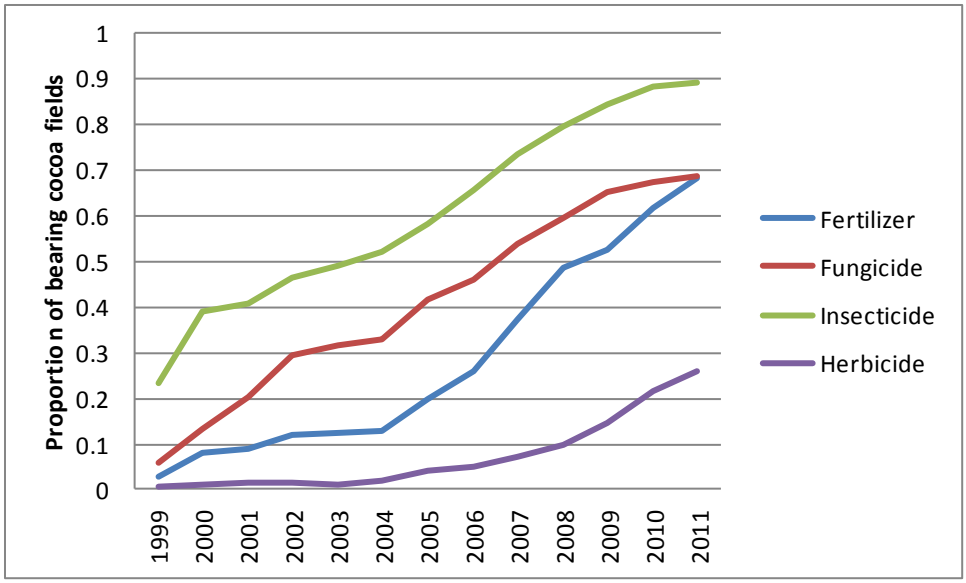


Figure 5. Proportion of bearing cocoa fields receiving agrochemical applications by year and type of product.

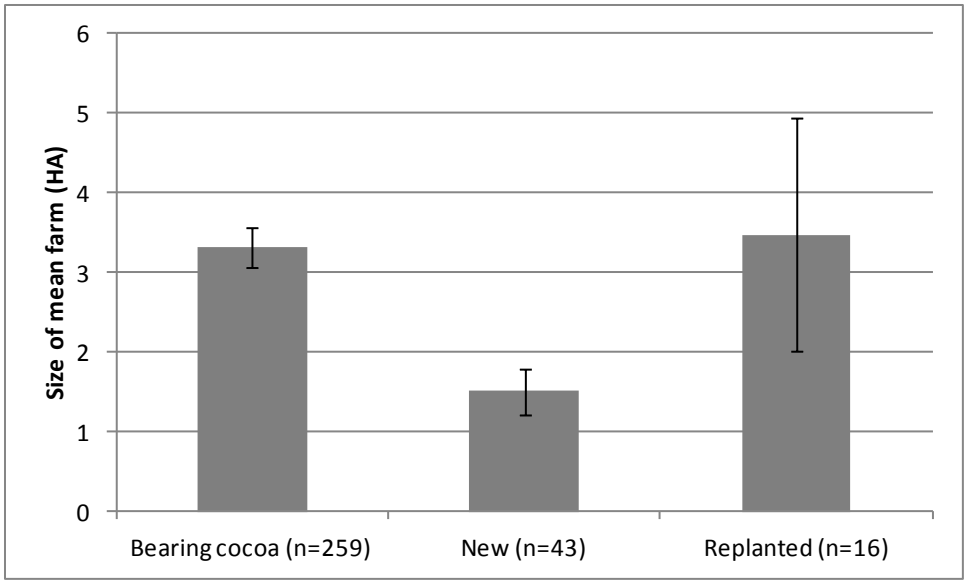


Figure 6. Comparison of average field size among bearing, new and replanted cocoa.

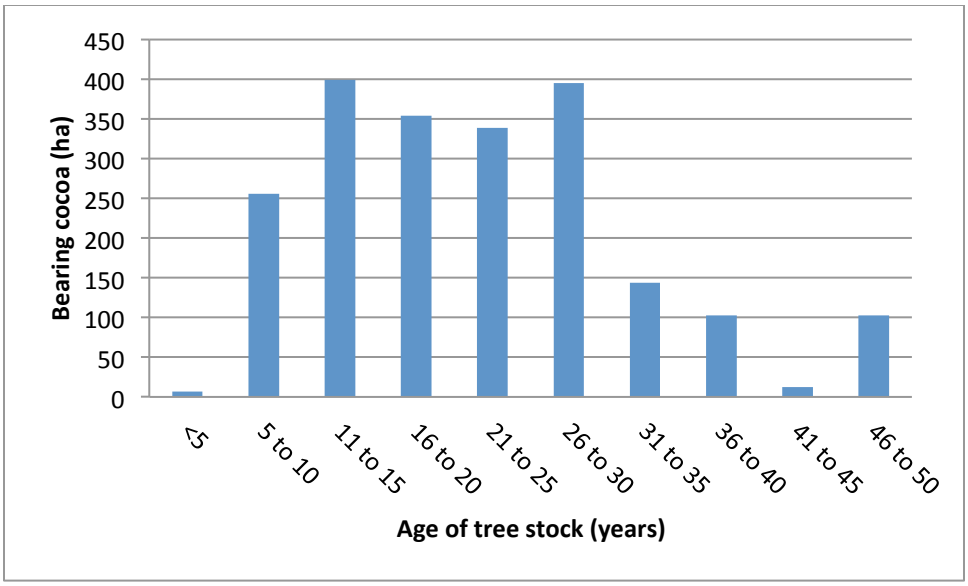


Figure 7. Distribution of bearing cocoa by age of tree stock.

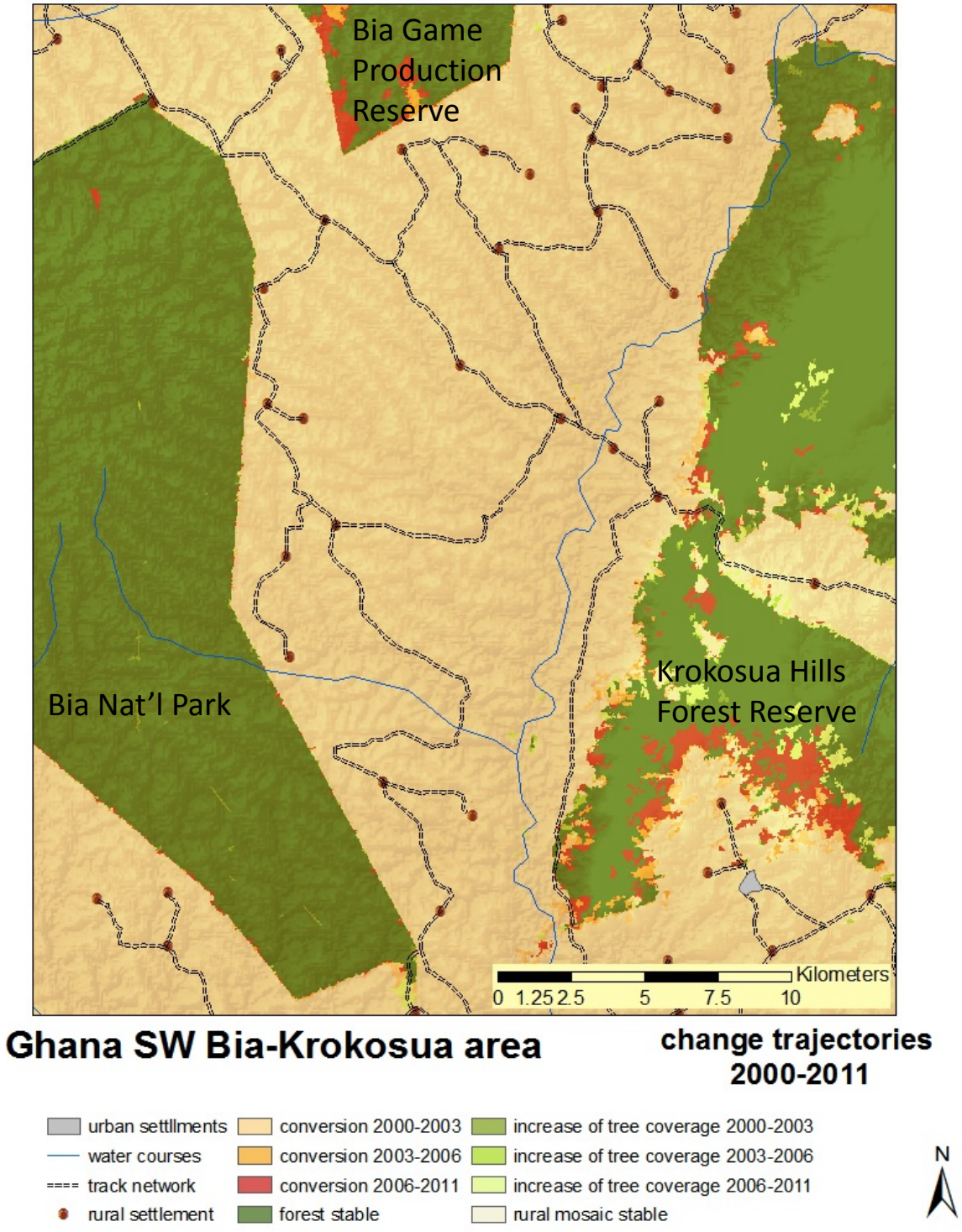


Figure 8. Land use change trajectories 2000-2011

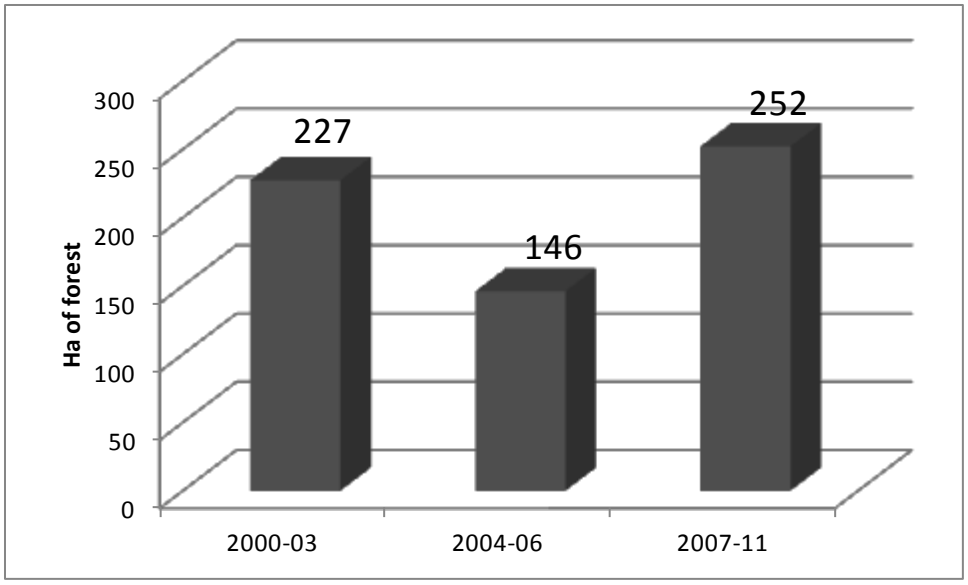


Figure 9. Rates of deforestation in Bia quadrat of the Western region in Ghana.

TABLES

Table 1. Descriptive statistics on household land use in Bia District of Western Region, 2011. (n=171)

	Mean area	Std Dev.	Median value	Households with nonzero obs.	Share of total farm area
	----------(ha)----------			----------(%)----------	
Forest	0.24	1.02	0.00	11.1%	3.4%
Fallow	0.36	1.68	0.00	15.2%	5.0%
Bearing Cocoa	5.03	5.83	3.24	97.7%	70.4%
Young cocoa	0.70	2.30	0.00	33.3%	9.9%
Food crop	0.40	0.86	0.00	40.4%	5.7%
Oil palm	0.40	0.91	0.00	28.7%	5.7%
Citrus	0.00	0.03	0.00	0.6%	0.0%
Total Farm Size	7.15	7.64	4.86		

Table 2. Land use patterns and cropping intensity ratio by size of farm in Bia District, 2011

Quartile of farm size	Mean farm size	Mean Cocoa Area Harvested	Non-bearing young cocoa	Area harvested noncocoa	Fallow land	Forest land	Cropping intensity ratio
	----------hectares----------						(proportion)
I (.81, 2.83]	1.87	1.55	0.16	0.10	0.06	0.00	0.97
II (2.83,4.86]	3.80	2.80	0.38	0.52	0.08	0.03	0.97
III (4.86,9.31]	6.59	4.10	0.92	1.06	0.20	0.31	0.92
IV (9.31,60.7]	16.54	11.84	1.38	1.59	1.10	0.64	0.90
All	7.15	5.03	0.70	0.81	0.36	0.24	0.92

Table 3. Variation in cocoa yield, labor measured in adult male equivalent units, capital and purchased inputs by farm size quartiles, 2011, Bia District, Ghana.

