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The Private Sector and HIV/AIDS in Africa: Taking Stock of Six Years of Applied Research

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Household Health and Cocoa Production: A Baseline Survey of Smallholder Farming Households in Western Region, Ghana

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EXECUTIVE SUMMARY

HOUSEHOLD HEALTH AND COCOA PRODUCTION: A BASELINE SURVEY OF SMALLHOLDER FARMING HOUSEHOLDS IN WESTERN REGION, GHANA

Background

Chronic illness and premature mortality from malaria, water-borne diseases, and respiratory illnesses have long been known to diminish the welfare of individuals and households in developing countries. Previous research has also shown that chronic diseases among farming populations suppress labor productivity and agricultural output. As the illness and death toll from HIV/AIDS continues to climb in most of sub-Saharan Africa, concern has arisen that the loss of household labor it causes will reduce crop yields, impoverish farming households, intensify malnutrition, and suppress growth in the agricultural sector.

If chronic morbidity and premature mortality among individuals in farming households have substantial impacts on household production, *and* if a large number of households are affected, it is possible that an increase in morbidity and mortality from HIV/AIDS or other diseases could affect national aggregate output and exports. If, on the other hand, the impact at the household farm level is modest, *or* if relatively few households are affected, there is likely to be little effect on aggregate production across an entire country.

Which of these outcomes is more likely in West Africa is unknown. Little rigorous, quantitative research has been published on the impacts of AIDS on smallholder farm production, particularly in West Africa. The handful of studies that have been conducted have looked mainly at small populations in areas of very high HIV prevalence in southern and eastern Africa. Conclusions about how HIV/AIDS, and other causes of chronic morbidity and mortality, are affecting agriculture across the continent cannot be drawn from these studies. In view of the importance of agriculture, and particularly smallholder agriculture, in the economies of most African countries and the scarcity of resources for health interventions, it is valuable to identify, describe, and quantify the impact of chronic morbidity and mortality on smallholder production of important crops in West Africa.

One such crop is cocoa. In Ghana, cocoa is a crop of national importance that is produced almost exclusively by smallholder households. In 2003, Ghana was the world's second-largest producer of cocoa. Cocoa accounted for a quarter of Ghana's export revenues that year and generated 15 percent of employment. The success and growth of the cocoa industry is thus vital to the country's overall social and economic development.

Study Objectives and Methods

In February and March 2005, the Center for International Health and Development of Boston University (CIHD) and the Department of Agricultural Economics and Agribusiness (DAEA) of the University of Ghana, with financial support from the Africa Bureau of the U.S. Agency for International Development and from Mars, Inc., which is a major purchaser of West African cocoa, conducted a survey of a random sample of cocoa farming households in the Western Region of Ghana. The survey documented the extent of chronic morbidity and mortality in cocoa growing households in the Western Region of Ghana, the country's largest cocoa growing region, and analyzed the impact of morbidity and mortality on cocoa production. It aimed to answer three specific research questions.

(1) What is the baseline status of the study population in terms of household size and composition, acute and chronic morbidity, recent mortality, and cocoa production?

(2) What is the relationship between household size and cocoa production, and how can this relationship be used to understand the impact of adult mortality and chronic morbidity on the production of cocoa at the household level?

(3) Do the impacts estimated in (2) above differ for different types of households?

The study population was the approximately 42,000 cocoa farming households in the southern part of Ghana's Western Region. A random sample of households was selected from a roster of eligible households developed from existing administrative information. Under the supervision of the University of Ghana field team, enumerators were graduate students of the Department of Agricultural Economics and Agribusiness or employees of the Cocoa Services Division. A total of 632 eligible farmers participated in the survey. Of these, 610 provided complete responses to all questions needed to complete the multivariate statistical analysis reported here.

The survey elicited information from the respondents, most of whom were heads of household, in three domains:

- Cocoa production during the 2003-2004 season, including farm size and management system, inputs used, and outputs obtained.
- Demographic makeup, including household size and composition, education levels, and the main activities of each household member.
- Mortality and chronic morbidity experienced by the households. Mortality questions covered the previous five years, while morbidity questions focused on the previous three months and one year. Funeral attendance was also queried.

Because very few people in rural Ghana have been tested for HIV infection and there is still a high degree of stigma associated with AIDS, the survey did not ask for any specific information about HIV/AIDS, but instead focused on permanent disabilities, chronic morbidity, and premature mortality from any cause.

Major Results

1. *What is the current status of households in terms of socioeconomic characteristics, recent morbidity, and recent mortality?*

    - In this sample of cocoa farming households, average household size was 6.08, median household size was 6, and 25 percent of households had 4 or fewer members. While variation existed in the composition of households, a "typical" (median) household included 3 adults aged 15-59, 2 children aged 5-14, no young children under 5 years old, and no elders 60 years or older.

- Twenty percent of surveyed households suffered at least one death during the 5-year period prior to the survey (January 2000 – February 2005). On average, about 2 percent of households experienced an adult (age 15-59) death in any given year. Among adults 15-59, a total of 63 deaths occurred, of which 53 were illness related. Two of these 53 deaths were reported to be from HIV/AIDS. Using information from verbal autopsy questions, we estimated that 8 deaths—15 percent of all adult mortality—were likely due to HIV/AIDS. A disproportionate share of adult deaths were among "other relatives," rather than household heads or spouses of household heads.

- Cocoa farming was the primary activity for almost half of the adults who died (47.6 percent). Other farming, off-farm labor, or trading was the primary activity for most of the other adults who died (40 percent of all adult deaths).

- About 2 percent of all adults (aged 15-59) were reported to have a physical disability, which included a partial or total loss of limb, some form of paralysis, or partial or total blindness or deafness. About 10 percent of all adults were reported to have some long-term illness or chronic disorder, such as leprosy, epilepsy, mental illness, cancer, immune disease, or other long-term illnesses. Four percent of adults were reported to be too sick to carry out their normal daily routine for at least 14 days in the three months prior to the survey; 2.6 percent were too sick to function normally for at least 30 days in that period.

- Almost all households sent members to at least one funeral in their local community in the three-month period prior to the survey, and those who did attended an average of 5 funerals in their local community in the three-month period. 88 percent of households also sent members to at least one funeral outside of their local community in the three-month period prior to the survey, and those who did attended as average of 4.6 funerals outside their community. Combined, households generally sent members to 3 funerals per month, which is conservatively estimated to reduce adult labor time in the household by 6 percent annually.

- Almost all households had 3 or fewer cocoa farms. Households maintained an average of 6.6 acres and a median of 6 acres in mature cocoa trees. Average and median yields were reported to be 475 lbs/acre and 254 lbs/acre, respectively, for the 2003-2004 season The surveyed households produced an average of 2,055 lbs of cocoa during the 2003-2004 cocoa season, with a median output of 1,364 pounds.

2. *What is the relationship between household size and cocoa production, and how can this relationship be used to understand the impact of adult mortality and chronic morbidity on the production of cocoa at the household level?*

   - There is no difference in the quantity of cocoa produced by households that have experienced a recent adult death and those that have not. This result holds for the death of any adult, male or female. If deaths were randomly distributed across households, then this result would imply that adult deaths in households do not affect cocoa output. It is very unlikely that deaths were randomly distributed, however. The large literature on estimating program treatment effects shows that a simple comparison of means provides biased results when the variable of interest (e.g. mortality) is not randomly distributed. With these cross-sectional data, therefore, we cannot make a direct estimate of the impact of mortality on cocoa production.

- We can, however, analyze the relationship between the number of adults in a household and crop outcomes (see Table 21 in the full report). As noted above, the average household has 3.3 adults. A household with one fewer adults than average—2.3 adults—produces 9-13 percent less cocoa. Using this result, an average household that loses an adult to HIV/AIDS or another illness is therefore expected to produce roughly 9-13 percent less cocoa than it otherwise would have.

- The presence of an adult with a permanent disability or long-term illness in a household does not appear to affect cocoa output.

3. *Do the impacts estimated in (2) differ across different types of households?*

- As we would expect, the loss of an adult has a greater impact on small households than on large ones. For those that have the average number of adults to start with (3.3), the loss of one adult is associated with a 9-13 percent decline in output. For a small household, however—with "small" defined as the modal household of 2 adults and one youth—the loss of one adult is associated with a 14-21 percent reduction in output. A reduction of this magnitude seems likely to affect household welfare negatively, especially if other crops (e.g. food crops) suffer a similar decline.

- About 2 percent of the surveyed households experienced an adult death in any given year. If we assume that all deaths were in average households, then each household that experienced a death lost 9-13 percent of its output. Aggregate decline in output across all the households would thus range from 0.2 percent to 0.3 percent. Given the much larger impact of weather, pests, and cocoa markets on production outcomes, it is hard to regard a 0.2-0.3 percent decline in output due to adult mortality as consequential at the level of aggregate cocoa production.

Conclusions

This survey of a sample of 632 cocoa farmers in Western Region, Ghana in 2005 used an instrument very similar to that developed for a survey of 737 cotton farmers in the Central Province of Zambia in 2004. A comparison of the two sets of results, provided in the table below, helps to provide some perspective on the results from Ghana presented here.

Adult mortality and crop production: comparison of Ghana and Zambia

Variable	Ghana	Zambia
Proportion of households experiencing an adult death per year	2.0%	4.7%
Proportion of adult deaths suspected to be due to HIV/AIDS	15%	60%
Proportion of adults reported to have been sick regularly or for long periods of time in previous year	2.6%	10%
Decrease in cocoa (Ghana) or cotton (Zambia) output associated with one fewer adults in a household		
Average household	-10.7%*	-9.2%
Median household	-11.8%*	-13.2%
Small household	-17.9%*	-22.2%
Estimated aggregate change in primary crop output due to adult mortality across the entire sample	-0.3%	-1.0%

*Midpoint of estimated range for average, median, and small households, respectively, from Table 21.

While the impact of the loss of one adult from a household is roughly similar between the two samples, the aggregate impact of adult mortality was much greater in Zambia than in Ghana, reflecting the much higher adult mortality rate in Zambia and thus, indirectly, the impact of HIV/AIDS.

We thus conclude on the basis of this cross-sectional data set that HIV/AIDS is not currently a major concern for overall cocoa production in Ghana. If adult mortality were to double, to a level similar to that found in Zambia, and if we assume that all deaths are in median households and that our higher estimate of impact is correct (i.e. a 14 percent decline in output for the loss of one adult), the analysis suggests that aggregate cocoa output might fall by 0.6 percent. Even under these more pessimistic assumptions, the effect on cocoa production at the national level is likely to be modest. Affected households do, in contrast, suffer welfare losses and probably substantial income losses.

