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THE IMPACT OF AIDS-RELATED PRIME-AGE MORTALITY ON RURAL FARM HOUSEHOLDS: PANEL SURVEY EVIDENCE FROM ZAMBIA

By

Antony Chapoto

A DISSERTATION

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ABSTRACT

THE IMPACT OF AIDS-RELATED PRIME-AGE MORTALITY ON RURAL FARM HOUSEHOLDS: PANEL SURVEY EVIDENCE FROM ZAMBIA

By

Antony Chapoto

Using nationally representative panel data of rural farm households surveyed in 2001 and 2004, this dissertation is divided into two parts. *First*, the study determines the ex-ante socioeconomic characteristics of prime-age adults who die between the ages of 15 and 59 years of disease-related causes and *second*, estimates the impact of prime-age mortality on rural farm households' composition, farm and crop production, livestock assets and off-farm income.

Given the dramatic rise in prime-age mortality in Zambia and other African countries due to HIV/AIDS, there is a critical need to better understand the pathways through with the disease in transmitted. The first essay of this dissertation is dedicated to this end. Results from several probit models show that single women are 2 to 5 times more likely to die of disease-related causes as women who are the heads or spouses of their households. There is no clear relationship between educational attainment and probability of dying; both well educated and poorly educated men and women should continue to be targeted for HIV/AIDS behavior change campaigns. Also, social factors driving the spread of AIDS are considerably more complex than simply poverty-based explanations, although poverty may certainly contribute to risky behavior and poor health which are important pathways by which the disease is spread.

The second essay of this dissertation determines the impacts of prime-age mortality on rural households in Zambia. Using prior death in the household (which is found to be a predictor of future mortality in the household), age dummies, and drought shocks as instruments for prime-age death between 2001 and 2004, the Hausman-Wu chi square test for endogeneity shows that prime-age mortality variables are endogenous for pooled ordinary least squares (OLS) models. Differencing the time-invariant unobserved household characteristics largely addressed the endogeneity problem. Based on these difference models, the second essay highlights the following: (1) in response to the death of a male household head, poorer households have substantially greater difficulties in coping than non-poor households, which are likely to almost fully restore household size to pre-death levels; (2) in contrast to the conventional wisdom that afflicted households cope with the reduction in family size by switching to labor-saving crops such as roots and tubers, the findings indicate no clear pattern of crop shifts to labor-saving crops. The death of non-spouse females in the household is actually associated with a 5% decline in area under roots and tubers; (3) wealth status does not seem to exacerbate the impact of mortality on area under cultivation. Instead, land cultivated and area under cereals decline more in relatively non-poor households than among poor households after the death of a male head of household; (4) afflicted households liquidate small animals to cope with the impact of prime-age (PA) death and the value of cattle assets appears to suffer greatly from the death of a PA male head of household. These findings provide important information that may assist the Zambian government, donors, and development planners in developing specific policies or interventions to mitigate the impacts of AIDS on vulnerable households.

To my mother*

*I would like dedicate this work to my mother who passed away on August 5, 2002. Unfortunately, she could not live to see the fruits of her love and sacrifice during my academic life. I know she would have loved to see me smile and say thank you for making my dream come true. May her soul rest in peace.

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CHAPTER 1

INTRODUCTION

It is now widely accepted that policy makers and development planners in Sub-Saharan Africa can no longer afford to ignore the potential economic impacts of HIV/AIDS. Yet, more than 20 years have passed since the onset of the disease in Africa and there remains a dearth of quantitative information available on the economic impacts of the disease on rural farm households and their responses.[1] Decisions need to be made soon rather than later on how to respond to the disease. However, due to limited resources, there is a gap between desired and available levels of funding and human resources for HIV prevention (e.g., vaccines, behavior change), treatment (e.g., ARV therapies), and mitigating the impacts of AIDS (e.g., social and economic programs to protect the living standards of afflicted households and hard-hit communities). Moreover, every dollar invested in AIDS prevention, treatment, and mitigation cannot be used to promote basic education, improved agricultural technology, the development of infrastructure and markets, and other long-term investments necessary to raising living standards. Therefore, governments and international organizations need solid guidance on the cost-effectiveness of alternative kinds of investments to simultaneously combat the AIDS pandemic and the chronic poverty also prevalent in the region. Combating the interrelated problems of HIV/AIDS and poverty requires a better empirical understanding of how communities, households, and individuals respond to the disease, how their responses differ according to various circumstances, the binding constraints that must be

[1] To quote Scicchitano and Whitlock (2002, p. 2), "the international community is now at the stage where technicians will have to shift from merely describing the effects of HIV/AIDS on agricultural production, to actually measuring it."

relieved in order to allow for recovery, and the factors affecting resistance and resilience.[2]

Southern Africa is home to less than 2% of the world's population yet it has about 30% of the world's people living with HIV/AIDS (UNAIDS, 2003). There are seven countries in the world where HIV-prevalence rates for prime-age adults (aged 15-49) exceed 20%, all of which are in Southern Africa. Zambia, which is the country of focus in this study, is one of these seven countries.

Zambia's estimated HIV prevalence rate is 21.6%,[3] making it the sixth most afflicted country in the world. A nationally representative Demographic and Health Survey (DHS) in 2001-2002 found that almost 16% people aged 15-49 (who agreed to be tested) were HIV-positive. Estimates based on antenatal clinic-based surveillance data reported higher HIV/AIDS prevalence rates of up to 22% (ZDHS, 2002). While HIV prevalence rates vary geographically from 8% percent in Northern Province to 22% in Lusaka Province, it is reasonable to assume that neither rural nor urban communities will be spared from the potential negative economic effects of HIV/AIDS.

There are a growing number of studies in Africa attempting to measure the economic impact of HIV/AIDS on rural households' livelihood and welfare. These studies are constrained by the absence of longitudinal comprehensive data from farm households, hence most empirical studies resort to making conclusions based on cross-sectional data analysis. Also, a major difficulty in measuring the impact of adult

---

[2] *Resistance* refers to the ability to avoid contracting the disease, while *resilience* refers to the ability to withstand its effects, once it has manifested in communities (Loevinsohn and Gillespie, 2003).

[3] These estimates are acknowledged to be potentially overstated, because (1) they are based on blood tests of women visiting antenatal clinics located mainly in urban areas, which are considered to have higher prevalence rates than in rural areas; and (2) the antenatal data does not include men, who are likely to have lower rates of HIV infection than women (UNAIDS, 2003; Chin, 2003).

mortality, especially mortality attributable to AIDS, is that it is influenced by behavioral choices rather than by random events. Individuals and households incurring adult mortality are more likely to display certain characteristics. For example, during the early years of the epidemic in sub-Saharan Africa, evidence suggested that men and women with higher education and income were more likely to contract HIV than others because they were more likely to have numerous sexual partners (Ainsworth and Semali 1998; Gregson, Waddell, and Chandiwana 2001).[4] If prime-age mortality remains correlated with individual and household characteristics such as social status, education, and wealth – which are also important determinants of incomes and other welfare indicators – failure to control for these characteristics may generate biased estimates of the impact of adult mortality on household welfare. The few longitudinal empirical studies measuring the impact of adult mortality from AIDS on agriculture and rural farm households' welfare acknowledge that illness and the death of prime-age adults especially mortality attributable to AIDS may be endogenous to outcomes but do not explicitly test and/or attempt to correct for this potential problem.

Using nationally representative two-year panel survey data of 5,420 households from Zambian small- and medium-scale rural farm households this dissertation measures the economic impact of AIDS-related prime-age mortality on rural household livelihoods. In particular, this dissertation has three specific objectives: *first*, to determine the socio-

[4] As information about HIV transmission spreads, it is believed that educated people are more likely to change their behavior in ways that reduce their vulnerability to the disease compared to less educated people.

economic characteristics of rural individuals and households afflicted[5] by illness-related mortality in Zambia; *second*, to estimate the effects of AIDS-related prime-age adult mortality on indicators of rural households' welfare, specifically agricultural production, cropping patterns, value of livestock and off-farm income; and *third*, to provide information on the effectiveness of alternative policy levers for mitigating the effects of HIV/AIDS on rural farm households.

The analysis of the socio-economic characteristics of rural individuals and households afflicted by illness-related death in Zambia will help us understand the vectors of HIV transmission. There may have been one main transmission vector in early years related to income and mobility, but it is possible that additional transmission vectors have become important. Therefore, this needs to be clarified in order to understand how to effectively combat the disease. In addition to providing us with potential evidence supporting the likely endogeneity of prime-age death, the findings will also help policy makers and development agencies to re-evaluate current policy interventions to address the HIV/AIDS crisis and poverty through effective poverty reduction initiatives to prevent new infection and provide appropriate treatment and care that targets the most vulnerable households and individuals. The second part of the dissertation, adopts and extends the empirical model of Yamano and Jayne (2004) in two ways: (1) I control for household characteristics and factors that may influence the severity of the impact on rural households, such as initial (pre-death) wealth status,

---

[5] This paper follows the taxonomy convention proposed by Barnett and Whiteside (2002): "Afflicted" households are those that have incurred a prime-age death in their households; households that have not directly suffered a death but are nevertheless affected by the impacts of death in the broader community are referred to in this study as "affected." Households not directly suffering a death may be non-afflicted, but it is doubtful that there are any non-affected households in hard-hit communities of Eastern and Southern Africa.

landholding size and effective dependency ratio; and (2) I test for the possibility that prime-age adult mortality in the household is endogenous, something that has not been done in previous studies. The findings from this analysis provide important information that will assist in developing specific mitigation or interventions to counteract the negative impacts of the disease to the vulnerable households by government, donors and development planners as well as stimulate more debate in the research community.

The rest of this dissertation is organized as follows: Chapter 2 examines the socio-economic characteristics of individuals afflicted by illness related mortality (objective 1), while the third chapter determines the impacts of prime-age mortality on household composition, land cultivated and crop mix, farm production, livestock assets and off-farm income (objective 2). Finally, chapter 4 presents the conclusion and policy recommendations.

CHAPTER 2

CHARACTERISTICS OF INDIVIDUALS AFFLICTED BY AIDS-RELATED MORTALITY IN ZAMBIA

2.1. Introduction

Campaigns to prevent the spread of HIV/AIDS require accurate knowledge of the characteristics of those most likely to contract the disease. Studies conducted in Sub-Saharan Africa during the 1980s generally found a positive correlation between socioeconomic characteristics such as education, income, and wealth and subsequent contraction of HIV (see Ainsworth and Semali, 1998, Gregson, Waddell, and Chandiwana, 2001). However, as the disease has progressed, the relationship between socioeconomic status and HIV contraction may have changed in many areas of Sub-Saharan Africa, although there is little hard evidence to support this. For example, it is increasingly believed that poverty forces some household members to adopt more risky behaviors that contribute to HIV infection, which could mean that AIDS-related mortality is disproportionately affecting relatively poor households. This chapter seeks to determine the *ex ante* socioeconomic characteristics of individuals who die from illness between 15 and 59 years of age (hereafter called "prime age" mortality), using nationally representative panel data on 18,821 individuals in 5,420 households surveyed in 2001 and 2004 in rural Zambia. The findings from this chapter will help policy makers and development agencies better understand current transmission pathways of HIV/AIDS, which should help in the formulation of AIDS prevention and mitigation strategies.

Several probit models of disease-related mortality of prime-age (PA) individuals in rural Zambia between May 2001 and May 2004 were estimated, using nationally representative rural household survey data collected by the Government of Zambia. The results of these models are used to report the probabilities of mortality over a three-year period for a range of individual profiles that differ according to their gender, level of income, education, months residing away from home, distance to district town, and other individual and household characteristics.

The remainder of this chapter is organized as follows: Section 2.2 describes the data, issues related to sample attrition between the 2001 and 2004 surveys, and estimation methods. Estimation results and their interpretation are presented in Section 2.3. Section 2.4 discusses the conclusions of the chapter and implications for donor and government response.

2.2. Data and Methodology

2.2.1. Data and attrition

The study uses nationally representative longitudinal data on 18,821 prime-age individuals (15-59 years of age) in 6,922 households in 393 standard enumeration areas (SEAs)[6] in Zambia surveyed in May 2001 and May 2004. The survey was carried out by the Central Statistical Office (CSO) in conjunction with the Ministry of Agriculture and Cooperatives (MACO) and Michigan State University's Food Security Research Project.

[6] "Standard enumeration areas" (SEAs) are the lowest geographic sampling unit in the Central Statistical Office's sampling framework for its annual Post Harvest Surveys. Each SEA contains roughly 150 to 200 rural households.

For sampling procedures, see Megill, 2004. Of the 6,922 households interviewed in 2001, 5,420 (78.3%) were re-interviewed in May 2004. If attrition caused by enumerators not re-visiting several SEAs in 2004 that were included in the 2001 survey is excluded, the re-interview rate rises to 88.7%. And if attrition caused by adult household members being away from home during the enumeration period and those refusing to be interviewed is excluded, the re-interview rate rises to 94.5%.

Table 2.1 presents the relationship between household attrition, dissolution, and household size in 2001. The findings show that the percentage of households "attriting" is inversely related to household size (column C). While 8.4% of the households sampled in 2001 contained either one or two members, these households accounted for over 12% of the cases of attrition and 18% of the cases of household dissolution. In contrast, 65.5% of the sample contained households with 5 or more members and among these households only 47% of attrition due to dissolution is observed. (columns C and D). In addition, Table 2.1, column F shows that dissolution was a more important cause of household attrition among smaller households than among larger households. By contrast, larger households were more likely to incur a prime-age adult death (column G and H). This is because the probability that a household will incur a prime-age adult death is positively correlated with the number of adult members in the household.

Table 2.2 presents basic information on the households surveyed, re-interview rates, and prevalence of disease-related mortality over the 2001-2004 period. Of the 5,420 households successfully re-interviewed, 362 of these households (6.3%) had at least one

Table 2.1. Relationship between household size, attrition, dissolution, and prime-age mortality in 2001-2004.

Household Size	Households in 2001 sample	Households attriting in 2001-2004	Households attriting due to dissolution	Households dissolving as % of 2001 sample	Households dissolving as % of households attriting	Households incurring PA mortality	Households incurring PA mortality as % of reinterviewed household
(A)	(B)	(C)	(D)	(E)[a]	(F)[b]	(G)[c]	(H)[d]
Number	number	number	number	(%)	(%)	number	(%)
1	199	68	30	15.1	44.1	1	0.8
2	385	118	43	11.2	36.4	12	4.5
3	781	196	57	7.3	29.1	27	4.6
4	1021	263	76	7.4	28.9	36	4.7
5	1041	224	48	4.6	21.4	55	6.7
6	924	211	46	5.0	21.8	46	6.5
7	730	126	32	4.4	25.4	40	6.6
8	606	108	24	4.0	22.2	44	8.8
9	387	70	11	2.8	15.7	25	7.9
≥10	848	119	23	2.7	19.3	76	10.4
Total	6922	1503	390			362	

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes:
[a]Column E =Column D /Column B
[b]Column F=Column D/Column C
[c]36 households incurred more than one prime-age death
[d]Column H=Column G/(Columns B-C)

disease-related prime-age (PA) death over the three-year period.[7] Of these 362 households incurring a prime-age disease-related death, 53 of them suffered multiple prime-age deaths, with 45 households experiencing 2 deaths, 6 households experiencing 3 deaths, and 2 households experiencing 4 prime-age deaths. Survey design problems made it difficult to determine the relationships between the deceased in households suffering multiple deaths.

Using the World Health Organization (WHO) standard algorithm for diagnosis of HIV infection in the absence of blood tests, 24% of the deaths due to diseases are estimated to be AIDS related.[8] However, because information was not collected on all of the WHO minor symptoms, it is likely that our classification of AIDS and non-AIDS deaths' underestimates the percentage of deaths related to AIDS. Therefore, in this chapter the analysis is confined to correlates of prime-age mortality due to disease in general.

There were 419 prime-age deaths recorded in the sample, 21 of which were due to accidents or homicide and 398 cases of illness-related PA mortality. Of the 398 cases of illness-related PA mortality, 165 (41%) were men and 233 (59%) were women (see

---

[7] This only includes households with individuals in both the first and second surveys. A small number of recorded deaths were due to violence or accidents; these were excluded from the analysis.

[8] Following the standard WHO algorithm, the major clinical symptoms for which data was collected are: chronic diarrhea for more than one month, prolonged fever (intermittent and constant) for more than one month, and weight loss of more than 10% of body weight. The minor signs were prolonged cough, prolonged difficulty in breathing, prolonged pneumonia, thrush in the mouth and 'rash', which is considered to be an indicator of generalized *pruritic dematitis* if it occurred in combination with two major signs. A review of literature on verbal autopsies and lay diagnoses shows that there is no "ideal" method of measuring AIDS-specific mortality in a Zambian population-based sample. Therefore, we cannot get a "gold standard" diagnosis on a true population basis, since the validation of verbal autopsy studies in literature are flawed (the validation sample come from a clinical sample and therefore are not likely to be representative of the population) (Birbeck, 2004).

Table 2.2. Prevalence of prime-age (PA) mortality[a] by province, rural Zambia between 2001 and 2004.

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Province	Households interviewed in 2001	Households re-interviewed in 2004[b]	Households from column (b) with at least one prime-age adult death in 2001-2004	Prime-age deaths due to illness				Predicted AIDS-related deaths[d]		Median age of adults dying from diseases between 15-59 years of age
				Male		Female		by WHO classification[e]	One major sign and at lease one minor sign	
	(a)	(b)	(c)	(d)		(e)		(f)	(g)	(h)
	number	number (%)	number (%)	number	AMR[c]	Number	AMR[c]	number (%)	number (%)	---Years----
Central	714	573 (80.3)	50 (8.7)	27	12.1(14.4)	26	13.7(16.1)	10 (18.9)	13 (24.5)	34
Copperbelt	393	312 (79.4)	16 (5.1)	6	11.1(14.8)	10	11.2(14.6)	4 (25.0)	6 (37.5)	36
Eastern	1331	1126 (84.6)	71 (6.3)	31	12.4(14.6)	45	15.4(18.5)	15 (19.7)	27 (35.5)	35
Luapula	777	619 (79.7)	41 (6.6)	19	9.7(12.1)	27	12.1(15.1)	11 (23.9)	22 (47.8)	36
Lusaka	214	161 (75.2)	15 (9.3)	5	15.7(19.2)	10	13.3(16.6)	3 (20.0)	6 (40.0)	36
Northern	1363	1027 (75.3)	55 (5.4)	27	8.0(10.3)	29	10.3(13.1)	14 (25.0)	18 (32.1)	38
Northwestern	472	324 (68.6)	15 (4.6)	9	6.1(9.3)	8	6.8(10.0)	2 (11.8)	3 (17.6)	36
Southern	872	690 (79.1)	55 (8.0)	25	12.0(15.1)	36	14.0(17.3)	15 (24.6)	25 (41.0)	32
Western	786	588 (74.8)	51 (8.7)	16	12.5(16.4)	42	12.6(17.7)	22 (37.9)	31 (53.4)	33
Total	6922	5420 (78.3)	362 (6.7)	165	11.1(14.0)	233	12.2(15.4)	96 (24.4)	151 (38.3)	35

Notes: [a]Prime-age is defined as ages 15-59 for both men and women. [b]Of the 21.7% not re-interviewed, 0.2% were refusals, 10.2% moved out of SEA, 5.7% recorded as dissolved and 5.2% non-contact. [c]AMR (adult mortality rate)=Prime-age deaths/1000 prime-age person years. Figures in parentheses are AMR including individuals who joined the household and died between 2001 and 2004 but were not in the first survey. [d]Cause of death is defined as HIV/AIDS using lay diagnosis data of the deceased (see section 2.2). [e]WHO classification: 2 major signs (weight loss greater than 10% of body weight in a short period of time, chronic diarrhea for more than a month) and at least one minor sign (persistent cough for more than one month, itching skin rash, fungal infection of mouth and/or throat, history of herpes zoster, generalized herpes simplex infection and enlarged lymph nodes).

figure A2.1 for the distribution of PA illness-related mortality by gender and age-groups).[9] Of the 18,821 prime-age adults recorded in 2001, 36% had left the sample between 2001 and 2004 for causes other than death, e.g., moving to another location, getting married and starting another household elsewhere. Non-afflicted individuals are defined as those remaining in the sample and alive at the time of the second interview in May 2004.

Excluded from this analysis are 211 prime-age individuals who joined the household after the 2001 survey and died between 2001 and 2004. Strictly speaking, the relevant sample is composed of prime-aged adults who were residents of sampled households in 2001. Including individuals joining sampled households later might overestimate the prevalence of prime-aged mortality, as indicated in Table 2.2, Columns D and E. Other studies have found that a high proportion of HIV-positive individuals returned to their rural families to receive terminal care after becoming ill (e.g., Kitange et al., 1996).

Comparison of means between reinterviewed and attrited households

To test for possible bias in results due to household attrition, the mean levels of control variables measured in May 2001 are compared for households that were re-interviewed versus those that attrited. The means of many variables differ statistically between re-interviewed and attrited households (Table 2.3). For example, households not re-interviewed had slightly younger household heads (43 years vs. 45 years), smaller household sizes with fewer children age 5 and below, fewer boys and girls age 6 to 14,

[9] After weighting, women accounted for 61% of PA mortality.

Table 2.3. Household characteristics stratified by attrition status.

Household attributes in 2000	Re-interviewed N=5420		Not re-interviewed N=1502		Difference	
	Mean	Std. dev	Mean	Std. dev	Mean	t-stat
Age of household head (years)	44.71	15.04	42.50	15.04	2.21**	5.72
Mean education of head and spouse(years)	5.78	3.22	5.86	3.68	-0.07	-0.27
Household size (number)	5.91	3.01	5.17	2.63	0.73**	9.58
Children 5 and under (number)	0.93	0.93	0.83	0.91	0.09**	4.08
Boys 6 to 14 (number)	1.47	1.34	1.30	1.21	0.17**	5.31
Girls 6 to 14 (number)	1.57	1.35	1.39	1.22	0.18**	6.08
Prime-age male 15 to 59 (number)	1.26	0.99	1.07	0.87	0.19**	6.71
Prime-age female 15 to 59 (number)	1.33	0.88	1.20	0.78	0.14**	6.52
Elderly Males age 60 and above (number)	0.14	0.35	0.10	0.31	0.04**	4.06
Elderly Females age 60 and above (number)	0.11	0.33	0.10	0.30	0.02+	1.84
Households with chronically ill adult (number)	1.27	0.46	1.31	0.50	-0.04	-0.58
Prime-age death between 1996-2000(=1)	0.10	0.30	0.10	0.30	0.00	-[a]
Landholding size (ha)	2.80	2.82	2.45	2.69	0.35**	5.44
Land cultivated (ha)	1.49	1.38	1.25	1.20	0.24**	7.19
Total household income ('000 Zkw)	1843	3962	1819	3571	23.91	1.10
Value of assets ('000 Zkw)	901	2793	550	1751	351.26**	5.76
Productive assets ('000 Zkw)[b]	108	399	53	238	55.02**	6.23
Distance to nearest tarmac/main road (km)	25.32	35.49	24.93	33.39	0.39	0.58
Distance to nearest district town (km)	34.48	22.57	36.00	23.77	-1.52	-1.78

Source: CSO/MACO/FSRP Post Harvest Survey 1999/00 and Supplemental Surveys, 2001 and 2004

Notes:
** indicates 1 percent significance level; *indicates 5 percent significance level; + indicates 10 percent significance level.

[a] t cannot be computed because the standard deviations of both groups are 0.

[b] Productive assets are the sum of the value of farm equipment (scotch carts, harrows and ploughs) and livestock.

fewer prime-age males and females and elderly males, slightly smaller landholdings, less farm equipment and animals, and slightly higher rates of chronically ill adults in 2001. This is not surprising given the data presented in Table 2.1 showing that attriting households were smaller to start with in 2001. Systematic differences between attritors and non attritors, coupled with a high attrition rate, may cause concern about inference with this data. Also, if the attrited households suffered a higher incidence of PA mortality between 2001 and 2004, there would be attrition bias when estimating the *ex ante* socioeconomic characteristics of individuals who died of AIDS-related causes.[10] So one should be worried about the possibility of systematic attrition leading to selection bias.

In order to deal with potential attrition bias, the inverse probability weighting (IPW) method is adopted, which assumes that the probability of being re-interviewed as a function of observables information is the same as the probability of being re-interviewed as a function of observables, plus unobservables that are only observable for non-attrited observations (see Wooldridge, 2002).[11] In general, the IPW method works well if the observations on observed variables are strong predictors of non-attrition and if the observations on unobserved variables are not strong predictors of non-attrition. Interview quality variables are used to predict interview; in particular, 59 enumeration teams are used to predict re-interview. Each enumeration team was headed by a supervisor who was authorized to decide how much effort enumerators make to contact designated

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[10] Available evidence on attrition rates in longitudinal surveys in developing countries range from 5 to 30 percent for two rounds (see Alderman, et al, 2001; Thomas, Frankenberg, and Smith, 2001, Yamano and Jayne, 2004). For a discussion of IPW see Wooldridge, 2002.

[11] The literature addressing the detection and correction of selection bias is extensive, and a complete review of this literature is beyond the scope of this paper. Overviews of sample selection models can be found in Fitzgerald, Gottschalk, and Moffit (1998), and Alderman et al (2001).

households after not finding a valid respondent at home after the first visit. The re-interview model is specified as follows:

$$\text{Prob}(R_{kht} = 1) = f(HIV_{t-j}, I_{hk,2000}, X_{h,2000}, E_{ht}, P) \quad (2.1)$$

Where R_{kht} is one if individual (k) is in a household (h) that is re-interviewed at time t, conditional on being interviewed in the previous survey, and zero otherwise; HIV_{t-j} is the district HIV-prevalence rate at the nearest surveillance site in 1999; $I_{hk,2000}$ is a vector of individual characteristics in 2000; X_{h2000} is a set of household characteristics in the 2001 survey including landholding, productive assets, demographic characteristics (number of children ages 5 and under, number of prime age males and females), ownership of various assets; E_{ht} is a set of 59 enumeration team dummies; and P is a set of 9 provincial dummies. Note that all of the variables in (2.1) are observable even for individuals in households that were not re-interviewed in 2004.

Equation (2.1) is estimated with Probit for attrition between the 2001 and 2004 surveys, obtaining predicted probabilities (Pr_{2001}). Then, the inverse probability ($1/Pr_{2001}$) is computed, and applied to the probit models described in the following section for estimating prime-age (PA) mortality.

Table 2.4 shows that single or previously married individuals were less likely to be re-interviewed than married individuals. However, other factors constant, the results also show that prime-age male members were 4.7 percent more likely to remain in the households between the first and second survey compared to females. This may be because in most parts of Zambia which are patrilineal, females are more likely to leave their parents' home when they marry compared to men who may marry and still live with

Table 2.4. Individual-level re-interview model (Probit[a])

Attributes	1=Individuals contained in 2001 and 2001 surveys, 0=individuals contained only in 2001		
	dy/dx	z	P>z
Individual characteristics in 2000			
Gender(1=male, 0=female)	0.047	6.69	0.000
Never married (=1)	-0.172	-14.28	0.000
Previously married (=1)	-0.139	-9.13	0.000
Age group (=1)			
Age 20-24	-0.076	-5.92	0.000
Age 25-29	-0.021	-1.42	0.155
Age 30-34	0.021	1.36	0.173
Age 35-39	0.037	2.02	0.043
Age 40-44	0.090	4.70	0.000
Age 45-49	0.103	4.56	0.000
Age 50-54	0.134	6.64	0.000
Age 55-59	0.124	5.38	0.000
Years of education (=1)			
1-3 years	0.023	1.48	0.139
4-6 years	0.020	1.53	0.125
7 years	0.000	-0.02	0.985
8 years and above	-0.007	-0.42	0.673
Salary wage income (=1)	-0.044	-3.15	0.002
Formal/Informal business activity (=1)	0.033	2.50	0.012
Months away from home (number)	-0.013	-4.51	0.000
Household characteristics in 2000			
Children 5 years and under (number)	0.010	1.77	0.077
Children ages 6 to 11 (number)	0.002	0.81	0.420
Prior PA death from diseases in 1996-2000 (=1)	-0.038	-2.25	0.024
Landholding size (Ha)	0.002	1.01	0.312
Draft animals and farm equipment (Zkw)	0.002	2.31	0.021
Community characteristics			
District HIV prevalence rate in 1999	-0.003	-1.73	0.084
District on the line of rail (=1 , 0 otherwise)	-0.030	-1.16	0.244
Distance to the nearest tarmac road (km)	-0.000	-0.09	0.927
Distance to the district Town/Boma (km)	-0.000	-0.82	0.410
Enumeration team dummies included[b]	Yes		
Joint test for individual characteristics (X^2)[c]	1477.83	[0.000]	
Joint test for household characteristics (X^2)[c]	20.38	[0.002]	
Joint test for community variables (X^2)	4.99	[0.288]	
Joint test for team effects (X^2)[c]	1074.45	[0.000]	
Predicted probability of positive outcomes at $\bar{x}$	0.81		
Number of prime-age adults	18817		

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for individuals. [a] Estimated coefficients are marginal changes in probability. [b]Enumeration teams are included but not reported in the table. [c]Joint test for individual and household characteristics, and enumeration team effects are significant at 1 percent significance level.

their parents. Older individuals (age 30 and above) were more likely to be contained in the panel compared to younger members (age 29 and below) who are more likely to relocate. Generally, there exists a stronger positive association with reinterview as age increases. Also, individuals with salary and wage income, and who spend more time away from home in 2000 were less likely to be contained in both surveys. This is an indication that individuals with these characteristics are more mobile and less likely to be in households re-interviewed.

In contrast, individuals who had formal or informal business income were more likely to be contained in both surveys. Although the coefficients on years of education are not significant even at the 10 percent level of significance, it would appear that the marginal probability of remaining in the sample decreases as an individual's years of education increases. This suggests that individuals with more years of education are more likely to be contained only in the first survey and may have moved elsewhere for better prospects.

Turning to household characteristics, results in Table 2.4 show that individuals in households experiencing adult death between 1996 and 2000 were less likely to be re-interviewed compared to individuals in households experiencing no death during the same period. Landholding size and productive assets are positively associated with reinterview. Individuals in households with many children were more likely to be re-interviewed.

The lagged HIV prevalence variable is negatively associated with re-interview and statistically significant at the 10 percent level. This may suggest that AIDS exacerbates attrition in standard household surveys. Households suffering from adult

mortality due to AIDS may have moved away or dissolved, although the lagged HIV prevalence rate may be picking up the effects of other spatial factors correlated with district-level attrition rates, such as migration and mobility. Other community characteristics such as distance of household to the nearest tarmac road or to the district town appear to reduce the probability of being re-interviewed although this effect is statistically insignificant at 10 percent. This is because enumerators may be less likely to attempt to re-visit households in remote or relatively inaccessible locations. The enumeration team dummies are also jointly significant; suggesting that differences in enumeration team effort are a strong predictor of re-interview. In any case, the results in Table 2.4 suggest the importance of controlling for attrition, as is done in the remainder of the analysis. However, the magnitudes of the results between models corrected for attrition (Tables 2.6 and 2.7) versus not-corrected for attrition (tables A2.6 and A2.7) do not differ significantly, which suggests that, at least in this particular national sample, attrition bias does not create major problems for statistical inference.