Quartile of farm size	Mean cocoa yield	Mean labor input	Mean capital input	Fertilizer	Fungi-cides	Insecti-cides	Herbi-cides
	kg/ha	AME/ha	GHc/ha	kg/ha	sachet/ha	-------L/ha-------	
I (.81, 2.83]	680	2.17	172	204	35.5	4.45	1.25
II (2.83,4.86]	705	1.22	123	116	12.0	3.34	0.53
III (4.86,9.31]	663	1.12	68	165	30.8	3.02	0.58
IV (9.31,60.7]	482	0.51	58	154	16.5	1.89	0.83
All	633	1.26	105	159.9	23.5	3.17	0.80

Table 4. Variation in the means of selected variables by quintiles of the income distribution, Bia district, Western region, Ghana 2011

	zero to 20th percentile	20 to 40th percentile	40 to 60th percentile	60 to 80th percentile	80 to 100th percentile	**Over all**
Bearing cocoa (ha)	4.18	8.78	8.67	16.0	23.2	12.3
Fertilizer use (kg/ha)	51.0	51.2	73.7	67.7	67.6	**62.5**
Insecticides (l/ha)	0.87	1.16	1.46	0.99	1.0	1.11
Herbicides (l/ha)	0.11	0.25	0.18	0.15	0.2	0.17
Number of caretakers employed	0.28	0.68	0.40	1.0	2.1	0.90
Area in noncocoa agriculture (ha)	1.65	2.01	1.60	1.46	3.19	1.99
Total farm size (ha)	8.59	15.0	14.1	19.3	28.3	17.2
Cocoa yield (kg/ha)	268	508	570	726	844	588
Per capita cocoa income	136	456	681	1,401	5,861	1,740
Age of household head (yr)	44	47	46	48	44	46
Education of household head (0 to 10)	3.6	2.8	3.4	3.3	4.4	3.5
Ha of bearing cocoa per worker	1.21	1.70	1.90	3.69	7.11	2.95

Table 5. Acquisition of land by period.

Period of land acquisition	Area acquired (ac)	% of total
<1961	876.7	35%
61-70	402.8	16%
71-80	306	12%
81-90	401.2	16%
91-00	137.5	5%
01-10	146.5	6%
Unknown	204.5	8%
Overall	2528.2	100%

Table 6. Modes of Land acquisition over time, Bia District, Ghana

	Period of land acquisition							
Type of acquisition	<1961	61-70	71-80	81-90	91-00	01-10	unknown	Overall
Purchase from another farmer	2%	0%	11%	37%	15%	18%	4%	10%
Purchase from the stool	17%	16%	31%	11%	5%	24%	8%	16%
Shared land in exchange for labor	4%	3%	2%	18%	71%	52%	11%	14%
Customary allocation by the stool.	77%	81%	56%	34%	9%	5%	76%	60%

Table 7. Proportion of farm fields with land title by type of acquisition

Type of acquisition	Titled?
Purchase from another farmer	0.778
Purchase from the stool	0.786
Shared land in exchange for labor	0.431
Customary allocation by the stool.	0.359
Overall	0.448

Table 8. Distribution of settler arrivals in Bia District of Western region, Ghana.

Arrival	Frequency of settler arrivals	Mean annual arrivals	Cumulative migrant arrivals
1920 to 1955	10.4%	0.29%	10.4%
1956 to 1965	6.0%	0.60%	16.4%
1966 to 1975	9.7%	0.97%	26.1%
1976 to 1985	24.6%	2.46%	50.7%
1986 to 1995	20.9%	2.09%	71.6%
1996 to 2005	23.1%	2.31%	94.8%
2006 to present	5.2%	0.87%	100.0%

Table 9. Frequency of settlers by region and by type (cocoa and non cocoa).

Region	Frequency of settlers
ASHANTI	12%
BRONG AHAFO	28%
CENTRAL	5%
EASTERN	15%
GREATER ACCRA	1%
NORTHERN	6%
TOGO	1%
UPPER EAST	8%
UPPER WEST	5%
VOLTA	7%
WESTERN	11%
Cocoa regions	79%
Non cocoa regions	21%

Table 10. Employment of settlers to Bia region, prior to migration episode.

Employment prior to migration	Proportion of migrants
Unemployed	5.26%
Student	22.37%
Self employed	15.79%
Govt work	9.21%
Farming	34.21%
Caretaker	13.16%

Table 11. Producer frequency and distribution of acreage by cocoa variety in bearing and young cocoa farms in Bia District, Ghana, 2011

		TQ Amelonado	F3 Amazon	Hybrid
Bearing cocoa (n=167)	Freq	13	158	29
	Freq %	7.8%	95%	17%
	% of total bearing acreage	3.0%	90%	6.9%
Young cocoa (n=57)	Freq	2	45	17
	Freq %	3.5%	79%	30%
	% of total acreage	1.1%	67%	31%

Table 12. Varieties used for replacement planting of dead cocoa trees.

Variety used for replacing	Producers
Amazon/Amelonado	69%
Hybrid	18%
Both	13%

Table 13. Results from a multivariate regression model of 2010 smallholder cocoa production in 17 villages of the Bia district of the Western Region of Ghana.

		Regression model				Model descriptives		
Variable	Variable Units	Coefficient	Robust std error	P>|t|		Variable mean	Min	Max
Village1	binary	355	1,359	0.794		0.0654	0	1
Village2	binary	-1,896	1,618	0.244		0.0458	0	1
Village3	binary	-1,082	1,033	0.297		0.0588	0	1
Village4	binary	-556	1,073	0.606		0.0654	0	1
Village5	binary	-952	1,068	0.374		0.0588	0	1
Village6	binary	1,733	1,273	0.176		0.0588	0	1
Village7	binary	271	991	0.785		0.0654	0	1
Village8	binary	1,358	962	0.161		0.0458	0	1
Village9	binary	159	1,169	0.892		0.0523	0	1
Village10	binary	2,487	1,500	0.1		0.0654	0	1
Village11	binary	844	1,044	0.421		0.0523	0	1
Village12	binary	470	1,107	0.672		0.0588	0	1
Village13	binary	1,416	908	0.122		0.0654	0	1
Village14	binary	-208	815	0.799		0.0654	0	1
Village15	binary	636	1,037	0.541		0.0523	0	1
Village16	binary	-986	933	0.293		0.0654	0	1
Acres_Amelonado	number	657	578	0.259		0.267	0	12
Acres_Amazon	number	126	44.7	0.006		12.1	0	100
Acres_Amazon2	number	-1.14	0.525	0.031		364	0	10,000
Acres_Hyb	number	586	394	0.14		0.877	0	21
Acres_Hyb2	number	-23.9	20.0	0.234		9.13	0	441
Food_acres	number	-112	122	0.360		1.05	0	20
Shadetrees	number	-2.34	1.24	0.061		46.2	0	1,612
Fertq	kilograms	1.40	0.419	0.001		871	0	31,000
Fertcarryover	applications in last 4 yr	270	163	0.100		1.94	0	4
Mass_spray	number of sprays	65.2	200	0.745		1.63	0	5
Fungq	sachets	-0.800	2.72	0.769		93.1	0	1000
Insectq	liters	22.2	23.3	0.342		11.1	0	59.5
Herbq	liters	-115	43.9	0.01		4.58	0	255
FFS_trained	binary for HH	1449	1091	0.187		0.0588	0	1
Gender	binary for HH	-696	675	0.305		0.843	0	1
Agehh	years	-267	109	0.016		46.1	19	90
Agehh2		2.57	1.09	0.020		2331	361	8,100
Educ_HH	0 to 11 attainment index	371	219	0.093		3.74	0	11
Labor	adult male equivalent	202	109	0.065		4.41	0	14.15
Capital	cedis	0.995	0.654	0.131		509	1	4234
Constant		3792	2233	0.092				
Cocoa production	kilograms					2,866	0	37,120
Number of obs = 153								
F(36, 116) = 22.4								
Prob > F = 0.000								
R-squared = 0.704								

Table 14. Predicted changes in output and yield due to increased agricultural intensification

	Model simulations		
Variable	2000-2001	2010-2011	Net effect on cocoa output (kg)
Fertilizer (kg)	31	871	1,180
Insecticide (liters)	8	11	57
Fertilizer carryover index (0 to 4)	0.0680	1.94	505
Mass spraying (number of sprays)	0.00	1.63	106
FFS-trained (producer freq)	0%	5.88%	85
subtotal			1,934
Yield in 2010 (kg/ha)			535
Predicted yield at 2000 input intensity (kg/ha)			174

Table 15. Land-use and land use change in a 1,201 km² quadrat of the Bia District in Western region, Ghana

	Land use				Land Use change		
Land use and Land Use Change	2000	2003	2006	2011	2000-2003	2004-2006	2007-2011
	(----------hectares----------)				(----------hectares----------)		
Forest to mosaic conversion					881	601	2,082
Mosaic to forest conversion					199	163	821
Net deforestation					682	438	1,261
Forested land use	42,619	41,937	41,499	40,238			
Rural mosaic land use	77,505	78,187	78,626	79,886			

Appendix A.

Provisional anthropological notes based on a case study on selected aspects of village life in the Bia district of the Western region Ghana

OBSERVATIONS ON: LAND TENURE, LABOUR ARRANGEMENTS, FORESTS AND INTENSIFICATION

The notes below are the result of stage one of a two-stage qualitative study of one single cocoa farming community, with a mixed composition of resident Akan 'citizens' and immigrant farmers of various provenances. The first stage research was based on relatively unbiased – or ignorant – observation, interview and rapid appraisal techniques. The researcher purposely did not study the available literature in order to keep 'an open mind'. None of the literature[7] therefore has been included into the present account, although by now it is clear the notes show a number of interesting disparities with some of the literature which will need to be addressed in stage II. Some of the quantitative data in this report, provided by the other authors, also identify new questions and demonstrates the need to deepen the analysis on a number of topics. Therefore, based on the data in this report and a thorough review of available literature, stage two will put the below account into question and deepen the analysis. In the first quarter of 2012 additional field work (on separate funding) will be conducted which should result in a separate publication.

The village

The studied village is a cocoa community in Ghana's Bia District. The chief does not know the number of inhabitants, but is estimated at around five hundred. The community is situated on a crossroads of four dirt roads. It has a central market place/football patch, 2 streams, 8 schools (2 up to JHS level), 6 boreholes, 9 churches, 1 mosque, 1 input dealer, 1 input dealer, 2 cocoa depots (1 privately and 1 community owned), 1 clinic, 1 teachers' house, 1 village chief, a couple of traditional healers and a patch of sacred forest. It has been assisted over the years by a Presbyterian church in Scotland in the building of a children's' library, a health clinic and a guest house. COCOBOD donated 10 solar powered street lights, of which four are still functional. The rural electrification project reached the community some years ago, though here are long and frequent power cuts. The community has access to a several radio stations and the most important
mobile telephone networks for which calling credit is sold within the community.

Almost all inhabitants, with the exception of a couple of tradesmen, farm cocoa. Many youths are in schools in the larger cities and Kumasi, and return during the holidays. There are some families receiving remittances, but not many. Predominantly young adults travel outside the community to look for work. A preferred country was Libya, but they are coming back now. According to the chief do those who find jobs outside of the village often continue to come back and often build a house within the town.

[7] Look for example at recent articles on the topic by Louis Awanyo of Queens University, Canada.

In 2009 a STCP Farmer Field School was held in the village, out if which a farmers organization (FO) with 74 members as emerged. The FO's main objectives are to improve the member's administrative and planning skills and to improve knowledge on the proper use of inputs.

History of Immigration

The village was founded before 1900, by the current chief's ancestor. The second chief was the current chief's grandfather. Two Akan clans arrived shortly after each other, somewhere before 1900. Initially there was the Asuna, but soon a second family clan, the Aduana, arrived. The rest of the native inhabitants or 'citizens' are all Sefwi's from local clans. For this reason the Asuna clan, who occupy 'the stool' (literally named after the stool the ruler sits on) 'owns' all the lands for eternity.

The first immigrants came from Eastern region. They came in for rubber, but later on they changed to cocoa farming. The Ashanti came in 1951 in as 'tenants'. Then the Fanti from Central Region came around 1954-55. The Fanti first lived in 'one house'. Those times are over now and they all have their own houses. The Fanti family guest house continues to play an important role though.

In 1969 the chief witnessed a big drama. All 'aliens' were summoned to leave Ghana. A large group used marriage with a Ghanaian as an alternative to deportation, but still they also had to speak the local language. Many learned the language and remained, but others had to leave; "and were crying because they had to sell everything at the lowest prices." For a while it affected local cocoa production although globally there was a lesser effect as most of the evicted aliens went on to farm in Côte Ivoire.