CHAPTER 1. INTRODUCTION

Infectious diseases have long been known to suppress the productivity of agricultural workers in sub-Saharan Africa and elsewhere. The impact of malaria, schistosomiasis, and other adult illnesses on individual labor productivity has been documented since at least the 1960s (Audibert, 1986, 2003; Fenwick and Figenschou, 1972; Foster, 1967; Gilgen, Mascie-Taylor, and Rosetta, 2001; Nur, 1993; Parker, 1992; and Picard and Mills, 1992). More recent evidence from agricultural estates in Kenya reveals the extent to which HIV/AIDS-related morbidity reduces individual labor productivity prior to death (Fox et al., 2004).

While the impacts of disease and morbidity on *individual* labor productivity are well documented, substantially less is known about how individual morbidity or premature mortality affects productivity and agricultural production at the *household farm* level. Throughout sub-Saharan Africa, household-based farming is responsible for a major share of aggregate production of key food crops for subsistence consumption, sales on local markets, and exports. If chronic morbidity and premature mortality among individuals in farming households have substantial impacts on household production, *and* if a large number of households are affected, it is possible that an increase in morbidity and mortality from HIV/AIDS or other diseases could affect national aggregate output and exports. If, on the other hand, the impact at the household farm level is modest, *or* if only a few households are affected, there is likely to be little effect on aggregate production across an entire country.

Despite widespread fears that HIV/AIDS has caused substantial reductions in agricultural production at household, regional, and national levels, the scientific evidence to date does not support such concerns. The several studies reviewed in Mather et al. (2004, p. vi), for example, suggest a "lack of widespread effects on crop income among affected households as well as similar cultivation rates and area cultivated to roots and tubers relative to non-affected households." Mather et al. (2004, p. vi) also observes that "the loss of family labor due to a death in the household may not necessarily mean that agricultural labor becomes the limiting input in agricultural production." Beegle (2005) provides data from the Kagera region of Tanzania that are consistent with this conclusion. With an average of 8.5 adults (ages 15-50) per household in the Kagera region, and with adults allocating less than three hours a day to farming (Beegle, 2005, p. 677), the loss of an adult seems unlikely to make labor a limiting input in production. The amount of time allocated to farming in Kagera is consistent with Gillespie's findings in Rwanda (1989, Figure 3, p. 307), where adults were observed to allocate between 2.3 and 3.9 hours per day to farming depending on the season and gender of the adult.

Yamano and Jayne (2004) find statistical evidence that households suffering the death of a male head of household did not increase the area they cultivated in high-value crops as much as other households did (an increase of 0.24 acres as compared to 1.097 acres, see Yamano and Jayne 2004, Table 7, Column H, p. 106). With 27 out of 1,422 households experiencing such a death, however, the results are of inconsequential magnitude at the aggregate level. Weak statistical evidence suggests that households suffering the death of a female household head or female spouse of a household head did not reduce the amount of land planted in cereals as much as did other households. Only 11 such deaths occurred in the sample of 1,422 households, however. Mortality among other adults (neither the household head nor the spouse of the household head) had no statistically significant impact on area cultivated.

The observed land allocation changes led to output changes of similar magnitude, suggesting no impact of mortality on yields.

Donovan and Bailey (2005) investigate the impact of chronic adult illness and death on agricultural production based on data for 1,168 households in Rwanda between the 1999/2000 and 2001/2002 agricultural seasons. In this sample, 78 adults (age 15-59) were chronically ill and 65 adults (age 15-59) died during the two year period. The analysis suggests that a household with an adult death produced less beer and fruit bananas, with no impact on several other crops grown. With an adult chronic illness, households adjusted by producing more sweet potatoes.

Larson et al. (2004) report on a survey of 750 cotton growing households in Central Province of Zambia. Between January 1999 and October 2003, when the survey was conducted, a total of 173 adult deaths (age 15-59) were reported in these households. While Larson et al. (2004) do not link deaths to production directly, they do show that area allocated to cotton and maize is significantly related to the number of adults (age 15-59) in the household, and that the average household with one fewer adults allocates about 7 percent less land to cotton and 8 percent less land to maize, with similar consequences for output.

All of these studies were conducted in countries with relatively high adult HIV prevalence: 8.8 percent in Tanzania, 6.7 percent in Kenya, 5.1 percent in Rwanda, and 16.5 percent in Zambia (UNAIDS 2004). In these countries, the empirical evidence suggests the following conclusions.

- Working-aged adult deaths in farming households are fairly common occurrences.
- The majority of deaths occur among adults who are not household heads or their spouses.
- Most adult deaths are preceded by a long period of illness.
- Labor is not apparently scarce or a key constraint to agricultural production in most cases.
- The impact of adult mortality on key production variables, such as land area planted in different crops and quantities harvested, is either (i) not statistically significant; (ii) statistically significant but minor in magnitude; or (iii) significant and important at the household level but inconsequential at the aggregate regional or national level.

Almost all of the existing evidence on mortality and agricultural production comes from eastern and southern Africa. Little comparable research exists from West Africa. This can be partly explained by the lesser extent of the HIV/AIDS epidemic in most of West Africa. In countries such as Ghana, Benin, and Togo, estimated HIV prevalence remains below 5 percent of the adult population. While there is concern that prevalence in Ghana has been rising, the recent Ghana Demographic and Health Survey (Republic of Ghana, Statistical Service and Macro International, 2003) reports 2.2 percent HIV prevalence among adults 15-49. Rural rates are slightly lower, and regional rates vary from a high of 3.9 percent among women in Western Region to a low of 0.3 percent among men in Central Region. Western and Eastern Regions have the highest adult infection rates (3.0 and 3.7 percent respectively).

In Ghana, cocoa is a crop of national importance that is produced almost exclusively by smallholder households.[1] Ghana was the world's second-largest producer of cocoa for the 2002/2003 season (after Cote d'Ivoire but ahead of Indonesia). While cocoa production in Cote d'Ivoire remained largely static between 2002 and 2004, production in Ghana more than doubled (FAO 2004). Cocoa is also Ghana's most important export earner, accounting for a quarter of the country's export revenue in 2003. The International Cocoa Organization estimates that about 15 percent of the total population works in cocoa production (ICCO 2004). The success and growth of the cocoa industry is thus vital to the country's overall social and economic development.

For the Government of Ghana to develop effective strategies for expanding the agricultural sector and cocoa exports, as well as addressing rural poverty and health, better information about health and productivity among cocoa farmers is needed. To that end, this study documents the extent of chronic morbidity and mortality in cocoa growing households in the Western Region of Ghana, the country's largest cocoa growing region, and analyzes the impact of morbidity and mortality on cocoa production. The study aims to answer three specific research questions.

(1) What is the baseline status of the study population in terms of household size and composition, acute and chronic morbidity, recent mortality, and cocoa production?

(2) What is the relationship between household size and cocoa production, and how can this relationship be used to understand the impact of adult mortality and chronic morbidity on the production of cocoa at the household level?

(3) Do the impacts estimated in (2) above differ for different types of households?

The remainder of this paper is organized as follows. Section 2 describes the design of the study and implementation of the household survey. Using the household survey data, Section 3 describes the surveyed households in terms of household size and composition, adult morbidity, recent mortality, and other information that helps to provide a perspective on the health and resources of cocoa farming households. Section 4 presents basic farming information for these households, including land allocation, cropping patterns, cocoa production, and inputs used in cocoa production. Section 5 then uses the survey data to estimate cocoa production models that can be used to explore the links among adult health, labor availability, and farm output. Section 6 concludes with a summary of key findings and implications for future research.

CHAPTER 2. METHODS

a. Study Site and Population

Ghana's Western Region was selected as the study site due to its current and future importance for the country's cocoa industry. The Ghanaian Cocoa Board (COCOBOD,

[1] Ghana differs in this respect from Cote d'Ivoire, where commercial plantations account for a substantial share of cocoa output and concerns about the use of child-slave labor have arisen (see, e.g., "US ban on Ivory Coast slave-labor cocoa, Reuters, 5/31/2002).

1998) estimated that about 500,000 Ghanaian households were growing cocoa on about 1.2 million hectares of land in 1998, suggesting a nationwide average of 2.4 hectares in cocoa per household.[2] Households in Western Region had somewhat larger land holdings: as of 1998, the COCOBOD estimated that 91,000 farming households in Western Region were growing cocoa on about 486,000 hectares (COCOBOD, 1998), for an average of about 5.33 hectares (13 acres) per household.[3]

Our study population was the 42,000 cocoa farming households in the southern part of Western Region. No roster or census of cocoa farming households exists in one location in Ghana, either at the national or the regional level. We instead used information from Cocoa Swollen Shoots Virus Disease (CSSVD) Districts and District Assemblies (DAs) in Western Region.[4] Western Region is divided into 11 Cocoa Swollen Shoots Virus Disease (CSSVD) Districts, 5 in the northern part of the Region and 6 in the southern part. The 6 CSSVD Districts in the south—Sekondi, Tarkwa, Dunkwa, Wassa Akropong, Samreboe, and Asankragua—comprise the study location. As of 1998, the COCOBOD (1998) estimated that about 42,000 farmers were growing cocoa in these six CSSVD Districts.

Each CSSVD District area overlaps with District Assembly (DA) areas, which are local government units. DAs are smaller geographic units than the CSSVD Districts. There are 5 DAs in the Sekondi CSSVD District, although cocoa is grown in only 3 of the DAs. All DAs where cocoa is grown in the 6 southern CSSVD Districts were included in the sample.