2.2.2. Estimation strategies and variables

In order to examine the relationship between socioeconomic characteristics and the probability of PA death, all individuals in households interviewed in 2001 were used, and it was determined whether they died between 2001 and 2004. Probit regressions were run for a dichotomous (0/1) dependent variable: whether the person died of disease-related causes equals one, zero otherwise. The base model for the analysis is as follows:

$$\text{Prob}(A_{it} = 1) = g(I_{i2000}, X_{h2000}, HIV_{t-j}, C) \qquad (2.2)$$

where A is a binary variable that equals one if individual *i* died between 2001 and 2004, zero otherwise, I_{i2000} is a set of individual characteristics in 2000, X_{h2000} is a set of household characteristics in 2000, HIV_{t-j} is the lagged district HIV-prevalence rate in 1999, and C is a set of community variables including 393 village dummies. Because initial 2000 conditions associated with subsequent mortality are being measured, all of the variables are observable even for individuals in households that were not re-interviewed in 2004 but contained in 2001 survey. The vector of individual characteristics include: relationship of the deceased to the person who was household head in 2000, marital status, age, years of education, and months residing away from home. Ages are entered as five-year age groups up to the age of 59, with ages 15 to 19 as the reference group. Years of schooling are also included in dummy variable form for lower primary (one to three years), upper primary (three to six years), completed primary (seven years), and secondary and higher schooling (eight years and above), with the reference group being those with no formal schooling. Months away from home are divided into three binary variables: 0, 1, and 2 or more months away during the 2000/01 survey season. Individuals who died in 2001 are excluded in computing months away from home variables because 86 (22% of total prime-age deaths) of those who died in 2001 were at home all the time in 2000, suggesting that these individuals were already chronically ill and were more likely to be at home throughout the year.

Household characteristics include: landholding size, value of productive assets (farm equipment and farm animals) and ownership of durable assets (housing quality, radio, motor vehicles and water source).

Community variables include: distance of the village from the nearest tarmac road and district town, whether the district is located on the line of rail (proxies for degree of interaction between local residents and extent of contact with outsiders passing through the area).

The inclusion of quadratic terms of landholding size, productive assets, distance of village from the nearest tarmac road and district town are tested for because their marginal effect on the probability of being afflicted may be non-linear. However, specification tests rejected the non-linearity hypotheses in all cases so no quadratic terms are included in the reported model results.[12] Potential regional differences in factors associated with prime-age adult mortality in terms of wealth and income were also tested for, but there was very limited evidence of this through specification tests,[13] so the pooled national sample stratified by gender and assets and/or income status is used.

Equation (2.2) is estimated with Probit using the inverse probabilities from the re-interview model as weights. These models are run separately for prime-aged men and women, and for individuals in the top versus bottom half of the 2001 income and assets distribution in order to understand whether the socioeconomic correlates of adult mortality vary by gender and/or assets/income. As a robustness check to examine the

[12] In addition to the linear terms, the quadratic terms of landholding size, productive assets, distance of village from the nearest tarmac road and district town are added to the models and a test of joint significance is done in order to determine whether to include the quadratic term in addition to the linear term.

[13] In order to test for regional wealth and/or income differences, I rank household wealth distribution (value of productive assets-farm equipment and livestock) into terciles then run two sets of models having two wealth dummies (top and bottom wealth distribution with the middle group as the reference), eight provincial dummies, interaction terms of wealth distribution dummies and provincial dummies and other household and community variables in the second model. The joint test of significance of wealth and provincial dummies was rejected even at 20% level of significance. A similar approach is done with household income (sum of value of productive assets, gross value of crop output, formal/informal business income, and non-farm income) but the test for joint significance showed no regional difference by income status as well.

impact of initial poverty levels on the correlates of prime-age mortality, marginal probabilities are reported for models stratified by value of assets and household income. Results by income stratification are reported in Tables A2.4 and A2.5. Also, presented in Appendix Tables A2.2 and A2.3 are village- and province-fixed effects models (stratified by gender but pooled across income and asset groups) with household income and value of assets dummies as explanatory variables. The results indicate that neither household income nor assets were statistically related to individuals' probability of death.

2.3. Results

2.3.1. Adult mortality and HIV prevalence in Zambia

This section begins by investigating the correlation between prime-age mortality rates from the Zambia panel household survey data and district HIV prevalence rates from antenatal clinics as reported in Zambia's Demographic Health Survey (CSO, MoH and Macro International, 2003).[14] A strong relationship between prime-age mortality and HIV prevalence rates would suggest that a large proportion of prime-age mortality observed in our household data is indeed due to AIDS-related causes.

Figure 2.1 presents a scatter plot of provincial HIV prevalence and rural adult mortality rates from our provincially representative household data. The strength of these correlations is notable, especially considering that the provincial HIV prevalence rate is not disaggregated by urban/rural classification. The Pearson correlation coefficient of 0.84 suggests that the adult mortality rates observed in our survey data is closely associated with HIV-prevalence.

[14] National estimates of HIV prevalence in sub-Saharan Africa are almost exclusively based upon surveys of antenatal clinics, the majority of which are located in urban areas. The Zambia Demographic Health Survey figures are derived from blood sample testing of a randomly selected national sample of PA adults.

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Rural adult mortality rate, 2001-2004

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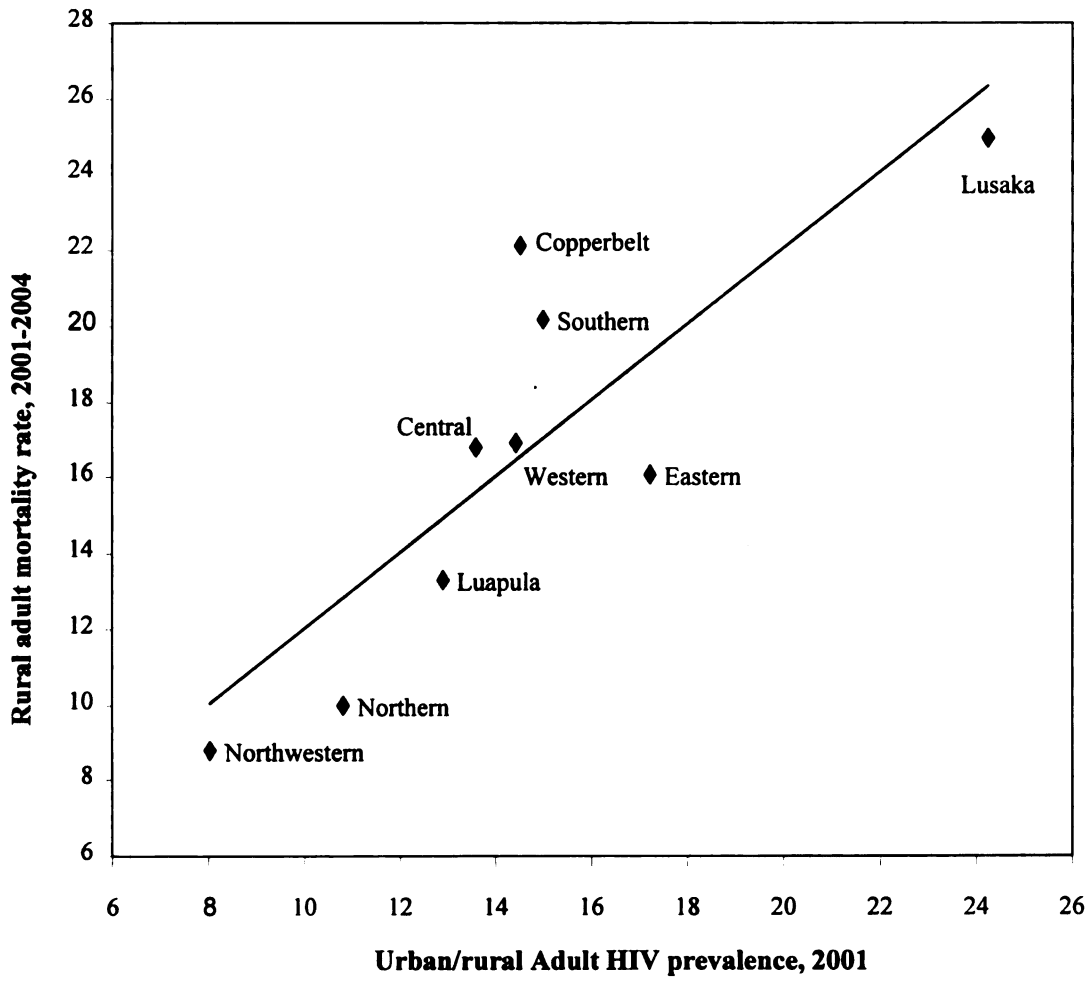
Figure 2.1. Correlation between Provincial adult mortality rates from CSO 2001 and 2004 household survey data and 2001 HIV + prevalence rates, Zambia.



Notes: Pearson correlation coefficient is 0.84.

Sources: Adult mortality rates (age 15-49) derived from the 2001 and 2004 household surveys. HIV+ prevalence rates are from 2001 Sentinel Surveillance Site information published by the Ministry of Health and ZDHS respectively.

2.3.2. Descriptive analysis

Table 2.5 presents characteristics of the prime-aged individuals who died in sampled households. The following features are discernible: First, more women die from prime-aged disease (and most likely, from AIDS) than men. The first row of Table 2.5 reports absolute numbers of prime-aged men and women having died compared to individuals remaining in the sample. After weighting the results to the national level, results indicate that 61% of the illness-related prime-age deaths in Zambia's small- and medium-scale farm sector between 2001 and 2004 were women. These results are also consistent with emerging evidence that a higher proportion of women are dying of AIDS than men in Southern Africa (UNAIDS, 2003). Women's mortality rates are expected to be somewhat higher than men's in low-income countries even in the absence of HIV because of maternal-related mortality, but these figures count only illness-related deaths. An important question is whether this 61% finding is explained by the physiological differences between men and women's susceptibility to contracting the disease,[15] or whether it also reflects gender differences in the use of ARV therapy. Because the use of ARV therapy was known to be extremely low during the survey period (less than 1% of all HIV-positive individuals), it is likely that physiological difference is the primary explanation for this finding.

In addition, prime-age female mortality is occurring predominantly among single women in the younger age groups (see figure A2.1). These results are consistent with the findings of a five-country study by Mather et al. (2004). Moreover, men and women

[15] Because of women's greater surface area where infected blood can be exchanged during sexual activity, the risk of HIV transmission from an infected male to a susceptible female is 2-4 times higher than the risk of HIV transmission from an infected female to a susceptible male (Chin, 2003, drawing from Gray et al, 2001 based on findings from Rakai, Uganda).

Table 2.5. Descriptive statistics among prime-age[a] adults who died due to illness in 2001-2004, and remaining prime-age adults in the sample

Attributes	PA adult deaths due to illness in 2001 –2004		PA adults remaining in the sample	
	Male	Female	Male	Female
Number prime-age adults (unweighted)	165	233	5735	5851
Number prime-age adults (weighted)	17,801	27,730	659,478	677,593
Individual Characteristics in 2000				
Relationship of deceased to the HH head in 2000 (%)				
Head/spouse	55.5	54.6	61.5	76.4
Others(sons and daughters, uncles etc.)	44.5	45.4	38.5	23.6
Marital Status in 2000 (%)				
Single	43.5	55.4	38.3	32.5
Married	56.5	44.6	61.7	67.5
Age (years)	35.6	33.5	31.2	32.7
Completed Schooling (%)				
No formal education	7.5	21.9	9.8	22.9
1-3 years	11.6	16.7	10.6	16.1
4-6 years	20.9	22.7	25.4	25.2
7 years and above	60.1	38.7	54.2	35.7
Salaried/wage employment (%)	11.3	3	14.2	4.1
Informal/formal Business activities (%)	21.2	13.2	18.5	13.3
Months spent away from home (median)	0.4	0.5	0.4	0.3
Household Characteristics				
Female headed HH in 2000 (%)	17.7	32.6	12.3	22.8
Prior death of adults between 1996-2003 (% of HH)[b]	68.4	65.5	6.0	5.9
Landholding size in 2000 (Hectares)	3.4	2.7	3.0	2.9
Draft animals and equipment (000' Zkw)	641.9	588.1	729.2	664.4
Per Capita Household income quartiles in 2000 (%)				
Poor (bottom 50%)	47.6	56.1	49.0	50.7
Non-poor (top 50%)	52.4	43.9	51.0	49.3
Community Characteristics in 2000				
Distance to the nearest town (km)	31.4	33.1	33.4	34.4
Distance to the nearest tarmac road (km)	23.7	22.9	24.1	24

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: [a]Prime-age is defined as ages 15-59 for both men and women. [b]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

who died between 2001 and 2004 were somewhat more likely to be better educated (Table 2.5).

2.3.3. Attributes of Deceased Prime-Age Individuals

This section presents results from probit models estimated to determine the attributes of deceased prime-age individuals in rural Zambia. Two sets of models were estimated: provincial- and village-fixed effects. Provincial fixed effects models allow us to examine the effects of variables measured at the district level, e.g., lagged HIV prevalence rates, and indicators of market access (distance to the nearest town, distance to the nearest tarmac road, and district on the line of rail). These models also provide more accurate estimates of probability of death over the three-year survey interval because the full sample is utilized.[16] All findings pertaining to probability of mortality are derived from these models. By contrast, the advantage of village-fixed effects models is that they control for inter-village differences in the attributes of mortality and thus may provide a more accurate indication of the importance of household-level and individual-level correlates of mortality within communities. Both sets of results are reported so that the reader can examine the robustness of these findings.

The probabilities of PA death for men and women were roughly 0.6% and 1.1%, respectively (see Table A2.1). However, the probability of death for relatively non-poor men was 0.9% and 0.6% (depending on whether the sample is stratified in terms of 2001

[16] By contrast, when estimating models with village dummies, the estimation program automatically drops those households where no within-village variation in the dependent variable exists, which restricts the sample somewhat. Of the 393 villages in the sample, 118 villages experienced no prime-age disease-related mortality among their households. Estimating probability of mortality from such models will generate upwardly biased probabilities because of the many cases dropped of individuals residing in villages where there were no recorded disease-related deaths over the survey interval.

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income or asset levels), whereas for relatively poor men, the death probabilities were 0.5% and 0.8%. There was little variation in probability of death between poor and non-poor women.

Table 2.6 and 2.7 presents the results of the province-level and village-level probit models stratified by assets distribution for some initial individual and household characteristics in 2001 that greatly affected the probability of dying. For both relatively poor and non-poor women, being married and/or the head or spouse of the household significantly reduces the likelihood of death. Among men, the effects of being married in 2001 on the probability of mortality between 2001 and 2004 are weak but still negative. In the village-fixed effects models, relatively poor men who are heads of households are significantly less likely to die than other poor men.

Other variables that affect the probability of death are whether the individual resided at home throughout the year, whether the household experienced prior prime-age mortality, and education (for non-poor women mainly). Variables that had little effect or ambiguous effects on the probability of dying included whether the individual was engaged in formal or informal business activities, landholding size of the household, and community indicators of proximity to towns and markets.

To aid in understanding the magnitude of the impact of these variables on death probabilities, the model results reported in Table 2.6 and Table A2.4 (Columns B, D, F and H) were used to compute estimated probabilities of dying over the 3-year period for 20 different individual "profiles." These simulations are reported in Table 2.8 and discussed in remainder of this paper.

Table 2.6 Probit models[a] of PA mortality in 2001-2004 by gender and wealth status (Province-fixed effects models): Corrected for

Table 2.6 Probit models[a] of PA mortality in 2001-2004 by gender and wealth status (Province-fixed effects models): Corrected for attrition.

	Deceased Prime-age Adult (=1, 0 otherwise)							
	Asset Poor (bottom 50%)				Asset non-Poor (Top 50%)			
	Male		Female		Male		Female	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Individual Characteristics in 2000								
Head/spouse (=1)	-0.004	-0.004	-0.007	-0.005	0.003	0.003	-0.007*	-0.006*
	(1.00)	(1.10)	(1.16)	(0.94)	(0.46)	(0.50)	(0.98)	(1.05)
Currently married (=1)	-0.007	-0.005	-0.011*	-0.010*	-0.008	-0.007	-0.013+	-0.010+
	(1.80)	(1.35)	(2.37)	(2.41)	(1.03)	(0.94)	(1.86)	(1.92)
Never married (=1)	-0.009	-0.005	-0.007	-0.005	0.004	0.005	-0.003	0.001
	(1.70)	(1.18)	(1.38)	(1.11)	(0.43)	(0.55)	(0.34)	(0.12)
Age groups in 2000 (=1)								
Age 20-24	0.017*	0.011*	0.009	0.008	0.003	0.002	0.008	0.007
	(2.09)	(2.01)	(1.09)	(1.08)	(0.52)	(0.36)	(1.07)	(1.01)
Age 25-29	0.030**	0.022*	0.015	0.016	0.043**	0.042**	0.038**	0.041**
	(2.74)	(2.50)	(1.51)	(1.80)	(3.68)	(3.64)	(3.23)	(3.75)
Age 30-34	0.027*	0.015*	0.041**	0.042**	0.037**	0.032*	0.029*	0.032*
	(2.28)	(1.94)	(2.95)	(3.22)	(2.75)	(2.47)	(2.02)	(2.29)
Age 35-39	0.036**	0.028*	0.025*	0.024*	0.042**	0.040**	0.060**	0.063**
	(2.60)	(2.44)	(2.10)	(2.21)	(2.84)	(2.76)	(2.98)	(3.35)
Age 40-44	0.090**	0.080**	0.023	0.027*	0.044**	0.044**	0.038*	0.041**
	(3.59)	(3.59)	(1.84)	(2.20)	(2.97)	(2.91)	(2.35)	(2.74)
Age 45-49	0.087**	0.077**	0.031*	0.031*	0.073**	0.068**	0.001	0.004
	(3.14)	(3.18)	(1.98)	(2.08)	(3.81)	(3.65)	(0.10)	(0.36)
Age 50-54	0.097**	0.087**	0.003	0.004	0.101**	0.096**	0.029	0.033*
	(3.78)	(3.74)	(0.28)	(0.38)	(3.54)	(3.47)	(1.75)	(2.06)
Age 55-59	0.108**	0.100**	0.021	0.023	0.079**	0.078**	0.031	0.031
	(3.81)	(3.90)	(1.50)	(1.70)	(3.76)	(3.70)	(1.65)	(1.78)

Table 2.6 continued.

Years of Education in 2000 (=1)								
1-3 years	0.005	0.003	0.009	0.008	0.034*	0.032*	-0.009	-0.009*
	(0.83)	(0.57)	(1.45)	(1.33)	(2.14)	(2.12)	(1.76)	(2.08)
4-6 years	0.003	0.001	0.003	0.002	0.022*	0.021*	-0.010*	-0.009*
	(0.55)	(0.26)	(0.52)	(0.33)	(2.03)	(2.05)	(2.03)	(2.23)
7 years	0.017**	0.012*	-0.003	-0.003	0.012	0.011	-0.007	-0.007
	(2.60)	(2.21)	(0.49)	(0.54)	(1.32)	(1.29)	(1.21)	(1.40)
8 years and above	0.006	0.003	0.014	0.013	0.010	0.008	-0.009	-0.010**
	(1.07)	(0.77)	(1.65)	(1.58)	(1.27)	(1.06)	(1.91)	(2.58)
Salary wage income in 2000 (=1)	-	0.008*	-	-0.008	-	0.002	-	-0.009
	-	(2.27)	-	(1.44)	-	(0.56)	-	(1.41)
Business activity in 2000 (=1)[b]	-	0.002	-	-0.002	-	-0.002	-	0.002
	-	(1.13)	-	(0.47)	-	(0.64)	-	(0.42)
Resided at home throughout	-	-0.016**	-	-0.034**	-	-0.013**	-	-0.046**
the year in 2000 (=1)	-	(3.85)	-	(4.44)	-	(2.65)	-	(6.02)
One month spent away from	-	-0.002	-	-0.012*	-	-0.007	-	-0.012**
home in 2000 (=1)	-	(0.90)	-	(2.37)	-	(1.12)	-	(2.99)
Household Characteristics in 2000								
Polygamous household (=1)	-0.006	-0.005*	-0.001	-0.001	0.002	0.001	0.002	0.003
	(1.91)	(2.25)	(0.11)	(0.17)	(0.35)	(0.26)	(0.39)	(0.59)
Prior PA death in 1996 -2003[c] (=1)	-	0.140**	-	0.169**	-	0.079**	-	0.111**
	-	(11.77)	-	(14.37)	-	(10.43)	-	(9.96)
ln(Landholding size (hectares)	-0.000	-0.000	-0.001	-0.001	-0.003	-0.003	-0.005*	-0.005**
	(0.19)	(0.17)	(0.34)	(0.48)	(1.48)	(1.49)	(2.42)	(2.70)
Community characteristics								
District HIV prevalence rate in 1999	-0.000	-0.000	0.000	0.000	0.001	0.001	0.002*	0.002*
	(0.48)	(0.37)	(0.45)	(0.51)	(0.66)	(0.72)	(2.29)	(2.57)
District on the line of rail (=1)	-0.000	-0.001	-0.005	-0.004	0.001	0.000	-0.006	-0.008
	(0.07)	(0.36)	(0.83)	(0.79)	(0.17)	(0.05)	(1.21)	(1.72)

Table 2.6 continued.

Distance to the nearest tarmac road (km)	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.000	0.000
	(0.39)	(0.13)	(0.00)	(0.03)	(0.50)	(0.53)	(0.41)	(0.47)
Distance to the district Town/Boma (km)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000*
	(0.55)	(0.44)	(0.24)	(0.21)	(0.79)	(0.66)	(1.63)	(1.97)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Predicted Probability of dying from disease-related causes[d]	0.006	0.005	0.013	0.012	0.009	0.009	0.012	0.011
Number of observations	3596	3596	3977	3977	3812	3812	3711	3711

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ** indicates 1 percent significance level; * indicates 5 percent significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis. [d]The probability of dying from disease related causes, setting all explanatory variables at their mean values.

Table 2.7. Probit models[a] of PA mortality in 2001-2004 by gender and wealth status, (Village-fixed effects models): Corrected for attrition

	Deceased Prime-age Adult (=1, 0 otherwise)							
	Poor (bottom 50%)				Non-Poor (Top 50%)			
	Male		Female		Male		Female	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Individual Characteristics in 2000								
Head/spouse (=1)	-0.001	-0.001*	-0.001	-0.001	-0.000	-0.001	-0.004	-0.004
	(1.84)	(2.00)	(0.47)	(0.39)	(0.11)	(0.27)	(1.17)	(1.43)
Currently married (=1)	-0.000	-0.000	-0.002	-0.002	-0.003	-0.001	-0.006	-0.005
	(1.58)	(1.25)	(1.13)	(1.18)	(0.55)	(0.20)	(1.52)	(1.53)
Never married (=1)	-0.000	-0.000	-0.000	0.000	0.004	0.005	-0.000	0.001
	(1.63)	(1.17)	(0.08)	(0.08)	(0.73)	(1.16)	(0.11)	(0.40)
Age groups in 2000 (=1)								
Age 20-24	0.004**	0.001**	-0.001	-0.001	0.002	0.001	0.009*	0.006
	(3.71)	(3.51)	(0.49)	(0.55)	(0.56)	(0.27)	(2.04)	(1.71)
Age 25-29	0.023**	0.013**	0.002	0.002	0.037**	0.035**	0.023**	0.025**
	(4.75)	(4.17)	(0.56)	(0.75)	(3.61)	(3.92)	(3.03)	(3.44)
Age 30-34	0.007**	0.003**	0.018**	0.017**	0.042**	0.029**	0.020*	0.024*
	(3.36)	(2.68)	(2.80)	(2.97)	(3.59)	(3.30)	(2.07)	(2.56)
Age 35-39	0.029**	0.015**	0.009	0.009*	0.042**	0.035**	0.058**	0.065**
	(3.95)	(3.38)	(1.81)	(1.97)	(2.85)	(2.92)	(3.19)	(3.74)
Age 40-44	0.107**	0.086**	0.005	0.005	0.079**	0.073**	0.021*	0.030**
	(5.65)	(5.28)	(0.94)	(1.32)	(3.53)	(3.47)	(1.98)	(2.67)
Age 45-49	0.107**	0.109**	0.020*	0.021**	0.131**	0.128**	0.004	0.007
	(5.11)	(4.75)	(2.26)	(2.62)	(3.79)	(4.08)	(0.50)	(0.85)
Age 50-54	0.038**	0.034**	-0.003	-0.002	0.121**	0.098**	0.028*	0.038*
	(4.00)	(4.35)	(1.11)	(0.99)	(3.62)	(3.50)	(2.00)	(2.46)
Age 55-59	0.263**	0.252**	0.011	0.012*	0.144**	0.153**	0.012	0.013
	(5.47)	(5.64)	(1.70)	(1.99)	(4.72)	(4.92)	(1.13)	(1.30)

Table 2.7 continued.

Years of Education in 2000 (=1)								
1-3 years	0.001	0.000	-0.000	-0.000	0.015	0.013	-0.004*	-0.004
	(1.56)	(1.43)	(0.08)	(0.26)	(1.43)	(1.39)	(1.98)	(1.90)
4-6 years	0.000	0.000	-0.001	-0.001	0.014	0.011	-0.005*	-0.004*
	(1.31)	(0.91)	(0.59)	(0.87)	(1.57)	(1.50)	(2.27)	(2.12)
7 years	0.002**	0.001*	-0.002	-0.001	0.005	0.004	-0.005	-0.004*
	(2.59)	(2.21)	(1.14)	(0.99)	(0.80)	(0.71)	(1.94)	(2.00)
8 years and above	0.000	0.000	0.003	0.003	0.005	0.003	-0.007**	-0.006**
	(1.22)	(0.85)	(0.92)	(1.16)	(0.83)	(0.56)	(3.19)	(3.50)
Salary wage income in 2000 (=1)	-	0.000*	-	-0.002	-	0.004	-	-0.003
	-	(2.46)	-	(1.05)	-	(1.30)	-	(1.06)
Business activity in 2000 (=1)[b]	-	0.000	-	-0.001	-	-0.002	-	0.002
	-	(1.58)	-	(1.36)	-	(1.16)	-	(0.59)
Resided at home throughout	-	-0.000*	-	-0.020**	-	-0.019**	-	-0.038**
the year in 2000 (=1)	-	(2.43)	-	(4.64)	-	(3.81)	-	(5.27)
One month spent away from	-	-0.000	-	-0.003*	-	-0.002	-	-0.004**
home in 2000 (=1)	-	(0.18)	-	(2.39)	-	(0.58)	-	(3.22)
Household Characteristics in 2000								
Polygamous household (=1)	-0.000	-0.000	0.003	0.002	-0.000	0.000	0.002	0.003
	(0.34)	(0.66)	(0.75)	(0.55)	(0.04)	(0.03)	(0.71)	(0.99)
Prior PA death in 1996 -2003[c] (=1)	-	0.070**	-	0.187**	-	0.099**	-	0.092**
	-	(9.01)	-	(12.77)	-	(8.02)	-	(8.34)
ln(Landholding size (hectares)	0.000	0.000	-0.001	-0.001	-0.004**	-0.003**	-0.002	-0.002
	(1.86)	(1.75)	(0.97)	(1.02)	(3.68)	(3.49)	(1.92)	(1.82)
Superior roofing material (=1)	-0.000	-0.000	-0.007	-0.003	-0.002	-0.001	0.003	0.002
	(0.90)	(0.85)	(1.83)	(1.31)	(0.51)	(0.46)	(1.00)	(0.99)

Table 2.7 continued.

Superior floor material (=1)	0.000	0.000	0.004**	0.003**	-0.000	0.000	-0.002	-0.002
	(0.36)	(0.05)	(2.87)	(2.68)	(0.00)	(0.01)	(0.56)	(0.82)
Standard door frame and door(=1)	0.000	0.000	0.002	0.001	0.000	0.000	-0.000	0.000
	(1.12)	(1.40)	(0.82)	(0.72)	(0.05)	(0.09)	(0.18)	(0.16)
Superior wall material (=1)	-0.000	-0.000	-0.000	-0.000	0.003	0.002	-0.003	-0.002
	(0.93)	(0.33)	(0.08)	(0.10)	(0.95)	(0.86)	(1.09)	(0.70)
Village dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1819	1819	2254	2254	1952	1952	2064	2064

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. **indicates 1 percent significance level; * indicates 5 percent significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

2.3.3.1. Relationship of deceased to head of household

Single and relatively young women are much more likely to die than married women. Individual profiles 1 and 2 in Table 2.8 are identical in every respect except for their marital status. According to the probit model results, women fitting the "profile 2" category have a 1.09% likelihood of dying over a 3-year period, compared to 0.45% for women fitting the "profile 1" category. Other attributes constant, single women are about 2.4 times more likely to die of disease-related causes than married women. Married men are also less likely to die from disease-related causes than single men. Comparing profiles 12 and 13 in Table 2.8, single men with the specified characteristics are 59% more likely to die than married men with otherwise similar characteristics.

2.3.3.2. Age groups

Age is one of the more important determinants of death due to illness as shown by the marginal probabilities in tables 2.6 and 2.7 (where the 15-19 year old age group dummy is omitted). The marginal probability of dying from disease rises steeply from age 15, peaking between ages 30 and 39 for poor females, and 45 to 59 years of age for men, regardless of their poverty status. This finding confirms previous findings showing that females are more likely to die at an earlier age than their male counterparts. The predicted probability of dying from diseases for women residing in relatively high-asset households rises from age 15, peaks between ages 50 and 54, and then declines. However, among women in relatively poor families, the probability of mortality peaks in the 30-34 year age range. The predicted probability of disease-related mortality for a relatively poor woman in the 30-34 year age range is roughly twice as high as a poor woman in the 20-24 year age

range. The probability of mortality for a relatively non-poor woman in the 30-34 year age range is only 1.3 times higher than a non-poor woman in the 20-24 year age range.

2.3.3.3. Education, mobility, income and household wealth indicators

Unlike earlier studies in Sub-Saharan Africa that generally found a positive correlation between education and HIV-related deaths (e.g., Ainsworth and Semali, 1998, Hargreaves, et al 2002, Gregson, et al 2001, Glynn, et al 2004), the results in Table 2.6 and 2.7 show a much weaker relationship between educational attainment and the probability of mortality from disease. There is no statistically significant relationship for men in household with either low- or high-income and/or assets. This appears to be in contrast to earlier findings showing that highly educated men were the most likely to die of disease-related death (Ainsworth and Semali, 1998). Among women, the findings generally indicate a negative relationship between educational attainment and the probability of disease-related death, especially for relatively non-poor women. The results for non-poor women do not show a clear relationship between educational attainment and probability of dying. These findings are consistent with de Walque (2004), who found that over time, susceptibility to HIV/AIDS in Uganda declined for relatively well-educated people more so than for poorly educated people, as information regarding precautionary measures spread. One apparent implication of this finding is that well educated and (especially) poorly educated men and women should continue to be targeted for HIV/AIDS education campaigns.