Internal migrants from Brong Ahafo came in great numbers between 1969 and 1971. As land was still abundant, these immigrants were given generous allocations (or rather; they 'bought the user right') and paid with a small gift; a small amount of money and/or spirits. As the land ultimately continues to belong to 'the stool', they agreed to pay annual royalties, and continue to do so till today. From 1971-72 also people came from Mali and Burkina (Moshi) to farm. The chief added that "in the last 40 years the ones that came in plenty are my next of kin."

All of these earlier immigrants mentioned above have settled in the village 'forever and ever' and can be called 'citizens'. All speak Sefwi now and intermarry. Having said that, the word 'citizen' is generally not applied to migrants. Having many immigrants is seen as a sign of progress. The immigrants report that when they arrived the natives initially had little interest in agriculture; "they were not serious, not happy to go into farming." In the past it was easy for migrants to get land as it was abundant. The chief was inviting people to come in and take their land. The current chief is no longer inviting people to settle, though they continue to come.

"My grandfather liked settlers a lot for their experience and a communal life. They brought prosperity to the community." The royalties the migrant farmers paid to the stool were also a strong incentive.

Cocoa

Today cocoa continues to be everybody's prime objective, or as one of the elder put it; "all else is secondary". However, people do not feel cocoa has recently expanded more rapidly than it did before.

The price of cocoa currently is driving added enthusiasm for cocoa, but a decrease in the price will not easily result in the uprooting of trees although that has occurred in the past. Cocoa is security.

When a cocoa farm is established the tree stock is build-up rapidly in the first years, after which expansion slows down to no more than a couple of acres per year, often (but not always) intermixed with food crops. At least an acre of land per nuclear family is generally kept for food crops mixed in with cocoa. As the available lands have now run out, the need to also grow food crops forces farmers to replant old and unproductive patches of their existing cocoa tree stock. For three to four years food crops are farmed on that land before the cocoa becomes well established and takes over. Once the cocoa canopy closes, food crops can longer be associated. As a partial and temporary solution the last patches of secondary forest are cut for food crops. A few farmers still have some patches of secondary forest left. The knowledge that you can have up to 15 bags per acre if you adopt some of the new techniques and work seriously is starting to change peoples' perceptions of cocoa farming. It has become more economically interesting for the last 15 years as market dependency has increased. And for many people – certainly those with limited scholastic achievement– cocoa is the only option they know to make money. Everybody is planting cocoa. According to most farmers it is correct that cocoa trees (and to a lesser extend oil palm) continue to take up a larger and larger percentage of farmers' farms. They are always on the lookout to expand into new lands. Some farmers are even acquiring new lands in Ashanti Region.

Still, the migrants report that they are more serious about cocoa and fully depend on themselves; "We look for progress, so the farm has to grow continuously", whereas the indigenous population continues to look to their family members for money. The community's elders also report that all the stool land is claimed and that even people who are in the administration come in to farm cocoa.

Food

Not ignorant of global commodity shortages, many in the community expect that the price of food will continue to rise and create serious problems for more and more farmers. Getting land for rice is less of a problem as it is cultivated in lowland swamps that are unsuitable for cocoa. Households will for now continue to grow most of their own food – if possible – and may even continue to be able to sell some of the produce. However, cocoa is definitely cannibalizing available lands for food crops right now. Food prices are perceived as highly variable, because the government doesn't control the market as with cocoa. Because of the price risk some farmers are hesitant to grow food crops for cash. Most farmers do sell their excess food produce and report high food prices at the same time. However, farmers suffer from a weak negotiating position and a lack of access to market information which limits their bargaining power and keeps the food prices down at the farm gate.

Land for food production is reported to be small and food is 'scarce' in the area. Many farmers have to buy food; "In the future we may have to buy most of our food." The elders report that they have less of a problem on their larger lands as they replant old cocoa stands and mix the food with the cocoa. It has always been like that. But there is an increase in the food prices. Food crops are regarded by many cocoa farmers as something that first of all serves as shade for young cocoa. Farmers acknowledge that not growing enough food will result in a financial loss (because you have to buy food) but at the same

time they report continuation of the same old “mistake’. *[This could be because cocoa is providing an income that is certain]*

SOCIOCULTURAL

Categories of Inhabitants

The elders of the village now divide it's population into four categories; (i) native inhabitants (citizens), connected to the ruling matrilineages, (ii) older immigrants and their families that arrived (a) generation(s) ago, who now live within the community and have raised their families in it, (iii) immigrants that do not ‘build a house’ and take the money they earn with cocoa back to their home regions and (iv) caretakers, who live on small settlements on cocoa farms, outside of the community, and save up their earnings for 2-5 years (sometimes longer) before they leave to invest the money elsewhere.

According to the elders and chief, the citizens’ and older immigrants’ families make up the population of the village; “We are one now” and “One man cannot build a community”. The fact that 'the other immigrants' – those who don't live in the community – take money away from the community is seen as an important development problem. All the immigrants that came under the rule of his grandfather are citizens for the chief, only those who come for land to him, he calls settlers. They will leave again and have to pay royalties until they do. The older migrant families are all here with the families and even extended families.

For a migrant your reputation with the chief is important, you need to invest in it. Everything goes through the chief, so you don't want to “find yourself alone”. It is important to make clear to the chief that you come to live within the community. The most important is 'to build a house', which includes bringing your family to the community. You need to be actively involved in activities like communal labour and attending funerals. If you don't participate they “may not even allow you to bury your relatives here, unless you pay a fine that can be as high as 200 GHc.”

Moving Away from Matrilineal Inheritance

The system of inheritance via the matrilineal line puts a lot of pressure on family ties every time someone dies, as the land is redistributed within the matrilineal family. A dramatic change in the system is currently going on, driven by the changed national laws of inheritance. The old ways are no longer functional in light of current developments and legislation.

Both religious (mostly Muslim) and modern legislative influences have broken down the matrilineal inheritance system. It is now broadly recognized that often the nephew or uncle did not always take proper care of the biological family members of the diseased. Nobody still wants to see his wife and children in trouble after one’s death. Even the chief (a Christian) says; "The Muslim way is better". His wife and son have been with him, so they need to inherit. "Formerly the wife and children were crying".

The imam negates any influence from Islam on this change.” In the Koran also there is no mention of the first son inheriting all. That is an African disease.” What is important to note is in Islam there is a clear difference between true children and bastard children with regard to inheritance. One case shows the

father of a cocoa farmer converting to Islam (and kicking the bottle), effectively and actively turning his back on the matrilineal system. The fact that he choose to have his children benefit directly caused major tension in the family; the wife's family (because they would no longer inherit) and his own family (because he was supposed to take better care of his sister's children than his own). It must be said that that system of taking better care of your own blood relatives' children than your biological children has been fading for decades now. But it did result in this particular farmer's father moving his family out of the community and into the nuclear family's farm village.

Today this particular father is regarded as an early adopter. Brothers have stopped complaining to their brothers about inheritance issues. This father went out of his way to clearly indicate that he officially bought the land and that it had to go to his biological children after his death. As a result the family did not even show up to claim the land, even though it was their right to do so according to customary law. In this case it did help that the father died just after the national law on patrilineal succession had been adopted. Because the ownership papers were available, the only other solution - if they had shown up - would have been to go to court.

An older (Akan) migrant reports that, although there was matrilineal inheritance before, among the Akan, Rawlings introduced a law that all Ghanaians now have to practice patrilineal inheritance. When his father died he himself did not get anything, but his own sons don't even know about matrilineal inheritance anymore. Families no longer go and claim lands. Only the children claim. It means that everybody has had to change at the same time, something which is reinforced by the government. With the '91 law nr. 111, the property now becomes divided in 16 parts as follows: 9 parts for the children, 3 for the wife , 2 for the father (or family), and 2 for the mother (or family). Nowadays, women also officially own lands. Often the children do not split up their father's lands.

The new patrilineal system *[although I would argue it is a mix of matrilineal and patrilineal systems, therefore 'bilineal'*] is working perfectly by now, according to the imam. The families also get something small, and the family head leads the negotiations. All farmers report everyone is happy with the change. "In the old days your wife and children would work hard and then a nephew would come after you died to claim all of it. It was a bad system." With the change there are winners and losers. One older cocoa farmer reports how he was very disturbed not to get any land from his uncle after his father - who had many lands - died, but had not choice to accept.

A Roman Catholic catechist and self-proclaimed traditional Akan stresses, just like the elders did, that in the Akan way a father would often give the lands out to his biological children before he died to prevent lands reverting back to the family, the uncle/nephew, after his death. So the change has not been that dramatic. "The only thing the chiefs want is for the peace to prevail. This new system is therefore better. Customary law is not fruitful on this point." The women also report that the land is for their children, not the family. "Everybody does it now." If there are no children, the land is given to a brother or sister.

One of the elders describes that he uses 'flowers' to demarcate the boundaries of this farm, but sometimes also to already split up the farm between his children. "If you do not do that it is the constitutional law that decides." Using flowers is not a general thing to do, but an accepted strategy to keep the

peace in the family after death. Any incoming person will understand. ”It is a long plant, with different kinds of flowers. They have no value, and only serve as a sign. Some flowers are green, some are violet, but they are very visible. It is easy to identify them, even at night.”

The elders report that today everybody wants to depend on himself. “It used to be the leader of each family who had to share. Today is not like that. You have to put things in writing before you ‘leave’. Today's system is better for the wives and children. Today, what you get is for you. Nobody plans for the family anymore, only for themselves. Today's practice is good for today, bad for the future. But what they have to do, they have to do”. Everyone wants to send their children to school hoping they will either have other opportunities than farming after school, or get more off one acre by using improved knowledge.

The change is still going on, people still call themselves matrilineal. The change is most notable with inheritance rules, because all have to change at the same time.

Some people are upset. The new rules are bringing a lot of conflicts when the father proposed the children will now inherit. But in court the children win. The rule of 16 applies. Some of the farmers report that they definitively want part of their farm(s) to go to the family and not only to the children. Farmers do see how splitting up the lands between the many children will become a problem in the future. The imam also mentions that the splitting of lands is a big problem. “But it cannot be resolved; also in the Koran it is written that all children shall inherit.” He is a surveyor and foresees an active land market coming into existence, more and more. The sale of lands will become common. He gives an example of a farmer with 15 children, where he assisted in dividing the land. Many of the 15 children sold their share. “Poverty is a big problem and when one family member would have to inherit or manage the lands instead of dividing the lands between all the children that person will most likely become selfish and may not take good care.”

If the landowner dies, his family formerly needed to come and claim the land. However after in 1991 the national law on succession was passed. It states that when a husband (and father) dies, his wife and children inherit. This was in conflict with the matrilineal system. Today the eldest son/children is/are often privileged. They get bigger shares, also because "they are greedy". Others decide to keep the lands as one, which only postpones the problem one generation. The chief: “the point is that you have to work to get more land. If you don't work it is your own fault.”

The migrants also foresee a big problem in the future, when everybody will have spread-out small lands. Everybody will try to send their children to school as a solution. “To have the papers of your land is now very important. The change created conflict; you take your mother's family land and give it to your ‘husband’s’ children.”

The chief adds; “If land only goes to one place, it will help to develop the family, that is why he said the Muslim way is the best. “The reality is that they share *[devide up]* everything and that is creating problems. If you don't work to get more land you will suffer. You have to get more than your father's land.” He will let the future chief solve the problem, together with the Omanhene, the paramount chief.

It is almost like he only recently sees that at some point land consolidation and re-allotment will have to happen. However, the chief feels that selling is never a good solution to land issues. Sharing and setting boundaries is how problems are solved.

Abunu/Abusan

Abusan merely means 'divides by three' and indicates an agreement between the land owner and person actually farming the land. Abusan usually refers to a division of the produce of a certain crop, rarely to a division of land, it seems. For maize, two thirds of the crop is for the tenant farmer and one third for the owner. For cocoa this is the other way around. If the caretakers (tenants) have an Abusan arrangement; they receive one third of the produce, whereas the landowner receives two thirds.

Abunu means 'that what is divided by two' and can refer to either the produce or the land ownership, depending on the crop and arrangement. For all food crops Abunu is practiced: 50:50. The food crops arrangements have nothing to do with land, only with the produce. Abusan on food is only for maize. Abunu when it refers to cocoa involves an exchange of land for the labor invested in developing the cocoa tree stock on the land. After 5 years when the farm is producing it is split 50:50 between the worker who developed the land and the landowner. However, if the farm is not producing cocoa at that time, the sharecropper enters into an Abusan arrangement until it is, receiving only one third of the produce.