District Assemblies are responsible for organizing and implementing the annual mass spraying program for cocoa swollen shoots, which began in 2002. Because of the nature of the disease, it is necessary for all fields to be sprayed for control to be effective (the virus is easily spread across farms). Each District Assembly is divided into mutually exclusive "spraying gang areas," to be sprayed by assigned teams of sprayers. In the Sekondi CSSVD District, for example, the 3 District Assemblies contain a total of 100 spraying gang areas covering 12,014 farmers. In the Tarkwa CSSVD District, the District Assembly is divided into 214 gang areas covering about 15,000 farmers. The spraying program maintains a list of spraying gang areas in the Western Region. Since all farms must be sprayed, this list effectively covers all cocoa farms in the region.

b. Sample Size

Answering our second research question required that we be able to detect differences between households that experienced an adult death or chronic morbidity and households that did not for key variables of interest, such as the area of land in cocoa trees from which pods are harvested or the quantity of cocoa harvested. We estimated the target sample size for the study based on t-tests for differences in sample means for two populations to detect a true

[2] While there is no exact definition of "smallholder," the International Cocoa Organization suggests that, for cocoa farming, a smallholder has less than 10 hectares, with a range of 2-5 hectares being typical. With output estimated at 409,383 tons for the 1997/98 season from 1.2 million hectares, yields averaged about 338 kilograms per hectare (COCOBOD, 1998).

[3] Throughout this paper, we will use acres as basic land units because farmers in Western Region think in terms of acres. When needed, hectares will be converted to acres at 2.471 acres per hectare.

[4] Cocoa Swollen Shoots Virus is a major cocoa tree disease. To combat it, the COCOBOD has cocoa growing regions of the country divided into Cocoa Swollen Shoots Virus Disease (CSSVD) Districts.

difference in population means (Meinert, 1986). The analysis uses the assumptions of a two-sided test, the Type I error probability is $\alpha = 0.05$, the power of the test is $\beta = 0.8$, and the allocation is four households without an adult death in the past five years for each household with such a death. We considered the number of households that would be needed to show at least an x-percent difference in acres of land in cocoa trees between the two sets of households and allowed x to vary between 15 and 30 percent. The power test calculations indicated that a sample size of 700 households would provide a reasonable compromise between variance and a detectable difference. To allow for possible non-participation, ineligibility, and incomplete questionnaire responses, we increased the number of households invited to participate in the survey to 804.

c. Sample Selection and Informed Consent

Based on the structure of CSSVD Districts and spraying gang areas, a two-stage sampling process was used to select a random sample of cocoa growing households in the study area. In stage 1, we selected a proportionate random sample of gangs to be included in the sample from each district. We first obtained the list of gangs for each of the 6 CSSVD Districts in our study area. With G_i number of gangs working in each CSSVD District i, i = 1, … 6 and G total gangs in all 6 districts, we selected randomly $n^g_i = 50*(G_i/G)$ number of gangs from each district for inclusion in the survey. For randomly selecting these 50 gang names, the study used nth name sampling from gang list with a random starting position, where G_i/n^g_i defines the correct number for n^{th} gang name sampling.[5]

In stage 2, cocoa farmers in each gang area were assembled with the assistance of the gang supervisor and the chief farmer to introduce the research study, determine the current number of cocoa farmers in the gang area (no list existed in advance), and develop a sample frame for each gang area. Cocoa gang areas typically cover about 80 cocoa farming households, although numbers vary somewhat. At this stage, a few gang areas were combined into one area for sampling purposes because they overlapped the same villages. A final set of 44 gang areas or combined gang areas were included in the sample, comprising a total of 4,022 cocoa farming households.

For each selected gang area, 20 percent of farmers were randomly selected to be invited to participate in the survey. Due to varying numbers of cocoa farmers in each gang area, a 20 percent sampling rate meant that we selected between 13-43 farmers in each gang area, with 15-16 being the most typical number. All farmer names were written onto pieces of paper and put in a box, and names were simply drawn from the box for the sample. These 804 farmers were initially invited to participate in the interview by reading the consent form to them in Twi, the main local language. Among these 804 households, 41 declined to participate. Of the 763 who agreed to participate, we excluded 79 households with 20 or more acres of cocoa because they did not meet the inclusion criteria for a "smallholder," leaving us with a final sample of 684. For the analysis, we further excluded 52 households that did not have farms with mature cocoa trees (only newly planted trees). Thus, our final sample size consisted of the 632 households that consented to participate and have more than 0 acres but fewer than 20 acres of land in mature cocoa trees.

[5] We choose 50 as the number of gangs to include in the study to allow for a sufficient number of gangs distributed across the study area while economizing on transportation costs for implementing the survey.

Interviews were conducted at each participant's home. Before beginning the interview, an informed consent information sheet was given to the farmer to read (or in some cases was read to the farmer) and verbal informed consent was requested. Those who consented were then interviewed. All informed consent materials are available from the authors. No vulnerable populations were interviewed as part of this survey.[6]

d. Questionnaire

The questionnaire was written in English, Ghana's official language. Enumerators for the survey used English and various dialects of the Twi language when talking to farmers. The informed consent information sheet was also translated into Twi. The questionnaire is available from the authors.

The questionnaire collected data on four sets of household variables and one set of outcome variables for each household: location, household demographic variables, health-related information including morbidity and mortality in households since January 2000, and agricultural variables. Several existing instruments and related studies were used to guide the development of the questionnaire, including the Ghanaian Living Standards Survey 4, the Ghanaian Demographic and Health Survey for 1998, the DFID (2002) Cocoa Farmers' Questionnaire, Ainsworth et al. (1992), Doctor and Weinreb (2003), Larson et al. (2004), and Yamano and Jayne (2004).

e. Survey Implementation

Enumerators for the survey were graduate students from the Department of Agricultural Economics and Agribusiness (DAEA), University of Ghana and staff of the Cocoa Services Division (CSD). Graduate students from the DAEA interviewed about 70 percent of the sample population and CSD staff the rest. All enumerators had good knowledge of cocoa farming and interviewing methods and communicated in local languages. The enumerators received training in conducting the interviews from the study team (DAEA and CIHD) prior to survey implementation and pre-testing.

After approval of the study protocol by ethics committees at the participating universities, the questionnaire was piloted with a small sample of farmers. Following the pilot, the enumerators reported on their experiences in soliciting informed consent and implementing the questionnaire, identified questions that were confusing or poorly phrased, and made suggestions for improvements.

The DAEA team then conducted the household survey in February and March 2005. Enumerators visited each household in the sample at a time of day when they expected to find the cocoa farmer (respondent) at home. The enumerator re-introduced the study, explained what would generally be asked of the farmer, and read to him or her the informed consent form. Farmers who provided consent were interviewed immediately. Respondents were all adult Ghanaian cocoa farmers. Within each household, the respondent was the person with

[6] Ethics approval was provided by the institutional review boards of the Boston University Medical Center, Boston University, and of the Noguchi Memorial Institute for Medical Research, University of Ghana, Legon.

main agricultural and financial responsibility for the household. This person was usually but not always the household head.

Data from the questionnaires were entered into SPSS datasets at the DAEA. As each questionnaire was entered into the computer, a study household ID number was assigned and identifiers were removed from the main database. Identifiers were collected that will allow data queries to be followed up if necessary and allow the same households to be surveyed again, should this study be extended for a second round in 2006 or later. The file linking study IDs with these household identifiers information is stored separately and is password-protected.

CHAPTER 3. DESCRIPTION OF HOUSEHOLDS

In this section we describe the sampled households in six domains: (a) household size and composition; (b) adult labor responsibilities; (c) recent mortality; (d) adult morbidity; (e) and other descriptive information about the households.

a. Household Size and Composition

The 632 sampled households included 3843 individuals. Table 1 provides the age distribution. The largest group is adults 15-59 years of age, sometimes referred to as "prime-age" adults or "working-age" adults. Throughout this paper, adults 15-59 will be simply called "adults," while those aged 60 and older will be called "elders." The age distribution reported in Table 1 differs somewhat from national estimates for rural areas in Ghana: the households we sampled have relatively more adults and fewer young children under five years old.

Table 1. Age distribution for all household members

Age category	Number	% of total	Estimate from national rural population survey*
< 5 (children)	409	10.6%	16.1%
5-14 (youths)	1,140	29.7%	30.8%
15-59 (adults)	2,096	54.5%	45.9%
60+ (elders)	198	5.2%	7.2%
Total	3,843		

* GDHS 2003

Average household size in the sample is 6 people, with about 3.6 adults and elders and 2.4 children and youths. The median household, which perhaps better represents a "typical" household, has no young children, 2 youths, 3 adults, and no elders. There are a few large households with 6 or more adults and 7 or more children under 15; at the other end of the distribution, 25 percent of all households have just 1 or 2 adults, no children, and 1 or fewer youths. Adults are almost exactly equally divided between males and females. The households we surveyed are about 50 percent larger than the average of 4.3 people for rural households in Ghana as a whole (GDHS 2003, Table 2.2).

Table 2. Average household size by age category

Age category (years)	Mean number per household	25th percentile	Median	75th percentile
Average household size (all ages)	6.08	4	6	8
< 5 (children)	0.65	0	0	1
5-14 (youths)	1.80	1	2	3
15-59 (adults)	3.32	2	3	4
60+ (elders)	0.31	0	0	1
Male adults	1.63	1	1	2
Female adults	1.68	1	1	2

The relationship of the adults in sampled households to the household head is shown in Table 3. The vast majority (88 percent) of households are composed of a household head, the spouse of the head, and biological offspring. 617 adults were reported to be household heads, among whom 7 percent are female and 93 percent are male. Male-headed households have essentially the same number of adults as female-headed households (3.3 adults on average for male-headed households and 3.1 for female-headed).

Table 3. Relation of adults and elders to household head

Member	Number in sample	% of all individuals in sample
Household head	617	26.9%
Spouse of household head	624	27.2%
Own biological son/daughter	775	33.8%
Other child called son/daughter	48	2.1%
Other relative	181	7.9%
Unrelated person	50	2.2%
Total	2,295	100.0%
Relationship not indicated (missing)	1	

Table 4 shows the highest level of school attended by adults. A substantially higher percentage of women than men never attended school (33.3 percent of adult women and 12.8 percent of adult men) and a substantially higher percentage of men than women reached senior secondary school level or higher (14.6 percent of men and 5.4 percent of women). In total, about 23 percent of all adults never attended school, 17.5 percent attended primary school, and almost 60 percent of all adults attended at least junior secondary school or higher. Most households (84 percent) include at least one adult who attended junior secondary or higher. Twenty-one households have no one who attended school or attended only primary school, all of them households with only one person older than 14.