The results are somewhat consistent with findings in the 1980s and early 1990s indicating that prime-age mortality is more likely to affect men in the upper income

brackets. This is shown in Table 2.8 by comparing profiles 13 vs.16, which are identical in all respects except for assets and/or income. Non-poor men with the attributes shown in profile 13 are 1.3 times more likely to die of disease-related deaths compared to men in the bottom half of the assets distribution (non-poor men have a probability of mortality over a three-year period of 2.09% compared to 1.58% for men in the bottom half of the assets distribution). Although poverty might be expected to raise the probability of infection of sexually transmitted diseases and HIV since men with low incomes may be less able to afford condoms or STD treatment, our findings indicate that the influence of high economic and social status tends to predominate for men. As shown in table 2.6, women in the lower and upper half of the asset distribution are equally likely to die of disease-related causes, with the probability of mortality over the 3-year period being roughly 1.0% regardless of their households' income or asset levels. This may vary somewhat according to age group. For example, comparing profiles 7 vs. 9, women in the bottom half of the asset distribution (with the particular characteristics specified for these profiles) have a probability of mortality over a three year period of 1.25% compared to 0.66% for women in the top half of the assets distribution. If the age group of profiles 7 and 9 is changed from 20-25 to 35-39 and all other characteristics kept the same, the opposite result is obtained where women in the bottom half of the asset distribution have a probability of mortality over a three year period of 2.2 % compared to 3.2% for women in the top half of the assets distribution. This finding highlights the sensitivity of the relationship between poverty and probability of death to age group.

Women from relatively poor households who have some form of formal/informal business income are less likely to die of disease-related causes than poor women who did

not have any formal/informal business activity (profiles 9 vs.10). This finding seems to support Epstein (2002, 2003) who contends that female members in poorer household with few employment opportunities are more likely to engage in riskier sexual activities for economic reasons exposing themselves to HIV infection. So efforts to provide greater income-earning opportunities for poor women may make at least a modest contribution to reducing female PA mortality. However, Epstein's argument is contradicted by our finding that women from relatively non-poor households having some formal/informal business income are 10% more likely to die of disease related causes than women with similar characteristics not having business income. Non-poor women with businesses are more likely to spend more time away from home and have more social interactions than poor women with and without businesses. Other things equal, working women with their own income sources may be less vulnerable (along the lines of Epstein's argument), but working may also involve being outside the village or working away from home more, which may in turn increase certain risk factors. Recent research demonstrates that relative economic disadvantage is found to significantly increase the likelihood of a variety of unsafe sexual behaviors and experiences in KwaZulu-Natal Province, South Africa (Hallman, 2004). However, the findings from rural Zambia provide mixed evidence, which calls into question the view that poverty leading to risky behavior is the major pathway through which the disease is spread, although this may certainly be one of many pathways. Among rural prime-aged Zambian women, there appears to be no clear relationship between income and asset levels, access to business income, and probability of dying.

Table 2.8. Simulations[a] of the probability of mortality based on specific individual and household attributes.

Individual Profile	Gender	Marital Status	Income group	Age group	Education	Months away from home per year	Salary wage income	Formal/ Informal Business Income	Prior death of adult in household, 1996-2004	Predicted p of mortality in 3 year period	
										Assets	Income
1	Female	Married	low	25-29	4-6 years	0	No	No	N	0.45%	0.59%
2	Female	Single	low	25-29	4-6 years	0	No	No	N	1.09%	2.17%
3	Male	Married	low	25-29	4-6 years	0	No	No	N	0.01%	0.66%
4	Male	Single	low	25-29	4-6 years	0	No	No	N	0.34%	1.50%
5	Female	Married	High	20-24	4-6 years	0	Yes	No	N	0.03%	0.05%
6	Female	Single	High	20-24	4-6 years	0	Yes	No	N	0.28%	0.20%
7	Female	Single	High	20-24	1-3 years	0	No	No	N	0.66%	0.95%
8	Female	Single	High	20-24	1-3 years	0	No	Yes	N	0.73%	1.41%
9	Female	Single	Low	20-24	1-3 years	0	No	No	N	1.25%	1.33%
10	Female	Single	Low	20-24	1-3 years	0	No	Yes	N	1.11%	0.82%
11	Female	Single	Low	20-24	1-3 years	≥2	No	Yes	N	4.69%	3.45%
12	Male	Married	High	45-49	≥8 years	0	No	No	N	0.90%	0.44%
13	Male	Single	High	45-49	≥8 years	0	No	No	N	2.09%	1.93%
14	Male	Single	High	45-49	≥8 years	≥2	Yes	No	N	7.76%	8.67%
15	Male	Single	High	45-49	≥8 years	0	Yes	No	N	3.61%	2.69%
16	Male	Single	Low	45-49	≥8 years	0	No	No	N	1.58%	1.14%
17	Male	Married	High	45-49	≥8 years	0	No	No	N	0.90%	0.44%
18	Male	Married	High	45-49	≥8 years	0	No	No	Y	12.8%	14.9%
19	Female	Married	High	35-39	≥8 years	0	No	No	N	0.72%	1.29%
20	Female	Married	High	35-39	≥8 years	0	No	No	Y	12.2%	18.8%

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

[a]Simulation outcomes based on regression models in Table 2.6. For purposes of the simulation, married men and women are simulated as being heads and spouses of their households.

The results show that irrespective of poverty status males and women living two or more months away from home per year in 2001/2001 period are more likely to die of disease-related causes between 2002 and 2004 compared to men and women of the same characteristics but who spent all the time at home. For example, comparing profiles 14 and 15, non-poor men who spend 2 and more months away from home in 2000/01 have a probability of mortality over a three year period of 7.8%, whilst males of the same characteristics who spend all their time at home and did not die in 2001 had a probability of mortality over the same period of 3.6%. In contrast, comparing profiles 10 and 11, poor women living 2 and more months away from home are 4 times more likely to die of disease related deaths than women of the same characteristics but resided at home through out the year.

Finally, the probit results show that the prior death of at least one adult in the household over the past 8 years is the single most important factor influencing the probability that a prime-aged individual will die due to illness.[17] Irrespective of income/assets status, men and women experiencing a prior death of a prime-age person in their household are 14 to 16 times more likely to die of disease-related causes than the average prime-age individual. This is shown by comparing Table 2.8 profiles 17 and 18 for men and profiles 19 and 20 for women. The probability that men and women with the profiles shown in rows 18 and 20 would die over a 3-year period is 12.8%and 12.2%. In this way, AIDS differs from other kinds of diseases (e.g., malaria), which does not appreciably raise the likelihood of subsequent death in the family after one member

[17] Respondents in the 2001 survey were asked about prior deaths in the household back to 1996, which respondents in the 2004 survey were asked about deaths experienced in the household since the 2001 survey. A binary variable equaling one if the household experienced a death between 1996-2004 period is computed.

contracts the disease. To the extent that the death of two prime-age members from the same household within a few years of each other causes extreme hardships on remaining members, especially for children, the implication of this finding is that special programs to target and support AIDS-afflicted households are likely to become an important component of poverty reduction strategies, especially in areas hard-hit by AIDS such as most of eastern and southern Africa.

Household variables that appeared to be largely unrelated to the probability of an individual dying from disease include several indicators of rural wealth such as landholding size and livestock assets. As reported in Table 2.6, indicators of market access, such as the village's distance to the nearest tarmac road or district town were largely unrelated to the probability of an individual dying from disease. This indicates that the disease has moved far into the interior of rural Zambia, such that proximity to towns and highways that initially were the main locations where the disease was transmitted no longer has a significant bearing on the probability of death. District-level HIV prevalence rates are correlated strongly only with the probability of death among women in the non-poor groups. This is perhaps not surprising considering that HIV prevalence rates are derived from blood tests of women (not men) who visit antenatal clinics in peri-urban and urban areas who are more likely to be non-poor than most women contained in this sample.

2.4. Summary of findings

This study has identified important *ex ante* socio-economic conditions of individuals and households in rural Zambia who die between the ages of 15 and 59 years

of disease-related causes, using nationally representative panel data on 18,821 individuals surveyed in 2001 and 2004 in rural Zambia. The findings of the study can help policy-makers and development agencies better understand current transmission pathways of HIV/AIDS, which should help in the formulation of up-to-date AIDS prevention and mitigation strategies.

Overall, the probability that a prime-aged (i.e., 15-59 year) woman would die of a disease was roughly 1.0 percent over the 3-year period, while the comparable probability for men was 0.6 percent. Just over 60% of the prime-age deaths observed in this nationally-representative rural sample were women, supporting other findings that women are being disproportionately afflicted by the disease.

Consistent with findings in the 1980s and early 1990s, men in the upper half of the assets distribution are more likely to die of disease-related causes than men residing in poor households. In contrast, women in the lower half of income/assets distribution are equally likely to die of disease-related causes as women residing in the upper half of assets/income distribution. An emerging strand of the social science literature on HIV/AIDS in Africa stresses the relationship between poverty, risky sexual behavior, and subsequent contraction of the disease. It has been argued that single women unable to sustain themselves through wage labor or agriculture are more likely to resort to transactional sex for survival. If this is an important social pathway contributing to the spread of the disease in Africa, then one might expect to find a relationship over time between household- and individual-level indicators of poverty, especially for single women, and subsequent chronic illness and death. The results also indicate that relatively poor women who have some form of formal/informal business income are less likely to

die of disease-related death than women with same characteristics and no formal/informal business activity. This finding suggests that efforts to provide greater income-earning opportunities for poor women may make at least a modest contribution to reducing female prime-age mortality. This relationship does not hold, however, for relatively non-poor females. And 47.2 (45.0) percent of the women dying of disease-related causes over the 3-year survey period came from households in the top half of the asset (income) distribution. These findings suggest that the social factors driving the spread of AIDS are considerably more complex than simply poverty-based explanations, although poverty may certainly contribute to risky behavior and poor health which are important pathways by which the disease is spread.

Single women and men in poor households are twice as likely to die of disease-related causes as poor women and men who are the heads or spouses of their households. Single women and men in relatively non poor households are 3.7 and 4.5 times more likely to suffer a disease-related death compared to married women and men who are the heads or spouses of their households. Irrespective of gender, individuals who spend several months or more away from home are 2 to 10 times more likely to die of disease-related causes in succeeding years than individuals with similar socio-economic attributes but who reside at home all year. It is possible that the creation of business opportunities that involve men and women spending more time away from home for extended periods may exacerbate the AIDS problem in rural Zambia and negate the positive effects of greater financial independence for women, unless progress is made in public health and educational campaigns to promote the use of condoms, other forms of safe sex, and prevention interventions.

Years of formal education was found to be largely unrelated to vulnerability to death for men. For women, the evidence is not robust, but the data tend to show that educational attainment reduces somewhat women's vulnerability to disease-related death, especially for non-poor women. This result may indicate that public health information is indeed working for the more educated strata of rural Zambian society, because earlier studies in the region found that HIV rates were much higher for relatively well educated men and women (Ainsworth and Semali, 1998). This finding suggests that education coupled with public health campaigns may be an important empowerment tool for women and may help to reduce the risk of HIV contraction among women. Also, HIV/AIDS education campaigns should still target both the literate and illiterate because men of any education level have roughly the same risk of contracting HIV.

Most importantly, the prior death of a prime-aged person in the household substantially increases the probability of another prime-aged member dying. Irrespective of income status, prime-aged men and women experiencing a prior death in their household are 23.0 and 18.1 times more likely to die of disease-related causes than men and women in households with no prime-age deaths in the past 8 years. The predicted probability of death was 12.4% and 16.3% for men and women experiencing a prior disease-related death in their household in the past 8 years versus 0.54% and 0.90% for men and women not experiencing a prior prime-aged death. Of the 362 households experiencing prime-age mortality between 2001 and 2004, 15% of them suffered multiple prime-age deaths. In this way, AIDS differs from other kinds of diseases (e.g., malaria), which do not appreciably raise the likelihood of subsequent death in the family after one member contracts the disease. To the extent that the death of two prime-age members

from the same household within a few years of each other causes extreme hardships on remaining members, especially for children, the implication of this finding is that programs and strategies to support the care and education of orphans and children in AIDS-afflicted households may need to become a critical component of poverty reduction strategies in areas hard-hit by AIDS, such as most of eastern and southern Africa. More research is necessary to understand the longer-term impacts of the disease on household behavior and welfare, and to develop programs that can mitigate the adverse consequences. At this point in time, the research community still knows very little about the cost-effectiveness of alternative ways of mitigating the impacts of AIDS, but a solid understanding of the socio-economic factors associated with the disease is likely to help considerably in designing appropriate risk messages and prevention strategies.

CHAPTER 3

IMPACT OF HIV/AIDS-RELATED MORTALITY ON RURAL FARM HOUSEHOLDS IN ZAMBIA: IMPLICATIONS FOR POVERTY REDUCTION STRATEGIES

3.1. Introduction

At this point in time, little is known about whether adult mortality due to AIDS causes different or more severe shocks to household welfare than mortality of adult members due to other causes. Most micro-level HIV/AIDS impact studies in the literature hypothesize about the impacts of the epidemic but rarely quantify them.[18] These studies are constrained by the absence of micro-level information on how households respond to HIV/AIDS and the subsequent impacts on agricultural production, productive assets, non-farm (off-farm) income and any other key indicators of household welfare. The behavioral responses factored into macroeconomic-level models of the impacts of HIV/AIDS on economic growth are largely assumed rather than derived from micro-level empirical findings. Not surprisingly, their predicted effects on economic growth and development differ substantially. For example, Cuddington (1993) estimates that an HIV prevalence of 10 percent implies a reduction in economic growth of less than one percent. By contrast, Sachs et al. (2001) calculate that the 2.2 million AIDS-related deaths in 1999 reduced Africa's gross domestic product growth rate by 35 percent. The

[18] For example see Haslwimmer, 1994; FAO, 2003; UNAIDS, 1999; Barnett et al., 1995; Du Guerny, J. 1999; Drinkwater, 1993; Mutangadura, 1999; Topouzis, 2000; Stokes, 2003; SAFAIDS, 1998; Kwaramba, 1997; Pitayanon, et al., 1997; Tibaijuka, 1998; Rugalema, 1998.

wide variation in these predictions is exacerbated by the paucity of quantitative micro-level information on how households respond to HIV/AIDS.

Using comprehensive rural farm household longitudinal data from Zambia, this paper measures the impacts of prime-age (PA) adult morbidity and mortality on crop production and cropping patterns, household size, livestock and non-farm income. The paper adopts and extends the counterfactual (difference-in-difference) approach used by Yamano and Jayne (2004), one of the few quantitative assessments to date using large-sample household survey data. This study goes beyond existing studies by controlling for initial (pre-death) household conditions that may influence the severity of the impacts of adult mortality and by treating mortality as potentially endogenous. In particular, the study determines the impact of prime-age mortality conditional on initial poverty status, landholding size, effective dependency ratio, and the gender and position of the deceased person. Moreover, the possibility that PA death in the household is endogenous is taken into account by conceptualizing the measurement of effects of prime-age adult death on rural agricultural households' welfare as a two stage process: *first,* by examining the characteristics of afflicted households; and *second*, conditional on being afflicted, determining the effects of morbidity and mortality on indicators of household welfare both prior to and after mortality. The findings from this chapter provide important information that may assist governments, donors, and development planners in developing specific policies or interventions to mitigate the impacts of the disease on vulnerable households.

The remainder of the chapter is organized as follows: Section 3.2 briefly reviews the literature on HIV/AIDS' impacts on rural household behavior and welfare in Sub-

Saharan Africa, and highlights key methodological issues involved in analyzing these issues. Section 3.3 describes the data and methods used in this chapter. Results and a summary of findings are presented in Sections 3.4 and 3.5 respectively.

3.2. Review of empirical studies

This section reviews some of the household-level studies measuring the impact of premature PA mortality in rural farm households in sub-Saharan Africa. *First*, the section begins by looking at some of the data and methodological challenges to be overcome in empirical measurement of impacts of AIDS. *Second*, the remainder of the section reviews the available literature on the effects of mortality and morbidity on household composition, crop production, livestock and off-farm income in developing countries.

3.2.1. Empirical limitations of prior studies

There are a growing number of studies in Africa attempting to provide micro-level information on the impacts of HIV/AIDS on rural households and their responses but there is still modest quantitative information on the effects of HIV/AIDS-related mortality. Most of these studies are faced with four major limitations. *First,* the few available micro-level studies of the effects of HIV/AIDS on rural households are almost always drawn from specific geographic sites purposively chosen because they were known to have high HIV infection rates, such as Rakai in Uganda and Kagera in Tanzania (Barnett and Blaikie, 1992; Barnett et al., 1995; Tibaijuka, 1997; World Bank,

1999; Lundberg, Over, and Mujinja, 2000). While providing valuable insights into how afflicted households respond to the disease, such studies are limited in their ability to extrapolate to understand national level impacts. The paucity of nationally representative micro-level information remains a critical limitation on the generation of more reliable macro-level projections on the effects of HIV/AIDS.

Second, there are only a few longitudinal studies that examine the effects of disease-related mortality on afflicted households. Cross-sectional surveys cannot adequately measure the dynamic effects of mortality or control for unobserved heterogeneity, which are undoubtedly important in this context. Cross-sectional studies do not allow us to measure effects of mortality on outcomes since there is no information prior to the death event; such studies only allow us to compare *ex post* outcomes of afflicted versus non-afflicted households, although this reveals very little about impacts of mortality. Furthermore, for studies with no controls, it is unclear if any observed changes in household welfare for the period before and after death can be attributed to morbidity and mortality apart from other shocks or initial conditions affecting afflicted and non-afflicted households alike.

Third, a major difficulty in measuring the impact of adult mortality, especially mortality attributable to AIDS, is that it is influenced by behavioral choices rather than by random events. The few longitudinal empirical studies measuring the impact of adult mortality from AIDS on agriculture and rural farm households' welfare acknowledge that the death of prime-age adults, especially mortality attributable to AIDS, may be endogenous to outcomes but nevertheless treat mortality as exogenous without testing for endogeneity (e.g. Ainsworth and Dayton, 2000; Beegle, 2003; Booysen, 2003; Yamano

and Jayne, 2004;). However, with longitudinal data, the endogeneity issue, while still important, is not as critical as with cross-sectional data because fixed effects and/or difference-in difference models can be estimated to control for time-invariant individual and household characteristics. Nevertheless, time-varying unobserved heterogeneity remains a major problem even with longitudinal data, which may influence both the dependent variables of interest as well as the probability of mortality in the household. Thus, there is the need to test for endogeneity and, if present, explore other methods that may control for endogeneity of PA mortality due to illness.

Fourth, almost all of the quantitative micro-level studies to date have measured the effects of mortality *in afflicted households* compared to non-afflicted households. Yet, especially in hard-hit areas, if non-afflicted households are likely to be indirectly affected by the mortality occurring around them, non-afflicted households may not be a valid control group. This situation, in which a minority of households incurs a shock, but the shock is spread across households in a community presents methodological challenges for estimating the full effects of the shock using household survey data. These four major limitations of existing studies should be kept in mind in the following review of empirical findings on the impact of premature HIV/AIDS-related death on farm households.

3.2.2. Effects on household composition and labor availability

The most immediate impact of HIV/AIDS-related illness and death is on the human capital base, principally in terms of the availability and allocation of labor (Rugalema, 1999; Topouzis and du Guerny 1999). At the household level, labor input

diminishes as a prime-age adult succumbs to protracted illness and the labor of other household members and extended family members is diverted to care. The death of any productive member of the household constitutes a permanent loss of labor for agricultural and off-farm employment and other social and home care activities, although caregiving labor will no longer be diverted to caring for the patient after his or her death (White and Robinson, 2000). This labor shock can also cause shocks to the household's capital resources as income streams are lost, and as medical and funeral expenses rise. The death of a male head can also be accompanied by loss of land for the remaining household members.

Some studies have shown that households experiencing premature PA mortality due to HIV/AIDS-related causes adopt a mixture of coping strategies including: an increased in- and out-migration of household members, an increased rate of fostering, and higher rates of remarriage for surviving spouses (Ntozi, 1997; Urassa et al, 2001). However, the way in which households adjust to internal labor supply shocks varies according to the resources of the households. For example, better-off households may be able to hire workers or attract additional members to at least partially offset the loss of another (see Yamano and Jayne, 2004; Beegle, 2003; Ainsworth, Ghosh, and Semali, 1995, Donovan et al, 2003, Mather et al., 2005). Yamano and Jayne (2004) show that households suffering the death of the head-of-household or spouse were largely unable to replace the labor lost through the death, whereas households suffering the death of another adult were able to attract new household members. Without such adaptation, either through altered structures or roles, and/or through external assistance, families and households may become non-functioning social and productive units and ultimately

dissolve (Hosegood et al., 2004). However, in most studies, the vast majority of households (with two or more members) suffering the death of an adult remain intact and do not dissolve (Mather et al., 2005).

3.2.3. Effects on agricultural production and cropping patterns

Existing research has presented mixed evidence on the impacts of mortality on agricultural households and consequently there is no clear consensus on appropriate programmatic responses, especially considering the opportunity cost of scarce government and donor resources. Some qualitative studies provide evidence of reduction in area cultivated, shifts to less labor-intensive crops, and reduced weeding (Barnett et al, 1995; Topouzis and du Guerny, 1999; Topouzis, 2000; Harvey, 2004). The view that emerges here is that mitigation policy should prioritize labor-saving technology. However, other research in Uganda finds no significant change in agricultural production induced by labor shortages (Barnett and Blaike, 1992). Also, Barnett et al. (1995) conclude from case study research in Uganda, Tanzania, and Zambia that the effects of adult mortality on rural livelihoods may vary considerably within and across countries given numerous factors such as the rate of HIV prevalence, population densities, the nature of the cropping system, and the size of the local labor market.

Beegle (2003), using panel data from Kagera, Tanzania, finds that although cash cropping is temporarily scaled back following a male death and wage income falls, afflicted households do not shift towards subsistence crops. Putting these findings in context, Beegle (2003) also notes that the areas of highest AIDS-related mortality in Tanzania (such as Kagera) are in the Lake Victoria basin, an area with high population

density and, thus, a large labor supply and relatively high labor/land ratios. However, her study lacks measures of aggregate output and does not draw conclusions on changes in total crop production or the composition of crop production. Also, the study evaluated short-term effects during the early years of the epidemic (1991-1993) and the extent to which these findings hold over the longer run is uncertain.

A study in Kenya by Yamano and Jayne (2004) found that rural households suffering a PA death between 1997 and 2000 generally experienced a decline in agricultural output relative to non-afflicted households, but the magnitude and statistical significance of this finding was a function of the gender, age, and position in the household of the deceased person as well as the household's initial level of wealth prior to incurring the shock. They found no evidence for significant losses in cultivated land and net crop output among households in the top half of the wealth distribution. These results suggest that the effects of mortality are highly context-specific and should not be over-generalized. Once again, however, the three-year time frame over which effects were measured raises questions about the potential longer-term impacts.

Barnett et al. (1995) find little evidence of impact of HIV/AIDS in Tanzania but in Uganda they find some discernible evidence where poor households shift to subsistence crops over the period 1989-1993. More recent work by Dorward (2003) using a non-linear programming model and a household typology in Malawi to predict input and output responses to various shocks, such as price, drought, and adult illness, shows that responses to adult illness such as reduced area cultivated and outcomes such as lower yields vary considerably by characteristics of the household, such as percentage loss in household labor, income and asset levels.

Other studies have noted that the recent shift in area cultivated from maize to root tubers in much of southern Africa may be reflecting labor shortages and small farmers' attempts to shift to less labor intensive crops (Barnett, 1994; FAO, 1993; FAO, 1995; FAO, 2004; FASAZ, 2003; Shah, 2002). It is possible that the AIDS epidemic has contributed to these shifts, but one has to acknowledge that such shifts may also be due to major changes in agricultural policy, such as market reform programs that eliminated pan-territorial price supports for maize and also reduced fertilizer subsidies (used primarily on maize) in much of eastern and southern Africa, resulting in a shift of household incentives from growing maize to tubers (Jayne et al., 2005). The failure to take account of such policy changes may result in mis-attributing the shifts in cropping patterns to AIDS-related causes.

3.2.4. Effects on assets and non-farm income

Farm households are known to rely on remittance and non-farm income as a primary means to afford assets such as oxen, scotch carts, ploughs, and fertilizer, which are used to capitalize farm production (Reardon et al., 1995). Unfortunately, such sources of income are often at risk among AIDS-afflicted households, particularly those that were already asset poor and vulnerable (Donovan et al., 2003; Mushati et al., 2003). Morbidity and death of a household member tighten cash constraints on agricultural production as medical and funeral expenses rise and care giving by other members further reduces household income-earning potential. Topouzis and du Guerny (1999) note that households respond initially by disposal of assets that are reversible, including liquidating savings, seeking remittances from the extended family and borrowing from

informal or formal sources of credit. If necessary, the sale or disposal of productive assets typically follows use of these sources of support but may jeopardize a household's future livelihood (Stokes, 2003). This is supported by evidence from Kenya which shows that households first attempt to dispose of small animals and other assets with the least impact on long-term production potential. Cattle and productive farm equipment are sold in response to severe cash requirements after incurring a death in the family (Yamano and Jayne, 2004). Such *ex post* coping strategies are costly in the short term and may cause households not to recover from impacts of death even in the long-term.

From this review it can be hypothesized that the effects of HIV/AIDS-related deaths are heterogeneous, that the magnitude and significance of the effects will be largely conditioned by the gender and household position of the deceased individual, and that effects may depend on household-specific characteristics, such as initial vulnerability and poverty prior to the onset of illness and a household's ability to attract new members. If this hypothesis receives more empirical support from ongoing studies, then it will be necessary to move away from generalized conclusions about the main factors constraining afflicted households' ability to recover and begin formulating appropriate policy and programmatic responses based on the specific characteristics of the region, the regional economy, the localized farming system, the profitability and riskiness of alternative crops, and available resources.

3.3. Data and methods

This section presents data and methods used in measuring the impact of PA mortality on household composition, land cultivated, crop production, livestock assets

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and off-farm income. *First*, the section begins by discussing the data and attrition issues associated with any longitudinal survey data. *Second*, the conceptual framework from which the hypotheses are generated is discussed. *Third*, the remainder of the section presents the estimation models and identification issues.

3.3.1. Data

The data comes from nationally representative longitudinal data on 5,420 households in 393 standard enumeration areas (SEAs)[19] in Zambia surveyed in May 2001 and May 2004. The survey was carried out by the Central Statistical Office (CSO) in conjunction with the Ministry of Agriculture and Cooperatives (MACO) and Michigan State University's Food Security Research Project. The 1999/2000 nationally representative Post Harvest Survey (PHS), which surveyed about 7,500 households, was the base for the Supplemental Survey (SS) of May/June 2001. The SS covered the same reference period as the PHS of 1999/00 crop and marketing year, but collected additional information on non-farm income, adult and child mortality information including retrospective questions on mortality in the household over the previous five years, and basic socio-economic information on all individuals listed in the 1999/00 PHS demographic roster. Because of missing information on some households, the valid sample was reduced to 6,922 households. A follow-up survey of the same 6,922 households surveyed in SS 2001 was revisited in May/June 2004 and a total of 5,420 households were re-interviewed. Enumerators revisiting these households asked for the

[19] "Standard enumeration areas" (SEAs) are the lowest geographic sampling unit in the Central Statistical Office's sampling framework for its annual Post Harvest Surveys. Each SEA contains roughly 15 to 20 rural households.

whereabouts of the members included in the demographic roster of the initial survey, and recorded cases of death and illness, departure, and new arrival of individual members.

The 1999/00 PHS sampling frame was based on information and cartographic data from the 1990 Zambia Census of Population and Households. The census questionnaire included a question on whether the household engaged in agricultural activities (crop growing, livestock and poultry raising, and fish farming), as well as check items to identify the specific crops grown and animals raised by the household. Households were included in the sample only if they were found to cultivate crops or raise livestock. The reason for excluding the non-agricultural households was to improve the efficiency of the sampling frame for crop and livestock production and other agricultural characteristics.[20]

Zambia is divided into nine provinces, which are further divided into 70 districts (see map of Zambia in appendix, Figure A3.1). For the Census enumeration, a cartographic operation was conducted to define census supervisory areas (CSAs), which were further divided into standard enumeration areas (SEAs).[21] A stratified three-stage sample design was used. The CSAs were primary sampling units selected with probability proportional to size (PPS) at the first stage, where the measure of size was based on the total number of households in the CSA. At the second sampling stage, one SEA was selected with PPS within each sample CSA. This resulted in a similar dispersion of the sample and probabilities of selection as if the SEAs had been selected

[20] Although the rural households of landless farm laborers and those engaged in other economic activities are of analytical interest, they are best studied through other surveys, such as the Living Conditions Monitoring Survey (Megill, 2004).

[21] The SEA is the smallest area with well defined boundaries identified on census sketch maps and each SEA was covered by an individual enumerator for the census data collection.

directly at the first sampling stage. Within each selected SEA, all households were listed and stratified by size for selecting the sample households at the last sampling stage.

Households were classified into small- and medium-scale farming households, defined as those cultivating areas less than 5 hectares and between 5 and 20 hectares, respectively. Households cultivating more than 20 hectares were classified as large-scale farmers and were not included in this survey. Initial village listings of all households were generated to prepare the sample frames. The percentage of households who engaged in neither crop nor animal production on their land was found to be low, less than 4%. Landlessness is somewhat higher in areas closer to towns, where a higher proportion of households are engaged exclusively in non-farm activities. Since smaller households vastly outnumber the larger ones, the survey over-sampled the medium-scale farming households in order to ensure adequate inclusion of the larger households in the survey. A weighting procedure was formulated in order for the sample estimates from the PHS and SS surveys to be representative of the population of small to medium scale farmers. These sampling weights were multiplied with sample descriptive estimates. For more details about survey design and sampling procedures see Megill (2004).

3.3.2. Attrition

In a study such as this, which addresses the impacts of mortality using longitudinal data, treatment of attrition is particularly important. Adult mortality may contribute to household dissolution, which contributes to attrition and may lead to under-reporting of mortality rates and biased measurement of the socio-economic impacts of

Table 3.1 Prevalence of prime-age (PA) mortality* by province, rural Zambia between 2001 and 2004

Table 3.1. Prevalence of prime-age (PA) mortality[a] by province, rural Zambia between 2001 and 2004.

Province	Households interviewed in 2001	Households re-interviewed[b]	Descriptive results in 5342 valid re-interviewed households					
			Household with at least one prime-age deaths due to illness		Cause of death		Predicted AIDS-related deaths[d]	
			Male	Female	Disease	Other[c]	by WHO classification[e]	One major sign and at lease one minor sign
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
	Number	number(%)	number	number	number	number	number (%)	number (%)
Central	714	573 (80.3)	34	34	68	4	13 (19.1)	16 (23.5)
Copperbelt	393	312 (79.4)	12	16	28	3	9 (32.1)	12 42.9)
Eastern	1331	1126 (84.6)	68	71	139	7	33 (23.7)	55 (39.6)
Luapula	777	619 (79.7)	24	29	53	4	15 (28.3)	26 (49.1)
Lusaka	214	161 (75.2)	8	19	27	1	7 (25.9)	14 (51.9)
Northern	1363	1027 (75.3)	42	46	88	4	31 (35.2)	37 (42.0)
Northwestern	472	324 (68.6)	15	7	22	-	3 (13.6)	6 (27.3)
Southern	872	690 (79.1)	33	51	84	6	28 (33.3)	43 (51.2)
Western	786	588 (74.8)	18	44	62	1	23 (37.1)	31 (50.0)
Total	6922	5420 (78.3)	254	317	571	30	162 (28.4)	240(42.0)

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: [a]Prime-age is defined as ages 15-59 for both men and women. [b]Of the 21.7% not re-interviewed, 0.2% were refusals, 10.2% moved out of SEA, 5.7% were recorded as dissolved, and 5.2% were categorized as "non-contact" (not home but still resident). [c]Other deaths were caused by unexpected causes such as accidents, murder and snake bite, and were excluded from the analysis in Section 4. [d]Cause of death is defined as HIV/AIDS using lay diagnosis data of the deceased. [e]WHO classification: 2 major signs (weight loss greater than 10% of body weight in a short period of time, chronic diarrhea for more than a month) and at least one minor sign (persistent cough for more than one month, itching skin rash, fungal infection of mouth and/or throat, history of herpes zoster, generalized herpes simplex infection and enlarged lymph nodes).

mortality. The impacts of adult mortality would most likely be different for households that dissolve as opposed to those that remain intact.