ISSUES WITH THE LAND (TENURE SYSTEM)

Stool Lands

The chief is in control of the stool lands. Of course – in principle – all the land belongs to the stool, but these are lands personally managed by the stool, not by a family or a private person. The chief is not happy when I try to talk about family lands as separate lands from stool lands. “All is stool lands. Away from the village it even becomes private land, although this is still stool land.” In the village the chief is 'the stool'. He reports to the Omanhene, the paramount chief/stool in Sefwi Wioso. Any new land arrangements or disputes are overseen by the stool. In some places there are no longer any actual stool lands left; in this village the stool lands left are limited. When the current chief assumed power in 1987, his grandfather had already given out almost all the land to immigrants. It is only the chief who can decide who gets stool land. Most of what remains of it is cocoa, though some are fallow lands. Not all ‘citizens’ can use it. None of the newer migrants works on such lands. Some of the early migrants worked on stool lands, but that is now private lands because of Abunu. If you have stool lands then you have to pay royalties to the chief. If you are absent you have to settle the debt when you come back. The least secure lands are those within/close to the community as they can be taken for development purposes.

Family Lands

In the old days the chief would increase the family lands as the family would increase in size. That is no longer the case. Family lands are still governed differently than private lands. The family head decides what to do with the lands in negotiations with the other influential members of the family. The older migrant families only have private lands which “makes their lives easier”. Only those ‘citizens’ who

belong to the first clan can ask to make use of stool lands for their family, which means there is a division even between the 'citizens'.

A chief/the stool can use his power to influence land sales but cannot insist on the sale of family lands, only on stool lands. A chief can take substantial parts of family lands if they are needed for developmental purposes like the construction of a school. Unfortunately for those farming on family lands, often family lands are the only suitable location for such building activities (as they are close to the community settlement). There will be negotiations with the family, but compensation - if any - may well be fewer lands elsewhere. In the end the chief decides. In the village this happened for the construction of the clinic and two schools, including a Muslim school. Family lands are less secure than private lands. Therefore migrants, who generally do not own land close to the town centre, are more secure on their land than the native citizens.

Negotiations are always between the family head(s) and the chief. Every family clan also has a head. Not in the village, but elsewhere supposedly there have been instances of chiefs taken family lands for sale to migrants, but this is ill-regarded. The family is in full control over their lands; they do not need to inform the stool about anything.

Royalties on Land

Those immigrants that do not live in the village pay royalties to the 'stool', which according to the chief currently amount to 10% of the cocoa harvest. Food crops are not taxed. *[I have however not found any proof that/how/when this is actually paid. Possibly this is not perceived as a tax to the stool, but as a national tax?]*

The taxation is collected by the chief, and payment is subsequently made to the traditional council in Sefwi Wioso. The village chief is part of this traditional council and reports to the Omanhene, the paramount chief. From the district level the taxes go to the regional and national level. The budget that the traditional council gets is allocated by the national level and is governed by the council meeting in Sefwi. The chief follows the Omanhene's instructions on how to spend within in his community. Whatever works are undertaken in the community are supported by communal labour provided by the village's inhabitants.

"It comes down to the fact that everybody has to contribute to the community. If you are not around to do that, you will have to pay." 'Nana', the chief, does not force anyone who lives within the community to contribute; payment is ensured by peer pressure. All inhabitants are expected to pay the same, although men have to pay more than women.

The older migrants report to only pay for festivals; between 10-20 GHc, depending on the size of their landholding. Caretakers report to pay 2 GHc, and the elders report 5-7 GHc. There is no yearly tax, I am assured. "The chief decides on the amount for migrants but the citizens decide for themselves what to give. Those who live here have to contribute to the festivals each year and do communal labour. Everybody pays the same." The women report that their husbands pay royalties during festivals to the chief. They themselves pay something to the queen mother.

The head of the farmer organisation, a key informant, reports that the general rule is that the chief takes a levy on the production, maybe 20 GHc for the whole year. It happens on an occasional basis and in reality it is more like a 'head count'; just go out and 'beg' from the farmers to help out. Before the chief decides on anything he sits down with the queen mother, to decide what to do with the money. The queen mother will decide on the in-kind contributions that people will have to bring and goes through the women to get those.

Migrants that do not live in the village confirm that the land is for the chief; but they work on it *[which is an accepted definition of ownership]*. They pay a contribution to the stool but know nothing about any 10% tax. They are not forced to pay, even not after returning. When there is a festival they pay 10-20 GHc. If they are in the community and the “gong-gong” sounds they have to come and do communal labour. If you are not here, you are not forced to pay. They are not invited to pay anything else. It has always been like that.

The chief says only those who do not live in the community pay the 10%. The natives don't pay any tax to the stool. The rest pay royalties for festivals. And they collect eggs, fowls, sheep and even goats. Many strangers attend the festivals and the chief has to take care of them. He insists that he goes to the absent migrants and collects the 10%. It is not difficult, he says, if he sends the collectors to them in June or July.

The migrants themselves confirm that when you live within the community you are treated like anyone else. The chief either fixes a price or comes for a voluntary contribution. “Nana cannot make a difference between groups; everybody either pays the same or the chief decides that everyone can decide what they pay. The official rule is that he doesn't force anyone to pay.”

District Stool Lands Office

The District Stool Lands Office is an official government agency in which customary and national law come together. The chief is said to call on this office its staff to monitor his area just as much as the government does. For the farmers it seems unclear whether these officials/surveyors actually work for the stool (chiefs and paramount chief) or for the government, but most believe it is the former. The office is where the stool royalties are collected and if you need a farm plan document you also go to the district (stool lands) office.

The chief reports that the Stool Land Office employs staff like surveyors. Government pays the salaries. They work both for the stool and the government to collect the tax. As a farmer, you need to have a farm plan document otherwise “they will charge you whatever tax they like and give you a receipt. This is why the surveyors are there: to produce farm plans.”

Ownership papers

Migrants warn you should always insist that the ownership papers are prepared. Government surveyors (from the District Stool Lands Office) regularly come in and see if anyone needs their services. They help farmer to write up their farm plan document and officialise their ownership claim. A farm plan document describes where the farm is, where it starts and ends, the size and the borders. The surveyors

work both for the government and the stool, but are paid by the government. This configuration ensures peace between the stool and the state.

For women, although they are the owner of the land, the official ownership can lie with their husbands; his name is on the paper. The women often don't have the ownership papers. If land was given to them by their mother, it will not be contested by anyone. The family knows it is theirs. Some women do have the ownership papers.

Private lands

Private lands have been acquired on different terms by different groups and on different times in history. In the past when a villager 'bought' private land from the chief, the payment was symbolic and the royalties of 10% would not apply as he would live in the village. Today this is not longer possible. In general though, the chief adds; "I have the right to the land, where there is no cocoa". The land is for the chief/stool, but as long as you are farming it, he has no right to come and claim it. The chief cannot touch lands with crops on it. “The land is not for the farmer outright, the final owner is the stool.”

The natives/citizens are actually losing in this situation, because the migrants have papers. The citizens now see that cocoa is very precious and whatever land they have, they have to give out as Abunu *[because they don’t (want to) farm (all of it) themselves?]*. The migrants have official ownership of the lands and the natives have family lands. In general though, the natives are not disappointed, because they also gain from the Abunu. The natives are not seen as lazy, but migrants feel they are more determined, they have an objective. “The native farmers are in their own community, are going nowhere and look at their family member to get something.” For the natives, anything under 1.5 acres is regarded as too small and over 6 is sufficient though it can go up to 30 or even 50. On private lands you can change from cocoa to any other crop without asking for anyone's consent.

Migrants who don't live in the village generally inherited the land from their father, or work with their father. If not, they got their lands through Abunu. Often the father had the papers and the children divided the land by now. They generally respect the new laws but will still give some of their own land to their (matrilineal) family and not all to their children. The early migrants often also acquired land by marrying into the local matrilineages, which “complicated their lives”. Only after Abunu, it became their own property. In the old days, after getting land through the Doko system (cut forest and farm as much as you can manage/“as far as your cutlass reaches”), often the land was shared (Abunu) with the chief. A migrant always looks to have bigger lands; “A good size land is 20 acres. You can still ‘share’ it. But getting even 2 acres of land more is almost impossible.”

Absent migrant farmer land

The ownership of private lands that migrant farmers obtained from the stool when the land was still abundant and whereof in general no paper contract exists, is defined as a 40 years period. After 40 years the cocoa will start dying. The 40 year period can be renewed without any condition. The chief cannot reclaim the land, or decline the renewal as long as the migrant still continues to farm the land. You only need to show up and renew the agreement, on paper this time. According to the chief this is the law in the whole of Ghana.

However, a number of these migrant farmers seem to have abandoned their farms. Most of the farms are 'destroyed'; the cocoa is dying and the land is abandoned. The farmers never came to live in the community; they often continued to live in Brong Ahafo. The chief is now 'working on it' to regain access to those lands, or as a calls it 'pick it'. Gradually some of the migrant farmers are coming in to renew the claim, but the chief is "praying that we get more land", meaning that he hopes many of them (or their families/inheritors) will not show up to come and claim the land. "If they don't come, I pick it for free."

The pressure on the lands, also for food crops is a big reason to be so keen on picking the immigrants large lands.

The women also agree that the chief should be able to take back ill-managed lands after 40 years. As long as he gives it back to the family if they would come and claim it after all. The newer migrants also report that some of the ill-managed old migrants' lands may be given out again. “Those lands were given out to caretakers who don't do a good job. Now the cocoa is dying.”

Land that was acquired through Abunu is harder to ‘pick’ than taking back land acquired through Doko. The chief can't simply claim that land back. But if the old migrant “just gives *[his land acquired through Doko]* to anyone he would come and 'ask questions'.” After Abunu, this is different: you have paid for the land. *[It seems that Doko is like paying for a use right, not land right].* Even the migrants that don’t live in the village I spoke to say that the chief has every right to take migrant's land back if it is neglected and you are no longer related to anyone here; if nobody comes for it.

It has happened that the chief took lands back, but he has yet not given anything out. The chief insists that the 40 year period is based on a national law.

Buying and selling lands

Anyone can buy land. The sale of land is possible but you cannot escape the obligation to pay land royalties to the stool. For a sale to happen the buyer and seller have to reach an agreement first, with witnesses present. After that, the chief has to be made aware that the land is changing ownership. Any sale has to be signed off on by the stool and often one of the elders, for which a payment has to be made to both the chief and a number of witnesses. This chiefly endorsement of sales serves as a quality check to both parties and ensures 'the peace'. They do take the time to go and see the land and its boundaries. If there is any dispute in future they are available.

The payment or this service is called ‘symbolic’, but can be substantial. The chief reports that if you buy a land for 4000 GHc, you pay 500 to the stool. “This is a small amount”, he says. It is for the stool and the witnesses.

It ensures the services of those witnesses in case of a later dispute. The agreement can be verbal or with a written contract. The choice for either has to do with the level of perceived risk for conflicts about the agreement (which within the family is limited). An owner can grow whatever crop he wants.

The stool has/had an interest in land sales to migrants as they will get more royalties for that land. 'Bad chiefs' will put too much attention on selling lands to migrants. In the past the buying of stool lands was easier, not only for migrants, but also for inhabitants.

Buying an existent farm is very expensive. The women report a 6 acres farm was sold for 9500 GHc. However, buying an existing cocoa farm will be easier than finding new land for cocoa establishment, to buy. Anyone, including government can buy any land and do whatever they want to do with it.

Migrants also report that it happens that land is sold, particularly also in the old days when people were not interested in farming. “Many people go to lending companies now. They take your land for 5 years to repay a loan. You can get up to 5000 GHc. It is like renting. Anyone can do it, you don't need permission.” Often it is not a company but an individual (the purchasing clerk and district agric offices play a major role). You need to ‘go to court’ to sign the agreement papers.

Conflicts on the sale of land

The chief (mainly in the olden days) had to keep a balance between the revenues from migrants, the level of conflict, more or less land opportunities for citizens or migrants and whether or not to even give migrants access to family lands or not. It supposedly has happened that even a paramount chief lost his chieftaincy for being a bad chief in this matter.

At this time 'many people' are taking other farmers to court in the village for situations comparable to the case of the father that converted to Islam. Notably the chief is called in as a witness in these court hearings, thereby enforcing the national law on succession, but weakening the customary system. To the chief this does not constitute a problem, because he also wants his (biological) children to inherit his land when he dies.

The chief stresses that many cases do not go to court because, during festivals, land tenure problems are resolved by him and the elders on the Thursday of the festival (the taboo day). He adds, “On Saturday we have fun and games and on Sunday it is church.”

Migrants land security

The claim on lands becomes weaker when you no longer farm the land. Supposedly there is a law that enforces the family's land claims when a person comes to die intestate and/or without clear inheritors. Even if the land is left fellow, there is nothing anyone can do; the ownership of private lands is permanent, or at least for 40 years.

The customary land tenure system, according to the interviewed farmers, is over. The stool now holds on to the last lands they still have for future generation of their own clan, but there has been no single incident of the stool reclaiming any land from anyone. When you have gone to court to get the documents for the farm nobody can take it from you.

The chief can however come for your land if you are not working on it. If you are dead and no family member comes to claim your land the chief can even take land with cocoa still on it. Older migrants also feel it is a good thing that the land ultimately is in the hands of the chief. He can solve problems. The

migrants are strangers so they welcome the chief overseeing the lands. It means they have someone to turn to in case of conflicts. The chief is like a referee. It is possible to have a bad chief, but that is why it is so important to have the papers. “If you have the papers, there is nothing the chief can do.”