Table 4. Highest level of school attended by adults

Highest level of schooling attended (adults)	Male adults (n=1031)	Female adults (n=1061)
None	12.8%	33.3%
Primary	15.6%	20.0%
Junior secondary	57.0%	41.2%
Senior secondary	11.9%	5.2%
Higher	2.7%	0.2%
Total Reporting	100.0%	100.0%
Missing information	6	11

b. Labor allocation

Cocoa farming is the most important activity for most adults in the sampled households: 64 percent of both male and female adults report cocoa farming to be their primary activity. (Table 5). "Other farming"—primarily raising food crops such as maize, cocoyam, cassava, and plantains—is reported as the second most important activity for 41 percent of females and 47 percent of males.

Besides agriculture, schooling is a common activity for both males (25%) and females (17%), mainly because most teenagers (15-18 year olds) are still in secondary school. Off-farm labor is reported to be the primary activity for about 6 percent of male and female adults. Trading is less common as a primary activity (reported by 5 percent of women and 1 percent of men) but slightly more common as a secondary activity (reported by 11 percent of women and 5 percent of men). Although we assume that all households must undertake household activities and childcare, few adults report these as their most important activities.

In general, there are few differences between men and women in their primary and secondary activities. Unlike in some other parts of Africa where cash crops are normally grown by men and food crops by women, cocoa farming is a family affair, although some tasks for each crop are more commonly done by men or by women. Women are slightly more likely to be engaged in trading and household activities than men, while men are slightly more likely to be in school and engaging in off-farm labor. The differences are small, however.

Table 5. Primary and secondary activities for adults (age 15-59)

Activity	Women (% reporting)		Men (% reporting)	
	Primary activity	Secondary activity	Primary activity	Secondary activity
Cocoa farming	64.3%	6.4%	63.7%	11.8%
Other farming	2.3%	41.0%	1.1%	46.6%
Off-farm labor	6.1%	1.3%	6.3%	5.7%
Trading	5.3%	11.1%	0.9%	5.4%
Household activities	2.6%	31.9%	0.3%	15.5%
Child care	0.4%	0.1%	0.0%	0.0%
School	16.8%	0.9%	24.8%	2.1%
None	2.2%	7.3%	2.9%	12.9%
Total	100.0%	100.0%	100.0%	100.0%
Number reporting	1059	1058	1031	1027
Missing information	2	3	0	4

c. Mortality

In our sample of 632 households, 129 households (20 percent) suffered at least one death during the 5-year period preceding the survey (January 2000-February 2005). A total of 212 deaths were reported, meaning that many households experienced more than one death and implying an annual average mortality rate of approximately 1.1 percent. This crude annual mortality rate is about equal to the 1.0 percent crude mortality rate reported for Ghana as a whole (Population Reference Bureau, 2004, p. 5).[7]

Table 6 shows the distribution of deaths by age group. Of the 27 deaths occurring among children 0-4 years of age, 14 (50 percent) were among very young children less than 1 year old. For adults age 15-59, the average age at death was 30.6 years for men and 35.1 years for women.

Table 6. Deaths by age category

Age category	Total deaths in age Category	% of total deaths	% of currently living household members in age category
Children (< 5)	27	12.7%	10.5%
Youths (5-14)	58	27.4%	29.8%
Adults (15-59)	63	29.7%	54.5%
Elders (60+)	64	30.2%	5.3%
All	212	100.0%	100.0%

The cause of death was reported as "illness" for 84 percent of all deaths. Accidents accounted for another 6.5 percent, and the remainder were from other or unknown causes. Table 7 shows the main types of illnesses associated with adult deaths. Of the 63 adult deaths, 53 were reported to be illness-related. HIV/AIDS was reported to be the cause of death for 3.8 percent of adult disease-related deaths. There were no deaths from TB. Stomach illnesses and malaria accounted for 5.7 percent and 3.8 percent, respectively. About 45 percent were reported to be from "other" illnesses, and 32 percent were from "unknown" illnesses.

Table 7. Illnesses associated with adult deaths

Illness	Number of adult deaths	% of deaths
Heart attack	4	7.5%
Cancer	0	0.0%
Immune disease (HIV/AIDS)	2	3.8%
TB	0	0.0%
Pneumonia	1	1.9%
Stomach illness	3	5.7%
Malaria	2	3.8%
Other	24	45.3%
Don't know	17	32.1%
Total illness-related deaths	53	

Fewer than 4 percent of adult illness-related deaths were directly attributed to HIV/AIDS by survey respondents. Given that 77 percent of adult deaths associated with an illness are reported to be either from other or unknown illnesses, however, it is likely that more than 4 percent of deaths were caused by HIV/AIDS. The questionnaire included seven standard verbal autopsy questions (3 major and 4 minor). Following Doctor and Weinreb (2003), a death is attributed to AIDS if a person suffered from at least 2 major symptoms and at least 1

[7] To calculate this number, we allocated the 212 deaths over five years (42.4/year), and then divided this number by the number of currently living household members (3843).

minor symptom. This verbal autopsy approach would attribute to HIV/AIDS 15 percent of total adult deaths from illness (8 adults out of 53) in our sample.

We therefore conclude that AIDS accounted for at least 4 percent and up to 15 percent of reported, illness-related adult deaths in the surveyed households between January 2000 and February 2005. The upper bound of this range is far lower than we observed among a sample of cotton farming households in Zambia, where we estimated that AIDS caused nearly 60 percent of adult illness-related deaths (Larson et al. 2004).

The estimated adult HIV prevalence in Western Region, 3.0 percent (Republic of Ghana, Statistical Service and Macro International, 2003), would probably lead to higher AIDS-related mortality than even the upper bound of our range. Given a median interval from infection to death of 9-10 years (UNAIDS Reference Group on Estimates, Models and Projections 2002), it is commonly assumed that roughly 10 percent of HIV-positive individuals will die of AIDS-related causes each year. For our sample of 2,096 adults, 3 percent HIV prevalence would thus predict 6-7 AIDS-related deaths per year, or 30-35 over the five-year period preceding the survey. This is considerably more than our verbal autopsy approach estimated (8 out of a total of 53 illness-related adult deaths). A reasonable explanation for this discrepancy is that the HIV epidemic in Ghana is still relatively new, and fewer than 10 percent of HIV-positive individuals are progressing to AIDS and dying per year. If this is so, then higher AIDS-related mortality should be expected in the future.

Beyond the impact of the death itself, the duration of illness prior to death could be expected to influence the effect of adult mortality on agricultural production. A sudden death from a vehicle accident or a heart attack gives a household little time to plan or adjust, but the household does not spend time and money caring for the individual prior to death. For a death preceded by a chronic illness, the household has time to adjust to the impending death, but the illness may impose relatively high costs in terms of the sick person’s time, the time of one or more caregivers, and money spent for medical care.

Table 8 describes the relationship of deceased adults to the household head. About 13 percent of adults who died were either the household head (3.2 percent) or the spouse of the head (9.5 percent). Most adult deaths occurred among biological offspring of the household head (30 percent) or other relatives (49 percent). Given that almost 50 percent of adult deaths were reported to be of “other relatives” living in the household, but only 2.2 percent of adults were classified as “other relatives,” the mortality rate for other relatives appears to be substantially larger than for household heads, spouses, and their biological children.

Table 8. Relation to household head of adults who died

Relationship to household head	Number of deaths	% of deaths	% of all currently living adults and elders with this relationship to the household head
Former head	2	3.2%	26.9%
Spouse	6	9.5%	27.2%
Own biological son/daughter	19	30.2%	33.8%
Grandchild	0	0.0%	2.1%
Parent	3	4.8%	7.9%
Other relative	31	49.2%	2.2%
Unrelated	2	3.2%	26.9%
Total	63	100%	100%

In Table 9, the primary activity of the adults who died is shown. Cocoa farming was the main responsibility of 47.6 percent of those who died. The remaining adult deaths were distributed among adults with a range of responsibilities.

Table 9. Primary activity of deceased adults

Activity	Number of deaths	% of deaths	% of all living adults with this primary responsibility
Cocoa farming	30	47.6%	64.0%
Other farming	6	9.5%	1.7%
Off farm labor	6	9.5%	6.2%
Trading	8	12.7%	3.1%
Household activities	5	7.9%	1.5%
Child care	0	0.0%	0.2%
Attending school	4	6.3%	20.8%
None	4	6.3%	2.5%
Total	63	100%	100.0%

Households commonly respond to the death of an adult member by adjusting labor responsibilities of other members to help offset the lost contribution of the deceased. The ability to substitute labor, and the opportunity costs of such labor, influences the extent to which mortality affects a household's overall income. For the 30 deaths among family members with cocoa growing as their primary responsibility, households reallocated labor to substitute, to some degree, for 29 of these deaths. There was no labor replacement for only one of these adults. Those who took over the responsibilities of the deceased adult included other adult family members (27 instances), elders in the household (2), hired workers (1), or friends (1). Children do not substitute for deceased adults. To find the time to take over these responsibilities, 22 people reduced their time allocated to other farming activities, 3 reduced their time allocated to off-farm labor, 3 just worked harder, and 1 reduced their time allocated to household chores or childcare.

To summarize the survey's findings about mortality, 4.1 percent of households experienced at least one death annually, and 2 percent of households experienced an adult death annually. Only three households suffered the loss of the household head in the five-year period preceding the survey. Almost all adult deaths were reported to be from illnesses. Cocoa farming was the most important activity for fewer than half (44.2 percent). In almost all cases, households adjusted to the lost adult labor for cocoa farming by re-allocating the responsibilities of other adults in the household. Most of the adults who took over the responsibilities of those who died shifted time away from other farming activities in the process.

Table 10 compares adult mortality in this sample with mortality reported from other household surveys. Recognizing that these data are not exactly comparable because different populations were surveyed, adult mortality among the sampled households in Ghana appears to be similar to adult mortality in sampled households in Kenya and Rwanda, both countries with higher HIV prevalence than Ghana. It is less than half, however, of the mortality suffered by cotton farming households in Central Zambia (Larson et al. 2004).

Table 10. Annual proportion of households experiencing an adult death in various countries

Country	Sample	Sample size	Annual % of households with an adult death	Source
Mozambique	National, rural small and medium holders	4908	1.0%	Mather et al., 2004
Zambia	National, rural small holders	6922	1.7%	Mather et al., 2004
Rwanda	National, rural small holders	1168	1.8%	Donovan and Bailey, 2005
Kenya	National, rural small holders	1422	2.0%	Yamano and Jayne, 2004
Ghana (current study)	Cocoa farming households, Western Region	763	2.0%	Larson et al., 2005
Zambia	Cotton farming households, Central Province	737	4.7%	Larson et al., 2004

d. Adult Morbidity

Morbidity as well as mortality reduces the labor available to farming households. The survey included detailed questions about disabilities and chronic illnesses among household members during the previous three months (roughly December 2004 to February 2005) and general questions about the frequency of illness for each adult during the preceding year (February 2004 to February 2005).