Table 3.1 presents basic information on the households surveyed, re-interview rates, and prevalence of disease-related mortality over the 2001-2004 period. Of the 5,420 households successfully re-interviewed, 571 households had at least one prime-age death in the sample, of which 547 of these households had at least one disease-related prime-age (PA) death over the three-year period, 30 households had prime-age deaths due to accidents or homicide, and 6 households had deaths due to both causes. Of the 5,420 households that were re-interviewed in 2004, 78 households did not appear to be the same households interviewed in 2001 so are excluded from this analysis. Of the remaining 5,342 households, 542 households incurred at least one prime-age disease-related death, 52 (9.6%) of them suffered multiple prime-age deaths, with 44 households experiencing 2 deaths, 6 households experiencing 3 deaths and 2 households experiencing 4 prime-age deaths. Of those households experiencing multiple prime-age deaths, 15 households experienced more than one male death and 16 households had more than one female death. Out of a total of 571 prime-age deaths, 211 (37.0%) prime-age individuals joined the household after the 2001 survey and died between 2001 and 2004. This is evidence that a high proportion of HIV-positive individuals returned to their rural families to receive terminal care after becoming ill.[22]

Longitudinal data often provide an understanding of the dynamic behavior of individual households not possible with cross-sectional data. However, one major detracting feature of panel data surveys is that they are almost always affected by some

[22] Other studies have found that a high proportion of HIV-positive individuals returned to their rural families to receive terminal care after becoming ill (e.g., Kitange et al., 1996).

level of attrition over time. Attrition is a result of a number of factors such as changes in population (e.g. dissolutions due to death or relocation), non-contact (qualified respondents away from home), death and/or relocation, non-contact (qualified respondents away from home), non-response and refusals. Non-random sample attrition may create selection biases.

As discussed in Chapter 2, the 2004 sample was affected by attrition. Of the 6,922 households interviewed in 2001, 5,420 (78.3%) were re-interviewed in May 2004. Therefore, these data only measure the effects of mortality and illness on households that remained intact over the 3-year survey interval.

To test for possible bias in results due to household attrition, the mean levels of control variables measured in May 2001 are compared for households that were re-interviewed versus those that attrited. The means of many variables differ statistically between re-interviewed and attrited households (Table 2.3). For example, households not re-interviewed had slightly younger household heads (43 years vs. 45 years), smaller household sizes with fewer children age 5 and below, fewer boys and girls age 6 to 14, fewer prime-age male and female and elderly males, slightly smaller landholdings, less farm equipment and animals, and slightly higher rates of chronically ill adults in 2001. This is not surprising given the data presented in Chapter 2, Table 2.1 showing that attriting households were smaller to start with in 2001. Systematic differences between attritors and non-attritors, coupled with a high attrition rate, may cause concern about inference with this data. Also, if the attrited households suffered a higher incidence of PA mortality between 2001 and 2004, there would be attrition bias when estimating the

ex ante socioeconomic characteristics of individuals who died of AIDS-related causes.[23] So one should be worried about the possibility of systematic attrition leading to selection bias. In order to deal with potential attrition bias, the inverse probability weighting method is adopted as discussed in detail in section 3.3.7.1.

3.3.3. Relationship between Adult mortality and HIV/AIDS

While not all disease-related mortality can be attributed to AIDS in any given country or region, recent epidemiological studies demonstrate that in Eastern and Southern Africa, HIV has become the leading cause of disease-related death among adults between 15 and 59 years of age (Ainsworth and Semali, 1998; UNAIDS/WHO, 1998; Ngom and Clark, 2003; World Bank, 1999). Given the difficulty and cost of obtaining reliable estimates of AIDS-related mortality, some studies have used a combination of serological surveys to track the HIV status of sampled adults over time (Urassa et al., 2001); and/or "verbal autopsies/lay diagnosis" in which relatives and caregivers of the deceased are interviewed to record information regarding signs and symptoms of the terminal illness, all of which help to reduce the probability of incorrect diagnosis (Garenne et al., 2000; Urassa et al., 2001; Doctor and Weinreb, 2003; Araya et. al., 2004). The diagnostic indicators of the lay diagnoses are then used to provide estimates of the share of AIDS-attributable mortality based on an "expert algorithm".

For example, used the World Health Organization (WHO) algorithm to estimate the share of AIDS-related deaths and this estimate with the

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[23] Available evidence on attrition rates in longitudinal surveys in developing countries range from 5 to 30 percent for 2 rounds (see Alderman, et al, 2001; Yamano and Jayne, 2004). For a discussion of IPW see Wooldridge, 2002.

expected number. The expected number was derived from a comparison of adult mortality in this sample with the pre-AIDS mortality levels measured in the 1987 Malawi census, giving an 'excess mortality factor' that can be considered to be AIDS related. It was calculated that 74.9% of observed deaths in 1998–2001 would be from AIDS and according to the WHO algorithm, 75.5% of the VA deaths was found to be AIDS-related deaths.[24] Araya et. al., 2004 used two "gold standards' to validate the lay diagnosis information: the hospital discharge diagnosis of causes of death obtained by surveillance of hospital deaths (including autopsy results) and the physician review of the VAs. Independent of the 'gold standard', they find that the lay diagonis such as *lung disease* and *cold* had a specificity of about 90% and a combined sensitivity of about 55% in determining AIDS mortality and the sensitivity increased to 60-65% when diarrhea, TB, herpes zozer and mental or nerve problem are included.

These studies concluded that even in the presence of a reluctance to talk to HIV/AIDS, lay diagnosis of causes of death can be used for monitoring AIDS mortality. However, an identification of 'AIDS' deaths' through VAs based diagnosis lacks sensitivity to the extent that certain illnesses will be missed and specificity to the extent that any non-HIV tuberculosis or cancer will also fit the criteria (Doctor and Weinreb, 2003). Also, a review of literature on verbal autopsies and lay diagnoses shows that there is no generally accepted ideal method of estimating AIDS-specific mortality in a Zambian population-based sample. Therefore it was not possible to get a "gold standard" diagnosis on a true population basis, since the validation of verbal autopsy studies in the

[24] WHO classification: 2 major signs (weight loss greater than 10% of body weight in a short period of time, chronic diarrhea for more than a month) and at least one minor sign (persistent cough for more than one month, itching skin rash, fungal infection of mouth and/or throat, history of herpes zoster, generalized herpes simplex infection and enlarged lymph nodes).

literature is flawed (the validation samples come from clinical samples and therefore are not likely to be representative of the population) (Gretchen Birbeck, personal communication).[25]

In the survey, we collected information from respondents about symptoms leading to death of the deceased in an effort to try to explore the potential differences between defining the death as adult mortality due to illness in general and defining it as prime-age mortality when the cause is predicted as AIDS-related. If the reason for cause of death was given as 'disease,' follow up questions on the symptoms leading to death (lay diagnosis) were asked for each adult who died between 2001 and 2003. The lay diagnosis (LD) questions were included to aid in developing an algorithm for prime-age mortality where the cause is predicted as AIDS-related. The major clinical symptoms for which data were collected are chronic diarrhea, prolonged fever (intermittent and constant), and sudden weight loss of more than 10% of body weight. The minor signs were prolonged cough, prolonged difficulty in breathing, prolonged pneumonia, and thrush in the mouth and 'rash', which is considered to be an indicator of generalized *pruritic dermatitis* if it occurred in combination with two major signs.

Using the World Health Organization (WHO) standard algorithm for diagnosis of HIV infection in the absence of blood tests, 28.4% of the disease-related deaths in our sample are estimated to be AIDS-related (columns g and h , Table 3.1). However, because questions were asked about only 3 of the 6 "minor symptoms" as specified by WHO, it is likely that our classification of AIDS and non-AIDS deaths underestimates the percentage of deaths related to AIDS. Therefore, as in chapter 2, the decision was

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made to confine the analysis to the impacts of prime-age mortality due to disease in general.

Table 3.2 summarizes the number of afflicted and non afflicted households. Among the afflicted households, death is disaggregated by age, gender and position of the deceased in the household. The majority of the deaths due to illness (63.4 %) are as a result of mortality of other non-core male and female household members (non-core referring to members other than the household head and spouse).

3.3.4. Conceptual framework

It is widely accepted that HIV/AIDS will affect many aspects of the rural economy in the hardest-hit countries of Africa, although the particular pathways, impacts and magnitudes remain unclear and continue to be debated. Using the household as the unit of analysis[26], one can try to understand the mechanism by which rural farm households are afflicted by AIDS-related illness and death by developing a framework that views the household as a system of interactions between the household supply of labor to off-farm activities and farm production and the return flow to the household of food and cash to sustain their

[26] The paper uses "household" as the basic unit of analysis. However, there is no universal definition of a household so the definition of a household adopted in the survey and in this study follows the concept of a rural farm household by the United Nations: *"The concept of household is based on the arrangements made by persons, individually or in groups, for providing themselves with food or other essentials for living. A household may be either (a) a one-person household, that is to say, a person who makes provision for his or her own food or other essentials for living without combining with any other person to form part of a multi-person household, or (b) a multi-person household, that is to say, a group of two or more persons living together who make common provision for food or other essentials for living. The persons in the group may pool their incomes and may, to a greater or lesser extent, have a common budget; they may be related or unrelated persons or constitute a combination of persons both related and unrelated"* (UN, 1998).

Table 3.2. Characteristics of non-afflicted and afflicted[a] households

Category	Poor	Non Poor	Total
	(A)	(B)	(C)
	---------- number ----------		
Non Afflicted (no PA death or chronic illness)	2122	2085	4207
Household with chronically ill PA adults and no deaths'	300	280	580
Prime-age mortality (ages 15 to 59)			
Male heads	53	38	91
Female Heads or spouse	61	61	122
Other males	75	92	167
Other females	76	126	202
Elderly mortality (ages 60 and above)			
Elderly male	60	68	128
Elderly female	41	49	90
Number of households[a]	2,675	2,667	5,342

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: [a]Afflicted households are those in which a person between the ages of 15-59 (i.e., "prime-aged" or PA individuals) died or has been chronically ill during the period 2001-2004. The number of households is the sum of households suffering a death (excluding elderly deaths'), households with chronically ill PA members but no death, and non-afflicted households less the number of households incurring more than one death between 2001 and 2004. There are 27 households with more than one prime-age death of which 12 are in the poor category and 15 in the non-poor category.

daily livelihoods (FAO, 1995). Inter-household dynamics, and the complex links between individual households and extended families, both within and between communities are also very important since they tend to interact with household production and consumption. Also, households' allocation of resources are based on a number of interacting factors, such as household characteristics; biophysical factors, tastes and preferences, institutional, regional community characteristics and economic factors, which may need to be taken into account when measuring the impacts of HIV/AIDS-related morbidity and mortality.

As shown in Figure 3.1, the most immediate impact of HIV/AIDS-related illness and death is on the human capital base, principally in terms of the availability and allocation of labor (Gohen, 1993; HSRC, 2001a; Rugalema, 1999a; Topouzis and du Guerny 1999). This may disrupt the flow of labor to farm production and off-farm activities. Thus, at household level, labor input diminishes as the chronically ill prime-age adult succumbs to illness, and the labor of other household members and extended family members is diverted to care. The ultimate death of any productive member of the household constitutes a permanent loss of one source of labor for agricultural and non-agricultural activities and potential income, although at the same time resources will no longer be diverted to caring for the patient (White and Robinson, 2000).

Second, expenditures for medical treatment and funeral costs represent foregone investment in agricultural production and education. In the event of prime-age adult mortality, family assets such as livestock and machinery, may be sold off to compensate for foregone income, thereby delaying the impact of death to a later stage (Barnett and Blaikie, 1992; Lunderberg, Over, and Munjinga 2000). For food insecure households or

those slightly above this threshold, the loss of labor, income and increased expenditures for medical care can push them further into poverty and food insecurity. AIDS-related death and illness are likely to progressively de-capitalize highly afflicted rural households and communities, resulting into loss of savings, livestock assets and draft equipment, and other assets. The loss of productive assets that would otherwise be used in production processes may raise the demand for labor to the extent that labor can substitute for capital. However, earlier studies point to the fact that this may not be a problem if afflicted households can meet the rising demand for labor by attracting family labor from other sectors.

The way in which households adjust to internal labor supply shocks varies according to the resources of the households. For example, better off households may be able to hire additional workers to fill the void left by the deceased. Some afflicted households are able to attract additional members to at least partially offset the loss of another member (Yamano and Jayne 2004, Beegle, 2003, Ainsworth, Ghosh, and Semali, 1995, Donovan et al, 2003, Mather et al., 2005). Households that are initially poor are faced with very hard challenges to adjust to both human and financial changes. Figure 3.1 summarizes the different coping strategies typically suggested in the literature.

If suitable instruments existed, one would be able to empirically distinguish the impacts of one factor from the other. Nevertheless, this conceptual framework provides some insights into the potential pathways by which adult morbidity and mortality may affect rural households' livelihoods. From this framework this paper tested the following hypotheses:

First, the death of prime-age adults reduces the households' supply of labor and adversely changes its dependency ratio.

Second, to the extent that some households are able to attract new or previously resident family members from elsewhere after a prime-age adult becomes chronically ill or dies, these households may incur smaller adverse impacts on production levels, assets, and other indicators of welfare than households that cannot attract additional adult members.

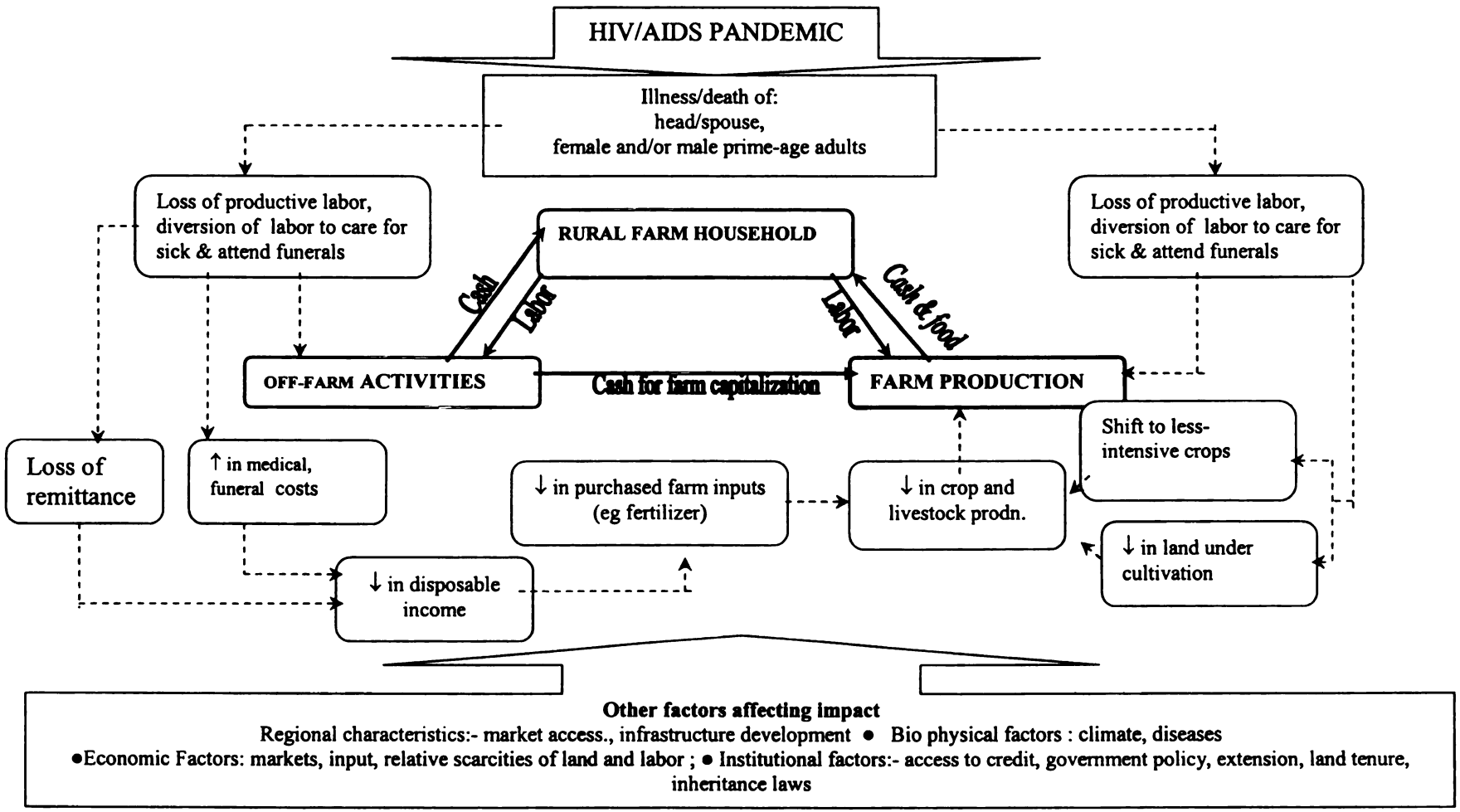
Third, *a priori*, the direction of the changes on household size are ambiguous since they are likely to be dependent on the gender, age, status of the deceased and the capacity of the household to attract new members or the extent to which the surviving household members leave the household to join other families or go and live elsewhere in search of non-farm opportunities [27]

Fourth, if households are experiencing income and labor constraints due to loss of prime-age adults to illness and death, one might expect to find some evidence that households are coping by shifting to cultivation of less labor-intensive crops such cassava and sweet potatoes.

Fifth, if the death of prime-age adults results in a loss of income and shortage of labor then one would expect to see a decline in the value of crop output and the value of crop output per hectare. However, the decline in output is expected to be sensitive to the gender and status of the deceased. In particular: a) cultivation of food crop production declines more if a female dies than if a male dies because females are more likely to devote most of their time to food crop production; b) cash crop production (coffee,

[27] (See Ainsworth, and Semali (1995); Janjaroen, (1998); Yamano and Jayne (2004)).

Figure 3.1. Potential Pathways by which HIV/AIDS prime-age morbidity and mortality affects rural farm household



Adapted from: FAO 1995; Barnett and Blaike 1992, Author's modifications.

tobacco, tea, and other export oriented horticultural crops) declines more if a man dies than if a woman dies because it is likely that cash crop production is the responsibility of the adult males in the household . c) if (b) is found to be true then it is expected that the death of male prime age adult members result in a higher decline of gross value of crop production compared to the death of a female member.

Sixth, if households cope with PA death by liquidating their assets, one would expect to see a decline in livestock assets, in particular cattle and small animals. Households may liquidate their assets starting with small animals (goats, sheep), which have the least impact on long-term productivity. However, in response to severe cash requirements households sell off larger animals such as cattle.

Seventh, the death of prime-age adults results in a loss of non-farm income, in particular remittances and wage income. If however, non-farm opportunities are available, the death of prime-age adults may encourage other household members to move off the farm to seek better paying jobs or activities if they have the necessary required skills. Therefore, *a priori* the direction of the impact of AIDS on non-farm income and remittances is ambiguous.

3.3.5. Econometric model

To measure the impacts of PA mortality and morbidity on outcome Y_i, we consider the estimation of a panel model that contains a binary variable for PA death as an explanatory variable. The following base model is formulated:

$$Y_{it} = \gamma_t + t * D_i\delta + \alpha_i + \varepsilon_{it} \quad i = 1,..., N \quad t = 1,..., T \qquad [3.1]$$

where Y_{it} denotes an outcome, such as household composition, area under cultivation, value of farm output, and non-farm income for household i at time t; $D_{it} = 1$ if a household experienced prime-age death between 2001 and 2004 and 0 otherwise; the parameter γ_t denotes a time-varying intercept[28]; α_i captures the household-level fixed effects (assumed constant over time); and ε_{it} is an error term.

A comparison of the changes in outcomes (Y) over time between the treatment group (households incurring a prime-age death and/or chronic illness) and the control group (households not incurring prime-age chronic illness or death) provides an estimate of the impact of prime-age mortality. Differencing the time 1 and time 0, equation 3.1 yields:

$$\Delta Y_i = \gamma + D_i\delta + \Delta\varepsilon_i \quad i = 1,..., N \qquad [3.2]$$

where ΔY_i is the 2004 - 2001 difference for a given outcome measure for each household i, D_i is the treatment indicator, δ is the treatment effect, γ is a constant, and $\Delta\varepsilon_i$ is the difference between errors at time 1 and time 0.

Estimation of equation 3.2 by OLS gives the average treatment (δ) which is essentially the impact of prime-age death on outcome Y. Assuming that neither initial household conditions nor attributes of the deceased person affect δ, and nothing else changes between afflicted and non-afflicted households, one could use this simple difference-in-difference estimator to evaluate the impact of death.

[28] Wooldridge, 2002 page 254.

However, rural households are heterogeneous in many variables that change and evolve differently for different households such as effective dependency ratios, the stock of education, incomes and assets levels. There is growing evidence that the effects of prime-age death differ between households depending on their initial conditions in terms of assets, income and stock of education (see Yamano and Jayne, 2004; Ainsworth and Dayton, 2000; Beegle, 2003; Yamano and Jayne, 2005). To control for these heterogeneous factors, a vector of exogenous household initial covariates (X_i) are introduced into equation 3.1 as follows:

$$Y_{it} = \gamma_t + t * D_i\delta + t * X_i^o\varphi + \alpha_i + \varepsilon_{it} \quad i = 1,..,\ N\ t = 1,...,\ T \quad [3.3]$$

Differencing the time 1 and time 0, equation 3.3 yields:

$$\Delta Y_i = \gamma + D_i\delta + X_i^o\varphi + \Delta\varepsilon_i \quad i = 1,...,\ N \quad [3.4]$$

However, in order to analyze the differential impacts of PA mortality, these initial (pre-death) characteristics were interacted with the treatment (D). The estimated treatment effect remains δ but it is now interpretable as a *ceteris paribus* effect. The model in equation 3.4 could then be re-expressed as:

$$\Delta Y_i = \gamma + D_i\delta + X_i^o\varphi + X_i^o * D_i\eta + \Delta\varepsilon_i \quad [3.5]$$

3.3.6. Empirical model and estimation strategy

Very little is known about the dynamics of household behavioral response to premature PA adult mortality in Africa and evidence to date shows great heterogeneity. Using the conceptual framework presented in section 3.3.4, I adopt and extend the model and estimation methods of Yamano and Jayne (2004) who chose to use methods that did not put a lot of restrictions on the data. As an extension of their study, this paper estimates impacts of mortality on various household outcomes taking into account the initial (pre-death) household variables as well as testing for the likely endogeneity of death variables before choosing the estimation method. Using equation 3.5 and adding provincial dummy variables (P), and interaction terms of deaths between 2001 and 2004 and pre-death household characteristics (X^o*D) the following model is estimated:

$$\Delta Y_i = \gamma + D_i\delta + X_i^o\varphi + X_i^o * D_i\eta + P\varsigma + \Delta\varepsilon_i \qquad [3.6]$$

Outcome variables (ΔY_i): The changes in outcome household level variables were grouped into four categories: (a) household composition; (b) agricultural production and cropping patterns; (c) value of livestock assets; and (d) non-farm income. Household composition variables included: changes in household size and composition of men,

women, boys and girls aged 11 and under[29]; agricultural production and cropping patterns variables: changes in total land cultivated, land cultivated by crop category (cereals, roots and tubers crops, high value crops) and gross value of crop production per hectare; value of livestock assets included: change in value of small and large animals, and non-farm income variables included off-farm income.

Death variables (D_i): D_i is a vector of deaths occurring in households between 2001 and 2004. Because the impact of prime-age mortality may differ depending on the gender of the deceased member, D_i was specified as two categorical variables, one for households suffering the death of a prime-age male (D^M) and one for households incurring the death of a prime-age female (D^F). I further differentiate the impacts of mortality according to the position of the deceased in the household by introducing categorical variables for male household head death (D^{MH}), female heads/spouses death (D^{FH}), other prime-age male death (D^{MO}) , and other PA females death (D^{FO}). This specification enables us to test for the possible status-differentiated effects of adult death.

Household pre-death conditions (X_i^o) : X^o is a vector of initial household conditions. This vector is comprised of asset poverty status, land holding size, and households' effective dependency ratio in 2000.[30] Effective dependency ratios, following de Waal (2003), are defined as the number of children, elderly, and chronically ill prime-aged adults divided by the number of healthy prime-aged adults. These variables were interacted with mortality variables to test whether the impacts of PA

[29] Due to data limitations the number of children could not be disaggregated into boys and girls age 6 to 11 and children under the age of 5. There is evidence in the literature that suggests that households cope with the loss of prime-age adults by either taking young boys and girls out of school to replenish the pool of physical labor or sending them away to live with relatives to ease the burden on food security.

[30] See Rosenzweig (1998) for a discussion of supposition that households' composition responds to the economic environment facing households.

mortality are sensitive to households' initial (2000) poverty levels, landholding size, and effective dependency ratios. Ideally, these initial conditions should be measured prior to the onset of chronic illness, but due to data limitation the onset of illness cannot be precisely determined.

The model specified in equation 3.6 is static in the sense that it measures a snapshot of afflicted households' changes in welfare outcomes in 2003/04 compared to pre-mortality conditions in 2000/01. Because households were re-visited only once, the analysis is not able to capture any dynamics associated with an adult death and outcomes for the surviving household members. Household responses to a death may not be constrained to one-time adjustments. Moreover, in the case of HIV/AIDS, the lag between infection and death (typically one year or less) may result in *ex ante* adjustments by the household already having been reflected in the first survey in 2001 in cases where an adult became chronically ill before this time. We considered the inclusion of a dummy variable that controls for current prime-age chronic illness in the household but decided against this because current chronic illness is likely to be endogenous given the fact that individuals to some extent may select which households to die in. As mentioned earlier, many individuals return to the homes of their parents to receive terminal care (Kitange et al., 1996). Moreover, chronic illness is believed to be measured with considerable error because of its subjective and self-reported nature (see Strauss et. al, 1993, Beegle, 2003).

Province x time dummies (A): Although the difference-in-difference estimator presented in this chapter controls for unobserved time-invariant household characteristics, there may be area-specific time-variant effects that might be corrected with both the

prime-age death and the outcome. To control for such area-specific time-variant effects, Provincial x time interaction dummies were added to the estimation models.

It must also be noted that the control group may be tainted by the fact that in areas where the epidemic is more widespread, no household in the community may remain unaffected. The increasing deaths and illness due to HIV/AIDS may for example result in a breakdown of social capital and local institutions that affect the whole community (afflicted and non-afflicted households alike). With a tainted control group our results may be biased. We address this concern by including lagged provincial HIV/AIDS prevalence rates in the model as a way to control for the extent of disease in an area and the probability of individuals contracting the disease.

3.3.7. Econometric issues

The model discussed above is faced with two econometric issues, namely the likely endogeneity of death variables and attrition bias. Ignoring these issues may result in inconsistent and biased results. Therefore, this paper attempted to address these issues simultaneously as discussed below.

3.3.7.1. Attrition bias

As mentioned earlier, the longitudinal data used in this study suffers from an attrition rate of approximately 19%. If this attrition occurs randomly, then there is no reason to worry about selection bias due to attrition, although efficiency will be lost because of a reduced sample. It is possible that the incidence of prime-age mortality is

higher among households that attrited but there is no way to determine this. If attrition bias is non-random then it is imperative to control for such attrition bias. Comparison of mean characteristics in 2001 (Table 2.3 in Chapter 2) seem to suggest systematic differences between attritors and non-attritors. Coupled with high attrition rate, this may cause concern about inference with this data. Also, if the attrited households suffered a higher incidence of PA mortality between 2001 and 2004, there would be attrition bias when estimating the impact of premature adult HIV/AIDS-related mortality.

The literature addressing the correction of selection bias is extensive, and a complete review of this literature is beyond the scope of this paper.[31] Similar to Chapter 2, the inverse probability weighting method (IPW) is used to deal with the potential attrition bias. The re-interview model is specified as follows

$$\text{Prob}(R_{it} = 1) = f(HIV_{t-j}, X_{i,2000}, E_{it}) \qquad (3.7)$$

R_{it} is one if a household (i) is re-interviewed at time t, conditional on being interviewed in the previous survey, and zero otherwise; HIV_{t-j} is the district HIV-prevalence rate at the nearest surveillance site in 1995; X_{i2000} is a set of household characteristics in the 2001 survey including landholding, productive assets, demographic characteristics (number of children ages 5 and under, number of prime age males and females), and ownership of various assets and E_{it} is a set of 59 enumeration teams. All of the variables in (3.5) are observable even for households that were not re-interviewed in 2004. Equation (3.7) is estimated with Probit for attrition between the 2001 and 2004

[31] For an overview of sample selection see Fitzgerald, Gottschalk, and Moffit (1998), and Alderman et al. (2001).

surveys, obtaining predicted probabilities (Pr_{2001}). Then, the inverse probability ($1/Pr_{2001}$) is computed, and then applied to the models estimated in section 3.4.

The results from the re-interview model (Table 3.3) show that households headed by older adults were 0.4 percent more likely to be re-interviewed compared to households headed by younger adults. Households with more adult males, adult females, and children were more likely to be re-interviewed. Thus, larger households were less likely to have dissolved and also it was more likely for an enumerator to find a qualifying respondent in larger households during the second survey.

Households who experienced an adult death between 1996 and 2000 were less likely to be re-interviewed compared to households experiencing no death during the same period. Also, landholding size and production assets are positively associated with reinterview. The lagged HIV prevalence variable is negatively associated with re-interview and statistically significant at the 10 percent level of significance. This suggests that AIDS exacerbates attrition in standard household surveys. Households suffering from adult mortality due to AIDS may have moved away or dissolved, although the lagged HIV prevalence rate may be picking up the effects of other spatial factors correlated with district-level attrition rates, such as migration and mobility.