Formerly the arrangement with the chief of paying only some schnapps seemed secure as there was abundant land. Each year you do have to pay the royalties. The first migrant in fact did not buy the land, which led to insecurity when the pressure on land increased. At that time however, there was no better kind of arrangement. They have now learned from the experience in the past and realise how important papers are. If the old migrant's land is not used, they agree the chief can go in and give it out to another farmer. There is a big difference between "I bought the land" and "I paid something to the chief" (Doko). If you don't have the papers and the land is grossly neglected, then ‘Nana’ can take it back. Only if you have the farm plan and ownership document you can dispute that decision. "If you were granted the land, then no way that Nana will come for it as long as you keep working on it." Migrants feel that formerly there was insecurity over land, but no longer.

They are adamant that there is nothing you can do, including bad behaviour or bad farming, that can make you lose your land, except neglecting it for many years. The women also report that you are secure of your land, but; “you have to build your house here. But even if you don't build your house you are still secure; “the village has to grow.” When land is acquired through Abunu, often there still are no ownership papers. This is not necessary, the farmers say, because it is an uncontested kind of agreement. Very secure.

The younger migrant farmers are 100% sure their land can be inherited by their children. Even if there is no paper there are witnesses who can guarantee. The elders gave the farms to the early migrants. Before national law came in with court rulings, the elders and the chief were there and ensured everything. “Once the chief and the elders know about your farm, you are secure.”

Even for the younger migrants, who when they came in up to 15 years ago, found little land available to them, even though at that time it was still possible to get some land. The native inhabitants were less interested in cocoa farming. Sharecropping (Abunu) and buying was still quite easy to do. “But the time for ‘Doko’ (farm until where your cutlass reaches/take as much as you can farm) is now far behind us”.

Whether you 'own' the land or only the crops on it is a difficult question to answer in a black or white fashion for any of the farmers. The stool’s ultimate ownership is always acknowledges in some way.

Rent Agreement/Abusan

The kind of crop you want to grow has to go into the contract. To hire land can be for 2,3 or 5 years. On such lands you cannot grow cocoa. So the owner has a say on what you plant. The 2-5 years period is to prevent the soil from being totally depleted by the user. In order to hire lands you can either negotiate a payment or practice Abusan (two thirds for the farmer). Abusan (50:50) is only reported for maize. The most bargaining power seems to lie with the land owner.

Land as Collateral

As there is no more land to be had, if you have some money you can lend it to someone and get a share of the harvest of a partiular farm or even use the farm for a while. The chief: you can use the trees and their production as collateral for a loan. During a number of years a caretaker will be on your farm. This can be done on the basis of a farm plan. However, if someone defaults, they cannot claim the land, says the chief.

Landless households

There are very few landless households. There are some traders, but even they have small farms. Some of them have 'finished' farming and have invested their money into a local business instead. Of course there are plenty caretakers, who do not own land.

ISSUES SURROUNDING (PROTECTED) FORESTS

The Forest and linking-up Forests

The chief claims that biodiversity is very important to them as their own children don't know the ani-mals in the forest anymore. *[It all sounded like socially appropriate answering]* The women confirm that it is sad to see their children grow up without knowledge about the forest and the animals, and they are annoyed that they cannot gain anything from the forest. “I you go you get arrested.”

The migrant who do not live in the village are making more use of the forest or are more open about it; they collect string, game, snails, etc. and some even point to the availability of timber. However, the forest is well protected, they say. An agent has even taken a farmer to court for collecting snails. Many farmers find it disturbing that they can't go and collect medicinal plants without a permit. “What if they become ill?”

If you go into a protected forest you will be arrested. You can however go and see the ranger to get a permit to collect snails for example, but no big animals like antelope and elephant can be hunted.

The elders explain that the forest dictates the rainfall and the younger migrants point to the same link. All farmers seem to agree that the forest reserves that are still there should be conserved. Some species can only be found there, including medicinal ones. To those medicines they have no more access, as the available secondary forest is disappointing in diversity. It is true that some farmers go into the reserves with their cocoa, “but this is unintentional.” Another factor is the availability of very fertile lands, which makes “individuals succumb to the temptation.” The chief adds; “It is true that people go into the forest, but I don't see them go. They have to go through the agent.” Between August to Decem-ber nobody can enter because of the breeding season.

If government would like to connect up forests, according to the chief, the only way would be to sit down with the chiefs and the involved families. The elders disagree; “It cannot be done, nobody can give up the land they feed on.” They argue that you can buy land, yes, but it will prove impossible to secure large stretches of land. The women are appalled by the idea; “Land cannot become forest again, what about the children? They also need land. When you die, the land should be there for your children.” Some of the farmers point to the Agricultural Extension Officer who is teaching them even to plant trees

on their farms. They feel it is better to plant more trees on cocoa farms, than to create new forest. “It cannot work to convert cocoa to forest.”

There are some smaller initiatives within the community with 5 acres of protected ancestral forest and regeneration of the forest. The ancestral forest is where the ancestors used to have their houses. Women are not permitted to go there. If they do visit the river in the forest they will never carry a child anymore. Some rituals are performed and some offerings are made to the ancestors. Interestingly this is the areas where they want to work with Care to plant timber trees (that are yet to be provided). The chief adds that he does not exactly know why it is sacred *[which seems highly improbable]*, but he follow the rules set by his ancestors. They offer schnapps, fowl. The stream is also said to protect the town.

The village has something called the ’Community Resource Management Council’. According to the chief it is still active in collecting market prices and group sales. They take a percentage from the sales.

ISSUES WITH LABOUR (ARRANGEMENTS)

Sharecropping for food crops (produce)

Sharecropping for food focuses on the produce, not the ownership of the land. It follows the 'Abusan' system, with one-third of the produce going to the owner and two-thirds for the farmer. Surprisingly in the village this does not count for maize; this is equally divided according to the 'Abunu' system that we further only know from cash crops, whereby the land is divided and not the produce. It seems that the pressure on the land may have caused this, as dividing food crops 50:50 would never be accepted in Ashanti region, reports the (Ashanti) interpreter. Sharecropping, both for food and cocoa should be regarded as a contract, so you cannot choose or change the crop.

Sharecropping for cash crops (land use rights)

Abunu for cocoa (or sharecropping) involves someone farming the owner’s land for 5 years, in which a certain surface of cocoa lands is to be established. During cocoa establishment the sharecropper needs not share any of the cocoa with the owner because the cocoa does not produce (much) in these first 5 years. However, at the same time an Abusan arrangement is practiced for the food crops with which the cocoa initially is mixed to provide shade and protection. This means the owner receives one-third of the food crops farmed by the sharecropper for 5 years. After 5 years a surveyor will come in and the completed newly established cocoa farm is officially divided fifty-fifty (Abunu). However, often the farm is not yet completely established after five years; there have been delays. The arrangement then changes to Abusan for cash crops (which also applies to caretakers), which means two-thirds of the cocoa produce goes to the owner until the sharecropper is ready to split the fully established cocoa farm fifty-fifty with the owner. However, one informant was adamant that in such a case the division key is open for discussion.

Caretakers

Caretakers are employed on an annual basis to take care of the cocoa trees. The sharing of food crops is not part of the agreement. If very lucky they will receive an acre of the landowners land to grow their own food without paying for it. Some receive some of the food on the owner’s farm. But until harvest they have to buy food. At times they can find some small patch of land (to sharecrop) somewhere. If the

owner has food crops on the farm, mixed with the cocoa, they do need to weed it, but cannot eat it. The general rule is that a caretaker does not have the right to eat from the farm.

Caretakers permanently live in the 'family villages' - a number of huts that are on the farm(s). The land owners (if they also work the land) often spent a number of nights there when there is much work to do on the farm and they don't want to return to the village. Caretakers generally are immigrants from other parts of the country (like Upper West and Upper East), often without any resources. They choose to be caretakers to build up some capital, generally for 2 to 4 years or longer, before taking up other projects or acquiring their own cocoa farms (for example as a sharecropper).

They have more responsibility than annual labourers, because they really take care of the farm. They don't get any payment, they get Abusan for cash crops; one third of the produce. Some will charge the caretaker 30 GHc for the initial arrangement and the witness, as a guarantee. Then the caretaker generally has to pay an annual fee of some 200 GHc (equal to one bag of cocoa) to the farm owner. When the production is low at the end of the year there may be no money for the caretaker. Although the arrangement is Abusan, they don't get the 200 GHc back. There is no room for negotiation; others will easily take their place. The positive side of the caretaker system is that you can make some serious money; like 5 bags or 1000 GHc per year. You will be able to keep 500 after spending 500 on food.

Single caretakers get told by landowners that they have to get married in order to work for them, before they give out the farm. “Owners want to know about you. Being married shows that you will not run away; that you are serious. Also, somebody needs to look after you on the farm. The farm owner does not trust that you can do it alone. You need someone to cook for you and bring you water. So either you bring a wife or you take one from the community.” Many caretakers quickly get married for this reason, and describe it as being forced. Marriage is both with local girls and with girls from their home towns. Previously, when they married into the local matrilineages, not everybody liked it (it gave access to family land). Nowadays, the land rights mainly come from bilineal inheritance and no longer through the matrilineal family. Those who marry locally now, have little hope of accessing land through their wives' family.

Citizen farmers say it is correct that caretakers have to be married. It is very hard work and after harvesting the man cannot break the pods alone. You need people to come in and help, and your wife needs to cook. Also, somebody has to stay behind and surveillance the drying mats when the man goes for the ‘nnoboe’ (reciprocal labour group arrangement) elsewhere. Strangely enough, the wife is not seen as a free labourer. Alternatively, land owners can sometimes also allow brothers to work together on a farm.

The chief adds;”They advise caretakers to take a wife. If the farm is big the owner will (literally) force the caretaker to marry. They will come with a good wife. It is part of the arrangement. If you say you are not married you have to go in for one. The owner generally does not help in finding a wife.” About one of five marries locally. With a wife the chance of cheating is reduced also. The chief admits that the wife is indeed an additional work force, although this is not said. She is not paid.

It happens that caretakers are being chased from the farm without pay after working for weeks or months under the pretence that they did something wrong. They have a very bad bargaining position, are very insecure and the arrangement is often based on trust only. The arrangement itself is that you have to weed the farm 3 times a year;cut/remove mistletoe and keep the farm tidy.

Some of the farm owners are “not helpful” and their farm are highly neglected. It happens that after working hard on a neglected farm, the next year they will be reassigned to a new neglected farm. Caretakers have very little hope to get land of their own. “That only happened in the past.”

If the farm owner comes and inspect the cocoa harvest and suspects a theft, he can chase the caretaker off the farm. They do not need to prove the allegation. They come to check the pods and the drying mats. Many of the caretakers admit they cheat (in general, not personally). The chief adds; “Caretakers steal. There are conflicts. There are many rules and the sanctions are big.” The proof of bad conduct by a caretaker is subjective and is based on the fact that the chief says; “there are no bad landowners.” If there is a conflict the landowner and the witness sit down and the caretaker can ‘beg’ there. But; "if you steal; no mercy".

Day Labour

This arrangement is called ‘12 o'clock’. It can take between 3 or 4 hours. It really depends on the farmer’s strength and speed because it is for a certain task/amount of work. The investment someone will do on one day also depends on how good your standing is with that person. If the person is a stranger they generally leave by latest by 12 o'clock. The caretaker arrangement is ranked as better than day labour. Day labour is the worst, most insecure form of labour to base your existence on.

Annual Labour

This arrangement means money at the end of the year. There is only a verbal agreement, with two elders as witness to the agreement. This arrangement is now less common because much of it was about employing youngsters. Some of it was technically child labour. Now everybody sends their children to school, also after 18, which makes it is difficult to find them. Annual labourers still come in when it is time for cultivation. In the old days they came in troupes, now only grown men come. In general they first look for land, but when that doesn't work out they accept annual labour for a year and make some money. They live together with the family and do not have specific tasks. During the year they get food and shelter. Annual labour is good for young people without a wife and children to care about. They can make up to 600 GHc a year.

Family Labour

Some couples farm together, some have separate farms. When the wive come from a different family in particular; "we don't mix up things". This also is getting less important as the familial provenance of land is getting less important within the nuclear family, now that the children inherit. Couples do expect help from each other, as there are women's and men's activities. The extended family takes care of the children when farmers are absent for shorter or longer periods.

One respondent explained in detail how he and his brothers are together working on the same land they inherited from their father. Each year they come together and plan the upcoming campaign. Cocoa has even brought them a Kia truck they now use to haul other farmers' produce.