The numbers of households and individuals with a permanent physical disability or long-term illness are shown in Table 11. Permanent physical disability is defined as a partial or total loss of a limb, some paralysis, partial or total blindness or deafness, or any other type of physical disability. Long-term illness or disorder includes leprosy, epilepsy, mental illness, cancer, immune disease, TB, and other long-term illnesses including hypertension and diabetes. Because certain types of illnesses may be underreported (mental illness, HIV/AIDS, etc.), we suspect that these figures are conservative.

Table 11: Permanent physical disabilities and long-term illnesses in sampled households

Variable	Permanent physical disability		Long term illness or disorder		Physical disability *or* chronic illness	
Adults	**No. of adults**	**% of adults**	**No. of adults**	**% of adults**	**No. of adults**	**% of adults**
Number of affected adults	43	2.05%	183	8.73%	226	10.78%
Households	**No. of households**	**% of households**	**No. of households**	**% of households**	**No. of households**	**% of households**
Households with ≥ 1 affected adult	42	6.65%	143	22.63%	172	27.22%
Households with ≤ 3 adults and at least 1 affected adult	24	3.80%	74	11.71%	91	14.40%
Households in which *all* adults are affected	4	0.63%	12	1.90%	15	2.37%

Besides the presence of chronic conditions, the survey asked a few questions about the impact of morbidity, such as how many days during the past 3 months each person in the household was not able to carry out his or her normal daily routine due to sickness or feeling not well for any reason. Results are shown in Table 12.[8]

Table 12: Effect of morbidity on adult activities

Variable	Individuals (adults)		Households	
	#	%	#	%
Too sick to work for ≥ 14 days in past 3 months	93	4.44%	79	12.50%
Too sick to work for ≥ 30 days in past 3 months	54	2.58%	48	7.59%
Sick "regularly" or "almost all the" time in the past year	51	2.43%	41	6.49%

As with mortality, the proportions of adults who were sick for substantial periods of time during the past three months or past year among these Ghanaian households were much lower than the corresponding proportions in a sample of Zambian farming households surveyed in 2004 (Larson et al. 2004). In the Zambian sample, for example, 25 percent of households and 10 percent of adults were reported to have been sick regularly in the previous year.

e. Funeral Attendance

In communities where mortality is high, funeral attendance can require a substantial investment of time. The survey asked about the number of local and non-local funerals attended by household members in the 3-month period preceding the survey (December 2004 to February 2005). Most (92 percent) households attended at least one funeral in their local community, and those that did went to an average of 5 funerals in the 3-month period. A similarly high proportion (88 percent) of households attended funerals outside their local community; the average over the 3-month period was attendance at 4.65 outside funerals. Combined, households generally sent members to three funerals per month.

[8] Answering such questions for all members of the household was clearly difficult for respondents, and they often consulted others in the household to answer these questions. In this case it is likely that sick days were underreported. Self-reported information about morbidity should be interpreted with caution. In their review of the literature on health and productivity, Strauss and Thomas (1995) observed, "Morbidity data are usually based on self-reports, which are, therefore, subjective and prone to reporting errors. …These errors may be related to information, education and thus to income."

Attending a funeral locally would typically involve the loss of one working day. If a household sent only one adult to local funerals, this household would lose roughly 5 working days (4.68) quarterly, or roughly 15 working days annually. Funerals outside the local community might involve twice as much time (2 working days). In total, households lose an average of at least 45 working days a year to attend funerals. For the median household with 3 adults, funeral attendance accounts for at least 6 percent of adult labor time per year.

Box 1: Other Aspects of Household Welfare

The survey obtained some additional information about the sampled households that is not used in the main analysis in this report but helps place the participating households in the broader context of agriculture, health, and development in Ghana.

Market access. Market access generally appears to be good. 61.5 percent of the sampled households are located within one kilometer of the nearest licensed buying center for cocoa, and about 81 percent are within 3 kilometers. About 23 percent of the households have access to a food market within 2.5 kilometers of their dwelling, while about 49 percent have access within 5 kilometers. The last quarter have to travel at least 12 kilometers to their nearest food market.

Food sales and purchases. During the 2003-2004 cocoa season, about half the households (49.5 percent) did not buy or sell any maize; 34 percent reported selling maize and 18 percent of households reported buying maize. Only 8 households both bought and sold maize. Almost all households (97 percent) purchased rice during this same period.

Assets. Most of the sampled households (82 percent) have a metal roof on their dwelling, 89 percent of households own at least one radio, 18 percent own at least one bike, and 23 percent own at least one television. For animals, 45 percent of households own at least one sheep or goat, and 72 percent of households own at least one fowl.

Bednets. Malaria is a major public health problem in Ghana, and the promotion of insecticide treated bed nets is a central component of the overall fight against the disease. Of the sampled households, about 76 percent do not own a bed net (untreated or treated), 15 percent of households own one net, and 7 percent own two nets. Of the households that include at least one child under 5 years of age, 26 percent own at least one net. Only 11 percent of households with a child under 5 own a net that was treated within the past six months.

Drinking water. Household access to safe drinking water is “Target 10” for Goal 7 of the Millennium Development Goals, where access is defined as sustainable availability of water (20 liters per day per capita) from an improved source (household connection, public tap, borehole, protected dug well, protected spring, rainwater collection) within one kilometer of the dwelling. Almost all of the sampled households (98 percent) obtain drinking water from a source within one kilometer of their dwelling. Distance is difficult to estimate, but 95 percent of the households obtain water within a 10 minute walk of their dwelling and 79 percent within a 5 minute walk. Fifty-six percent of the households obtain water from a borehole and the remaining 44 percent from surface waters or unprotected wells—none of the households have piped water in or near the house. When combining access and source, 56 percent of the sampled households meet the MDG target for safe water and 44 percent of household do not.

CHAPTER 4. LAND MANAGEMENT AND COCOA PRODUCTION

a. Land Management

Farming households typically own and/or manage one or more contiguous parcels of land that were acquired at the same time and in the same manner. The 763 households in our sample manage a total of 1,605 parcels of land.

Each parcel of land may be organized into one, two, or more sub-parcels. The word “farm” is typically used to describe these sub-parcels.[9] The sampled households manage a total of 2,708 farms, or an average of 4.28 farms per household. Table 13 provides the distribution of farms per household. Four is the median and mode number total farms per household. About 8 percent of households have only one or two farms, while at the upper end of the distribution, about 6 percent have 7 or more farms.

Table 13. Distribution of farms per household

Farms/household	No. of households	% of households	Cumulative
1	15	2.4%	2.4%
2	36	5.7%	8.1%
3	165	26.1%	34.2%
4	203	32.1%	66.3%
5	97	15.4%	81.7%
6	45	7.1%	88.8%
7	35	5.5%	94.3%
8	12	1.9%	96.2%
9	22	3.5%	99.7%
10	2	0.3%	100.0%

In the study area, seven different farm management patterns are used:

i. Mature cocoa trees from which cocoa pods can be harvested
ii. Food crops (typically maize, cassava, coco yam, and plantain) also containing young cocoa trees
iii. Fallow only
iv. Other non-food crops (e.g. oil palm)
v. Food crops only
vi. Rented out
vii. Food crops and fallow.

Table 14 shows the distribution of farms by management type. Mature cocoa trees, food crops intercropped with young cocoa trees, and farms left fallow account for about 75 percent of all farms.

[9] Otsuka el al. (2003) use the word “field” rather than “farm” to refer to a sub-parcel. During focus group discussions with cocoa farmers, they recommended that we use the word “farm.”

Table 14. Distribution of farms by main management pattern

Management Type	Number of farms	% of farms	Cumulative
Mature cocoa trees	973	37.4%	37.4%
Food crops with young cocoa trees	513	19.7%	57.1%
Fallow only	144	5.5%	62.6%
Other non-food crops	58	2.2%	64.9%
Food crops only	338	13.0%	77.9%
Rented out	478	18.4%	96.2%
Food crops and fallow	98	3.8%	100.0%
Total	2602	100.0%	
No information	622		

Most households have one or two cocoa farms, where a cocoa farm is defined as being planted with mature trees of pod-bearing age (minimum age of 3-8 years depending on the variety of tree). The distribution of cocoa farms is shown in Table 15. Fewer than 2 percent of households have more than three cocoa farms.

Table 15. Number of cocoa farms per household

Number of cocoa farms	Number of households with this number of farms	% of households	Cumulative
1	376	59.49%	59.49%
2	185	29.27%	88.77%
3	60	9.49%	98.26%
4	8	1.27%	99.53%
5	2	0.32%	99.84%
6	1	0.16%	100.00%
Total	632	100.00%	

The variety of cocoa trees planted, as well as the area in cocoa, affects cocoa output. Newer hybrid varieties of cocoa mature faster and are potentially higher yielding. Among the surveyed households, 8 percent of all cocoa farms are planted in the traditional variety “amelonado,” 53 percent of farms are in “amazon,” 20 percent in “hybrid,” and 19 percent in mixed varieties.

b. Cocoa Farm Size

The size of cocoa farms and the amount of land planted in mature cocoa trees are shown in Table 16. Households have on average 6.59 acres in mature cocoa, with a median of 6 acres. For up to three farms, which includes all farms for more than 98 percent of the surveyed households, the average area in mature cocoa is 6.18 acres.

Table 16: Cocoa farm size and area in cocoa, in acres

Unit	Average	25^{th} percentile	Median	75th percentile
Cocoa farm size	4.78	2.5	4	6
Household acreage in mature cocoa trees	6.59	4	6	8.75
Combined size of first three cocoa farms/household	6.18	3.25	5.5	8

c. Cocoa Output

Cocoa production by the surveyed households in the 2003-2004 growing season is reported in Table 17. Total production for up to 3 farms per household is reported. Average and median annual cocoa output per household are 2,055 lbs and 1,364 lbs, respectively, for the 620 households with farms from which cocoa can be harvested and which reported cocoa acreage (acreage information is incomplete for 12 households). Average annual yield (output per acre) is 475 lbs/acre. This figure is close to the mean yield of 439 lbs/acre reported in Teal and Vigneri (2004, Table 3) for Western Region in the 1997/98 season.