Households located in a district that is on the line of rail were on average 5 percent less likely to be re-interviewed compared to those households not on the line of rail. Districts along the line of rail also contain most of the main roads linking Zambia to other southern African countries. Households in these districts may be considered generally more mobile and integrated with the main thoroughfares by which HIV has been spread. Mobility is also considered to reduce the likelihood of re-interview. Other

Table 3.3. Household-level re-interview model (Probit[a])

Covariates	1=Households contained in 2001 and 2004 Surveys, 0=contained only in 2001		
	dy/dx	Z	p>z
Demographic characteristics in 2000			
Female headed (=1)	-0.01989	-1.42	0.154
Age of household head (years)	0.00426	1.92	0.055
Age of household head squared (years)	-0.00003	-1.44	0.15
Mean years of education of head and spouse (years)	-0.00257	-1.65	0.099
Number of male adults	0.01643	2.76	0.006
Number of female adults	0.01844	3.03	0.002
Number of children under age 6 years	0.01625	2.61	0.009
Number of children age 6-11	0.00713	2.05	0.041
Prime-age adult mortality and illness in 1996-2000			
Death of head/spouse in 1996-2000 (=1)	-0.06482	-1.87	0.062
Death of non head/spouse on 1996-2000 (=1)	-0.01047	-0.55	0.581
Household assets in 2000			
ln (Value of assets (Zkw))	0.00271	2.54	0.011
ln (Landholding size(Ha))	0.02859	4.77	0.000
Community variables			
District HIV prevalence rate in 1999	-0.00058	-1.66	0.097
Distance to the nearest tarmac (Km)	-0.00027	-1.13	0.258
Distance to the nearest district town (Km)	-0.00006	-0.23	0.817
On line of rail (=1)	-0.04973	-2.30	0.021
Enumeration team dummies included[b]	Yes	Yes	Yes
Joint tests (X^2)			
Household characteristics		158.77 [p=0.000]	
Enumeration Team effects		209.26 [p=0.000]	
Community variables		15.66[p=0.029]	
Predicted probability of re-interview[c]		0.795	
Number of households		6922	

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: [a]Estimated coefficients are marginal changes in probability. Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. [b]Enumeration teams are included but not reported in the table. [c]Predicted probability of re-interview is estimated at model mean values

community characteristics such as distance of the household to the nearest tarmac road or to the district town appear to reduce the probability of being re-interviewed, although this effect is statistically insignificant at 10 percent. This may be because enumerators were less likely to attempt to re-visit households in remote or relatively inaccessible locations. The enumeration team dummies are jointly significant, suggesting that differences in enumeration team effort could be a strong predictor of re-interview. Also, the 2000 household characteristics are jointly significant as determinants of re-interview. In any case, the results in Table 3.3 suggest the importance of controlling for attrition, as is done in section 3.4.

3.3.7.2. Identification of impact of death

The DID fixed effects estimator of equation 3.6 is confounded by the possibility that PA death variables are endogenous, hence OLS results may be biased. There is growing evidence that households afflicted by prime-age mortality are not randomly distributed, for they tend to display certain features with respect to initial income, asset levels, education, etc. (see Ainsworth and Semali, 1998; Ainsworth and Dayton, 2000; Yamano and Jayne, 2004; Beegle, 2003). Unfortunately, these studies did not empirically test for the likely endogeneity of prime-age mortality.

Beegle (2003) outlines some of the reasons why AIDS-related prime-age death could be viewed as endogenous. *First*, AIDS-related mortality is caused by behavioral choices rather than random events. Contraction of HIV/AIDS is an endogenous occurrence, resulting from distinct patterns of behavior, particularly with respect to

sexual activity, and perhaps influenced by economic and social conditions. *Second,* individuals have some scope to choose where to live once they become ill. For example, seriously ill individuals may move into a household seeking terminal care and would like to die and be buried in their home area. Since these individuals are selecting which households to die in, the death variable(s) are not likely to be independent of the disturbance term in the household outcomes of interest. Over one third (36%) of the people who died between 2001 and 2004 in our sample were persons who moved back into the household and died before the second survey. So there is a possibility that the decision to return to a household for terminal care is related to the receiving household's or the returning individual's economic circumstances.

In the early years of the epidemic in Sub-Saharan Africa, evidence suggests that men and women with higher education and income were more likely to contract HIV than others because they were more likely to have numerous sexual partners (Ainsworth and Semali, 1998; Gregson, Waddell, and Chandiwana, 2001).[32] Using the same data set, results in Chapter 2 on the characteristics of individuals who died of disease related deaths between 2001 and 2004 in Zambia exhibited the following characteristics: (1) 61% of the prime-age deaths observed in the nationally-representative rural sample were women; (2) single women and men are 2 to 5 times more likely to die of disease-related causes than women and men who are the heads or spouses of their households; (3) females are more likely to die at an earlier age than their male counterparts; (4) relatively wealthy men (defined according to initial household assets and income) are 1.4 to 1.8

[32] As information about HIV transmission spreads, however, it is believed that educated people are more likely to change their behavior in ways that reduce their vulnerability to the disease compared to less educated people.

times more likely to die than relatively poor men; (5) relatively wealthy and poor women are equally likely to die of disease-related causes; (6) among relatively poor women, those having some form of formal or informal business income are 15% less likely to die of disease-related causes than those without any form of business income; (7) by contrast, among relatively non-poor women, those with business income were 7% more likely to die than those without business income; (8) irrespective of income status, prime-aged men and women experiencing a death in their household in the past 6 years are 23.0 and 18.1 times more likely to die of disease-related causes than men and women in households with no prime-age deaths in the past 6 years; and (9) men and women living two or more months away from home per year are 2 to 10 times more likely to die than men and women living at home throughout the year. These characteristics seem to buttress the argument against treating premature adult death in the household as a random event. If prime-age mortality remains correlated with individual and household characteristics such as social status, education, and wealth – which are also important determinants of incomes and other welfare indicators – failure to control for these characteristics may generate biased estimates of the impact of adult mortality on household welfare.

The DID fixed effects methods employed by Yamano and Jayne (2004) may result in biased estimates if the death variables remain endogenous even after controlling for time-invariant individual and household characteristics. Several methods have been proposed in the literature to deal with endogenous dummy variables when estimating treatment effects models including: "Heckman-type" selection models (Goldberger 1972, based on Heckman's [1976] sample selection model) in which a selection equation and

an outcome equation are jointly estimated, assuming a bivariate normal error term in the two equations; and instrumental variables (IV) estimators and nonparametric matching methods, most prominently propensity score matching (Rosenbaum and Rubin 1983), in which the probability of each unit selecting treatment is first estimated, and control observations are chosen by matching this score to the treatment observations. However, all of these methods are dependent on the availability of instruments to identify the impact of death.

Using the two-step IV method that exploits the binary nature of the endogenous explanatory variable(s), endogeneity of PA mortality variables by gender position in the household is tested for at two levels. First, the two years of data are pooled and tested to determine whether mortality is endogenous.[33] Second, the data are tested again to see if death variables are still endogenous after controlling for time-invariant unobservable effects by differencing the outcome variables. Evidence of endogeneity at this stage would warrant the use of instrumental variable fixed effects; otherwise, OLS on the difference models will be sufficient.

The challenge is finding instruments with some explanatory power in distinguishing between afflicted and non-afflicted households, and not directly correlated with the welfare indicators of interest. Time-invariant variables from *ex ante* survey data (e.g., distance from the household to a main road or distance to health facilities) could potentially be used, but their usefulness in distinguishing between afflicted and non-

[33] First, the method involves estimating the probit model $P(D=1|\mathbf{x},\mathbf{z})=G(\mathbf{x},\mathbf{z};\gamma)$ and obtaining fitted probabilities . Second, equation 5 is estimated by IV using instruments 1, $\hat{G}_i$ and $\mathbf{x}_1$. The method has a unique robustness property because using $\hat{G}_i$ as an instrument for D_i, the model for $P(D=1|\mathbf{x},\mathbf{z})$, does not have to be correctly specified and identification is achieved off the non-linearity of $P(D=1|\mathbf{x})$. However, $\Phi(\gamma_0+x\ \gamma_1)$ and x are usually highly correlated which may result in imprecise estimators (see Wooldridge, 2002, pages 621-625).

afflicted households may be limited. On the other hand, a variable such as educational attainment of the most highly educated person in the household may have some explanatory power in distinguishing between afflicted and non-afflicted households. However, education is also likely to be directly correlated with income, so the direct link between education and income is likely to distort or bias the effect of adult mortality on income if education is indeed correlated with income as one might imagine. Moreover, it is educational attainment *prior* to the onset of illness that would be appropriate; this variable might change after the death of an adult if that adult was the most highly educated person in the household. In other words, education level after the death of a household member is likely to be endogenous. At worst one could have used the non-linearity of the first stage regression to identify the impact of death but our results would be less convincing in the absence of plausible exclusion restrictions.

This study considers the use of rainfall shocks as a proxy for migration in and out of the community, lagged district HIV prevalence rates, and prior death in household as likely instruments.[34] Below is a discussion about the possible pathways in which these instruments are linked to PA death.

Lagged HIV/Prevalence: An investigation of the correlation between prime-age mortality rates from our household survey data and district HIV prevalence rates from antenatal clinics as reported in Zambia's Demographic Health Survey (CSO, MoH and Macro International, 2003) show a strong relationship between prime-age mortality and HIV prevalence rates making HIV prevalence a possible instrument (see Chapter 2,

[34] An instrumental variable must satisfy two requirements: it must be correlated with the included endogenous variable(s), and orthogonal to the error process.

Figure 2.1).[35] The Pearson correlation coefficient of 0.84 suggested that provincial-level adult mortality rates observed in our survey data are closely associated with HIV-prevalence rates. However, the use of lagged HIV/AIDS prevalence as an instrument could be problematic in the sense that prevalence rates based on sentinel site data may be biased upward, but this problem would less severe to the extent that the upward bias is uniform across all regions. However, if some differential bias existed, then lagged HIV/AIDS prevalence would not be a good instrument because the variable may also be correlated with the outcome variables. For example, women's use of the clinics where HIV testing is performed may be correlated with income levels, thus high income people are more likely to use these facilities than poor people. Despite the high correlation between HIV prevalence and prime-age mortality, HIV prevalence failed to pass the overidentification test, suggesting that the variable is also correlated with the outcome variables. Therefore, as suggested earlier, HIV prevalence is included as a control in both the first and second stage models.

Prime-age deaths in 1996-2000: In the 2001 survey, respondents were asked about prior mortality of household members during the 1996-2000 period. Results in Chapter 2, showed that individuals in households experiencing deaths between 1996-2000 were more likely to die of disease-related causes in the 2001-2004 period, making prior PA death good proxy for future deaths. Thus, the correlation between prior deaths' and current mortality makes prior death during 1996-2000 period a good instrument for PA mortality due to illness in 2001-2004. However, it is also possible that mortality in the 1996-2000 period may be related to the dependent variables in the 2001-2004 period.

[35] National estimates of HIV prevalence in sub-Saharan Africa are almost exclusively based upon surveys of antenatal clinics, the majority of which are located in urban areas. The Zambia Demographic Health Survey figures are derived from blood sample testing of a randomly selected national sample of PA adults.

Therefore, prior PA death is not used as an instrument in pooled models because it is likely to be correlated with the unobserved household characteristics. In contrast, as a robustness check of the endogeneity tests in differenced model, prior PA death is included as an instrument in the first model (model 1) and excluded in the second (model 2). The results in Table 3.5 show that we still reach the same conclusion in both cases.

Rainfall shocks: A long history of variation in rainfall may be correlated with earlier migration in and out of the community. For example, a drought tends to induce people to leave the rural areas and their families to seek income in the cities and send food home. (See Thiam et al. 2002). Once away from the family, some may rely on risky livelihood strategies that expose them to HIV infection and on their return to the community may pass the disease to unsuspecting partners. On the other hand, during good years, rural areas may attract traders from towns and cities and farmers may travel to markets and spend some time away from their families and communities. Such activity results in increased interaction with the outside community increasing their susceptibility to the spread of the disease.[36] Also, some studies have suggested that rural people may be infected with AIDS because of the interaction of drought and poverty, thus poor people (especially young girls) with no other survival alternatives may be forced into transactional sex in order to survive thereby exposing themselves to HIV. For example, a study by Bryceson et al. (2005) of smallholder farmers in three rural villages in Malawi's Lilongwe district revealed that hunger was a greater contributing

[36] A study in Senegal found that 27 percent of the men who had previously traveled in other African countries and 11.3 percent of spouses of men who had migrated were infected with HIV. In neighboring villages where men had not migrated less than one percent of the people were HIV positive (see Thiam et al., 2003).

factor to increasing susceptibility to HIV/AIDS, as these communities were engaging in risky sexual practices to survive.

Since deaths that occurred between 2001 and 2004 are being dealt with, it is more likely that people dying of HIV/AIDS-related causes might have contracted the disease five to eight years ago. Therefore, this study uses annual rainfall shocks in the 1994/95 drought season (crop season rainfall in 1994/95 minus mean rainfall over the 10-year period from 1990/1991 to 1999/2000) as a proxy for migration. This particular year is used because it was a severe drought year in the country and most likely induced significant migration that could affect mortality with a 7-10 year time lag, taking into account the mean period between HIV infection and death. However, not everyone migrates to other areas in search of other opportunities to help out their families in time of such hardship. It is likely that gender and age influences who migrates. To improve the predictive power of the instruments, age group of the deceased and rainfall shock interaction variables are computed. In particular, eight variables are computed to interact with deviations in rainfall from the 1994/95 drought season from the 10 year mean with eight age groups 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54 and 55-59. The results were not sensitive to which drought year was selected, 1991/92 or 1994/95. Due to high multicollinearity between the deviations in rainfall by year only deviations from the 1994/95 drought year are used.

3.4. Results

This section begins with a discussion of the results from the first stage regression models, where the suitability and strength of the instruments is tested followed by a discussion of the results from the Hausman Wu Chi-square test for endogeneity of prime-age death variables by gender and position in the household for pooled OLS and DID regression models. Then, having determined whether the prime-age death variables are still endogenous or not after purging the time-variant unobservable effects by taking differences, the remainder of the section presents the results from appropriate models measuring the impacts of PA death on rural household variables.

3.4.1. First-stage regression models

An instrumental variable must satisfy two requirements: it must be correlated with the included endogenous variable(s) and orthogonal to the error process. The former condition is tested by F-test of the joint significance of the instruments in the first-stage regression. The inverse of the F-statistic is proportional to the bias in the second stage (Duncan and Strauss, 1997). Table 3.4 reports the first-stage F-statistics for the significance of the identifying instruments. In all cases, the joint F-test for prior death and the 1994 drought age-group shocks are highly significant. Surprisingly, prior prime-age death is a significant predictor of other males and females mortality. In spite of these fairly large F-statistics and high percentage correctly predicted, a good deal of unexplained heterogeneity remains, as indicated by the low pseudo R^2. Also, in one case, changes in area under high-value crops, the null hypothesis that our instruments are not

correlated with the error term is rejected. So the test for endogeneity should be interpreted with these shortcomings in mind. Tables A3.8 to A3.14 in the appendix present the first- and second-stage regression results from which the results in Table 3.4 are derived.

3.3.2. Is prime-age death endogenous?

As discussed in section 3.2.1 there are reasons to believe that PA mortality from disease-related causes is likely to be endogenous and OLS estimates are biased in such instances. Table 3.5 columns A to F, summarizes the results from the Hausman-Wu test for endogeneity and Sargan N*R-squared test for overidentification of exclusion restrictions. A complete set of the first and second stage results are presented in tables A3.6 to A3.14 in the appendix. The results in Table 3.5, column A show that prime-age death is endogenous when OLS and IV results for the pooled sample are compared. Thus, in all the cases except when measuring the impact of death on gross value of crop production and area under roots and tubers, the null hypothesis that all the prime-age gender and position mortality variables are exogenous is rejected at the 1-5% level of significance. This finding implies that any attempt to measure impacts of prime-age death on rural household welfare with pooled cross-sectional data would yield biased estimates because of the unobserved effects, which are correlated with the error term. Taking advantage of the availability of panel data, the time-invariant unobserved household characteristics are differenced out as shown in equation 3.5 and further tested for endogeneity of prime-age death variables. Any evidence of endogeneity at this stage would indicate that even after differencing out the time-invariant unobserved

Table 3.4. First-stage F-statistic for significance of identifying instruments, Pseudo R^2 and % correctly predicted

Table 3.4. First-stage F-statistic for significance of identifying instruments, Pseudo R^2 and % correctly predicted

	F-test for instruments					% correctly predicted and (Pseudo R^2)		
	Pooled Sample	----------Differenced Models----------						
	Rainfall deviations and age group shocks	Rainfall deviations and age group shocks	Prior Death	Rainfall deviations and age group shocks	All Instruments	Pooled Sample	Differenced Sample	
		Model 1[a]	----------Model 2[b]----------				Model 1[a]	Model 2[b]
Prime-age Mortality	(A)	(B)	(C)	(D)	(E)	(E)	(F)	(G)
Male head death	147.38**	310.10**	0.01	303.0**	328.3**	98.8(11.3)	98.1(44.1)	98.3(44.1)
Female heads/spouses death	237.11**	363.3**	0.34	3.56.7**	357.8**	98.5(15.5)	96.7(46.5)	97.7(46.9)
Other males death	325.19**	468.7**	15.7**	466.8**	464.6**	97.8(16.1)	97.2(42.6)	96.9(43.6)
Other females death	273.53**	481.5**	5.3*	472.1**	465.6**	97.2(16.4)	96.6(50.6)	96.4(50.7)

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: + significant at 10%; * significant at 5%; ** significant at 1%. [a]F-test results from first stage regression models without prior death as an instrument.
[b]F-test results from first stage regression models with both prior death and age group and rainfall shock variables.

Table 3.5. Summary table of Hausman Wu Chi-square test and Sargan N*R square test for overidentification for pooled and differenced samples.

	Hausman Wu Chi-square test[a]			Sargan N*R square test of overidentification[b]		
	Pooled Sample	First differenced		Pooled Sample	First differenced	
		Model 1	Model 2		Model 1	Model 2
	(A)	(B)[c]	(C)[d]	(D)	(E)[c]	(F)[d]
Land cultivated						
Total area cultivated	22.26**	0.82	0.38	4.24	2.72	2.85
Area under cereals	18.32**	2.09	1.89	7.26	3.36	3.97
Area under tubers	6.17	2.64	3.06	5.21	6.82	7.25
Area under high value crops	19.41*	5.41	5.51	8.15	9.43+	9.57+
Household demographics						
Household size	29.26**	1.80	0.65	5.01	7.57	3.16
Males	22.69**	7.19	2.37	8.91	5.02	7.67
Females	22.87**	6.04	6.88	5.85	8.15	8.72
Boys	29.26**	1.80	0.65	5.01	7.57	3.16
Girls	14.56**	5.85	6.09	4.76	8.69	8.71
Crop production						
Gross value of output	5.26	1.32	1.23	7.14	3.71	3.96
Gross value of output/ha	9.46+	2.05	5.51	4.28	2.14	3.22
Assets and off-farm income						
Values of cattle	20.11**	1.49	0.77	5.12	6.72	7.85
Values of small animals	10.40*	4.22	2.99	8.90	7.59	8.12
Off-farm income	25.01**	7.53	8.61	6.99	9.01	9.18

Source: Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: [a]Tests of endogeneity of prime-age mortality (male heads, female heads/spouse, other males and other females): H_0: Regressors are exogenous. [b]Tests of overidentifying restrictions: H_0: All instruments are exogenous. + significant at 10%; * significant at 5%; ** significant at 1%. [c]Results from models without prior death as an instrument. [d]Results from models with both prior death and age group and rainfall shock variables.

characteristics there still remains time-varying unobserved household characteristics correlated with the error term, which would require us to consider the use of instrumental variable DID fixed effects estimation. However, the results in Table 3.5, column B and C, indicate that differencing of the household time-invariant unobservable characteristics adequately addresses the endogeneity problem, since the null hypothesis that all prime-age mortality variables are exogenous is not rejected. These findings offer some support for the validity of earlier studies using fixed effects, RE or DID (but which did not explicitly test for endogeneity). Since this is the first study (to my knowledge) that attempts to test for endogeneity of prime-age mortality when measuring household outcomes, there is need for further empirical evidence on this issue. Given these findings, results from fixed effects models using differenced data are presented in the remaining sections.

3.4.3. Impact of prime-age death on household composition

The results in table 3.6 (columns A and B) show that irrespective of gender and/or position of the deceased person in the household, a prime age death is associated by less than a one-person decline in household size. For example, the death of any prime-age male reduces the size of the household by 0.84 members and death of a PA woman reduces the size of the household by 0.69 members. Compared to non-afflicted households, the death of male head of the household results in a reduction of household size by 0.71 person and the death of females who were heads or spouses of their households reduces household size by 0.81 person. The death of another adult male reduces the household size by 0.88 persons whilst death of other females reduces the

household size by 0.56. This finding indicates that households respond to mortality by partially replenishing their household size.

Changes in household size, shown in column A and B, are the sum of changes in men, women, boys and girls, as shown in columns C to J. As mentioned earlier, due to data limitations it was not possible to split boys and girls into two age groups, age 5 and under and age 6 to 11, so I only look at effects of death on boys and girls ages 11 and under. Looking across the row, it can be seen that the reduction of household size due to male heads/spouses death is mainly caused by a reduction of 0.55 in the number of adult males. The change in number of females is positive whilst that for girls and boys are negative but with the exception of change in number of girls, the estimates are not statistically significantly different from zero. The drop in adult males is less than one, suggesting partial replacement of males. In contrast, the death of PA female heads or spouses and other females reduces the size of the household by 0.81 and 0.56 respectively and this reduction is due to the changes in the number of females. Similar to the effect of male heads/spouses death, the reduction in household size is less than unity suggesting some partial replacement of household members. The results are slightly different for other non-core male death. The reduction in household size due to other male death is a result of a decline in the number of adult males by 0.42 as well as a reduction in the number of girls by 0.34. This additional decline in number of girls explains why the reduction in household size is close to unity. This finding seems to suggest that households incurring other male death are coping by sending away small girls to live with other relatives.

Table 3.6. The impact of PA mortality on household composition by gender

Table 3.6. The impact of PA mortality on household composition by gender and position of the deceased

Covariates	Δ Household size		Change in number of : Adult males		Adult females		Boys		Girls	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
Prime-age (PA) adult mortality										
Male	-0.84**		-0.55**		0.04		-0.07		-0.26**	
	(3.94)		(6.17)		(0.54)		(0.78)		(2.63)	
Female	-0.69**		0.07		-0.48**		-0.17*		-0.11	
	(3.40)		(0.99)		(6.10)		(2.09)		(1.27)	
Male head/spouse		-0.71**		-0.73**		0.11		0.01		-0.10
		(2.60)		(5.13)		(1.01)		(0.08)		(0.73)
Female head/spouse		-0.81*		0.01		-0.63**		-0.16		-0.04
		(2.32)		(0.11)		(4.79)		(1.19)		(0.24)
Male non-head/spouse		-0.88**		-0.42**		0.00		-0.13		-0.34*
		(3.06)		(3.77)		(0.03)		(1.19)		(2.50)
Female non-head/spouse		-0.56*		0.12		-0.39**		-0.14		-0.15
		(2.36)		(1.33)		(4.22)		(1.43)		(1.37)
Elderly mortality										
Elderly males	-0.81*	-0.81*	-0.71**	-0.72**	-0.02	-0.02	0.15	0.15	-0.23+	-0.22+
	(2.47)	(2.49)	(5.57)	(5.66)	(0.15)	(0.20)	(1.21)	(1.22)	(1.78)	(1.71)
Elderly females	-0.57+	-0.57+	0.14	0.13	-0.42**	-0.42**	-0.08	-0.07	-0.21	-0.20
	(1.65)	(1.66)	(1.16)	(1.09)	(2.83)	(2.85)	(0.51)	(0.49)	(1.37)	(1.32)
Constant	0.09	0.09	0.19**	0.19**	0.23**	0.23**	-0.18**	-0.18**	-0.16**	-0.16**
	(1.01)	(0.99)	(4.89)	(4.94)	(6.69)	(6.71)	(3.78)	(3.81)	(3.29)	(3.37)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on Mortality	14.98**	7.73**	19.16**	10.37**	18.59**	10.87**	2.58+	1.24	4.60*	2.64*
R-squared	0.11	0.11	0.11	0.11	0.09	0.09	0.10	0.10	0.11	0.11
Number of observations	5308	5308	5308	5308	5308	5308	5308	5308	5308	5308

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and $^{+}$ 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors.

In contrast to PA mortality which generally is not anticipated very far in advance, elderly mortality can be anticipated to some extent. Over time, their roles in the household may progressively be absorbed by other household members. Our results show that the death of elderly adult male and female members reduces the household size by 0.81 and 0.57 respectively. Thus, there is greater partial replacement of household members by males (though not statistically significant) in the event of an elderly female death compared to elderly male death. The death of elderly males also results in a decline in number of girls. Although statistically significant at the 20% percent level, death of elderly males tends to increase the number of boys in the household suggesting that the tasks performed by elderly males may be assumed by boys absorbed in the household from the extended family.

Do these findings support the general assumption in most qualitative literature and popular discussion suggesting that, in general, households incurring prime-age death face severe agricultural labor constraints based on the notion that death of a prime-age adult reduces household's labor supply and increases its dependency ratio? Unfortunately, results in Table 3.6 alone cannot adequately provide definitive answers to this important question. But these results do provide some indications. *First,* there seems to be evidence suggesting that households are coping by partially replacing lost household members. *Second,* a comparison of household size *ex ante* shows that afflicted household had initially larger household sizes compared to non-afflicted households (see Table A3.1 and A3.2 in the appendix). In addition, one has to bear in mind that, in general, most agricultural households are likely to face labor shortages of some kind at particular times of the season. Based on these reasons I suggest caution before making

any conclusions that assume that the loss of a PA adult will cause the household to face greater labor shortages than non-afflicted households. To seek more clarity on this issue, the impact of death on household composition is considered by examining the differential impacts due to the differences in initial pre-death wealth status, land holding size and effective dependency ratios.

Also, the sensitivity of the findings is tested by stratifying the sample into two groups based on the initial pre-death value of household assets in the 2001 survey[37] and then estimate the models in Table 3.6 with gender and position mortality variables. This is done because the ability of a household to respond to any kind of death shock is subject to some of these factors and to ignore them in the discussion may lead us to make incorrect conclusions (Drimie, 2002; Yamano and Jayne, 2004).

Does the impact on household composition differ by initial household conditions?

First, I look at the results from models with interactions terms between death by gender and position and pre-death household poverty status, landholding size and effective dependency ratio to capture the likely differential impacts of the death shock. The hypothesis to be tested is that initial poverty exacerbates the impacts of death and that poor households are less able to cope with the shock.

Wealth status in 2000: The results of the interaction terms between death and wealth status as shown in Table 3.7 are not statistically significant except for the male heads/spouses death and wealth status interaction which is statistically significant at the 10% level. The positive coefficient suggests that the reduction in household size is

[37] Value of assets includes farm equipment including scotch-carts, oxcarts and harrows, value of cattle and small animal stock and non farm assets such as bicycles and motor vehicles.

greater in poorer households compared to non-poor households. Non-poor households are attracting boys and other males (statistically significant at 15%) to replace the labor lost among households incurring male head/spouse death. Notwithstanding the loss of knowledge about farm practices and the foregone income of the deceased, older boys and other males may be filling the labor void left by the deceased male head in non-poor households. Since all the other interaction terms are statistically insignificant only some simulations are done to compare the impact on household size due to male head/spouse death between poor and non-poor households. In order to do this the impact of male head of household death on household size, change in males and boys is evaluated for two scenarios: (1) poor households (bottom 50% of value of assets distribution), mean land size (3.10 hectares) and mean effective dependency ratio (1.33); and, (2) non-poor households (upper 50% of value of assets distribution), mean land size and mean dependency ratio. See table A3.3 in the appendix for descriptive statistics on initial (pre-death) household characteristics. The results indicate that household size declines by -0.301 in non-poor households compared to -0.838 in poorer households. The implications of this finding are that poorer households have substantially greater difficulties in coping with the death of core male household members while non-poor households are likely to almost fully restore household size to former pre-death levels. These results seem to support earlier findings in Kenya that poor households experiencing a male head death are less able to cope with the shock due to limited household resources to support additional members (Yamano and Jayne, 2004).

Table 3.7 The impact of PA mortality on household composition by initial

Table 3.7. The impact of PA mortality on household composition by initial household pre-death characteristics.

Covariates	Δ Household size		Change in number of:							
			Males		Females		Boys		Girls	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
Prime-age (PA) adult mortality										
Male head/spouse	-0.838**	-0.828**	-0.703**	-0.693**	0.119	0.116	-0.074	-0.065	-0.180	-0.187
	(3.16)	(2.78)	(5.02)	(4.16)	(1.14)	(1.12)	(0.51)	(0.40)	(1.40)	(1.31)
Female head/spouse	-0.933**	-1.084**	0.066	0.017	-0.588**	-0.528**	-0.281*	-0.382*	-0.130	-0.191
	(2.69)	(2.64)	(0.56)	(0.13)	(4.53)	(3.99)	(2.20)	(2.29)	(0.89)	(1.10)
Male non-head/spouse	-0.810**	-0.752**	-0.420**	-0.398**	0.008	0.028	-0.099	-0.090	-0.298*	-0.292*
	(2.86)	(2.73)	(3.84)	(3.67)	(0.07)	(0.25)	(0.92)	(0.85)	(2.27)	(2.28)
Female non-head/spouse	-0.457+	-0.444+	0.115	0.138	-0.397**	-0.387**	-0.085	-0.105	-0.091	-0.090
	(1.92)	(1.82)	(1.28)	(1.49)	(4.32)	(4.08)	(0.88)	(1.10)	(0.86)	(0.87)
Elderly mortality										
Elderly males	-0.707*	-0.727*	-0.750**	-0.757**	-0.043	-0.051	0.234+	0.228+	-0.148	-0.146
	(2.21)	(2.27)	(5.74)	(5.80)	(0.34)	(0.41)	(1.92)	(1.87)	(1.19)	(1.18)
Elderly females	-0.389	-0.413	0.080	0.069	-0.456**	-0.459**	0.067	0.064	-0.080	-0.088
	(1.16)	(1.23)	(0.66)	(0.57)	(3.09)	(3.10)	(0.44)	(0.42)	(0.54)	(0.60)
1999 HIV Prevalence rate	-0.026	-0.027	-0.001	-0.001	-0.013*	-0.013*	-0.002	-0.003	-0.010	-0.011
	(1.47)	(1.56)	(0.08)	(0.16)	(2.17)	(2.15)	(0.21)	(0.31)	(1.41)	(1.45)
Pre-death HH Characteristics	-0.197*	-0.182*	-0.016	0.010	0.023	0.023	-0.089*	-0.107**	-0.115**	-0.108*
Poverty status (1=non poor)	(2.40)	(2.16)	(0.51)	(0.30)	(0.73)	(0.72)	(2.32)	(2.69)	(2.87)	(2.58)
	-0.090**	-0.085**	-0.008	-0.007	-0.007	-0.004	-0.034**	-0.032**	-0.041**	-0.040**
Landholding size (Ha)	(5.63)	(5.13)	(1.30)	(1.11)	(1.04)	(0.64)	(4.44)	(3.97)	(5.59)	(5.31)
	-0.429**	-0.443**	0.164**	0.162**	0.103**	0.096**	-0.382**	-0.383**	-0.314**	-0.319**
Dependency ratio(number)	(11.22)	(11.22)	(7.83)	(7.34)	(7.66)	(6.96)	(17.05)	(16.21)	(15.61)	(15.28)
	-0.838**	-0.828**	-0.703**	-0.693**	0.119	0.116	-0.074	-0.065	-0.180	-0.187

Table 3.7 continued

Table 3.7 continued

PA death by poverty status										
Male heads *poverty status		0.960+		0.058		-0.241		0.728*		0.215
		(1.31)		(0.19)		(1.14)		(2.37)		(0.83)
Female H/S * poverty status		-0.234		-0.214		-0.080		0.078		-0.018
		(0.35)		(0.90)		(0.30)		(0.33)		(0.06)
Other males*poverty status		-0.264		-0.284		0.275		0.107		-0.362
		(0.47)		(1.34)		(1.26)		(0.48)		(1.47)
Other females*poverty status		-0.497		-0.355+		-0.100		-0.002		-0.040
		(1.03)		(1.95)		(0.53)		(0.01)		(0.19)
PA death by 2000 land size										
Male heads/spouses*land size		-0.164		-0.017		0.011		-0.102*		-0.057
		(1.50)		(0.36)		(0.25)		(2.24)		(1.11)
Female heads/spouses*land size		0.067		-0.056		0.041		0.039		0.043
		(0.44)		(1.11)		(0.87)		(0.68)		(0.70)
Other adult males*land size		-0.128		-0.052+		-0.073*		-0.023		0.019
		(1.30)		(1.89)		(2.14)		(0.63)		(0.49)
Other adult females*land size		0.016		0.051**		-0.013		0.001		-0.023
		(0.25)		(2.61)		(0.53)		(0.03)		(0.80)
PA mortality by dependency ratio										
Male heads*EDR[f]		0.064		0.050		0.070		-0.071		0.015
		(0.25)		(0.36)		(0.73)		(0.44)		(0.13)
Female heads/spouses* EDR		-0.585		-0.056		0.142		-0.397*		-0.274
		(1.31)		(0.38)		(0.75)		(2.13)		(1.48)
Other adult males* EDR		0.022		0.039		-0.032		0.010		0.006
		(0.09)		(0.39)		(0.40)		(0.08)		(0.05)
Other adult females* EDR		0.514**		0.004		0.154*		0.158*		0.198
		(2.89)		(0.06)		(2.07)		(2.18)		(1.59)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.311**	1.339**	0.024	0.022	0.333**	0.332**	0.429**	0.449**	0.525**	0.535**
	(4.26)	(4.34)	(0.20)	(0.18)	(3.03)	(3.02)	(3.01)	(3.14)	(4.01)	(4.08)

Table 3.7 continued

Joint tests										
Prime-age mortality	8.20**	7.13**	10.22**	7.81**	10.54**	8.68**	1.72	1.89	2.38*	2.45*
Elderly mortality	3.22**	3.46*	16.61**	16.91**	4.85**	4.92**	1.99	1.88	0.87	0.89
Asset poverty status*PA mortality		1.68		1.43		0.72		2.34*		2.18*
Land size*prime-age mortality		7.27**		2.65*		1.34		5.41**		7.04**
Dependency ratio*PA mortality		27.01**		13.05**		13.01**		60.72**		51.47**
R-squared	0.15	0.15	0.14	0.14	0.10	0.11	0.19	0.19	0.17	0.17
Number of observations	5306	5306	5306	5306	5306	5306	5306	5306	5306	5306

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and $^{+}$ 10% level of significance.