Communal Labour

This labour arrangement is very essential for your standing within the community. Every person has to participate, wherever you come from. It happens often when projects/infrastructure come in from the outside. A clear example was when the guest house the researcher stayed in was build with support of the Scottish church, but also during the rural electrification project. “The community does its part.” Communal labour mainly focuses on infrastructure (electricity, roads, the palace, gutters, hole digging, clearing, carrying, bridges...). Farmers report that if you do not contribute, you have to pay more levies to the chief. Also the caretakers have to participate. They also have to attend funerals. When in-laws die, the migrant husband has to provide them with the coffin. The chief says: “Communal labour is for public works. If you don't attend you have to pay 10 GHc within the week or 60 GHc if you are late.” And; “We beat the gong-gong one week in advance so the people know.”

Reciprocal Labour Groups: Nnoboe

Nnoboe is a reciprocal group labour arrangement where 4 or 5 people come together to work together on one of the farmers' farm. The next day, they shift to the next farm until everybody has been served. When you have people working on your farm you have to provide them with food. It used to be a very common arrangement, done by both men and women, though more often by men. The arrangement is never mixed, always gender-separated. If the men come to work on your farm, the man provides (pays) the food, but his wife has to prepare it. It is often used during pod breaking.

ISSUES SURROUNDING INTENSIFICATION

Intensification

The migrants have heard about intensification and are interested as they are no longer getting the same yield as they used to. They recognize they need to use fertilizers and that they are profitable. However, so many factors keep farmers from using them; poverty, access to credit, prices; finding it on the market. For pesticides you need to rent the sprayer. “Many give up.” A big worry is that the recommended fungicides are not for sale.

As they can't get those inputs you may still lose too much of your produce to black pod and not get a return on investment. Women agree; they feel the inputs are difficult to acquire themselves. They generally go to the purchasing clerk and pay half upfront and the other half at the end of the year. The women observe that the fertilizers help a lot, but if you cannot have access to fungicides then you will run a loss. The trees will produce many pods, but the black pod will destroy them. They could only afford both inputs on a credit basis.

Farmers generally only think about fertilizers after the tree becomes 30 years old, when production goes down. They learn from extension agents that it is not good to apply fertilizers on younger cocoa. Next to this they know it is also important to know your land/soil well. The elder report that the transport of

inputs is the greatest problem (after coming up with the money of course); “even if your farm is close and a road leads to it, you have to pay the transport” A distance of 4 miles on a good road can already cost 24 GHc. “It has broken a lot of farmers to use fertilizers.” The subsidised price has also been increasing, with a bag at 29 GHc now, which has tempered the enthusiasm and makes them uncertain about the future price.

One immigrant farmer claims he got 55 bags of his 10 acres of land after FFS and fertilizers, where his neighbour only got 36 bags of his 15 acres. One of the elders reports that he now has increased the space between trees for example and uses the recommended quantities of fertilizer. This year he is getting 310 bags of his 50 acres.

Immigrants were not used to using inputs but get it from the agric. extension officer now. It gets them a profit. However, the fertilizers are too late on the market. “You will not get it before August/September while you need it April/May. If you apply then it does not help for the main season. Only if you plan well you have money for pesticides.”

To get improved planting materials means to suffer. “You have to travel far and register before you may get something next time.” If you organise yourself in an association you can get improved planting materials through the agric. extension district officer. “If you are not grouped you suffer to get it.”

If the land is abundant, in general, the farmers agree that everyone will choose expansion over intensification. “You can see a farmer with 10 different farms and none is intensified and they still look for more land”. Farmers often think that bigger farms means more cocoa yield. Most want expansion more than intensification. Some farmers “now know better, but another factor is that if you came in for Abunu in cocoa, you have to finish the land before it can be shared and you get your part.” The chief however is adamant that farmers prefer intensification over expansion.

Strategies to achieve more intensification and replanting

According to the chief, forming groups could help intensification: making them understand that they have to pay every month, increase knowledge sharing, having meetings is important and payments for group buying of inputs. In general the chief would like to see more FOs.

The elderly migrants state they will always mix cocoa with food crops until the cocoa farm is complete. Only then they will replant the weak parts and eventually will restart replanting where they originally started the farm. Again the farmers point out that you can almost only get the right inputs at the right time when you organise yourself in an association, but it is really very difficult to get the inputs on time. The money is the worst problem, but also getting enough confidence to use it *[take the plunge].* Some farmers even think fertilizers are not good for the cocoa *[in the long run]*.

Some caretakers are lucky when the land owner pays for the inputs. In general though, they agree that the caretaker should also pay one third. In fact they would generally agree to such an arrangement if their land-owner would propose it; “because it is a profitable arrangement.” They get double the yield. There is a risk though. They could be sacked from the farm before the inputs would have provided a return on their investment. None of this can be put on paper, all arrangements between caretakers and

land-owners are generally verbal. Some landowners however do report they put these arrangements on paper with the caretakers.

Most farmers will choose expansion over intensification say also the caretakers. “Some have big farms here but still move to Ashanti to expand.” They already have their children in mind. Securing more land for your children is more important than getting more cocoa. Buying of inputs is difficult so many give up and wait for others to lead the way. Another important development which could induce change is that with more and more children inheriting parts of their parents' lands we will see increased (emergency) land sales. Interesting also is to note that according to several inhabitants of the village Ashanti Region is the new cocoa frontier. The old lands that were cleared because of swollen foot are now being replanted. Also the lands that were destroyed by the great fires qualify. One of the elder; “Some people are even going back.”

Appendix B

The Interviewer

	Name of Interviewer:
	Date of Interview: (dd/mm/yyyy): |___|___|20__|
	Name of Questionnaire Controller:

HOUSEHOLD QUESTIONNAIRE

DEMOGRAPHICS			
HH1	Name of Household Head		
HH2	Name of respondent (if different from above)		
HH3	Relationship between respondent and Household Head	__1 Household Head __2 Spouse of Household Head __3 Son of Household Head __4 Daughter of Household Head __5 Member of extended family of Head of Household __6 Others State_____	
HH4	Contact No. of respondent		
HH5	Sex of respondent	__1 Male __0 Female	
HH6	Age of respondent	_____ *years*	
HH7	Education Level of respondent	__1 No Education __2 Non-Formal Education __3 Primary __4 JHS __5 MSLC (Standard 7) __6 O' Level __7 SHS __8 Technical/Vocational __9 A' Level __10 Training(Teaching/Nursing) __11 Polytechnic/University __12 Post-graduate __13 Others state _____	
HH8	Marital Status	__1 Married __2 Not Married __3 Widow(er) __4 Divorced	
MIGRATION AND HOUSEHOLD LABOUR ENDOWMENTS			
HH9	Are **you** or **your** ancestors originally from this community?	__1 Yes __0 No	IF YES, GO TO HH14
HH10.1	If No **where** & **when** did **you** or **your** ancestors migrate from most recently?	Village _____ District _____ Region _____ Year of migration _____	
HH10.2	Was this village your ancestral village	__1 Yes __0 No __2 Don't know	
HH11	Do you have people in this community who speak your language?	__1 Yes __0 No __2 Don't know	
HH12	What type of settler are you?	__1 First generation settler (farmer migrated into community himself) __2 Child of settler farmer(s) (farmers' parents were migrants but farmer was born in the village)	IF 2, GO TO HH14

HH13.1	What work were you doing before coming to this community	__1 Farming: __1: owner of farm __2: Caretaker __2 Sharecropper __3 Unemployed __4 Student __5 Self-employed (state type)_____ __6 Government work (state type)_____ __7 Others state_____					IF 3-6 GO TO HH13.4
HH13.2	If you were a **farmer/sharecropper**, which crops were you cultivating	__1 Cocoa __2 Food crop: 1. _____ 2. _____ __3 Other cash crop _____ __4 Others (state)_____					
HH13.3	What has become of the land you were previously farming?	__1 Sold __4 Caretaker __2 Still own, in fallow __5 Others_____ __3 Given to family members					
HH13.4	What factors influenced your coming into this community?	***PULL FACTORS*** ***PUSH FACTORS*** Y/N: Land availability Y/N: Declining crop yield Y/N: Other family members Y/N: Land Scarcity Y/N: Other friends Y/N: Land Conflicts Y/N: Sharecropping to get land Others (state) _____					
HH13.5	How long have you been farming in this community?	_____years					
HH14	How did farmer get into farming?	__1 First generation farmer (farmer began all his farms by himself) __2 Second/third generation farmer (farmer inherited some farms from parents and might have cultivated others)					
HH15	**Household Labour Endowments**	**No. of Children <10**	**No. of Boys 10 to 17**	**No. of Girls 10 to 17**	**No of Adult Men 18+**	**No. of Adult Women 18+**	
HH15.1	Total No. in Household						
HH15.2	Number who help in: Cocoa Fields						
	Food Crops Fields						
	Other Cash crops Fields						
NON-AGRICULTURALLY PRODUCTIVE LANDS							
HH16.1	Do you have fallow fields (<25 yrs)	__1 Yes, Size _____ acres __0 No					IF NO GO TO HH16.3
HH16.2	If fallow field	Year field was last cropped _____ Year field would be cropped _____					
	Is this fallow field inheritable?	__1 Yes __0 No					
	If No, to whom does this land/farm revert to when you no longer use it?	__1 Landlord __2 Forestry __3 Chief/stool __4 Family __5 Spouse Others (state) _____					
HH16.3	Do you have secondary forest (>25 yrs)	__1 Yes, Size _____ acres __0 No					IF NO GO TO HH16.5
HH16.4	Is this forest land inheritable?	__1 Yes __0 No					
	If No, to whom does this land revert to when you no longer use it?	__1 Landlord __2 Forestry __3 Chief/stool __4 Family __5 Spouse Others (state) _____					
HH16.5	Do you have Abandoned farms	__1 Yes, Size _____ acres __0 No					IF NO GO TO HH17.1

HH16.6	If Yes, why was it abandoned?		
	Is this land inheritable?	__1 Yes __0 No	
	If No, to whom does this abandoned farm revert to when you no longer use it?	__1 Landlord __2 Forestry __3 Chief/stool __4 Family __5 Spouse Others (state) _____	
TRAINING			
HH17.1	Have you received farm training from any organisation? __1 Yes __0 No		IF NO, GO TO HH18.1
HH17.2	What were you trained in? __1 Farm maintenance __2 Farm establishment Others_____		
HH17.3	Which Organisation trained you?		
CREDIT ACCESSIBILITY			
HH18.1	Do you receive inputs on credit?	__1 Yes; Organisation _____ __0 No	IF NO GO TO HH19.1
HH18.2	If Yes, which types of inputs do you receive on credit	__1 Pods/Seedlings __2 Fertilizers __3 Fungicides; __4 Insecticides __5 Don't know __6 Herbicides Others (state)_____	
HH19.1	Do you receive free inputs?	__1 Yes __0 No	IF NO GO TO HH20.1
HH19.2	Which organizations provides free inputs and the year inputs were last received	__1 NGOs; Name:_____ Year:_____ __2 Government Mass Spraying Year:_____ __3 Licensed Buying Company Year: _____ __4 Input Dealers Year:_____ Others (state) _____ Year: _____	
HH19.3	Which types of inputs do you receive on credit	__1 Pods/Seedlings __2 Fertilizers __3 Fungicides; __4 Insecticides __5 Don't know __6 Herbicides Others (state) _____	
HH20.1	Will you get access to loan if you need it?	__1 Yes __0 No	IF YES HH20.3
HH20.2	If No, why won't you get the loan?	__1 High interest rate __2 No Financial Institution in the community __Others (state) _____	GO TO HH20.4
HH20.3	Where would you get the loan from?	__1 Banks & microfinance Institutions __2 Cocoa Purchasing Clerks __3 Family and Friends __4 Money Lenders Others (state) _____	
HH20.4	What is the current interest rate in this community	_____%	
HH21	What was your total cocoa output from Oct 1, 2009 to Sept 30, 2010	_____ bags	
HH22	What proportion of your food requirements do you buy?	_____/10	GO TO HH23

HH23	**Fixed Item**	**Quantity**	**Number and Working Condition**				
			Not working	Poor	Good	Excellent	
HH23.1	Cutlass						
HH23.2	Go to Hell						
HH23.4	Pruner						
HH23.5	Baskets						
HH23.6	Raffia Mat						
HH23.7	Knapsack sprayer						
HH23.8	Motorised sprayer						
HH23.9	Jute bags						
HH23.10	Wellington boots						
HH23.11	Gloves						
HH23.12	Nose guards						
HH23.13	Protective clothes						
HH23.14	Chainsaw						
HH23.15	Motorbike						
HH23.16	Tractor (any type)						
HH23.17	Radio						
HH23.18	Cell phone						
HH23.19	Pickup truck (e.g. Kia Trade)						END

Farm Type	***No. of Sharecroppers***	***No. of Caretakers***	***No. of permanent workers***	***Expenditure on casual/hired labour/yr (GHC)***	***Expenditure on permanent workers/yr (GHC)***
Cocoa					
Food Crops					
Other Cash Crops					

MATURE COCOA (4 YRS+)