Table 17. Cocoa production and yields (2003-2004 cocoa season)

Indicator	Household cocoa output (lbs)—first 3 farms	Cocoa yield (lbs/acre)—first 3 farms
Mean	2,055	475
10th percentile	341	65
25th percentile	682	123
50th percentile (median)	1,364	254
75th percentile	2,728	491
No. of households reporting	620	620

CHAPTER 5. ADULT HEALTH, LABOR AVAILABILITY, AND COCOA PRODUCTION

a. Introduction

In Chapter 5, we use the cross-sectional household data presented above to investigate empirically relationships among health, labor availability, and crop production. The goal is to understand the impact of adult mortality and chronic morbidity on the quantity of cocoa harvested.

Because our data are cross-sectional—a single observation per household at a specific point in time—we cannot simply compare cocoa output by households that experienced an adult death (or chronic morbidity) with output by those that did not, even if we control for a range of other variables (see Box 2). The main reason that this simple approach is not appropriate is that the variable of interest—adult mortality—is very unlikely to be distributed randomly across the sampled households. Because households in which an adult died are likely to differ from other households in ways that will also affect cocoa output, there is no way to know how much cocoa the households with a death *would have produced* had no one died.

An illustration of this problem is provided by HIV/AIDS. HIV infection among adults is not randomly distributed: for various reasons, some people are at higher risk than others. It is possible that adults who are HIV-positive differ from HIV-negative adults in ways that could have affected cocoa output even before anyone become infected with HIV. For example, adults who die of AIDS-related causes, or their spouses, might, on average, have riskier lifestyles than those who don’t, and a riskier lifestyle might indicate less time or energy invested in farming. Alternatively, the presence of an HIV-positive household member could indicate more interaction with the outside world, which could in turn reflect better access to technology. Similarly, households that choose to seek appropriate medical care for a sick family member earlier (or at all) may suffer fewer deaths and may also, independently of health status, be more efficient farmers. These examples, for which we have no evidence one way or the other, are intended only to illustrate the possibility of a correlation between health risks and productivity. In any of these cases, households with adults who die of AIDS could have been less or more productive than other households, *even had there been no deaths*.

The literature on program evaluation and on health and agriculture do not offer an easy way to overcome this problem, known as selection on unobservables, with cross-sectional data. The best solution in the long term is to collect a second round of data from the same households, in 2-3 years, so that the data collected in 2005 can serve as the baseline for methods that can overcome the problems with cross-sectional data, such as difference-in-differences analysis. Since we do not yet have the second round of data and therefore cannot estimate the impact of morbidity and mortality on cocoa production directly, we will approach the problem from a different direction in the remainder of this section.

Box 2: Why a direct comparison of households with and without an adult death won't work

To estimate the impact of an adult death on cocoa output, we could in principle follow the statistical literature on program evaluation and average treatment effects (see Ravallion (1999 or 2001) for an introduction and Imbens (2003) for a more complete review). In this literature, a person who participated in a program is defined as being "treated," while a person who did not is defined as a "comparison" or "control". A fundamental challenge in this literature is to control for the fact that individuals may self-select into these programs or that the programs are targeted to specific groups.

Imbens (2003, p.6) suggests that a "natural starting point in the evaluation of any treatment would appear to be a comparison of average outcomes for treated and control units." For our purposes, we first define any household i with a recent adult death as a "treated" household (D_i = 1) and a household without a recent death as a "control" household (D_i = 0). We then consider two additional definitions of "treated"— at least one male adult death or at least one female adult death. For each treated household, we know how much the household produced, denoted as $Q_{1i} \mid D_i = 1$, and for each control household we also know how much was produced, $Q_{0i} \mid D_i = 0$. Based on this definition of control and the three definitions of treated, let $E(Q_{1i} \mid D_i = 1)$ represent the sample mean cocoa output for treated households and let $E(Q_{0i} \mid D_i = 0)$ represent the sample mean cocoa output for control households. The table below summarizes these means for control and treated households.

Cocoa output (lbs per household) for control and treated households

Variable	Control household— 0 adult deaths	Treated household— 1 adult death	Treated household— 1 male adult death	Treated household— 1 female adult death
Mean cocoa output	2046	2206	2135	2315
# households	567	48	29	19

The mean difference between treated and control households, $\delta = E(Q_{1i} \mid D_i = 1) - E(Q_{0i} \mid D_i = 0)$, is not obviously different for households with recent deaths and households without deaths. Mean output for households with one adult male death is about 10 percent higher than for control households, standard deviations are large enough to suggest that these means are not statistically different.

(Box 2, Continued)

The question that needs to be answered is if information in the data set can be used to make a reasonable estimate of how much treated households would have produced in the absence of the treatment. If households were randomly allocated between the treatment and control groups from the same population, which would imply that adult mortality is a truly random event, this analysis would suggest that there is no difference between the level of cocoa produced by households with a recent adult death and those without. If households were not randomly assigned to treatment and control groups, however, then the 'control' group no longer provides the appropriate comparison group.

The basic problem is summarized by Imbens (2003, p. 6) as:

> …..almost any evaluation of a treatment involves comparisons of units who received the treatment with units who did not receive the treatment. The question is typically not whether such a comparison should be made, rather which units should be compared, that is which units would have been comparable to treated units had those treated units not been treated.

To find comparable households, the treatment effects literature has proposed various strategies, including matching, propensity scores, and instrumental variable regression methods (see, e.g., Imbens 2003, 2004; Abadie et al., 2004; Ravaillon, 2001) when selection on observables is the main problem. The basic idea behind these approaches is to use a selected set of exogenous background variables (meaning not affected by the treatment) to identify a group of appropriate control households for comparison.

While these methods are now easy to implement in STATA 8 (e.g., nnmatch, pscore, attr, and ivreg commands), they require that we select the correct exogenous variables, have the necessary data, and have a large enough sample size. An initial exploration using matching and instrumental variable methods with the data for cocoa growing households reported here does not generate results that conflict with the simple mean differences in Table 16.* These methods do not handle problems of selection on observables.

The logical way to solve this problem is to obtain a second round of data on the same households in 2-3 years. The initial round of data, the baseline, can be considered a "pre-treatment" observation. Certain health events (mortality and morbidity) will occur in some households during the next 2-3 years. A second observation of the same households made 2-3 years later can then be considered the "post-treatment" observation. With such data (before and after observations for treated and control households), a simple difference-in-difference estimator and complementary regression methods can be employed to estimate directly the impact of health on cocoa production. Since we do not yet have the second round of data and therefore cannot estimate the impact of morbidity and mortality on cocoa production directly, we will approach the problem from a different direction in this report.

*Given an initial exploration of the data, larger households clearly produce more cocoa, although there is substantial variation. A simple Logit regression estimated to explain the probability of having an adult death in a household does not reveal any clear relationships between household characteristics and the probability of having an adult death in the household.

b. Results Using a Production Function Approach

It is reasonable to assume that cocoa output depends in part on how much labor is allocated to cocoa production. That is, two households with exactly the same land, trees, and other inputs like water and fertilizer, but different amounts of labor, would be expected to produce different amounts of cocoa. The amount of labor allocated to cocoa production, in turn, should depend to some degree on the amount of labor available in the household, in the absence of perfect labor markets.[10] If an empirical model were available that provided an elasticity of cocoa output with respect to household size, either directly or though labor use, it would be possible to estimate the impacts of household size on cocoa production (See Box 3). The death of an adult implies that household size falls, at least in the short term.[11] The marginal impact of household size on output, all else constant, can thus be used as an estimate of the initial impact on households of one adult death.

Box 3: Calculating an elasticity of cocoa output with respect to household size

Using data for the 1990/91 and 1997/98 cocoa seasons from the Ghana Living Standards Surveys for 1991 and 1998, Teal and Vigneri (2004) estimate cocoa production functions. The results of their Model 3 suggest that the elasticity of output with respect to labor is $n_{YL} = 0.243$, meaning that 10 percent more labor increases output by 2.43 percent. In Model 3, labor is considered an endogenous variable, and the first-stage regression estimates labor as a function of other exogenous and instrumental variables (see Table A4 of Annex 4, p. 27). Household size is used as one of these instrumental variables, where the elasticity of labor used with respect to household size is $n_{LH} = 0.406$ (i.e., a 10 percent increase in household size increases labor use by 4.06 percent).

We are interested in the impact of household size on output, which can be estimated with an elasticity of output with respect to household size, n_{YH}, which can be estimated as $n_{YH} = n_{YL}\, n_{LH} = 0.243 * 0.406 = 0.099 \sim 0.10$. In other words, a 10 percent increase in household size is associated with a 1 percent increase in cocoa output.

This elasticity of output with respect to household size can then be used to estimate the impacts of one fewer adults on average output. Teal and Vigneri (2004) report that average household size in their sample equaled 5, so a one-person reduction in household size (from 5 to 4) was a 20 percent reduction in household size. Using the elasticity of output with respect to household size of 0.10 estimated above, a one person reduction in average household size would be thus be expected to reduce cocoa production by an average of 2 percent.

The statistical analysis in Teal and Vigneri (2004), however, suggests that their Model 3 and Model 2, which account for the possible endogeneity of inputs, are not any better than a simple production function estimated using ordinary least squares (OLS). If their OLS model is correct, then their analysis implies that that household size does not actually condition how much labor the household uses for cocoa production. This may be due to the availability of hired labor for the households in Western Region in their sample, about 28 percent of total labor used in cocoa production was hired during the 1997/98 season.

[10] In the absence of labor markets where a household can buy or sell labor at a fixed wage, household production and consumption decisions are considered "non-separable" in the household economics literature. See, e.g., Singh, Squire and Strauss, 1986 and Berhman and Deolalikar, 1995.

[11] In Kenya, Yamano and Jayne (2004) found that some deceased adults were replaced by bringing other relatives into the household, so that average household size fell by slightly less than 1 person after a death. It is not clear whether any of the households in our survey adopted the same strategy.