Table 3.8. The impact of PA mortality on household composition by gender and position in household by poverty status

Covariates	Δ Household size		Change in number of: Males		Females		Boys		Girls	
	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor
Prime-age (PA) adult mortality										
Male head/spouse	-1.001**	-0.338	-0.716**	-0.747*	0.235	-0.066	-0.308+	0.448+	-0.212	0.027
	(3.62)	(0.63)	(5.54)	(2.57)	(1.60)	(0.45)	(1.75)	(1.68)	(1.22)	(0.12)
Female head/spouse	-0.747+	-0.908	0.146	-0.137	-0.633**	-0.649**	-0.206	-0.110	-0.053	-0.012
	(1.76)	(1.61)	(0.81)	(0.89)	(3.67)	(3.25)	(1.22)	(0.53)	(0.29)	(0.05)
Male non-head/spouse	-0.637+	-1.128*	-0.204	-0.604**	-0.062	0.058	-0.196	-0.086	-0.175	-0.496*
	(1.92)	(2.45)	(1.38)	(3.75)	(0.43)	(0.35)	(1.22)	(0.55)	(1.02)	(2.47)
Female non-head/spouse	-0.261	-0.688*	0.290*	0.016	-0.339*	-0.421**	-0.131	-0.132	-0.081	-0.151
	(0.70)	(2.28)	(2.06)	(0.13)	(2.30)	(3.52)	(0.90)	(1.03)	(0.58)	(1.01)
Elderly mortality										
Elderly males	-1.111**	-0.469	-0.695**	-0.734**	-0.226	0.167	0.086	0.241	-0.276+	-0.142
	(3.20)	(0.85)	(4.02)	(4.03)	(1.62)	(0.81)	(0.50)	(1.39)	(1.89)	(0.66)
Elderly females	-0.349	-0.806	0.254+	0.002	-0.512**	-0.346	0.138	-0.268	-0.229	-0.193
	(0.89)	(1.45)	(1.66)	(0.01)	(2.59)	(1.58)	(0.71)	(1.19)	(1.11)	(0.85)
Constant	0.114	0.007	0.215**	0.109	0.247**	0.202*	-0.192**	-0.132	-0.156**	-0.171+
	(1.11)	(0.04)	(4.71)	(1.43)	(6.49)	(2.54)	(3.56)	(1.37)	(2.84)	(1.76)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Joint tests for										
Prime-age mortality	5.41**	4.11*	9.07**	5.40**	5.55**	5.96**	1.89	1.05	0.80	1.98+
Elderly mortality	5.55**	1.53	9.59**	8.13**	4.71*	1.53	0.39	1.55	2.42+	0.62
R-squared	0.20	0.17	0.19	0.18	0.17	0.15	0.18	0.16	0.18	0.16
Number of observations	2653	2655	2653	2655	2653	2655	2653	2655	2653	2655

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance

Turning to the models stratified by asset poverty status, results in Table 3.8 show that among poor households, male head/spouse death causes a unity decline in household size whilst among non-poor households the impact is statistically insignificant. Therefore, the significant negative impact on household size in the full sample is to an extent influenced by what is going on in households that are in the bottom 50% of the assets distribution. The reduction in total household size as a result of female head/spouse death in both poor and non-poor households is mainly explained by the change in the number of females. Whilst, an additional other male death among non-poor households results in a more than one person reduction in household size. Looking across the columns under non-poor, the decline in household size is due to a reduction in males and young girls consistent with the finding in the full sample models in table 3.7 column I.

Effective dependency ratio (EDR) in 2000: Tables A3.1 and A3.2 in the appendix show that both *ex ante* and *ex post* EDR ratios of afflicted households are generally equal to those of non-afflicted households. Households incurring prime-age female death (heads/spouses and other females) between 2001 and 2004 had a decline in mean effective dependency ratio in 2001 of 0.16 and 0.35, respectively. Households incurring PA mortality of male heads/spouses and other males had a decline in EDR of 0.34 and 0.41. Non-afflicted households had a decline of mean EDR of 0.34. It is likely that most afflicted households are able to restore their dependency ratios, at least to some extent, by attracting new PA members or sending away children to other relatives, or that afflicted households are in general further along in the household lifecycle, such that some

children are old enough to have switched from the numerator to the denominator of the dependency ratio, or have already left to start their own households.

Given this background, the impact of PA mortality on household composition may depend on the initial household effective dependency ratio. To empirically test this apparent relationship, death variables and pre-death EDR in 2000 variables are interacted. The results in Table 3.7 show that not all interaction terms are statistically significant except for deaths of female members, heads/spouses and other females. Table 3.7, column H show that there are differences in the change in number of boys by initial EDR in households experiencing female heads/spouses and other female death. Among households with higher effective dependency ratios in 2000, other female death results in a smaller reduction in numbers of boys compared to households that had a lower EDR in 2000. This could be explained by the fact that households with a higher EDR in 2000 that experienced non-core female deaths were able to partially replace the lost female by attracting other females in the household.

Land holding size in 2000: The land/labor ratio[38] provides a rough measure of the household's potential supply of labor per hectare owned. *A priori* one expects that households with lower land/labor ratios in 2000 are less likely to need to attract new members if the household experiences a death, whilst one might expect to see households with high land/labor ratios attempting to attract new members in the event of a death. However, descriptive results in tables A3.1 and A3.2, do not show any significant differences in land/labor ratio between afflicted and non-afflicted household, either *ex ante* or *ex post*. Since changes in adult equivalency are endogenous, I estimated models

[38] Adult equivalents are used as a proxy of farm labor.

with interaction of PA mortality between 2001 and 2004 and initial land holding size in 2000 in order to determine the differential impact of death on household composition according to initial land holding size. Despite the loss of wealth due to illness and prime-age death, non-poor households may be able to restore their land/labor ratio, at least to some extent, by hiring in extra labor or attracting new PA members compared to their less wealthy counterparts. The results in Table 3.7 show that there is differential impact on household size among households experiencing male head death. Among poor households with small (25^{th} percentile of landholding size, 1.06 hectares) and large land sizes (75^{th} percentile in 2000, 4.0 hectares), and using the mean effective dependency ratio of 1.33, the death of a male head of household results in a decline in household size of 0.92 and 0.74 respectively. Among wealthier households, the results indicate that household size *rises* by 0.04 and 0.22 persons respectively. This finding suggests that the effect of male head death on subsequent household size varies greatly between poor and non-poor households. Poor households experience a decline in household size after the male head dies, while non-poor households are able to partially compensate for the loss of a male head, primarily through attracting more boys into the household.

3.4.4. Impact of PA death on farm and crop production

There are at least four pathways in which farm production can be affected by prime-age mortality, through impacts on labor, knowledge, capital, and land. *First*, the reduction in household size may result in labor shortages, which force households to cut back on land cultivated or switch to labor saving crops. As mentioned earlier, this general assumption has led some development agencies to advocate for greater

investment and promotion of labor-saving crop technologies. Results from the impact of mortality on household composition in the preceding section show that there is partial replacement of members when a prime-age member dies but less so for relatively poor households experiencing the death of a household head or spouse. *Second*, the death of an adult may also entail a loss of agricultural husbandry, management, and marketing knowledge, requiring a change in crop mix. Even in households coping by attracting new members, the skills of the new member may not match the skills of the deceased, who we found to be primarily boys and girls. *Third*, crop mix and the intensity of input application may change because of cash constraints imposed on the households after incurring the loss of an adult member. Certain crops require greater use of capital (e.g., purchasing farm inputs, chemical sprayers in the case of cotton, rental of animal traction services). Fourth, and especially in cases where the male household head dies, the widow and her dependents may have insecure land tenure rights.

The results presented in this section should be interpreted taking into account the dynamics of household composition from the preceding section. Table 3.9 (column A) show that, in general, adult male mortality resulted in an 13% decline in total land cultivated; this effect is significant at the 5% significance level. Female death of any kind resulted in a 5% decline of cultivated land but the impact is not significant at the 10% level. Surprisingly, there is a 30% decline in land cultivated when elderly (>59 years) men died. This finding suggests that men (aged 60 and above) remain productive in their old age and probably devote a greater portion of their time to crop cultivation than the younger male heads (who tend to be the primary earners of off-farm income in sampled households).

Table 3.9 also disaggregates impacts according to the gender and position of the deceased person (Column B) . Male head/spouse mortality is associated with a 21% reduction in land cultivation. Examining across the row for "male head/spouse death," it is shown that most of the decline in cultivated area is for cereal crops (-19%) and high-valued cash crops (-4%). Column B results also indicate the important impact of elderly male mortality on crop cultivation, particularly cereals. All the other mortality categories are negative but not statistically significant. This finding seems consistent with our earlier findings that households incurring male head/spouse mortality experience a higher decline in net household size, which may partially explain the significant cut back in land cultivated for this particular case.

By disaggregating area cultivated by area under cereals, root and tuber crops, and high-value cash crops, I examine the impact of mortality on particular crops by (columns C through H in Table 3.9) and test the hypothesis that households experiencing prime-age mortality switch to less labor-intensive crops Examining the first row of data in Table 3.9, we see that the 13% decline in land cultivated among households incurring a male death is due to the reduction in area under cereals and, to a lesser extent, high-value crops. The coefficient on changes in roots and tubers is positive but not statistically significant. By contrast (examining the second row of data), PA female mortality is associated with a 5% decline in area under roots and tubers. When distinctions are made between gender and position of the deceased (in the subsequent rows of Table 3.9), we see that mortality is associated with a subsequent decline in cereal area of 19% in the case of male heads/spouses, 8% in the case of female heads/spouses, 11% when the death was another non-head male, and 20% for men over 59 years of age. These results support

the importance of disaggregating mortality by gender and position in the household of the deceased as well as by crop mix. Otherwise, one would have concluded that households incurring male deaths had a statistically significant decline in land cultivated but missed the fact that mortality of older members has the most important impact on crop area cultivated.

Also, the results in table 3.9 column H show that among households experiencing male head/spouse death, area under high value crops declined by 4%, suggesting that, to some extent, the death of a male core member of the household adversely affects cash cropping.

Regarding impacts on area under roots and tubers, there is a significant 5% decline among households experiencing the death of women other than the head or spouse. No significant impacts on root and tuber cultivation are found in the case of men in any category or for female head/spouse or elderly women. These findings do not seem to support the hypothesis that households experiencing prime-age death cope with the reduction in family size by switching to labor saving crops such as roots and tubers. However, the small and generally statistically insignificant declines in root and tuber cultivation are substantially less than the estimated declines in cereal area in response to adult mortality. Moreover, there might be differential impacts by pre-death household characteristics in 2000 survey. This is analyzed in the next section.

Does the impact on land cultivated and crop mix differ by initial household conditions?

Turning to results from models with interactions terms between mortality variables and pre-death household characteristics, the likely differential impacts of the

Table 3.9. The impact of PA mortality on cultivated land by gender and position in household

Covariates	Δ ln(Area cultivated)		Change in natural log of area under (ha):					
			Cereals[a]		Tubers and root crops[b]		High-value crops[c]	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Prime-age (PA) adult mortality								
Male	-0.13*		-0.16*		0.01		-0.02+	
	(2.26)		(2.31)		(0.66)		(1.78)	
Female	-0.05		-0.01		-0.05*		-0.01	
	(0.91)		(0.23)		(2.09)		(0.99)	
Male head/spouse		-0.21**		-0.19*		-0.03		-0.04*
		(2.87)		(2.36)		(1.00)		(2.41)
Female head/spouse		-0.02		-0.08+		-0.01		0.00
		(0.23)		(1.92)		(0.18)		(0.06)
Male non-head/spouse		-0.06		-0.11*		0.03		-0.01
		(0.81)		(2.10)		(1.52)		(0.58)
Female non-head/spouse		-0.07		-0.04		-0.05*		-0.02
		(1.01)		(0.57)		(2.35)		(1.18)
Elderly mortality								
Elderly males	-0.30**	-0.30**	-0.20*	-0.20*	-0.05	-0.05	-0.01	-0.01
	(3.53)	(3.57)	(2.27)	(2.29)	(1.42)	(1.41)	(0.71)	(0.72)
Elderly females	-0.05	-0.05	-0.14	-0.14	0.05	0.05	0.02	0.02
	(0.48)	(0.52)	(1.04)	(1.06)	(1.34)	(1.32)	(0.99)	(0.97)
Constant	0.04	0.04	-0.12+	-0.12+	-0.01	-0.01	0.00	0.00
	(0.91)	(0.95)	(1.78)	(1.78)	(0.75)	(0.75)	(1.55)	(1.56)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on Mortality	3.18*	2.67*	2.77+	2.06+	2.35+	2.22+	1.97	1.82
R-squared	0.20	0.20	0.19	0.19	0.25	0.25	0.18	0.18
Number of observations	5305 Households							

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Cereals include: maize, millet, wheat, sorghum and all other minor food crops. [b]Root crops include cassava, sweet potatoes. [c]High value crops include cotton, sunflower, coffee, tobacco, Irish potato, vegetables and fruits.

death shock on land cultivated and crop mix by wealth status, effective dependency ratio, and landholding size are discussed.

The interaction terms between mortality and wealth status are jointly statistically significant. However, there are differential impacts by wealth status among households experiencing mortality of male heads/spouses and other males as shown by the statistically significant interactions in Table 3.10. The negative interaction coefficients suggest that mortality leads to a greater reduction in land cultivated among non-poor households compared to poor households. The impact of mortality of male heads/spouses and other males on land cultivated was evaluated for two scenarios: (1) poor households (bottom 50% of value of assets distribution), mean land size (3.10 hectares) and mean effective dependency ratio (1.33); and (2) non-poor households (upper 50% of value of assets distribution), mean land size and mean dependency ratio. From these simulations, land cultivated and area under cereals decline by 75% and 61% among non-poor households experiencing mortality of male core members of the household compared to 35% and 36.1% decline among households in the same situation but in the bottom 50% of the 2000 assets distribution. By contrast, the impacts are lower in both poor and non-poor households experiencing female heads/spouse mortality. For example, among poor households experiencing female head/spouse of household mortality, total land cultivated and area under cereals declined by 0.4% and 7.3%, respectively, compared to declines of 6.4% and 4.7% among non-poor households, holding all other variables constant. There is a less severe but similar pattern of results for other (non-head) prime-age males. These results indicate that other PA males are also

key to crop production in rural Zambia and that their death adversely affects land cultivation in both poor and non-poor households alike.

Turning to the models stratified by poverty status, the results in table 3.11 seem to reinforce the above observations that land cultivation and particularly the area under cereals declines significantly among non-poor households incurring male mortality, both among heads and non-core men. Similar to the findings by Yamano and Jayne (2004), mortality of the male head of the household in poor households is associated with reductions in area under high-value crops. However, there are no other statistically significant impacts of mortality among households in the bottom 50% of the assets distribution except in the case of elderly male mortality. The results reinforce findings reported earlier that men over aged 59 still exert an important contribution to crop cultivation, not necessarily entirely through their own labor input but also through their capital resources for renting animal draft power, hiring labor, and other inputs into the production process.

The interaction terms between PA mortality variables and EDR as well as mortality and landholding size in 2000 are not jointly significant, suggesting that there are no differential impacts of PA death by initial dependency ratio or land holding size. In all cases only the coefficient on male head/spouse death is statistically significant on changes of area under cereals and total land cultivated, respectively. The interaction term between male head/spouse death and EDR in 2000 is negative, implying that among households with higher EDR in 2000, male head of household death results in a larger decline in area under cereals compared to similar households that had lower EDR in 2000. In contrast, the interaction term on landholding size in 2000 and male head/spouse

Table 3.10. The impact of PA mortality on cultivated land by gender, position and initial household pre-death characteristics

Covariates	Δ ln(Area cultivated)		Change in natural log of area under (ha):					
			Cereals[a]		Tubers and root crops[b]		high-value crops[c]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Prime-age (PA) adult mortality								
Male head/spouse	-0.309**	-0.351**	-0.306*	-0.361**	-0.037	-0.027	-0.043*	-0.041*
	(3.16)	(3.56)	(2.55)	(3.18)	(1.19)	(0.84)	(2.42)	(2.07)
Female head/spouse	-0.009	0.004	0.036	0.073	-0.005	-0.004	0.002	0.001
	(0.12)	(0.05)	(0.40)	(0.68)	(0.16)	(0.09)	(0.11)	(0.03)
Male non-head/spouse	-0.041	-0.044	-0.088	-0.089	0.041	0.044+	-0.008	-0.007
	(0.57)	(0.61)	(1.05)	(1.05)	(1.63)	(1.75)	(0.51)	(0.47)
Female non-head/spouse	-0.035	-0.012	-0.007	0.007	-0.060*	-0.042	-0.020	-0.017
	(0.54)	(0.17)	(0.10)	(0.10)	(2.15)	(1.58)	(1.27)	(1.21)
Elderly mortality								
Elderly males	-0.299**	-0.299**	-0.188*	-0.187*	-0.045	-0.046	-0.012	-0.010
	(3.51)	(3.49)	(2.21)	(2.18)	(1.37)	(1.39)	(0.67)	(0.57)
Elderly females	-0.041	-0.046	-0.133	-0.139	0.051	0.048	0.019	0.019
	(0.39)	(0.44)	(1.01)	(1.06)	(1.43)	(1.35)	(0.92)	(0.91)
1999 HIV Prevalence rate	-0.008	-0.007	-0.011+	-0.011+	-0.000	-0.000	-0.003**	-0.003**
	(1.35)	(1.30)	(1.72)	(1.70)	(0.30)	(0.27)	(3.52)	(3.58)
Pre-death household characteristics in 2000								
Poverty status (1=non-poor, 0=poor)	-0.176**	-0.162**	-0.160**	-0.141**	-0.044**	-0.040**	0.013*	0.015**
	(6.22)	(5.44)	(5.05)	(4.22)	(4.20)	(3.63)	(2.46)	(2.67)
Landholding size (Ha)	-0.027**	-0.028**	-0.029**	-0.030**	-0.005*	-0.004+	0.001	0.001
	(5.93)	(5.55)	(5.47)	(5.39)	(2.39)	(1.88)	(0.51)	(0.58)
Effective dependency ratio(number)	0.006	0.005	0.009	0.008	-0.001	-0.001	-0.002	-0.001
	(0.48)	(0.43)	(0.66)	(0.59)	(0.24)	(0.26)	(0.87)	(0.61)

Table 3.10 continued

PA death by 2000 poverty status				
Male heads/spouses*poverty status	-0.380*	-0.310*	0.046	-0.000
	(2.03)	(2.32)	(0.76)	(0.01)
Female heads/spouses*poverty status	0.028	-0.002	-0.048	-0.003
	(0.18)	(0.01)	(0.78)	(0.12)
Other adult males*poverty status	-0.181	-0.303+	0.002	-0.055*
	(1.24)	(1.75)	(0.03)	(2.10)
Other adult females*poverty status	-0.121	-0.093	-0.122*	-0.007
	(0.87)	(0.61)	(2.25)	(0.26)
PA death by 2000 land holding size				
Male heads/spouses*land size	0.064*	0.065+	0.014	-0.002
	(1.96)	(1.94)	(1.32)	(0.37)
Female heads/spouses*land size	-0.023	-0.027	-0.004	-0.002
	(1.07)	(1.26)	(0.29)	(0.16)
Other adult males*land size	0.021	0.021	-0.000	0.002
	(1.17)	(0.92)	(0.04)	(0.22)
Other adult females*land size	-0.015	0.007	-0.016+	-0.002
	(0.88)	(0.36)	(1.86)	(0.54)
PA death by 2000 dependency ratio				
Male heads/spouses*dependency ratio	-0.194	-0.104+	-0.007	0.018
	(1.53)	(1.96)	(0.23)	(1.04)
Female heads/spouses* dependency ratio	0.084	0.155	0.010	-0.002
	(0.78)	(1.08)	(0.19)	(0.07)
Other adult males* dependency ratio	0.013	0.035	-0.022	-0.013
	(0.19)	(0.46)	(1.34)	(1.53)
Other adult females* dependency ratio	0.029	0.014	0.032	-0.006
	(0.63)	(0.30)	(1.63)	(0.51)

Table 3.10 continued

Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.266*	0.258*	0.179	0.174	0.019	0.015	0.050**	0.049**
	(2.55)	(2.46)	(1.44)	(1.39)	(0.62)	(0.47)	(3.21)	(3.13)
Joint tests								
Prime-age mortality	2.77*	3.34**	2.03+	2.98*	2.18+	1.55	1.87	1.41
Elderly mortality	6.28**	6.23**	3.03*	3.02*	1.90	1.82	0.63	0.57
Poverty status*prime-age mortality		9.63**		7.26**		4.87**		2.01+
Land size*prime-age mortality		8.46**		7.32		2.12+		0.15
Effective dependency ratio*PA mortality		0.74		1.14		1.02		0.82
R-squared	0.21	0.21	0.22	0.22	0.26	0.26	0.18	0.18
Number of observations	5304							

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. [a]Cereals include: maize, millet, wheat, sorghum and all other minor food crops. [b]Root crops include cassava, sweet potatoes. [c]High value crops include cotton sunflower, coffee, tobacco, Irish potato vegetables fruits.

Table 3.11. The impact of PA mortality on cultivated land by gender and position in household by poverty status

Covariates	Δ ln(Area cultivated)		Change in natural log of area under (ha):					
			Cereals[a]		Tubers and root crops[b]		high-value crops[c]	
	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor
Prime-age (PA) adult mortality								
Male head/spouse	-0.194	-0.352**	-0.129	-0.302**	-0.060	0.003	-0.039*	-0.048
	(1.48)	(3.29)	(0.77)	(3.18)	(1.41)	(0.07)	(2.32)	(1.32)
Female head/spouse	-0.037	0.008	0.001	0.066	0.021	-0.040	0.004	-0.011
	(0.34)	(0.07)	(0.01)	(0.55)	(0.54)	(0.88)	(0.33)	(0.27)
Male non-head/spouse	0.015	-0.136+	0.028	-0.238*	0.042	0.036	0.017	-0.033
	(0.13)	(1.71)	(0.21)	(2.35)	(0.98)	(1.27)	(1.18)	(1.18)
Female non-head/spouse	0.041	-0.087	0.018	-0.032	0.026	-0.118**	-0.009	-0.026
	(0.34)	(1.14)	(0.14)	(0.41)	(0.63)	(3.23)	(0.57)	(1.13)
Elderly mortality								
Elderly males	-0.370**	-0.130	-0.246	-0.142	-0.096+	0.001	-0.007	-0.019
	(3.39)	(1.28)	(1.61)	(1.39)	(1.78)	(0.02)	(0.50)	(0.61)
Elderly females	-0.142	0.024	-0.258	-0.050	0.031	0.056	-0.001	0.035
	(0.99)	(0.17)	(1.38)	(0.27)	(0.59)	(1.19)	(0.06)	(0.93)
Constant	0.064	-0.040	-0.115	-0.116	0.002	-0.059+	0.001	0.003
	(1.40)	(0.54)	(1.44)	(1.01)	(0.12)	(1.67)	(1.00)	(1.47)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Joint tests for								
Prime-age mortality	0.60	4.07**	0.16	4.25**	0.92	3.11*	1.97+	1.18
Elderly mortality	6.25**	0.82	2.31+	1.04	1.75	0.71	0.13	0.58
R-squared	0.26	0.26	0.26	0.26	0.30	0.33	0.39	0.20
Number of observations	2653	2655	2653	2655	2653	2655	2653	2655

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. [a]Cereals include: maize, millet, wheat, sorghum and all other minor food crops. [b]Root crops include cassava, sweet potatoes. [c]High value crops include cotton sunflower, coffee, tobacco, Irish potato vegetables fruits.

death is positive implying that among households with larger landholding sizes, male head of household death results in a slightly less severe decline in land cultivated compared to households in similar situations but having smaller landholding sizes in 2000. For example, among households with landholdings in the 75th percentile and incurring mortality of male head/spouse, total land size declined by 54% compared to 73% among similar households but with land sizes in the 25th percentile. This result is surprising, because it implies that remaining household members are switching to other non-farm activities because of the departure of the core person responsible for the farm enterprise. I empirically check this fact later in the paper when I look at impact of mortality on off-farm income.

Impacts on Crop Production:

Before incurring a death, afflicted *h*ouseholds had higher gross value of output and gross value of crop output per hectare for the crop season 1999/2000 compared to non-afflicted households. Generally, households incurring prime-age death between 2001 and 2004 experienced a decline in gross value of crop production and gross value of crop output per hectare (Table A3.1 in the appendix).[39] Due to large standard errors, the difference-in-difference descriptive statistics were not statistically significant even at the 10% level. Unlike in the Kenyan study where gross value of crop output was observed to decline significantly due to a switch from high value crops, our findings show a slight decrease.

[39] There values are calculated by applying mean crop prices from the 1999/2000 and 2003/04 seasons uniformly to the quantities of crops produced in each season. This method avoids the possibility that changes in crop production values are caused by weather-induced price changes. All changes in crop production values between 1999/2000 and 2003/2004 are caused by changes in physical production.

Table 3.12 presents the regression results from models measuring impact of PA death on gross value of crop output and gross value of crop output per hectare. Although the coefficients on mortality variables are negative as expected, there is no statistically significant effect on gross value of output for mortality by gender in general or disaggregated by gender and position of the deceased.

The results are similar for the models measuring the impact of PA mortality on gross output per hectare except for the statistically insignificant but positive impact among households experiencing male head of household death. Although insignificant, this result is surprising because there is no evidence to suggest that these households shifted to high value crops and, in fact, land cultivated declined by a larger percentage among households incurring male head of household death.

Does the impact on crop production differ by initial household conditions?

Potential differential impacts by initial household conditions are tested for by estimating models with interactions of PA mortality with household wealth status, land holding size and effective dependency ratios in 2000. Table 3.13 column B shows that PA mortality impact on gross value of output does not differ by initial poverty status. In contrast, the impact of male head of household mortality on gross value of output per hectare seems to be influenced by initial poverty status (column D). The statistically significant positive interaction term on male head death and poverty status implies that among wealthier households, gross value of crop production per hectare increases more than in assets-poor households experiencing the same shock. For example, evaluating the impact of male head death on gross value of output per hectare at mean land size and

Table 3.12. The impact of PA mortality on gross value of output and gross output per hectare by gender and position in household

Covariates	Δ ln(Gross value of output)				Δ ln(Gross value of output/ha)			
	----------Full sample----------		Poor	Non poor	--------Full sample------		Poor	Non poor
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Prime-age (PA) adult mortality								
Male	-0.127				-0.008			
	(1.61)				(0.12)			
Female	-0.116				-0.050			
	(1.13)				(0.77)			
Male head/spouse		-0.211	-0.221	-0.236		0.076	-0.042	0.270+
		(1.39)	(1.39)	(1.40)		(0.69)	(0.28)	(1.83)
Female head/spouse		-0.113	-0.090	-0.104		-0.089	-0.050	-0.110
		(1.13)	(0.64)	(0.75)		(0.88)	(0.38)	(0.73)
Male non-head/spouse		-0.084	0.053	-0.200+		-0.051	-0.038	-0.056
		(0.95)	(0.39)	(1.81)		(0.61)	(0.27)	(0.57)
Female non-head/spouse		-0.104	-0.067	-0.104		-0.013	-0.067	0.004
		(1.19)	(0.42)	(1.01)		(0.16)	(0.44)	(0.04)
Elderly mortality								
Elderly males	-0.165	-0.169	-0.239	-0.082	0.113	0.114	0.192	0.047
	(0.87)	(0.79)	(1.48)	(0.67)	(1.34)	(1.34)	(1.38)	(0.46)
Elderly females	-0.045	-0.048	-0.118	0.008	-0.013	-0.011	-0.009	-0.017
	(0.43)	(0.46)	(0.66)	(0.07)	(0.12)	(0.11)	(0.05)	(0.13)
Constant	-0.127+	-0.028	-0.020	-0.050	-0.008	-0.054	-0.072	-0.004
	(1.76)	(0.57)	(0.33)	(0.67)	(0.12)	(1.04)	(1.10)	(0.05)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on prime-age mortality	3.11*	1.77	0.68	1.75	0.31	0.42	0.14	1.07
R-squared	0.15	0.15	0.22	0.23	0.21	0.21	0.27	0.27
Number of observations	5123	5123	2511	2612	5120	5120	2510	2610

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors.

mean effective dependency ratio, we find that output per hectare rises by 32% in wealthier households experiencing male head death compared to a 19% decline in assets-poor households. Since there was a net decline in land cultivated in both cases due to male head death these results seem to suggest greater intensification in wealthier households experiencing male head death. Also, earlier it was found that wealthier households incurring male head of household death attract boys and other males suggesting labor lost from male head of household is taken up by boys and/or other males.