MC1	What is the Size of this farm?	_____acres	
MC2	What is the distance from your house to this farm?	_____miles	
MC3	Can a car get to your farm or close to it	__1 Yes __0 No	
MC4	Was this land inherited (or given as gift)?	__1 Yes __0 No	
MC5	How land was first acquired	__1 Customary (from Stool) __2 Sharecrop –sharecropper __3 Sharecrop-owner __4 Cash Purchase (Stool) __5 Cash Purchase (individual) __6 Caretaker (Abunu, 50-50) __7 Caretaker (Abusa, 67-33) __8 Borrowed (family) __9 Leased	IF 2 GO TO MC6.1; IF ANY OTHER GO TO MC7
MC6.1	Who determined the boundaries	__1 Sharecropper __2 Landowner __3 Chief __4 Surveyor Others (state)_____	
MC6.2	At what age of cocoa was land shared?	_____years	
MC6.3	Who made the first choice of the shared land?	__1 Sharecropper __2 Landowner	
MC6.4	Is this field inheritable?	__1 Yes __0 No	IF YES GO TO MC7
MC6.5	If it is not, to whom does this land revert to when you no longer use it?	__1 Landlord __2 Forestry __3 Chief/stool __4 Family __5 Spouse Others (state)_____	
MC7	If you own the land, do you have title to this land?	__1 Yes __0 No	
MC8	Year land was first acquired?	_____	
MC9	Age of majority of the cocoa trees	_____years	
MC10	Type(s) of labour used by household on this farm	__1 Household __2 Casual/hired __3 Salaried __4 Caretakers __5 Sharecropping by HH __6 Sharecropping by other __7 Nnoboa __8 Family (siblings) Others (state)_____	
MC11	Are you currently replacing dead trees?	__1 Yes __0 No	IF NO GO TO MC21
MC12	Type of planting materials used in replacing dead trees	__1 Pods (at stake) __2 Pods (Seedlings) __3 Seedlings	
MC13	Source(s) of planting materials for replacement dead trees? (Multiple Choice)	__1 Seed Garden __2 Research Institute __3 Own farm __4 Other farmers' farm Other organisations: name_____ Others (state)_____	IF 1 OR 2 GO TO MC14; IF 3 OR 4 GO TO MC19; IF MIX DON'T SKIP
MC14	If Seed Garden/Research Institute, do you always get the quantity you want?	__1 Yes __0 No	IF YES GO TO MC17.1

MC15	If No, what proportion of planting materials from Seed Garden do you get?	____/10	
MC16	How do you supplement your requirement?	__1 Use own farm pods __2 Use pods from other farmers' farms __3 Plant what I get __4 Other organisation: name_____	
MC17.1	Cost of transporting seedlings to village	GHC _____ per 100	
MC17.2	Cost of transporting seedlings to farm	GHC _____ per 100	
MC18	Quantity of planting materials purchased in the last 12 months for replacement		
MC19	If you use pods from your farm or other farmer's farms, what are the reasons?	__1 Hybrids are expensive __2 Does not get the quantity required __3 Seed Garden far from this community __4 Don't know of any other planting materials __5 High transport cost __6 Poor road network __7 Local varieties last longer __Others (state) _____	
MC20	Do you practice lining and pegging on this farm?	__1 Yes __0 No	
MC21	What proportion of the different types of cocoa are found on your farm (total should be 10)	__/10 Amelonado (Tetteh Quarshie) __/10 Amazonia (Agric) __/10 Hybrid	
MC22	How many permanent shade trees you have on this farm?	No. of shade trees _____ No. of shade trees that are timber trees____ No. of shade trees that are fruit trees _____	
MC23	What is the previous land cover for this farm? ***Fallow land = 1; Forest land = 2; Secondary forest=3; Swamp=4 Abandoned cocoa farm =5; Current crop=6; Do not know =7; Others (state)***		
	At the time household acquired the land		
	2000		
	2003		
	2007		
MC24.1	Do you use fertilizer on this farm?	__1 Yes __0 No	IF NO GO TO MC24.6
MC24.2	If Yes, indicate the first and last year you used fertilizer	Year fertilizer was first applied _____ Year fertilizer was last applied _____	
MC24.3	Type(s) of fertilizer used?		
MC24.4	Quantity applied in last 12 months	_____ (bags/bottles)	
MC24.5	Price per unit	GHC _____ per unit	GO TO MC25.1
MC24.6	If you have **never used fertilizer** on this farm before, what are your reasons? (Multiple response)	__1 Not available in village __2 Purchasing point far from village __3 Expensive __4 Credit not available __5 Don't know about it __6 Negative previous experience __7 Poor transport system __8 Others (state)_____ __99 Not Applicable	

MC25.1	What type of pest does Mass Spraying spray against?	__1 Black Pod __ 2 Capsids __3 Both __4 No Mass Spraying	IF 4 GO TO MC26.1
MC25.2	How many times was this farm sprayed in the last 12 months against Black Pod by Mass Spraying?		
MC25.3	Did this Mass Spraying against Black Pod on this farm cover the entire farm?	__1 Yes __0 No	IF YES GO TO MC26.1
MC25.4	If No, how did you supplement your requirements?	__1 Sprayed myself __2 Does not spray __Others _____	IF 1 GO TO MC26.2; IF 2 GO TO MC26.8
MC26.1	Apart from Mass Spraying, do you or have you sprayed **fungicides** on this farm before?	__1 Yes __0 No	IF NO GO TO MC26.8
MC26.2	Indicate the first and last year you sprayed	Year fungicide was first sprayed:_____ Year fungicide was last sprayed: _____	
MC26.3	Number of times farmer sprayed fungicides in the last 12 months		
MC26.4	Type(s) of fungicide used in spraying?		
MC26.5	Quantity of fungicides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	
MC26.6	Do you apply the fungicides yourself?	__1 Yes __0 No, I hire	
MC26.7	If **you hired someone** to spray this farm, what is the total cost of spraying per year?	GHC _____/year	GO TO MC26.9
MC26.8	If you have **never personally used fungicides** on this farm before, what are your reasons? (Multiple response)	__1 Fungicides not available on the market __2 Not available in village __3 Purchasing point far from village __4 Fungicides are expensive __5 Credit not available __6 Black Pod not a severe problem __7 Don't know about it __8 Negative previous experience __9 Poor transport system Others (state)_____ __99 Not Applicable	
MC26.9	Do(es) the cocoa farmer(s) you share boundary with use fungicides?	__1 Yes, all of them use fungicides __2 Yes, some of them use fungicides __0 No, none of them use fungicides __3 There is no cocoa farmer __4 Don't Know	
MC27.1	Do you receive enough insecticides from the Mass Spraying gangs to cover your entire farm?	__1 Yes, enough __0 No, not enough Qty in last 12 months _____ __2 Don't receive any insecticides	IF 2 GO TO MC28.1
MC27.2	If No, how do you supplement your requirement?	__1 Sprayed myself __2 Does not spray Others _____	IF 1 GO TO MC28.2; IF 2 GO TO MC28.8
MC28.1	Apart from Mass Spraying, do or have you sprayed **insecticides** on this farm before?	__1 Yes __0 No	IF NO GO TO MC28.8
MC28.2	Indicate the first and last year of use	Year insecticide was first sprayed_____ Year insecticide was last sprayed _____	
MC28.3	How many times did you spray insecticides in the last 12 months?		
MC28.4	Type(s) of insecticides used?		

MC28.5	Quantity of insecticides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	
MC28.6	Do you apply the insecticides yourself?	__1 Yes __0 No, I hire	IF YES GO TO MC28.9
MC28.7	If **you hired someone** to spray this farm, what is the total cost of spraying per year?	GHC _____	GO TO MC28.9
MC28.8	If you have **never personally used insecticides** on this farm before, what are your reasons? (Multiple response)	__1 Insecticides not available on the market __2 Not available in village __3 Purchasing point far from village __4 Insecticides are expensive __5 Credit not available __6 Capsids not a problem __7 Don't know about it __8 Negative previous experience __9 Poor transport system Others (state)_____ __99 Not Applicable	
MC28.9	Do(es) the cocoa farmer(s) you share boundary with use insecticides?	__1 Yes, all of them use insecticides __2 Yes, some of them use insecticides __0 No, none of them use insecticides __3 There is no cocoa farmer __4 Don't Know	
MC29.1	Do you use **herbicides** on this farm?	__1 Yes __0 No	IF NO GO TO MC29.6
MC29.2	If Yes, indicate the first and last year you used herbicides	Year herbicide was first sprayed_____ Year herbicide was last sprayed _____	
MC29.3	How many times did you spray herbicides in the last 12 months		
MC29.4	Type(s) of herbicides used?		
MC29.5	Quantity of herbicides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	GO TO MC30
MC29.6	If you have **never used herbicides** on this farm before, what are your reasons? (Multiple response)	__1 Not available in village __2 Purchasing point far from village __3 Herbicides are expensive __4 Credit not available __5 Cocoa canopy closed (weeds not a problem) __6 Don't know about it __7 Negative previous experience __8 Poor transport system Others (state)_____ __99 Not Applicable	
MC30	**If farmer uses fertilizers and/or pesticides on this farm**, what is the average yearly **cocoa** output	before using fertilizer _____bags after using fertilizer _____bags	END

YOUNG COCOA (<4 YRS)

YC1	Is this farm a replanted old farm or new farm	__1 Replanting __2 New Planting	
YC2	What is the Size of this farm?	_____ acres	
YC3	What is the distance from your house to this farm?	_____miles	
YC4	Can a car get to your farm or close to it	__1 Yes __0 No	
YC5	Year young cocoa was planted?		
YC6	Did you plant food crops before planting the cocoa	__1 Yes __0 No	
YC7	Type of planting materials used	__1 Pods (at stake) __2 Pods (Seedlings) __3 Seedlings	
YC8	Source(s) of planting materials (Multiple Choice)	__1 Seed Garden __2 Research Institute __3 Own farm __4 Other farmers' farm Other organisations: name_____ Others (state)_____	IF 1 OR 2 GO TO YC9; IF 3 OR 4 GO TO YC14; IF MIX DON'T SKIP
YC9	If Seed Garden/Research Institute, do you always get the quantity you want?	__1 Yes __0 No	IF YES GO TO YC12
YC10	If No, what proportion of planting materials from Seed Garden/Research Institute do you get?	____/10	
YC11	How do you supplement your requirement?	__1 Use own farm pods __2 Use pods from other farmers' farms __3 Plant what I get __4 Other organisation: name_____	
YC12	Cost of transporting seedlings to village and to farm	GHC _____ per 100 to village GHC _____ per 100 to farm	
YC13	Quantity of planting materials purchased in the last 12 months?		GO TO YC15
YC14	Reasons farmer uses pods from his own farm/other farmer's farms?	__1 Hybrids are expensive __2 Doesn't get quantity required __3 Seed Garden far from community __4 Don't know of any other planting materials __5 High transport cost __6 Poor road network __7 Local varieties last longer __Others (state) _____	
YC15	Do you practice lining and pegging on this farm?	__1 Yes __0 No	
YC16	What proportion of the different types of cocoa are found on your farm (total should be 10)	__/10 Amelonado (Tetteh Quarshie) __/10 Amazonia (Agric) __/10 Hybrid	
YC17	Was this land inherited (or given as gift)?	__1 Yes __0 No	
YC18	How land was first acquired	__1 Customary (from Stool) __2 Sharecrop –sharecropper __3 Sharecrop-owner __4 Cash Purchase (Stool) __5 Cash Purchase (individual) __6 Caretaker (Abunu, 50-50) __7 Caretaker (Abusa, 67-33) __8 Borrowed (family) __9 Leased	IF 2 GO TO YC19.1; IF ANY OTHER GO TO YC20

YC19.1	Who determined the boundaries	__1 Sharecropper __2 Landowner __3 Chief __4 Surveyor Others (state)_____	
YC19.2	At what age of cocoa was land shared?	_____years	
YC19.3	Who made the first choice of the shared land?	__1 Sharecropper __2 Landowner	
YC19.4	Is this shared-land inheritable?	__1 Yes __0 No	IF YES GO TO YC20
YC19.5	If No, to whom does this land/farm revert to when you no longer farm it?	__1 Landlord __2 Forestry __3 Chief/stool __4 Family __5 Spouse Others (state)_____	
YC20	Year land was first acquired?	_____	
YC21	If you own the land, do you have title to this land?	__1 Yes __0 No	
YC22	Type(s) of labour used by household on this farm	__1 Household __2 Casual/hired __3 Salaried __4 Caretakers __5 Sharecropping by HH __6 Sharecropping by other __7 Nnoboa __8 Family (siblings) Others (state)_____	
YC23	Number of permanent shade trees you have on this farm	No. of shade trees _____ No. of shade trees that are timber trees____ No. of shade trees that are fruit trees _____	
YC24	What is the previous land cover for this farm? ***Fallow land = 1; Forest land = 2; Secondary forest=3; Swamp=4 Abandoned cocoa farm =5; Current crop=6; Do not know =7; Others (state)***		
	At the time household acquired the land		
	2000		
	2003		
	2007		
YC25.1	Do you use **fertilizer** on this farm?	__1 Yes __0 No	IF NO GO TO YC25.7
YC25.2	If Yes, indicate the first and last year you used fertilizer	Year fertilizer was first applied _____ Year fertilizer was last applied _____	
YC25.3	Type(s) of fertilizer used?		
YC25.4	Quantity applied in last 12 months	_____ (bags/bottles)	
YC25.5	Price per unit	GHC _____ per unit	
YC25.7	If you have **never used fertilizer** on this farm, what are your reasons? (Multiple response)	__1 Not available in village __2 Too young for fertilizer to be applied __2 Purchasing point far from village __3 Fertilizers are expensive __4 Credit not available __5 Don't know about it __6 Negative previous experience __7 Poor transport system __8 Others (state)_____ __99 Not Applicable	
YC26.1	Do you receive enough insecticides to cover your entire farm?	__1 Yes, enough __0 No, not enough Qty in last 12 months _____ __2 Don't receive any insecticides	IF 2 GO TO YC27.1