To estimate a production relationship with our data set, we posit a simple Cobb-Douglas cocoa yield function (output in pounds per acre) as:

$$\ln(\text{yield}) = \alpha + \beta_1 \ln(\text{acres}) + \beta_2 (\text{yes\_fert}) + \beta_3 \ln[(\text{fertilizer} + 1)/\text{acres}]$$
$$+ \beta_4 (\text{yes\_insect}) + \beta_5 \ln[(\text{insecticides} + 1)/\text{acres}]$$
$$+ \beta_6 (\text{male adults}) + \beta_7 (\text{female adults}) + \beta_8 (\text{age\_farm})$$
$$+ \beta_9 (\text{age\_farm2}) + u \qquad (1)$$

where

yield	=	cocoa output in pounds per acre
acres	=	acres in cocoa trees from which cocoa pods can be harvested
yes_fert	=	dummy variable equal to 1 if the household uses fertilizer, otherwise zero
(fertilizer+1)/acre	=	pounds of fertilizer applied to cocoa farms per acre
yes_insect	=	dummy variable equal to 1 if the household used any insecticides, otherwise zero
(insecticides+1)/acre	=	expenditures on insecticides used on cocoa farms (1,000 KES) per acre
male adults	=	number of male adults (15-59) in the household
female adults	=	number of female adults (15-59) in the household
age_farm	=	average age of cocoa farms (time since original planting)
age_farm^2	=	average age of cocoa farms squared
u	=	error for each household, with $E(u) = 0$ and $E(u^2) = d > 0$.

With the formulation of the production function in (1):

- The parameters β_3 and β_5 on fertilizer and insecticides, respectively, are interpreted as input elasticities (percentage change in yield for a 1 percent change in the input). It is likely that these parameters are positive but less than one.

- The parameters β_8 and β_9 account for biological aspects of the cocoa farms, with $\beta_8 > 0$ and $\beta_9 < 0$ typically for perennial crops.

- The dummy variable 'yes_fert' is included because only 35 percent of households reported applying fertilizer to their cocoa farms during the past year. The parameter β_2 allows for a structural difference in the production function for households not applying fertilizer as compared to households applying any amount of fertilizer. The variable ln(fertilizer + 1) then considers how much fertilizer is actually used. To allow the natural log to be calculated for households that do not use fertilizer, 1 is added to all fertilizer amounts for all households. Households not applying fertilizer receive a value of 1, with ln(1) = 0. The same logic is used with the insecticide data, although a majority of all households (80 percent) reported applying insecticides.

- Finally, the parameters β_6 and β_7 show the percentage change in output for a one-person change in the number of male or female adults in the household, which is the outcome of interest for our analysis.

Table 18 provides summary information for the variables used in the production estimation. Complete data on 610 households are available for this analysis. Information on output, acres, and the number of male and female adults is self explanatory. Since cocoa farms are almost 20 years old on average (age_farm mean = 19.659), we consider cocoa acres fixed and estimate a yield function.

Table 18. Summary information for variables used in cocoa yield function estimation (n = 610)

Variable Name	Mean	Standard deviation
ln(yield)	5.555	1.074
ln(acres)	1.660	0.652
yes_fert	0.346	0.476
ln(fertilizer + 1)	0.523	3.089
yes_insect	0.792	0.406
ln(insecticides + 1)	3.016	2.702
male adults	1.623	1.117
female adults	1.672	1.027
age_farm	19.659	19.867
age_farm^2	780.519	2423.037

For our initial analysis, we follow Teal and Vigneri (2004) (see Box 2) and estimate the production function using ordinary least squares with robust standard errors to correct for heteroskedasticity. The results are provided in Table 19, Model A. All the estimated parameters are significant at the 5-percent level or less.

The coefficient estimate of $\beta_6 = 0.076$ implies that one more male adult in the household is associated with a 7.6 percent increase in cocoa production. Similarly, the parameter estimate of $\beta_7 = 0.063$ implies that one more female adult in the household is associated with 6.3 percent more output. A null hypothesis that $\beta_6 = \beta_7$ cannot be rejected at the 5-percent level. We thus conclude from Model A (OLS) that the number of adults in the household is associated with cocoa output, but the sex of the adults is not.

Although Teal and Vigneri (2004, p. 6) report that their ordinary least squares results are "reasonably robust to tests for endogeneity," using OLS to estimate a production may lead to biased parameter estimates if the inputs are also endogenous. As an alternative, we estimated Model B, which excludes the input variables from the yield equation and can be considered a simplified reduced form model.[12] Model B is a reduced-form version of Model A, where the

[12] While we could also pursue an instrumental variable approach to account for input endogeneity, initial exploration of the data does not identify any variables that can be considered instruments and that have some substantive exploratory power in the first stage regression.

variables included in Model B are implicitly the explanatory variables used to explain the quantity of variable inputs used in Model A. The signs of the estimated coefficients in Model B and statistical significance remain essentially consistent with Model A, except that the magnitudes of the coefficients for male and female adults are substantially larger. The results of Model B suggest that households with one fewer male adults produce 9.2 percent less cocoa, and households with one fewer female adults produce 11.7 percent less cocoa. Again, the null hypothesis that $\beta_6 = \beta_7$ cannot be rejected at the 5-percent level, and we conclude from Model B that the number of adults in the household is associated with cocoa output, but the sex of the adults is not. Model B may come closer than Model A in capturing the full impact of number of adults on cocoa yield.

Table 19. Yield production function estimates (adults in levels)

Variable		**Model A. (robust standard errors)**		**Model B. (robust standard errors)**	
Dependent variable		ln(yield)		ln(yield)	
Independent variables	Empirical coefficient	Coefficient estimate	t-stat	Coefficient estimate	t-stat
ln(acres)	β_1	-0.153	-2.28	-0.785	-13.1
Yes_fert	β_2	-1.837	-5.58		
ln(fertilizer/acre)	β_3	0.355	6.67		
Yes_insect	β_4	-1.169	-5.51		
ln(insecticides/acre)	β_5	0.317	9.33		
Male adults	β_6	0.076	2.98	0.092	2.84
Female adults	β_7	0.063	1.89	0.117	2.83
Age_farm	β_8	0.011	3.91	0.010	2.59
Age_farm^2	β_9	-0.000038	-2.15	-0.000045	-1.85
Constant	A	5.822	45.87	6.354226	45.07
Observations	=	610		610	
R-squared	=	0.56		0.27	

We thus find that cocoa yield is significantly related to the number of adults in the household, where one fewer adults is associated with a 6-12 percent decline in yield. This is a substantially larger effect than implied by the production function estimates in Teal and Vigneri (2004). We speculate that the difference comes from the fact that they estimate instrumental variable models using pooled data at the national level, while the data analyzed here are from Western Region only. Another possibility is that labor data are poorly measured in the GLSS as noted by Teal and Vigneri (2004).

We also investigated whether the number of adults with permanent disabilities or long-term illnesses altered the results in Table 19. Since many adults have been living with these chronic conditions for many years (e.g. blindness), it can be assumed that the distribution of these conditions among adults is not correlated with current production. Thus, the number of adults reported to have chronic conditions could be included as an explanatory variable in the yield function estimates in Table 19. If households allocate substantial amounts of time to care for such adults, or if the labor of such adults is less productive (because, e.g., a blind adult may not be able to undertake certain farming tasks), then it is possible that the number of adults with chronic conditions is also associated with cocoa yield. We investigated this possibility and found no statistical relationship between yield and adults with chronic conditions.[13]

c. Effect of Household Size

The functional form of the production function in (1), with results reported in Table 19, assumes that one additional adult increases yield by a fixed percentage (β_6 and β_7) regardless of the number of adults in the household. In other words, all else equal, a 3-adult household produces 6-12 percent more than a 2-adult household, a 4-adult household produces 6-12 percent more than a 3-adult household, and so on.

To allow for the possibility that the percentage impact on yield, and therefore output when acreage is fixed, differs for households of different sizes, we re-estimated the yield functions using ln(adults + 1) as an explanatory variable, where adults is defined as the total number of male and female adults (15-59) in the household. For this function form, the parameter estimate β_a shows directly the elasticity of yield with respect to household size.[14] The results are reported in Table 20.

Table 20. Yield production function estimates (adults in natural logs)

Variable		**Model C. (robust standard errors)**		**Model D. (robust standard errors)**	
Dependent variable		ln(yield)		ln(yield)	
Independent variables	Empirical coefficient	Coefficient estimate	t-stat	Coefficient estimate	t-stat
ln(acres)	β_1	-0.159	-2.36	-0.790	-13.19
Yes_fert	β_2	-1.810	-5.51		
ln(fertilizer/acre)	β_3	0.350	6.61		
Yes_insect	β_4	-1.168	-5.52		
ln(insecticides/acre)	β_5	0.316	9.35		
ln(adults + 1)	β_a	0.286	3.86	0.428	4.83
Age_farm	β_8	0.011	4.08	0.010	2.75
Age_farm^2	β_9	-0.000042	-2.34	-0.000050	-2.06
Constant	A	5.650	38.51	6.108	36.83
Observations	=	610		610	
R-squared	=	0.57		0.27	

The parameter estimates for all variables except the number of adults are consistent across Tables 19 and 20. In Table 19, all coefficients are also estimated to be significant at the 5-percent level or better. The coefficient estimate for ln(adults + 1) is 0.286 for Model C and 0.428 for Model D. In other words, Models C and D suggest that a 10 percent decrease in the number of adults (regardless of how many adults a household starts with) is associated with a 2.8-4.2 percent decrease in yield.

[13] As with recent mortality however, we cannot assume that recent illnesses (or days too sick to work recently) are uncorrelated with cocoa production variables.
[14] Since a few households have no adults aged 15-59, we added 1 to calculate the natural log.

Table 21 provides the estimated changes in yield associated with a one-adult reduction in household size for different sizes of households, using the elasticity estimates from Table 20.

Table 21. The effect of household size on yield

Household size	Percentage change in number of adults for a one-adult change	Output elasticity with respect to adult numbers from Model C	Output elasticity with respect to adult numbers from Model D	Percentage decrease in output with one fewer adults (Model C)	Percentage decrease in output with one fewer adults (Model D)
Average— 3.34 adults	30%	0.286	0.428	8.6%	12.8%
Median— 3 adults	33%	0.286	0.428	9.4%	14.1%
Mode (25th percentile)— 2 adults	50%	0.286	0.428	14.3%	21.4%
75th percentile— 4 adults	25%	0.286	0.428	7.2%	10.7%

The data thus suggest that a one-person change in household size for an average household is associated with an 8.6-12.8 percent reduction in yield. The impact on yield is slightly greater for a median household (3 adults) and slightly smaller for a 4-adult household. Not surprisingly, given that a one-person change for a small household represents a very large percentage change in the number of adults, the impact on a small household is more substantial. For a 2-adult household, the decline in cocoa yield associated with the loss of one adult is 14-21 percent.

d. Impact of Mortality on Household Welfare and Aggregate Cocoa Output

The results of the analysis in the previous section suggest that one fewer adults in a cocoa farming household is associated with a decline in cocoa production in the range of 8-12 percent for average households and 14-21 percent for small households. For all households, such reductions in output seem likely to affect household welfare negatively, especially if other crops (e.g. food crops) suffer a similar decline.