Similar results are found when the sample is stratified into two groups by value of assets in 2000. Table 3.12 column H shows a statistically significant positive (27%) impact on gross value of crop production per hectare among households with male head of household death. The death of other males reduces the gross value of crop output by 20% (column D). This decline could be explained in two ways. *First*, it could be because of labor shortages due to the death of other male PA adults. Earlier, in section 4.4, it was found that mortality of other males resulted in a reduction in the number of young girls who might have provided extra farm labor. *Second*, other male members may possess extra knowledge and farming skills that are lost when they die. The rest of the impacts of mortality by gender and position of the deceased on gross value of output and gross value of output per hectare are not statistically significant.

Turning to the likely impact of PA mortality by initial land holding size, results in Table 3.13 show some statistically significant differential impacts on the gross value of output due to male head death and on gross value of crop output per hectare due to either male and female head or spouse death. The negative coefficient on the interaction of

male head death and landholding size implies that among households with larger landholdings and death of male head, gross value of output decreases more compared to similar households but with small initial landholdings. Evaluated at mean effective dependency ratio and mean wealth status, households' crop output decreased by 57.2 % among households with landholding sizes in the 75th percentile and having a male head of household death compared to 41.3% in similar households but having landholding sizes in the 25th percentile.

Somewhat different results are obtained on the impact of gross crop output per hectare. At mean effective dependency ratio and mean wealth status, the gross value of output per hectare decreased by 6.2% among households with landholding sizes in the 75th percentile and having a male head of household death compared to 34.7% in similar households but having land holding sizes in the 25th percentile.

In the event of female head/spouse death, table 3.13 column D also shows the impact on gross value of output per hectare is opposite that of male head death. The significant positive coefficient on female head/spouse death and landholding size implies that the impact of female head/spouse mortality is smaller for households with larger initial landholdings. Evaluated at mean effective dependency ratio and mean wealth status, gross value of output per hectare increased by 17.1% among households with landholding sizes in the 75th percentile and having a female head/spouse of household death compared to a decrease of 3.7% in similar households but having landholding sizes in the 25th percentile.

Table 3.13. The impact of PA mortality on crop output and output per hectare, by gender and position in household

Covariates	Change in natural log of:			
	Gross value of output		Gross value of output/ha)	
	(A)	(B)	(C)	(D)
Prime-age (PA) adult mortality				
Male head/spouse	-0.239	-0.270	0.077	0.090+
	(0.80)	(1.21)	(0.70)	(1.84)
Female head/spouse	-0.104	-0.043	-0.088	-0.040
	(1.05)	(0.43)	(0.87)	(0.41)
Male non-head/spouse	-0.060	-0.053	-0.046	-0.042
	(0.68)	(0.60)	(0.54)	(0.49)
Female non-head/spouse	-0.074	-0.068	-0.014	-0.030
	(0.84)	(0.72)	(0.17)	(0.33)
Elderly mortality				
Elderly males	-0.162	-0.152	0.115	0.125
	(1.63)	(1.52)	(1.36)	(1.46)
Elderly females	-0.037	-0.035	-0.012	-0.005
	(0.35)	(0.33)	(0.12)	(0.05)
1999 HIV Prevalence rate	-0.016*	-0.016*	-0.009	-0.009
	(2.30)	(2.34)	(1.34)	(1.42)
Pre-death household characteristics in 2000				
Poverty status (1=non-poor, 0=poor)	-0.119**	-0.107**	0.059+	0.054
	(3.58)	(3.08)	(1.78)	(1.57)
Landholding size (Ha)	-0.034**	-0.035**	-0.008	-0.008
	(6.55)	(6.25)	(1.48)	(1.44)
Effective dependency ratio(number)	0.006	0.007	0.000	0.003
	(0.38)	(0.47)	(0.02)	(0.17)

Table 3.13 continued

Table 3.13 continued

PA death by 2000 poverty status		
Male heads/spouses*poverty status	0.042	0.510**
	(0.18)	(2.63)
Female heads/spouses*poverty status	-0.138	-0.185
	(0.69)	(0.91)
Other adult males*poverty status	-0.278	-0.024
	(1.55)	(0.13)
Other adult females*poverty status	-0.088	0.028
	(0.46)	(0.15)
PA death by 2000 land holding size		
Male heads/spouses*land size	-0.054+	-0.139**
	(1.77)	(4.14)
Female heads/spouses*land size	0.040	0.071**
	(1.52)	(2.69)
Other adult males*land size	0.024	0.008
	(1.13)	(0.35)
Other adult females*land size	-0.002	0.009
	(0.11)	(0.52)
PA death by 2000 dependency ratio		
Male heads/spouses*dependency ratio	-0.049	0.112
	(0.35)	(0.92)
Female heads/spouses* dependency ratio	0.119	0.015
	(0.80)	(0.10)
Other adult males* dependency ratio	-0.113	-0.115
	(1.62)	(1.47)
Other adult females* dependency ratio	0.052	0.012
	(0.60)	(0.14)

Table 3.13 continued

Province x time dummies	Yes	Yes	Yes	Yes
Constant	0.342**	0.340**	0.091	0.094
	(2.68)	(2.66)	(0.76)	(0.78)
Joint tests				
Prime-age mortality	1.69	1.99+	0.40	0.32
Elderly mortality	1.42	1.213	0.92	1.07**
Poverty status*prime-age mortality		2.74**		2.80*
Land size*prime-age mortality		7.42**		3.72**
Effective dependency ratio*PA mortality		1.47		0.52
R-squared	0.16	0.17	0.21	0.21
Number of observations	5309	5309	5309	5309

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance

There is no evidence of any differential impact of PA death on either gross value of output or gross value of output per hectare by initial (pre-death) effective dependency ratio. All interactions between mortality variables and EDR are statistically insignificant. Also, the null hypothesis that the joint effect of the interaction terms is not statistically different from zero is not rejected.

3.4.5. Impact of PA mortality on value of livestock

Liquidation of assets is cited as one of the coping mechanisms to mitigate the impact of mortality and other shocks (see Barnett and Blaikie, 1992). Assets depletion can increase households' vulnerability to income shocks, and may decrease household use of cash inputs and animal traction in crop cultivation, which will tend to result in lower productivity and overall crop production (Mather et al., 2004). Due to data limitations, I could not obtain a comparable measure of value of assets between the two surveys, so the focus is limited to value of livestock, which was collected consistently in the two surveys. In addition I analyze the impact of mortality on non-farm (off-farm) income.

The results in table 3.14, columns A and B, show that there is a negative impact of PA mortality on value of cattle but the impact by both gender and position in the household of the deceased are not statistically significant except among households experiencing death of a male head of household. Among households experiencing a male head death, values of cattle declined by about 29.9% but this impact is only significant at the 10% level. The results on the impact of mortality on values of cattle are somewhat similar to those found by Yamano and Jayne (2004) in Kenya. Thus, to some extent,

households appear to try to hold on to productive cattle and probably sell only as a last resort. However, this coping strategy does not seem to strongly apply among households incurring male head of household death.

Table 3.14, columns C and D, show that PA mortality has significant adverse effects on the values of small animals. The value of small animals declines by 29.5% and 41.5% after the death of adult men and women, respectively. When the results are disaggregated by gender and position in household of the deceased, the impact is highest among households with a male head death with a 65.3% decline, followed by mortality of other females with a 44.3% decline, and a 37.0% reduction in values of small animals among households with female head/spouse death. The result on female head or spouse death of a 37.0% decline in value of small animals is only significant at the 10% level. Generally, these results seem to suggest that afflicted households cope with mortality of males and/or females by selling off small animals.

Does the impact on values of livestock differ by initial household conditions?

Results in Table 3.15, column B, show no evidence of differential impacts of mortality on values of cattle by initial pre-death household characteristics. In contrast, there seem to be differential impacts on values of small animals among households experiencing a male head of household death. Table 3.15, column D, shows a negative interaction between wealth status and male head death, implying a greater decline in the value of small animals among wealthier households experiencing male head death compared to poor households experiencing a similar shock. For example, evaluating the impact on values of small animals at mean land size and mean effective dependency

Table 3.14. The impact of PA mortality on assets and off-farm income by gender and position in household

Table 3.14. The impact of PA mortality on assets and off-farm income by gender and position in household

Covariates	Change in natural log of:					
	Values of cattle		Values of small animals[a]		Off-farm income[b]	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age (PA) adult mortality						
Male	-0.287+		-0.295+		0.096	
	(1.71)		(1.66)		(0.37)	
Female	-0.145		-0.415**		0.017	
	(0.91)		(2.71)		(0.08)	
Male head/spouse		-0.299+		-0.653**		0.366
		(1.73)		(2.70)		(0.95)
Female head/spouse		-0.018		-0.370+		0.290
		(0.07)		(1.81)		(0.89)
Male non-head/spouse		-0.279		0.002		-0.083
		(1.26)		(0.01)		(0.25)
Female non-head/spouse		-0.185		-0.443*		-0.159
		(0.89)		(2.46)		(0.58)
Elderly mortality						
Elderly males	-0.328	-0.324	-0.353	-0.368	-0.304	-0.280
	(1.11)	(1.10)	(1.36)	(1.41)	(0.91)	(0.84)
Elderly females	-0.096	-0.094	0.060	0.046	0.508	0.525
	(0.31)	(0.30)	(0.22)	(0.17)	(1.31)	(1.35)
Constant	0.030	0.028	0.294**	0.298**	-0.882**	-0.888**
	(1.53)	(1.41)	(2.87)	(2.90)	(6.28)	(6.32)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on mortality	2.06	1.19	5.33**	3.88**	0.07	0.51
R-squared	0.13	0.13	0.18	0.18	0.35	0.35
Number of observations	5309 Households					

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Small animals include goats, sheep, pigs, chicken, ducks and rabbits. [b]Off-farm income include salary and wage income, informal and formal business income.

ratio, the value of small animals declined by 76.9% in wealthier households experiencing male head death compared to a 54.6% decline in assets-poor households. This result might be reasonable because wealthier households have more to spend.

3.4.6. Impact of PA mortality on off-farm income

Off-farm income: Previous studies have suggested that off-farm income sources are at risk among households experiencing PA mortality[40], particularly among those that are asset poor and vulnerable to begin with. In this section I test the hypothesis that a reduction in PA adults due to prime-age mortality results in a reduction of off-farm income. Yet the results in table 15, columns D and E, show mixed results that are not statistically significant for all cases of mortality by gender and position in the household of the deceased.

Turning to differential impacts by initial household characteristics, Table 3.15, column E, shows that there seem to be differential impacts by initial effective dependency ratio and by landholding size in households experiencing female head or spouse death. The statistically significant negative interaction between pre-death EDR in 2000 and female head/spouse death implies that there is a greater decline in off-farm income among households with higher EDR in 2000 and experienced female head or spouse death compared to households experiencing a similar shock but having lower

[40] See Mather et al., 2004, Yamano and Jayne, 2004, Donovan et al., 2003.

Table 3.15. The impact of PA mortality on assets and off-farm income by initial household pre-death characteristics

Covariates	Change in natural log of:					
	Values of cattle		Values of small animals[a]		Off-farm income[b]	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age (PA) adult mortality						
Male head/spouse	-0.355+	-0.347+	-0.612**	-0.685**	0.323	0.220
	(1.56)	(1.10)	(3.28)	(3.28)	(0.84)	(0.53)
Female head/spouse	0.039	0.104	-0.331+	-0.185	0.299	0.122
	(0.15)	(0.40)	(1.29)	(0.68)	(0.91)	(0.32)
Male non-head/spouse	-0.283	-0.286	-0.019	-0.009	-0.034	-0.027
	(1.31)	(1.31)	(0.09)	(0.04)	(0.10)	(0.08)
Female non-head/spouse	-0.137	-0.141	-0.353*	-0.350+	-0.119	-0.130
	(0.67)	(0.75)	(2.05)	(1.84)	(0.44)	(0.47)
Elderly mortality						
Elderly males	-0.313	-0.328	-0.346	-0.329	-0.257	-0.279
	(1.08)	(1.13)	(1.36)	(1.29)	(0.77)	(0.84)
Elderly females	-0.103	-0.115	0.070	0.071	0.554	0.545
	(0.33)	(0.37)	(0.27)	(0.27)	(1.44)	(1.41)
1999 HIV Prevalence rate	-0.799**	-0.800**	-1.365**	-1.332**	-0.012	-0.027
	(9.24)	(8.80)	(17.73)	(16.53)	(0.10)	(0.22)
Pre-death household characteristics in 2000						
Poverty status (1=non-poor, 0=poor)	0.042**	0.043**	0.064**	0.061**	-0.065**	-0.061**
	(3.03)	(2.88)	(5.88)	(5.28)	(3.51)	(3.14)
Landholding size (Ha)	0.049	0.036	-0.001	-0.000	-0.032	-0.030
	(1.31)	(0.91)	(0.03)	(0.00)	(0.70)	(0.62)
Effective dependency ratio(number)	-0.355	-0.347	-0.812**	-0.885**	0.323	0.220
	(1.56)	(1.10)	(3.28)	(3.28)	(0.84)	(0.53)

Table 3.15 continued

PA death by 2000 poverty status			
Male heads/spouses*poverty status	0.140	-0.233+	-0.502
	(0.28)	(1.87)	(0.63)
Female heads/spouses*poverty status	0.416	-0.240	-0.072
	(0.82)	(0.46)	(0.11)
Other adult males*poverty status	-0.311	-0.718	0.662
	(0.68)	(1.56)	(0.99)
Other adult females*poverty status	-0.070	0.116	0.186
	(0.18)	(0.30)	(0.34)
PA death by 2000 land holding size			
Male heads/spouses*land size	-0.007	0.061	-0.053
	(0.10)	(0.90)	(0.40)
Female heads/spouses*land size	-0.147	0.015	0.154*
	(1.62)	(0.18)	(2.01)
Other adult males*land size	-0.012	0.024	-0.085
	(0.25)	(0.47)	(0.78)
Other adult females*land size	0.050	0.006	-0.042
	(0.87)	(0.12)	(0.58)
PA death by 2000 dependency ratio			
Male heads/spouses*dependency ratio	-0.091	-0.038	-0.118
	(0.36)	(0.47)	(0.24)
Female heads/spouses* dependency ratio	0.361	0.445	-0.205**
	(1.01)	(1.12)	(2.82)
Other adult males* dependency ratio	0.231	-0.070	0.195
	(1.39)	(0.32)	(0.70)
Other adult females* dependency ratio	0.132	-0.062	-0.091
	(0.53)	(0.36)	(0.39)

Table 3.15 continued

Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.713**	0.728**	0.824**	0.813**	-0.092	-0.092
	(3.14)	(3.22)	(3.01)	(2.96)	(0.22)	(0.22)
Joint tests						
Prime-age mortality	1.31	1.07	4.26**	3.76**	0.42	0.15
Elderly mortality	0.66	0.73	0.95	0.85	1.32	1.33
Poverty status*prime-age mortality		10.00**		36.59**		0.26
Land size*prime-age mortality		1.96*		5.74**		1.69
Effective dependency ratio*PA mortality		1.27		2.00*		0.58
R-squared	0.14	0.14	0.22	0.22	0.35	0.35
Number of observations				5306		

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Small animals include goats, sheep, pigs, chicken, ducks and rabbits. bOff-farm income include salary and wage income, informal and formal business income.

Table 3.16. The impact of PA mortality on assets and off-farm income by gender and position in household by poverty status

Covariates	Change in natural log of:					
	Values of cattle		Values of small animals[a]		Off-farm income[b]	
	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor
Prime-age (PA) adult mortality	(A)	(B)	(C)	(D)	(E)	(F)
Male head/spouse	-0.324+	-0.358	-0.375	-0.116**	0.608	0.051
	(1.68)	(0.76)	(1.08)	(2.75)	(1.29)	(0.08)
Female head/spouse	-0.229	0.206	-0.203	-0.532	0.271	0.236
	(0.85)	(0.50)	(0.51)	(1.63)	(0.56)	(0.52)
Male non-head/spouse	-0.143	-0.426	0.338	-0.320	-0.348	0.142
	(0.59)	(1.20)	(1.03)	(1.14)	(0.73)	(0.31)
Female non-head/spouse	-0.176	-0.118	-0.326	-0.274	-0.192	-0.129
	(0.74)	(0.39)	(0.98)	(1.44)	(0.43)	(0.38)
Elderly mortality						
Elderly males	0.098	-0.654	-0.370	-0.317	-0.302	-0.233
	(0.37)	(1.31)	(0.92)	(1.01)	(0.62)	(0.51)
Elderly females	0.196	-0.376	0.099	0.078	0.50+	0.060
	(0.58)	(0.77)	(0.23)	(0.25)	(1.83)	(0.11)
Constant	0.029	0.018	0.671**	-0.844**	-0.882**	-0.916**
	(1.43)	(0.39)	(5.56)	(5.23)	(5.39)	(3.27)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Joint tests for						
Prime-age mortality	1.17	0.71	1.53	3.46**	0.66	0.12
Elderly mortality	0.29	1.25	0.45	0.52	1.87	0.14
R-squared	0.30	0.20	0.28	0.24	0.45	0.35
Number of observations	2651	2654	2651	2654	2651	2654

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Small animals include goats, sheep, pigs, chicken, ducks and rabbits. [b]Off-farm income include salary and wage income, informal and formal business income.

EDR in 2000. Evaluated at mean land holding size and mean wealth status, off-farm income decreased by 2.06% among households with EDR in the 75th percentile and having a female head or spouse of household death compared to an increase of 22.5% in similar households but having EDR in the 25th percentile. In contrast, the interaction between interaction between landholding size in 2000 and female head/spouse death is statistically significant and positive implying that there is a smaller decline in off-farm income among households who had bigger landholding in 2000 and experienced female head or spouse death compared to households experiencing a similar shock but having smaller landholdings in 2000.

Evaluated at mean EDR and mean wealth status, off-farm income increased by 21.4% among households with landholdings in the 75th percentile and having a female male head or spouse of household death compared to a decrease in off-farm income of 23.8% in similar households but having landholdings in the 25th percentile. This result suggests that the deceased female head was central in sourcing income off the farmamong households with limited land resources. Their death results in a significant decline in off-farm income

3.4.7. Does the impact differ if the sample excludes homecoming sick prime-age household members who died between 2001 and 2004?

The impact of PA mortality on rural welfare may differ between (a) households experiencing deaths of resident members who were enumerated in the first survey and (b) households with homecoming sick members who were not residents at the time of the first survey but rather re-joined the household to receive terminal care between the time

of the first and second survey. All other factors constant, one would expect to find more severe impacts of mortality among households in category (a) than in category (b). For category (a) households, their asset and income levels, and crop cultivation patterns reflect the productivity of household laborers in 1999/00, prior to the household incurring a death, and possible before any members became chronically ill. The effects of having had at least one adult turn ill and die is measured by the change in household behavior and outcomes between the 2001 and 2004 surveys. By contrast, among category (b) households, none of the members enumerated in 2001 became sick and/or died between 2001 and 2004. Hence the changes in household behavior and outcomes as measured by the differences in the 2001 and 2004 surveys reflect not the effects of mortality of resident members in 2001, but rather the effects of increased care giving, feeding, and other kinds of adjustments. While the welfare indictors of households in both categories (a) and (b) are expected to be adversely affected, the magnitude of the death shock may differ.

In order to analyze if there are differential impacts between household with PA mortality of homecoming sick and those with PA mortality of members who where in the 2001 survey, one would need to include two dummy variables: one for households incurring the death of a resident PA member and one for households taking in a sick member who was not a resident of the household in 2001 and who subsequently died prior to 2004. However, these variables would be endogenous (see Beegle, 2004 and earlier discussion in section 3.3.7.2).

I approach this problem by comparing the results of the restricted sample (households in category (a) only, with category (b) households excluded from the

sample) and results from the full sample as presented in earlier sections. The main shortcoming of this approach is that we do not have any information about how long the homecoming sick stayed in the household before death. If they stayed for a longer period the impact may be similar to those households that had a chronically ill adult in 2000 but died between 2001 and 2004 since the households had to spend some of their time and financial resources to take care of them.

Although the sign and statistical significance of the results remain the same for all models, the magnitude of changes in household size is note-worthy especially for households experiencing male head death and other males. Therefore, the restricted sample results examining the impact of PA death on land cultivated, values of cattle and small animals, crop production and off-farm income are presented in appendix, Tables A3.21 to A3.23. Only the results on impact of PA death on household composition are discussed here because they are slightly different among households with non-core males and females' death.

Table 3.17, Columns A and B shows that the reduction in household size is greater than unity, for example death of other non-core PA male is 2.02 members and is a result of a decline in the number of males by 0.89 as well as a reduction in the number of females, boys and girls of 0.32, 0.36 and 0.55 respectively. Mortality of other non-core females results in the reduction of household size of 1.46 members as well as a significant decline in number of boys and girls of 0.31 and 0.34 respectively. Thus, in addition to the person who died, the net effect on household size was negative, suggesting that the death of non-core members results in the departure of some members especially boys and girls. This result is surprising because one would expect boys and girls to

Table 3.17. The impact of PA mortality on household composition by gender and position of the deceased: Restricted sample

Covariates	Δ Household size		Change in number of :							
			Adult males		Adult females		Boys		Girls	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
Prime-age (PA) adult mortality										
Male	-1.44**		-0.85**		-0.11		-0.15		-0.33**	
	(5.71)		(8.13)		(1.16)		(1.27)		(2.70)	
Female	-1.20**		-0.03		-0.72**		-0.23**		-0.21*	
	(5.20)		(0.31)		(8.13)		(2.62)		(2.08)	
Male head/spouse		-0.65*		-0.75**		0.12		0.05		-0.08
		(2.31)		(5.19)		(1.11)		(0.34)		(0.55)
Female head/spouse		-0.80*		0.01		-0.64**		-0.12		-0.05
		(2.26)		(0.10)		(4.87)		(0.93)		(0.33)
Male non-head/spouse		-2.12**		-0.89**		-0.32*		-0.36*		-0.55**
		(5.33)		(5.97)		(2.18)		(2.31)		(2.77)
Female non-head/spouse		-1.46**		-0.02		-0.78**		-0.31**		-0.34**
		(5.36)		(0.16)		(7.27)		(2.65)		(2.73)
Elderly mortality										
Elderly males	-0.90**	-0.85**	-0.73**	-0.73**	-0.03	-0.02	0.13	0.14	-0.27*	-0.26+
	(2.71)	(2.59)	(5.60)	(5.58)	(0.20)	(0.12)	(1.05)	(1.15)	(2.06)	(1.95)
Elderly females	-0.67*	-0.64+	0.10	0.11	-0.48**	-0.47**	-0.06	-0.05	-0.24	-0.22
	(1.96)	(1.86)	(0.87)	(0.89)	(3.29)	(3.21)	(0.35)	(0.29)	(1.52)	(1.44)
Constant										
	0.12	0.10	0.20**	0.20**	0.25**	0.24**	-0.18**	-0.18**	-0.15**	-0.16**
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.13	0.13	0.12	0.12	0.09	0.09	0.10	0.10	0.14	0.14
Number of observations	5150	5150	5150	5150	5150	5150	5150	5150	5150	5150

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors.

perform caregiving functions for the sick member. The results for the full sample, as presented earlier in Table 3.17, show that there is indeed partial replacement of household members among households with male head and female head/spouse mortality. However, despite the shortcomings of the data on timing, these findings if supported by other studies are important for targeting of assistance. These somewhat point to the need to take into account the different types of mortality in the household. Since, the impact of the death of a member who was in the household in the first survey in terms of the direct the contribution to the labor supply and demand and welfare needs of the household may differ compared to the death of a 'member' who comes to seek short-term care before they die. In order to seek more clarity to this issue, in addition to collecting information about ill and deceased members, future studies need to consider collecting more complete information about homecoming ill, for example, when they joined the household, whether left any children, as well as information about remittances from the deceased. These questions may help disentangle impact from the various illness-related PA mortality that we are unable to answer with this data.

3.5 Summary of findings

Fully two decades since the HIV/AIDS epidemic in Africa has been characterized as a major economic development crisis, there remains a dearth of micro-level information on the impacts of the disease on rural African households and their responses, although this is fortunately beginning to change. Using comprehensive rural farm household longitudinal data from Zambia, I measured the impacts of prime-age (PA) adult morbidity and mortality on crop production and cropping patterns, household

size, livestock and non-farm income. The paper adopted and extended the counterfactual (difference-in-difference) approach used by Yamano and Jayne, (2004) by controlling for initial (pre-death) household conditions that may influence the severity of the impacts of adult mortality. In particular, I controlled for initial poverty status, landholding size, effective dependency ratio, and the gender and position of the deceased person. Moreover, this study extends previous research on this topic by explicitly taking into account the possibility that prime-age adult death in the household is endogenous.

The study highlights a number of noteworthy findings: *first*, using prior death and age group-specific drought shocks as instruments for prime-age deaths' between 2001 and 2004, the Hausman-Wu chi square test for endogeneity shows that indeed death variables are endogenous for pooled OLS models. However, after differencing out the time-invariant unobserved household characteristics, the Hausman-Wu test indicates that the endogeneity problem is addressed and that OLS estimation using household fixed effects is appropriate. These findings offer some support for the estimates of earlier studies using fixed effects, random effects or difference-in-difference (but which didn't explicitly test for endogeneity). However, since there are very few, if any, other studies examining the endogeneity of prime-age mortality when measuring household outcomes, there is need for further empirical treatment of this issue.

Second, based on the difference models, the study reports the impact of prime-age mortality on rural households' welfare. In contrast to the general assumption that HIV-related mortality is typically associated with household heads/spouses, the survey findings show that, only 36.6% of households with PA death incurred household heads/spouse death. While most adults are considered to make important contributions to

their families, both materially, in their roles as nurturers and teachers, and in less tangible ways, it is likely that the most severe economic effects would occur when the death is the household head or spouse. The fact that less than 36.6% of the prime-age deaths observed in Zambia's rural areas involved a household head or spouse suggests that the potential magnitude of rural PA mortality on rural household agricultural and off-farm incomes and orphaning rates -- while still very serious -- may be somewhat less severe than often suggested in the conceptual literature on this topic.

Third, irrespective of gender and/or position in the household of the deceased person, household size declines by less than one member. This indicates that households are to some extent successful in replenishing their household sizes, though the net impact on labor productivity is most likely negative.

Fourth, households' initial poverty levels affect the relationship between a prime-age death and changes in household composition. For example, among households experiencing a male head death, household size changes by -0.30 in non-poor households compared to -0.84 in poorer households. The implications of this finding are that poorer households have substantially greater difficulties in coping with the death of core male household members while non-poor households are likely to almost fully restore household size to former pre-death levels.

Fifth, both *ex ante* and *ex post* the effective dependency ratios of afflicted households are roughly equal to those of non-afflicted households. Actually, households incurring prime-age female death (heads/spouses and other females) between 2001 and 2004 experienced a decline in mean effective dependency ratio in 2001 of 0.16 and 0.35, respectively, suggesting that households are partially able to restore their dependency

ratios, by attracting older girls into the household with initial high EDR to assist in caring for other children, the elderly or the sick when other females die. Despite the fact that women in households experiencing death may well face increased demands on their time for domestic tasks and crop production out results indicate that the relative burden of dependents in relation to healthy adults is not much different for non-afflicted and afflicted households.

Sixth, the net effect on household size among poor households experiencing male head or spouse death is negative but not unity, implying that there is some partial replacement of household members. In contrast, under the same circumstances non-poor households are able to attract boys and girls into the household.

Seventh, the effects of PA death on farm production are sensitive to the gender and position in the household of the deceased. For example, the death of a PA male resulted in a 13% decline in total land cultivated whilst death of a PA female resulted in a 5% decline of cultivated land but the impact is not significant at the 10% level. After disaggregating mortality by gender and position in the household, I find that the death of male heads/spouses resulted in a 28% reduction in land cultivated. All the other mortality categories are negative but not statistically significant. This finding seems to follow from the earlier reported finding that households experiencing male heads/spouse death tend to incur a higher decline in household size. Without full replacement of household members, land cultivation is cut back to cope with the labor shortage.

The area under cereals and other food crops declines among households experiencing male or female head/spouse death and other females' death. However, the impact is more severe among households with male head/spouse death (a decline of

19%), followed by the death of other males and female heads/spouses of household (a decline of 11% and 8% respectively). Also, the death of male core members is associated with an additional 4% decline in high-value crops.

One would find these results a bit puzzling given that women devote more labor hours to agriculture than men. However, in about 33% of the cases among households experiencing a male head of household death, the widow ended up cultivating less land. This could be due to loss of land, capital and livestock assets to other relatives after the death of their husband. We also find that relatively wealthy widow-headed households are particularly vulnerable, as they have more land and assets that can be claimed by relatives than afflicted households that are poor to begin with. (see Chapoto and Jayne, 2006-forthcoming). Therefore, the severe reduction in land cultivated that we are seeing among households experiencing male head of household may be due to the loss of labor as well as decapitalization of agricultural production among widow headed households.

The implication of this finding implies that the responses to mitigating the social and economic impacts of HIV/AIDS in Zambia may not be successful if they ignore the gender inequalities that that exist in terms of land access and other productive assets important for rural livelihood. Therefore, efforts to safeguard widows' rights to land through land tenure innovations involving community authorities may be an important component of social protection and poverty alleviation strategies.

Eighth, in contrast to the general hypothesis that households experiencing prime-age death cope with the reduction in family size by switching to labor saving crops such as roots and tubers, I find little evidence of this. The death of other females in the household results in a 5% decline in area under roots and tubers. The death of all other

person categories has no statistically significant impacts on roots and tuber cultivation. These findings indicate that afflicted households appear to be no more likely to switch to these less labor-intensive crops than non-afflicted households.

Ninth, the findings of this study seem to be going against conventional wisdom that suggests initial poverty exacerbated the impact of mortality on cultivated area. Our results indicate that the area under cereals declines most among wealthier households incurring male head-of-household mortality (-75%) compared to -35% among households in the same situation but in the bottom 50% of the 2000 assets distribution. In contrast, the impact is almost the same among both poor and non-poor households experiencing female head/spouse of household death. Similar, to point 7 above, one may find this finding puzzling considering that women devote most of their time to agriculture than men. However, as mentioned above it is likely that widow are losing their land and productive assets rights after their husband death and relatively wealthy widow-headed households are particularly vulnerable, as they have more land and assets that can be claimed by relatives than afflicted households that are poor to begin with.

Tenth, in terms of value of crop output and gross output per hectare, the results of this study do not strongly support the contention that households incurring prime-age death suffer huge declines in crop output except among poor households experiencing PA male head death. Gross value of output actually went up by 32% in wealthier households experiencing male head/spouse death (admittedly a finding that is hard to explain) whilst among poorer households gross value of crop production declined by 19%. There is evidence to suggest that wealthier households incurring male head of household death attract boys and other males to join the household. Also since there was a net decline in

land cultivated in both cases due to male head death these results seem to suggest greater agricultural intensification in wealthier households experiencing male head death.