YC26.2	If No, how do you supplement your requirement?	__1 Sprayed myself __2 Does not spray Others _____	IF 1 GO TO YC27.2 IF 2 GO TO YC27.8
YC27.1	Apart from Mass Spraying, do you or have you sprayed **insecticides** on this farm before?	__1 Yes __0 No	IF NO GO TO YC27.8
YC27.2	Indicate the first and last year you used insecticides	Year insecticide was first sprayed_____ Year insecticide was last sprayed _____	
YC27.3	Number of times you sprayed insecticides in last 12 months		
YC27.4	Type(s) of insecticides used?		
YC27.5	Quantity of insecticides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	
YC27.6	Do you apply the insecticides on yourself?	__1 Yes __0 No, I hire	IF YES GO TO YC27.9
YC27.7	If **you hire someone** to spray this farm, what is the total cost of spraying per year?	GHC _____	GO TO YC27.9
YC27.8	If you have **never personally used insecticides** on this farm, what are your reasons? (Multiple response)	__1 Insecticides not available on the market __2 Not available in village __3 Purchasing point far from village __4 Insecticides are expensive __5 Credit not available __6 Capsids not a problem __7 Don't know about it __8 Negative previous experience __9 Poor transport system Others (state)_____ __99 Not Applicable	
YC27.9	Do(es) the cocoa farmer(s) you share boundary with use insecticides?	__1 Yes, all of them use insecticides __2 Yes, some of them use insecticides __0 No, none of them use insecticides __3 There is no cocoa farmer __4 Don't Know	
YC28.1	Do you use herbicides on this farm?	__1 Yes __0 No	IF NO GO TO YC28.6
YC28.2	If Yes, indicate the first and last year you used herbicides	Year herbicide was first sprayed_____ Year herbicide was last sprayed _____	
YC28.3	Number of times you sprayed herbicides in last 12 months		
YC28.4	Type(s) of herbicides used?		
YC28.5	Quantity of herbicides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	END
YC28.6	If you have **never used herbicides** on this farm, what are your reasons? (Multiple response)	__1 Not available in village __2 Purchasing point far from village __3 Herbicides are expensive __4 Credit not available __5 Don't know about it __6 Negative previous experience __7 Poor transport system Others (state)_____ __99 Not Applicable	END

FOOD CROPS

FC1	What types of food crops do you cultivate on this land?	__1 Cassava __2 Plantain __3 Cocoyam __4 Maize __5 Rice Others (state) _____	
FC2	What is the Size of this farm?	_____acres	
FC3	What is the distance from your house to this farm?	_____miles	
FC4	Can a car get to your farm or close to it	__1 Yes __0 No	
FC5	Was this land inherited (or given as gift)?	__1 Yes __0 No	
FC6	How land was first acquired	__1 Customary (from Stool) __2 Sharecrop –sharecropper __3 Sharecrop-owner __4 Cash Purchase (Stool) __5 Cash Purchase (individual) __6 Caretaker (Abunu, 50-50) __7 Caretaker (Abusa, 67-33) __8 Borrowed (family) __9 Leased	
FC7	Year land was first acquired?	_____	
FC8	If you own the land, do you have title to this land?	__1 Yes __0 No	
FC9	Can you plant cocoa or other perennial crops on this land?	__1 Yes __0 No	IF YES GO TO FC11
FC10	If No, why can't you plant cocoa?	__1 Swamp __2 Land not mine Others (state) _____	
FC11	Type(s) of labour used by household on this farm	__1 Household __2 Casual/hired __3 Salaried __4 Caretakers __5 Sharecropping by HH __6 Sharecropping by other __7 Nnoboa __8 Family (siblings) Others (state)_____	
FC12	What is the previous land cover for this farm? ***Fallow land = 1; Forest land = 2; Secondary forest=3; Swamp=4 Abandoned cocoa farm =5; Current crop=6; Do not know =7; Others (state)***		
	At the time household acquired the land		
	2000		
	2003		
	2007		
FC13.1	Do you use **fertilizer** on this farm?	__1 Yes __0 No	IF NO GO TO FC13.6
FC13.2	If Yes, indicate the first and last year you used fertilizer	Year fertilizer was first applied _____ Year fertilizer was last applied _____	
FC13.3	Type(s) of fertilizer used?		
FC13.4	Quantity applied in last 12 months	_____ (bags/bottles)	
FC13.5	Price per unit	GHC _____ per unit	GO TO FC14.1

FC13.6	If you have **never used fertilizer** on this farm before, what are your reasons? (Multiple response)	__1 Not available in village __2 Purchasing point far from village __3 Expensive __4 Credit not available __5 Don't know about it __6 Negative previous experience __7 Poor transport system __8 Others (state)_____ __99 Not Applicable	
FC14.1	Do you or have sprayed **fungicides** on this farm before?	__1 Yes __0 No	IF NO GO TO FC14.6
FC14.2	Indicate the first and last year of use	Year fungicide was first sprayed:_____ Year fungicide was last sprayed: _____	
FC14.3	Number of times you sprayed fungicides in the last 12 months		
FC14.4	Type(s) of fungicide used in spraying?		
FC14.5	Quantity of fungicides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	GO TO FC15.1
FC14.6	If you have **never used fungicides** on this farm before, what are your reasons? (Multiple response)	__1 Food crops do not need fungicides __2 Fungicides not available on the market __2 Not available in village __3 Purchasing point far from village __4 Fungicides are expensive __5 Credit not available __6 Fungi are not a problem __7 Don't know about it __8 Negative previous experience __9 Poor transport system Others (state)_____ __99 Not Applicable	
FC15.1	Do you or have you sprayed **insecticides** on this farm before	__1 Yes __0 No	IF NO GO TO FC15.6
FC15.2	Indicate the first and last year you sprayed insecticides	Year insecticide was first sprayed_____ Year insecticide was last sprayed _____	
FC15.3	How many times did you spray insecticides in the last 12 months?		
FC15.4	Type(s) of insecticides used?		
FC15.5	Quantity of insecticides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	GO TO FC16.1
FC15.6	If you have **never used insecticides** on this farm before, what are your reasons? (Multiple response)	__1 Insecticides not available on the market __2 Not available in village __3 Purchasing point far from village __4 Insecticides are expensive __5 Credit not available __6 Insects not a problem __7 Don't know about it __8 Negative previous experience __9 Poor transport system Others (state)_____ __99 Not Applicable	

FC16.1	Do you use herbicides on this farm?	__1 Yes __0 No	IF NO GO TO FC16.6
FC16.2	If Yes, indicate the first and last year you used herbicides	Year herbicide was first sprayed_____ Year herbicide was last sprayed _____	
FC16.3	How many times did you spray herbicides in the last 12 months		
FC16.4	Type(s) of herbicides used?		
FC16.5	Quantity of herbicides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	END
FC16.6	If you have **never used herbicides** on this farm before, what are your reasons? (Multiple response)	__1 Not available in village __2 Purchasing point far from village __3 Herbicides are expensive __4 Credit not available __5 Don't know about it __6 Negative previous experience __7 Poor transport system Others (state)_____ __99 Not Applicable	END

OTHER CASH CROPS

CC1	What types of cash crops do you cultivate on this land?	__1 Oil Palm __2 Coffee __3 Cashew Others (state) _____	
CC2	Year farm was established?		
CC3	What is the Size of this farm?	_____acres	
CC4	What is the distance from your house to this farm?	_____miles	
CC5	Can a car get to your farm or close to it	__1 Yes __0 No	
CC6	Was this land inherited (or given as gift)?	__1 Yes __0 No	
CC7	How land was first acquired	__1 Customary (from Stool) __2 Sharecrop –sharecropper __3 Sharecrop-owner __4 Cash Purchase (Stool) __5 Cash Purchase (individual) __6 Caretaker (Abunu, 50-50) __7 Caretaker (Abusa, 67-33) __8 Borrowed (family) __9 Leased	
CC8	Year land was first acquired?	_____	
CC9	If you own the land, do you have title to this land?	__1 Yes __0 No	
CC10	Can you plant cocoa or other perennial crops on this land?	__1 Yes __0 No	IF YES GO TO CC12
CC11	If No, why can't you plant cocoa?	__1 Swamp __2 Land not mine Others (state) _____	
CC12	Type(s) of labour used by household on this farm	__1 Household __2 Casual/hired __3 Salaried __4 Caretakers __5 Sharecropping by HH __6 Sharecropping by other __7 Nnoboa __8 Family (siblings) Others (state)_____	
CC13	What is the previous land cover for this farm? ***Fallow land = 1; Forest land = 2; Secondary forest=3; Swamp=4 Abandoned cocoa farm =5; Current crop=6; Do not know =7; Others (state)***		
	At the time household acquired the land		
	2000		
	2003		
	2007		
CC14.1	Do you use **fertilizer** on this farm?	__1 Yes __0 No	IF NO GO TO CC14.6
CC14.2	If Yes, indicate the first and last year you used fertilizer	Year fertilizer was first applied _____ Year fertilizer was last applied _____	
CC14.3	Type(s) of fertilizer used?		
CC14.4	Quantity applied in last 12 months	_____(bags/bottles)	
CC14.5	Price per unit	GHC _____ per unit	GO TO CC15.1

CC14.6	If you have **never used fertilizer** on this farm before, what are your reasons? (Multiple response)	__1 Not available in village __2 Purchasing point far from village __3 Fertilizer is expensive __4 Credit not available __5 Don't know about it __6 Negative previous experience __7 Poor transport system __8 Others (state)_____ __99 Not Applicable	
CC15.1	Do you or have sprayed **fungicides** on this farm before?	__1 Yes __0 No	IF NO GO TO CC15.6
CC15.2	Indicate the first and last year you used fungicides	Year fungicide was first sprayed:_____ Year fungicide was last sprayed: _____	
CC15.3	Number of times farmer sprayed fungicides in the last 12 months		
CC15.4	Type(s) of fungicide used in spraying?		
CC15.5	Quantity of fungicides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	GO TO CC16.1
CC15.6	If you have **never used fungicides** on this farm before, what are your reasons? (Multiple response)	__1 Fungicides not available on the market __2 Not available in village __3 Purchasing point far from village __4 Fungicides are expensive __5 Credit not available __6 Fungi are not a problem __7 Don't know about it __8 Negative previous experience __9 Poor transport system Others (state)_____ __99 Not Applicable	
CC16.1	Do you or have sprayed **insecticides** on this farm before?	__1 Yes __0 No	IF NO GO TO CC16.6
CC16.2	Indicate the first and last year you used insecticides	Year insecticide was first sprayed_____ Year insecticide was last sprayed _____	
CC16.3	How many times did you spray insecticides in the last 12 months?		
CC16.4	Type(s) of insecticides used?		
CC16.5	Quantity of insecticides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unsit	GO TO CC17.1
CC16.6	If you have **never personally used insecticides** on this farm before, what are the reasons? (Multiple response)	__1 Insecticides not available on the market __2 Not available in village __3 Purchasing point far from village __4 Insecticides are expensive __5 Credit not available __6 Insects not a problem __7 Don't know about it __8 Negative previous experience __9 Poor transport system Others (state)_____ __99 Not Applicable	
CC17.1	Do you use **herbicides** on this farm?	__1 Yes __0 No	IF NO GO TO CC17.6

CC17.2	If Yes, indicate the first and last year you used herbicides	Year herbicide was first sprayed _____ Year herbicide was last sprayed _____	
CC17.3	Number of times you sprayed herbicides in the last 12 months		
CC17.4	Type(s) of herbicides used?		
CC17.5	Quantity of herbicides applied in the last 12 months and the price per unit	_____ (bottles/sachets) GHC _____ per unit	END
CC17.6	If you have **never used herbicides** on this farm, what are your reasons? (Multiple response)	__1 Not available in village __2 Purchasing point far from village __3 Herbicides are expensive __4 Credit not available __5 Don't know about it __6 Negative previous experience __7 Poor transport system Others (state)_____ __99 Not Applicable	END