We can also use these findings to make a first cut estimate of the impact of adult mortality on aggregate cocoa production by our surveyed households. About 2 percent of the surveyed households experienced an adult death per year. If we assume that all deaths were in average households, the analysis suggests that total output would fall by 0.17-0.26 percent. (These numbers would be slightly smaller using the results from Models A and B.) Given the much larger impact of weather, pests, and cocoa markets on production outcomes, it is hard to regard a 0.17-0.26 percent decline in output due to adult mortality as consequential at the level of aggregate cocoa production and international cocoa markets.

We thus conclude on the basis of this cross-sectional data set that adult mortality in general and HIV/AIDS in particular is not currently a major concern for overall cocoa production in our study population. If adult mortality were to double, to a level similar to that found in

Zambia, and if we assume that all deaths are in median households and that our higher estimate of impact is correct (i.e. a 14 percent decline in output for the loss of one adult), the analysis suggests that aggregate cocoa output in our study region might fall by 0.6 percent. Even under these more pessimistic assumptions, the effect on cocoa production at the national level is likely to be modest. The affected households may, in contrast, suffer substantial income losses.

CHAPTER 6. CONCLUSIONS

a. Key Findings and Answers to Research Questions

This study aimed to answer three research questions about a population of smallholder cocoa farmers in the Western Region of Ghana:

(1) What is the baseline status of households in terms of socioeconomic characteristics, chronic morbidity, recent mortality, and cocoa production?
(2) What is the relationship between household size and cocoa production, and how can this relationship be used to understand the impact of adult mortality and chronic morbidity on the production of cocoa at the household level?
(3) Do the impacts estimated in (2) differ across different types of households?

In this section we summarize our key findings in order to answer each of these questions.

1. *What is the current status of households in terms of socioeconomic characteristics, recent morbidity, and recent mortality?*

   - In our sample of cocoa farming households, average household size is 6.08, median household size is 6, and 25 percent of households have 4 or fewer members. While variation exists in the composition of households, a "typical" (median) household includes 3 adults aged 15-59, 2 children aged 5-14, no young children under 5 years old, and no elders 60 years or older.
   - Twenty percent of surveyed households suffered at least one death during the 5-year period prior to the survey (January 2000 – February 2005). On average, about 2 percent of households experienced an adult (age 15-59) death annually. A total of 63 deaths occurred among adults 15-59, of which 53 were from illnesses. Two of these 53 illness-related deaths were reported to be from HIV/AIDS. Using information from verbal autopsy questions, we estimated that 8 deaths were likely due to HIV/AIDS. A disproportionate share of adult deaths were among "other relatives," rather than the household head or spouse of the household head.
   - Cocoa farming was the primary activity for about half of the adults who died (44 percent). Other farming, off-farm labor, or trading was the primary activity for another 40 percent of adults who died.
   - About 2 percent of all adults (aged 15-59) are reported to have a physical disability, which included a partial or total loss of limb, some form of paralysis, or partial or total blindness or deafness. About 10 percent of all adults were reported to have some long-term illness or chronic disorder, such as leprosy, epilepsy, mental illness, cancer,

immune disease, or other long-term illnesses. 4.4 percent of adults were reported to be too sick to carry out their normal daily routine for at least 14 days in the three months prior to the survey, 2.6 percent were too sick to function normally for at least 30 days in that period.

- Almost all households sent members to at least one funeral in their local community in the three-month period prior to the survey, and those who did attended an average of 5 funerals in their local community in the three-month period. 88 percent of all households also sent members to at least one funeral outside of their local community in the three-month period prior to the survey, and those who did attended an average of 4.65 funerals outside their community. Combined, households generally sent members to 3 funerals per month, which is conservatively estimated to reduce adult labor time in the household by 6 percent annually.
- Almost all households have 3 or fewer cocoa farms containing mature cocoa trees from which pods are harvested. Households maintain an average of 6.59 acres in mature cocoa trees. Average annual yields are reported to be 475 lbs/acre, although yield is skewed so that the median yield is 254 lbs/acre. The surveyed households produced an average of 2,055 lbs of cocoa during the 2003-2004 cocoa season, with a median output of 1,364 pounds.

2. *What is the relationship between household size and cocoa production, and how can this relationship be used to understand the impact of adult mortality and chronic morbidity on the production of cocoa at the household level?*

- There is no difference in the quantity of cocoa produced by households who have experienced a recent adult death and those who have not. This result holds for any adult, male or female. If deaths were randomly distributed across households, then this result would imply that adult deaths in households do not affect cocoa output. It is very unlikely that deaths were randomly distributed, however. The large literature on estimating program treatment effects shows that a simple comparison of means provides biased results when the variable of interest (e.g. mortality) is not randomly distributed.
- Although with cross-sectional data we cannot make a direct estimate of the impact of mortality on cocoa production, we can analyze the relationship between number of adults in a household and crop outcomes. On average, the loss of one working-aged adult is associated with a 6-12 percent decrease in cocoa output (using the results of Model A and B, Table 19).
- The presence of an adult with a permanent disability or long-term illness does not appear to affect cocoa output.

3. *Do the impacts estimated in (2) differ across different types of households?*

- As we would expect, the loss of an adult has a greater impact on small households than on large ones (see Table 21). For an average or median household, with 3.3 or 3.0 adults to start with, respectively, the loss of one adult is associated with an 8-14 percent decline in output. For a small household, however—with “small” defined as the modal household of 2 adults and one youth—the loss of one adult is associated with a 14-21 percent reduction in output.

- About 2 percent of the surveyed households experienced an adult death per year. If we assume that all deaths were in average households, the analysis suggests that total output would fall by 0.2-0.3 percent. Given the much larger impact of weather, pests, and cocoa markets on production outcomes, it is hard to regard a 0.2-0.3 percent decline in output due to adult mortality as consequential at the level of aggregate cocoa production.

b. Comparison of Morbidity, Mortality, and Farm Output in Ghana and Zambia

The survey of cocoa farmers in Western Region, Ghana used an instrument very similar to that developed for a survey of cotton farmers in the Central Province of Zambia in 2004 (Larson et al. 2004), with the aim of answering a similar set of questions about adult health and farm output (cotton, in the case of Zambia). To provide some perspective on the results from Ghana presented here, Table 22 compares findings from the two studies.

Table 22: Comparison of Ghana and Zambia survey results

Variable	Ghana (this study)	Zambia (Larson 2004)
Study parameters		
Study population	Smallholder cocoa farmers	Smallholder cotton farmers
Location	Western Region, Ghana	Central Province, Zambia
Year of data collection	2004	2003
Estimated adult HIV prevalence (year)	3.0% (2002)	15.3% (2001)
Number of households surveyed	632	737
Household demographics, morbidity, and mortality		
Mean household size	6.1	7.45
Number of working-aged adults in median household	3.0	3.0
Proportion of households experiencing an adult death in any one year	2.0%	4.7%
Proportion of adult deaths suspected to be due to HIV/AIDS	15%	60%
Proportion of adults reported to have been sick regularly or for long periods of time in previous year	2.4%	10%
Decrease in primary crop output associated with loss of one adult[a]		
Average household	-10.7%[b]	-9.2%
Median household	-11.8%[b]	-13.2%
Small household	-17.9%[b]	-22.2%
Estimated aggregate change in primary crop output per year due to adult mortality	-0.3%	-1.0%

[a]The primary crop is cocoa for the Ghana study and cotton for the Zambia study.
[b]Average reported from Table 21.

While the impact of the loss of one adult from a household is roughly similar between the two samples, the aggregate impact is much greater in Zambia, reflecting the much higher mortality in Zambia and thus, indirectly, the impact of HIV/AIDS. To the extent that the greater impact in Zambia does reflect Zambia's much more severe AIDS epidemic, these findings argue for continued investment in HIV prevention in Ghana.

c. Directions for Future Research

This initial report describes the households surveyed and the relationship between household labor availability and crop production outcomes, allowing us to answer our primary research questions. While a good deal can be learned from a one-time, cross-sectional survey of households, carrying out a second round of surveillance of these same households would substantially strengthen our ability to link changes in health status to agricultural outcomes. An interval between surveys of 3 years would be appropriate. A survey team could then be fielded in November of 2006 to collect additional information about the 04/05 and 05/06 cropping seasons and household health outcomes. Funding would need to be secured in early 2006 for the survey team to be fielded in late 2006.

There is also the opportunity to use the cross-sectional data already collected to investigate several additional topics, including:

1. *Extensions of the existing models*. The basic regression models reported in this paper can be extended by considering additional exogenous variables that may be relevant for each model. Such extension would likely improve the accuracy of our estimated results.

2. *Analysis of additional household outcomes*. The survey collected data on several agriculture input variables that can be treated as household outcome variables, such as the use of fertilizer, pesticides, and labor in cocoa production. With such input data, it may be possible to estimate "structural" cocoa production functions using instrumental variable methods.

3. *Analysis of demographic and health data for children*. Demographic and health data on children in the surveyed households were collected but have not yet been analyzed. Crude under-five mortality in this population—about 1.4 percent—appears to be rather low, and a comparison of child health in this sample to national averages would be interesting.

4. *Analysis of the long-term dynamic relationships among mortality, household size, cocoa acreage, and cocoa output*. Cocoa farm management and cocoa production involve long-term investment decisions. In our sample, cocoa trees were an average of nearly 20 years old. Decisions to plant cocoa trees 20 years ago were based to some degree on expectations of the future, and annual management decisions are also made in part on current conditions and expectations of the future. With large variations over time in producer prices, input costs, and pest populations, these long-term investment decisions have to be made in a highly risky environment. Additional work is needed to investigate the long-term dynamic relationships among health and farming decisions in a dynamic environment. In the short term, data will not be available to undertake such analysis empirically, but simulation models can be developed to explore these relationships and identify data that will be needed in the future to estimate the relationships empirically.

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