Eleventh, these results indicate that initial landholding size greatly influences the change in the value of crop output due to male head death (and on gross value of crop output per head due to either male and female head or spouse death). Evaluated at mean effective dependency ratio and mean wealth status, gross value of output decreased by 57% among households with land holding sizes in the 75th percentile and having a male head of household death compared to 41% in similar households but having land holding sizes in the 25th percentile.

Twelfth, values of cattle appear to suffer greatly from the death of a PA male head of household (30% decline) whilst the impacts of death of other household members are negative but not statistically significant. These results seem to suggest that households appear to try to hold on to productive cattle and probably sell only as a last resort but the result does not seem to strongly hold among households incurring male head of household death. In contrast, there is strong evidence to suggest that afflicted households liquidate small animals to mitigate the impact of PA death. For example, disaggregated by gender and position in household of the deceased our results show that death of male head of household resulted in 65% decline in values of small livestock, whilst death of other females' death and female head/spouse resulted in a decline of 44% and 37%. Also, the value of small animals reduced by 77% in wealthier households experiencing male head death compared to a 55% decline in assets-poor households.

Thirteenth, contrary to the hypothesis that off-farm income sources are at risk among households experiencing PA mortality, particularly among those that are asset

poor and vulnerable to begin with, results of this study show mixed results that are statistically insignificant for all cases of mortality by gender and position in the household of the deceased. However, evidence does point to differential impacts by initial household effective dependency ratio and by landholding size among households experiencing female head or spouse death. For example, evaluated at mean land holding size and mean wealth status, off-farm income *decreased* by 2% among households with EDR at the 75th percentile and having a female male head or spouse of household death compared to an *increase* of 23% in similar households but having EDR at the 25th percentile. Off-farm income increases by 21% among households incurring the death of a female head/spouse with landholdings at the 75th percentile. In contrast, off-farm income declines by 24% in similar households incurring a female/spouse death but whose landholdings are at the 25th percentile. This result suggests that the deceased female head was central as a source of off-farm income especially among households with limited land resources and their death resulted in a significant decline in off-farm income.

Last but not least, there is some evidence that warrants taking into account the different impacts on household welfare resulting from households experiencing deaths of resident members versus households with homecoming sick members who joined or re-joined the household to receive terminal care. Further study is needed, based on carefully constructed survey information about ill and deceased members.

CHAPTER 4

CONCLUSION AND POLICY RECOMMENDATIONS

Using nationally representative panel data on 18,821 individuals surveyed in May, 2001 and May, 2004 in rural Zambia, Chapter 2 of this paper identified important *ex ante* socio-economic conditions of individuals who die of disease related causes between the ages of 15 and 59 years. The findings of the study can help policy-makers and development agencies better understand current transmission pathways of HIV/AIDS, as well as help in the formulation of up-to-date AIDS prevention and mitigation strategies.

Overall, the probability that a prime-aged (i.e., 15-59 year) woman would die of a disease was roughly 1.0 percent over the 3-year period, while the comparable probability for men was 0.6 percent. Just over 60% of the prime-age deaths observed in this nationally-representative rural sample were women, supporting other findings that women are being disproportionately afflicted by HIV/AIDS.

For both asset-poor and non-poor women, the probability was roughly 1.0 percent whilst for asset-poor and non-poor men the probabilities were 0.5 and 0.7/0.8 percent, respectively. Consistent with findings in the 1980s and early 1990s, we find that men in the upper half of the assets or income distribution are more likely to die of disease-related causes than men residing in poor households. In contrast, women in the lower half of assets or income distribution are equally likely to die of disease-related causes as women residing in the upper half of assets/income distribution.

An emerging strand of the social science literature on HIV/AIDS in Africa stresses the relationship between poverty, risky sexual behavior, and subsequent

contraction of the disease. It has been argued that single women unable to sustain themselves through wage labor or agriculture are more likely to resort to transactional sex for survival. If this is an important social pathway contributing to the spread of the disease in Africa, then we might expect to find a relationship over time between household- and individual-level indicators of poverty, especially for single women, and subsequent chronic illness and death. We find that relatively poor women who have some form of formal/informal business income are less likely to die of disease-related causes than women with the same characteristics and no formal/informal business activity. This finding suggests that efforts to provide greater income-earning opportunities for poor women may make at least a modest contribution to reducing female prime-age mortality. This relationship does not hold, however, for relatively non-poor females. And 47.2 (45.0) percent of the women dying of disease-related causes over the 3-year survey period came from households in the top half of the asset (income) distribution. These findings suggest that the social factors driving the spread of AIDS are considerably more complex than simply poverty-based explanations, although poverty may certainly contribute to risky behavior and poor health, which are important pathways by which the disease is spread.

Single women and men in poor households are twice as likely to die of disease-related causes as poor women and men who are the heads or spouses of their households. Single women and men in relatively non-poor households are 3.7 and 4.5 times more likely to suffer a disease-related death compared to married women and men who are the heads or spouses of their households. Irrespective of gender, individuals who spend several months or more away from home are 2 to 10 times more likely to die of disease-

related causes in succeeding years. It is possible that the creation of business opportunities that involve men and women spending more time away from home for extended periods may exacerbate the AIDS problem in rural Zambia and negate the positive effects of greater financial independence for women, unless progress is made in the use of condoms, other forms of safe sex, and prevention interventions.

Educational attainment was found to be largely unrelated to vulnerability to death for men. For women, the evidence is not robust, but the data tend to show that educational attainment reduces somewhat women's vulnerability to disease-related death, especially for non-poor women. This finding suggests that education is an empowerment tool for women and helps reduce mortality of females and should be encouraged in rural Zambia. Also, HIV/AIDS education campaigns should still target both literate and illiterate men because men of any education level have roughly the same risk of contracting HIV.

Most importantly, the prior death of a prime-aged person in the household substantially increases the probability of another prime-aged member dying. Irrespective of income status, prime-aged men and women experiencing a prior death in their household are 23.0 and 18.1 times more likely to die of disease-related causes than men and women in households with no prime-age deaths in the past 8 years. The predicted probability of death was 12.4% and 16.3% for men and women experiencing a prior-disease-related death in their household in the past 8 years versus 0.54% and 0.90% for men and women not experiencing a prior prime-aged death. Of the 362 households experiencing prime-age mortality between 2001 and 2004, 15% of them suffered multiple prime-age deaths. In this way, AIDS differs from other kinds of diseases (e.g., malaria),

which do not appreciably raise the likelihood of subsequent death in the family after one member contracts the disease. To the extent that the death of two prime-age members from the same household within a few years of each other causes extreme hardships on remaining members, especially for children, the implication of this finding is that programs and strategies to support the care and education of children in AIDS-afflicted households may need to become a critical component of poverty reduction strategies in areas hard-hit by AIDS, such as most of eastern and southern Africa. More research is necessary to understand the longer-term impacts of the disease on household behavior and welfare, and to develop programs that can mitigate the adverse consequences. At this point in time, the research community still knows very little about the cost-effectiveness of alternative ways of mitigating the impacts of AIDS, but a solid understanding of the socio-economic factors associated with the disease is likely to help considerably in designing appropriate risk messages and prevention strategies.

If resources for ARV therapy remain highly constrained in the foreseeable future, ARV therapy may be prioritized for single parents in households where the spouse has already died. This option may help to reduce the strains on communities caused by double-orphans and help nuclear families remain intact as best as possible. Given the long period between infection with HIV and the transition to full-blown AIDS and death, these findings reflect patterns of infection 4-8 years ago. It is critical to continue assessing the factors associated with AIDS-related mortality to understand how they may be shifting over time, in order to develop appropriate risk messages and public campaigns targeted at high-risk groups.

Chapter 3 of this study estimated the impact of prime-age mortality occurring between May 2001 and May 2004 on household composition, land cultivated, changes in cropping patterns, value of livestock assets and off-farm income. Based on the difference models, the analysis yields a number of noteworthy findings important for AIDS policy and mitigation strategies for rural farm households. *First*, in contrast to the general assumption that HIV-related mortality is typically associated with household heads/spouses, the survey findings show that, only 36.6% of households with PA death incurred household heads/spouse death. While most adults are considered to make important contributions to their families, both materially, in their roles as nurturers and teachers, and in less tangible ways, it is likely that the most severe economic effects would occur when the death is the household head or spouse. The fact that less than 36.6% of the prime-age deaths observed in Zambia's rural areas involved a household head or spouse suggests that the potential magnitude of rural PA mortality on rural household agricultural and off-farm incomes and orphaning rates -- while still very serious -- may be somewhat less severe for many households than often suggested in the conceptual literature on this topic.

Second, irrespective of gender and/or position in the household of the deceased person, rural farm households in Zambia attempt to cope with the death of PA adults through changes in household composition. In all cases household size declined by a factor less than one member, suggesting that afflicted households are partially successful in replenishing their family size. However, in response to the death of a male household head, poorer households have substantially greater difficulties in coping than non-poor households, which are likely to almost fully restore household size to former pre-death

levels. These results imply that the widespread view that death of productive members of the family results into labor shortages needs to be more carefully nuanced, taking into account the position of the deceased person and the initial conditions of the household. Nevertheless, the loss of adult members, especially heads and spouses, may have longer run impacts not measured in the relatively short three-year period of this analysis, such as the loss of inter-generational knowledge in terms of farming skills and knowledge, especially in households that are poor to begin with and experience the death of a male household head. This may require the targeting of assistance and skill training to relatively poor households headed by widows.

Third, both prior to households' experiencing adult mortality and after, the effective dependency ratios of afflicted households are roughly equal to those of non-afflicted households. Effective dependency ratio is defined as the number of children, elderly, and chronically ill persons divided by the number of healthy prime-age adults (between the ages of 15 and 59). Actually, households incurring prime-age female death (heads/spouses and other females) between 2001 and 2004 experienced a *decline* in mean effective dependency ratio in 2001 of 0.16 and 0.35, respectively, suggesting that households are partially able to adjust dependency ratios, by attracting older girls into the household with initial high EDR to assist in caring for other children, the elderly or the sick when other females die. Despite the fact that women in households experiencing death may well face increased demands on their time for domestic tasks and crop production, these results indicate that the relative burden of dependents in relation to healthy adults is not much different for non-afflicted and afflicted households.

Fourth, the effects of PA death on farm production were sensitive to the gender and position in the household of the deceased. For example, death of a PA male resulted in a 13% decline in total land cultivated whilst death of a PA female resulted in a 5% decline of cultivated land and the death of male heads/spouses resulted in a 21% reduction in land cultivated. All the other mortality categories are negative but not statistically significant. This finding appears to be consistent with the findings above that households experiencing male heads/spouse death tend to incur a higher decline in household size, and thus may experience greater declines in land cultivation associated with household labor shocks. Also, the results show that land cultivated and area under cereals decline more in relatively non-poor households than poor households after the death of a male household head. These results seem to suggest that despite the fact that the death of productive members may result into a reduction in the total cultivated land, the position and gender of the deceased member matters.

Fifth, in contrast to the widespread view that households experiencing prime-age death cope with the reduction in family size by switching to labor-saving crops such as roots and tubers, the results show positive but statistically insignificant effects on the cultivation of these crops except among households experiencing the death of non-head/spouse females. The death of other adult women in the household results in a 5% decline in area under roots and tubers. These findings indicate that afflicted households are not more likely to switch to these less labor-intensive crops than non-afflicted households. While many have identified HIV/AIDS as the cause of recent shifts in area cultivated from maize to less labor-intensive root and tuber cultivation in Zambia as well as other parts of southern Africa, it is important to acknowledge that recent crop and

input policy changes in the region associated with structural adjustment and food market reform have affected the relative output/input price ratios for grain crops relative to roots and tubers, reducing the profitability in some areas of grains as compared to roots and tubers. The potential for such national and/or regional cropping trends exemplifies the importance of investigating cropping patterns of afflicted households in comparison with the non-afflicted population. These results suggest that for afflicted households as a group, 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 (any more so than capital assets, for example, which are likely to be drawn down due to foregone income, medical treatment, and funeral expenses among afflicted households). The macro-level picture emerging from recent demographic population projections, which include the impact of AIDS-related deaths, demonstrates that although the epidemic will reduce life expectancy and population growth considerably in the hardest-hit countries, the epidemic has not caused a decline either in the aggregate labor supply or in the labor-to-available- land ratios in agriculture. In fact, between 1990 and 2000, the rural population of Zambia has grown at a considerably faster rate than the overall population – 43.6% vs. 33.9%. Therefore, prioritization of public sector investment in the development and dissemination of technologies aimed at mitigating the effects of prime-age adult mortality ideally requires in-depth evaluation of household constraints and opportunities, as well as consideration of the need for balance between investments in long-term rural economic productivity growth and targeted assistance to both afflicted and non-afflicted households. Assessing which labor-saving technologies to prioritize should involve investigation of the characteristics of affected households, whose labor

time is most constrained, who would benefit from these technologies, who has effective access to new technologies, and which technologies promote efficiency of allocation of public resources across sectors.

Sixth, in terms of value of crop output and gross output per hectare, the results do not strongly support the contention that households incurring prime-age death suffer large declines in crop output -- except among initially poor households experiencing the death of a male household head. Among this group of afflicted households, the gross value of crop production per hectare declined by 19% relative to non-afflicted households. There is evidence to suggest that wealthier households incurring male head-of-household death attract boys and other males to join the household, while initially poor households have greater difficulty in doing so. This finding supports the need for creating or and/or strengthening community-based networks to assist poorer households experiencing mortality of household heads and spouses. Government and interested donor agencies may also assist with agricultural extension programs to reach afflicted poor households in order to strengthen their capacity to cope with the loss of prime-age core members.

Seventh, the value of cattle assets appear to suffer greatly from the death of a PA male head of household whilst the impacts of death of other prime-age members are negative but not statistically significant. Similar to the findings by Yamano and Jayne (2004), there is strong evidence to suggest that afflicted households liquidate small animals to mitigate the impact of PA death. The sale or liquidation of livestock as a means of coping with illness and death of prime-age adults is costly in the short-term and may also compromise the household's future livelihood (Stokes, 2003). Another possible explanation why the results show a significant decline in cattle assets among households

experiencing male head-of-household mortality is that property of the deceased man (including cattle) is often redistributed to surviving relatives. Cattle assets are not only a stock of wealth but are also an input into agricultural production (through draft power for land preparation) which in some cases raises the average product of other inputs such as fertilizer (Xu et al., 2005). Therefore, in order to support the food security and farm productivity of households afflicted by male head mortality, the Zambian government and development agencies may consider targeting households whose capital base is affected by AID-related illness and death as well as encourage cultural changes that empower widows who need not be pushed into poverty further by assets redistribution after their husband's death. Also, programs similar to the 'Heifer project' may need to be targeted to poor households and especially households with male head of household death.

Eighth, the study shows mixed findings in terms of the impact of PA death on off-farm income. Contrary to the hypothesis that off-farm income sources are at risk among households experiencing PA mortality, particularly among those that are asset poor and vulnerable to begin with, the results were statistically insignificant for all cases of mortality by gender and position in the household of the deceased. However, evidence does point to differential impacts by initial household effective dependency ratio and by landholding size among households experiencing female head or spouse death. Households with female head or spouse female death and having higher effective dependency ratios seem to suffer more compared to those with lower initial dependency ratio.

Ninth, the study points to the potential need to take into account the different types of mortality in the household, especially the potential differences in households welfare between households experiencing deaths of resident members versus households with homecoming sick members who joined or re-joined the household to receive terminal care. The impact of the death of a member who was always resident in the household in terms of the direct the contribution to the labor supply and demand and welfare needs of the household may differ compared to the death of a 'member' who re-joins the household to seek short-term care before they die. In order to seek more clarity to this issue, future studies need to consider collecting more complete information about the homecoming ill, for example, when they joined the household, whether they left any children, as well as information about remittances from the deceased. These questions may help disentangle impact from the various illness-related PA mortality that we are unable to answer with this data.

Overall, the results of this study question the usefulness of a homogeneous conceptualization of "afflicted households," especially in the context of proposals for targeted assistance, technology development, and other programs/policies. In most cases the gender and household position of the deceased appear to strongly condition the effects on the household. The death of a male household head is associated with larger negative impacts on household size, farm production and livestock assets than any other kind of adult death. In addition, the results show that initial asset levels, land cultivated and initial effective dependency ratios also condition the effects of mortality on households. In general, the impact of adult mortality appear to be most severe for households in the bottom half of the distribution of assets in 2000. Overall, these

findings suggest that poorer households headed by HIV/AIDS widows are in especially precarious positions. This would imply that AIDS mitigation programs should target their scarce resources particularly toward widow-headed households, especially those that were relatively poor to begin with.

Also, the results in this chapter show more severe impacts on household land cultivated among households experiencing male head of household death. One would the find this result a bit puzzling given that women devote more labor hours to agriculture than men. However, in about 33% of the cases among households experiencing a male head of household death, the widow ended up cultivating less land. This could be due to loss of land, capital and livestock assets to other relatives after the death of their husband. We also find that relatively wealthy widow-headed households are particularly vulnerable, as they have more land and assets that can be claimed by relatives than afflicted households that are poor to begin with. Therefore, the severe reduction in land cultivated that we are seeing among households experiencing male head of household may be due to the loss of labor as well as decapitalization of the agricultural production among widow headed households.

The implication of this finding implies that the responses to mitigating the social and economic impacts of HIV/AIDS in Zambia may not be successful if they ignore the gender inequalities that exist in terms of land access and other productive assets important for rural livelihood. Therefore, efforts to safeguard widows' rights to land through land tenure innovations involving community authorities may be an important component of social protection and poverty alleviation strategies.

Caveats and limitations: It is important to take note that the findings from this study only measured short run effects of prime-age mortality between April 2001 and April 2004 on a few aspects of Zambia rural farm households. Future research studies need to be designed in order to measure full long-run effects of prime-age adult death. This would entail tracking affected households over a long time frame.

Also, the situation in which a relatively small percentage of households incur a shock, but the shock is spread across households in a community presents methodological challenges for estimating the full effects of the shock using household survey data. This study and most prior household-level panel studies, using difference-in-difference, household fixed-effects, or random-effects models, have measured the effects of mortality *in afflicted households* on differenced household-level outcomes, typically over a 2–5 year time frame, compared to differenced outcomes on non-afflicted households. Yet if non-afflicted households are likely to be indirectly affected by the mortality occurring around them, non-afflicted households may not be a valid control group. In communities hard-hit by HIV/AIDS, households not directly incurring a death may nevertheless be affected by taking in orphans, losing access to resources owned by kin-related "afflicted" households, intra-household resource transfers to afflicted households, and broader effects of high mortality rates on communities' economic and social structures. Future studies may need measure the effects of mortality on rural welfare other than at the household level.

APPENDICES

Table A2.1. Descriptive Statistics of variables used in the analysis

Variable	Mean	Std Dev	Min	Max	Value of variable at xth percentile		
					25th	50th	75th
Gender (1=male, 0 otherwise)	0.49	0.50	0	1			
Head/spouse (=1 , 0 otherwise)	0.57	0.50	0	1	-	-	-
Marital status (=1)							
Currently married	0.56	0.50	0	1	-	-	-
Never married	0.36	0.48	0	1			
Previously married	0.08	0.28	0	1			
Age groups in 2000 (=1)							
Age 15-19	0.23	0.42	0	1			
Age 20-24	0.18	0.38	0	1	-	-	-
Age 25-29	0.15	0.35	0	1	-	-	-
Age 30-34	0.11	0.31	0	1	-	-	-
Age 35-39	0.09	0.29	0	1	-	-	-
Age 40-44					-	-	-
Age 45-49	0.08	0.28	0	1	-	-	-
Age 50-54	0.06	0.24	0	1	-	-	-
Age 55-59	0.06	0.23	0	1	-	-	-
Years of education (=1)							
None	0.15	0.35	0	1			
1-3 years	0.12	0.32	0	1	-	-	-
4-6 years	0.25	0.43	0	1	-	-	-
7 years	0.24	0.43	0	1	-	-	-
8 years and above	0.24	0.43	0	1	-	-	-
Salary wage income in 2000 (=1)	0.09	0.29	0	1	-	-	-
Formal/Informal business activity (=1)	0.14	0.35	0	1	-	-	-
Months spent away from home in 2000							
Resided all months at home (=1)	0.87	0.33	0	1	-	-	-
Spent one month away (=1)	0.04	0.19	0	1	-	-	-
Spent two or more months away (=1)	0.09	0.28	0	1	-	-	-
Polygamous household in 2000 (=1)	0.13	0.34	0.00	1.00	-	-	-
Prior death in 1996-2004 (=1)[a]	0.07	0.25	0.00	1.00	-	-	-
Land holdings (hectares) in 2000	3.39	3.30	0.03	20.00	1.13	2.25	4.50
Productive assets ('000 Zkw) in 2000[b]	814	2502	0.00	42000	7	50	314
District HIV prevalence rate in 1999	15.88	3.25	10.8	31.0	13.34	15.90	17.20
District on the line of rail (=1)	0.36	0.48	0.00	1.000	-	-	-
Distance to the nearest tarmac road (km)	23.41	33.23	0.00	188.90	3.60	10.40	27.50
Distance to the district Town/Boma (km)	33.83	22.48	0.30	104.40	15.40	28.80	46.50

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004
Notes: [a]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis. [b]Productive assets are the sum of the value of farm equipment (scotch carts, harrows and ploughs) and livestock.

Figure A2.1. Distribution of illness-related prime-age mortality by gender and age-groups between 2001 and 2004

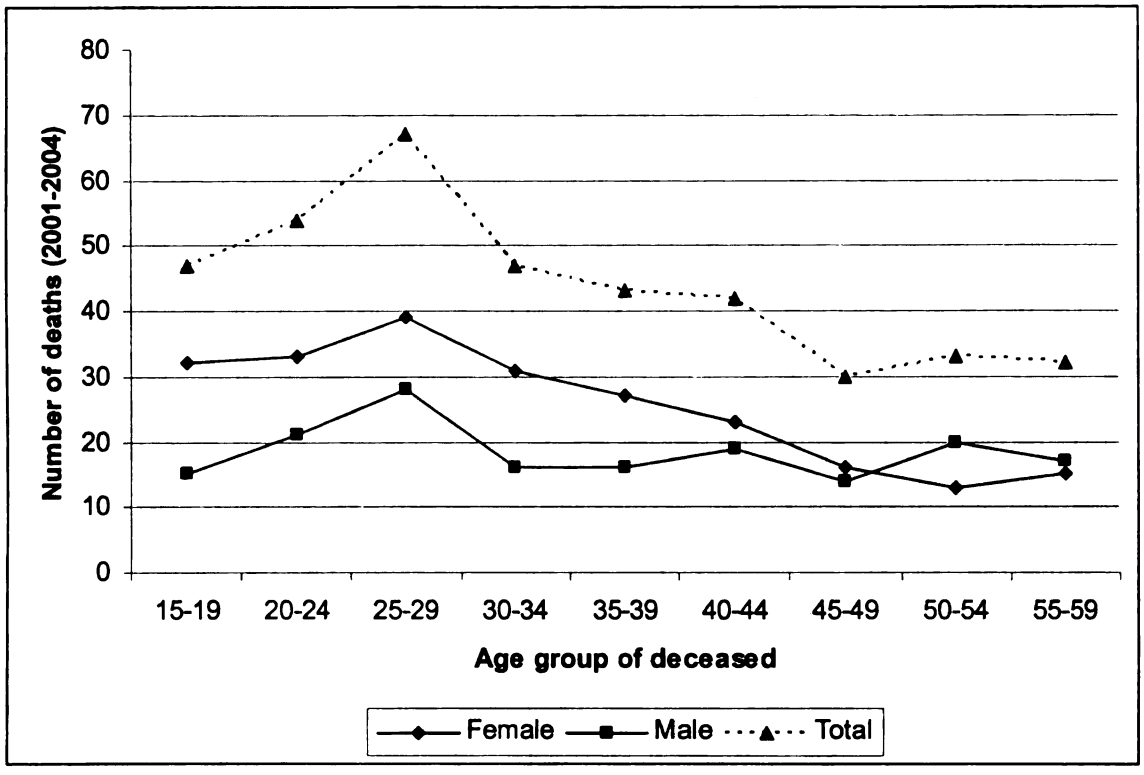


Table A2.2. Probit model results[a] of PA mortality between 2001-2004 by gender (village-fixed effects)

	Pooled Sample		Male		Female	
		Corrected for attrition		Corrected for attrition		Corrected for attrition
	(1)	(2)	(3)	(4)	(5)	(6)
Gender(1=male, 0=female)	-0.006**	-0.007**	-	-	-	-
	(3.09)	(3.63)	-	-	-	-
Head/spouse (=1)	-0.010**	-0.011**	-0.008	-0.009	-0.019**	-0.020*
	(3.18)	(3.44)	(1.21)	(1.59)	(2.58)	(2.51)
Currently married (=1)	-0.007*	-0.007*	-0.016	-0.014	-0.016*	-0.018*
	(2.28)	(2.21)	(1.86)	(1.78)	(2.48)	(2.55)
Never married (=1)	-0.002	-0.002	-0.004	-0.004	-0.001	-0.003
	(0.43)	(0.60)	(0.49)	(0.39)	(0.11)	(0.41)
Age groups in 2000 (=1)						
Age 20-24	0.011**	0.011**	0.016*	0.013	0.015	0.018*
	(2.83)	(2.75)	(1.98)	(1.73)	(1.91)	(2.01)
Age 25-29	0.038**	0.042**	0.076**	0.083**	0.041**	0.046**
	(6.35)	(6.46)	(4.78)	(5.20)	(3.50)	(3.48)
Age 30-34	0.039**	0.046**	0.043**	0.048**	0.081**	0.095**
	(5.72)	(5.92)	(3.14)	(3.34)	(4.66)	(4.66)
Age 35-39	0.054**	0.065**	0.079**	0.092**	0.078**	0.091**
	(6.17)	(6.49)	(3.94)	(4.33)	(4.14)	(4.21)
Age 40-44	0.063**	0.077**	0.175**	0.202**	0.065**	0.077**
	(5.88)	(6.02)	(5.42)	(5.73)	(3.63)	(3.66)
Age 45-49	0.054**	0.062**	0.183**	0.209**	0.051**	0.055*
	(4.62)	(4.51)	(5.38)	(5.57)	(2.67)	(2.52)
Age 50-54	0.063**	0.072**	0.193**	0.214**	0.033*	0.037*
	(5.55)	(5.63)	(5.58)	(5.85)	(2.02)	(2.05)
Age 55-59	0.077**	0.094**	0.239**	0.285**	0.051**	0.066**
	(6.18)	(6.39)	(6.20)	(6.80)	(2.92)	(3.06)

Table A2.2. continued

Years of Education in 2000 (=1)						
1-3 years	-0.001	0.001	0.011	0.018	-0.007	-0.006
	(0.22)	(0.29)	(1.23)	(1.63)	(1.21)	(0.85)
4-6 years	-0.001	-0.000	0.010	0.016	-0.011*	-0.011
	(0.46)	(0.08)	(1.22)	(1.68)	(2.08)	(1.65)
7 years	0.000	0.002	0.010	0.017	-0.011	-0.012
	(0.06)	(0.44)	(1.24)	(1.88)	(1.90)	(1.81)
8 years and above	-0.002	-0.001	0.001	0.004	-0.010	-0.010
	(0.64)	(0.34)	(0.09)	(0.57)	(1.58)	(1.33)
Salary wage income in 2000 (=1)	0.001	0.002	0.011*	0.015*	-0.013	-0.012
	(0.19)	(0.68)	(2.09)	(2.51)	(1.44)	(1.14)
Business activity in 2000 (=1)[b]	-0.001	-0.001	0.002	0.003	-0.005	-0.004
	(0.43)	(0.30)	(0.53)	(0.73)	(0.97)	(0.71)
Resided at home throughout the year in 2000 (=1)	-0.043**	-0.038**	-0.032**	-0.028**	-0.100**	-0.097**
	(9.32)	(8.05)	(4.80)	(4.45)	(8.10)	(7.47)
One month spent away from home in 2000 (=1)	-0.011**	-0.012**	-0.006	-0.005	-0.020**	-0.024**
	(4.25)	(3.96)	(0.94)	(0.65)	(4.03)	(4.27)
Polygamous household in 2000(=1)	-0.002	-0.002	-0.005	-0.005	0.002	0.003
	(0.48)	(0.46)	(0.82)	(0.86)	(0.29)	(0.40)
Prior PA death in household in 1996 -2003[c](=1)	0.185**	0.164**	0.276**	0.228**	0.274**	0.260**
	(26.72)	(23.80)	(15.16)	(13.57)	(17.60)	(15.92)
ln(Landholding size (hectares) in 2000)	-0.003*	-0.002	-0.002	-0.001	-0.005	-0.005
	(2.19)	(1.68)	(0.92)	(0.53)	(1.87)	(1.68)
Protected water source (=1)	0.000	0.001	0.019	0.025*	-0.009	-0.012
	(0.08)	(0.15)	(1.66)	(2.14)	(0.78)	(0.97)
Superior roofing material (=1)	-0.001	-0.001	-0.010	-0.010	0.005	0.005
	(0.31)	(0.34)	(1.37)	(1.26)	(0.78)	(0.61)
Superior floor material (=1)	-0.000	0.001	0.003	0.005	-0.007	-0.007
	(0.06)	(0.20)	(0.46)	(0.63)	(0.97)	(0.86)
Standard door frame and door (=1)	0.002	0.002	0.006	0.005	0.002	0.004
	(0.61)	(0.70)	(1.20)	(1.08)	(0.31)	(0.60)
Superior wall material (=1)	0.002	0.002	0.008	0.008	-0.003	-0.002
	(0.59)	(0.61)	(1.41)	(1.32)	(0.48)	(0.27)

Table A2.2. continued

Quartiles of value of household assets	Mid-Low	0.003	0.004	0.004	0.003	0.003	0.007
		(1.07)	(1.35)	(0.68)	(0.57)	(0.58)	(1.05)
	Mid-High	0.002	0.003	0.001	-0.000	0.006	0.009
		(0.84)	(0.87)	(0.16)	(0.07)	(0.94)	(1.16)
	Highest	0.001	0.002	-0.002	-0.001	0.003	0.009
		(0.16)	(0.58)	(0.26)	(0.14)	(0.45)	(0.97)
Village dummies included		Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations		9806	9804	2866	2866	3498	3497

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ** 1 percent significance level; * indicates 5 percent significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

Table A.2.3. Probit Models[a] of prime-age mortality in 2001-2004 by gender (province-fixed effects)

	Pooled Sample		Male		Female	
		Corrected for attrition		Corrected for attrition		Corrected for attrition
	(1)	(2)	(3)	(4)	(5)	(6)
Gender(1=male, 0=female)	-0.004**	-0.006**	-	-	-	-
	(2.85)	(3.39)	-	-	-	-
Head/spouse (=1)	-0.007**	-0.008**	-0.001	-0.002	-0.009*	-0.010*
	(2.67)	(3.02)	(0.43)	(0.78)	(2.55)	(2.53)
Currently married (=1)	-0.006*	-0.006*	-0.007	-0.007	-0.009**	-0.010**
	(2.48)	(2.57)	(1.78)	(1.80)	(2.70)	(2.81)
Never married (=1)	-0.002	-0.002	-0.001	-0.001	-0.002	-0.003
	(0.53)	(0.60)	(0.20)	(0.15)	(0.54)	(0.74)
Age groups in 2000 (=1)						
Age 20-24	0.008*	0.009*	0.007	0.007	0.009*	0.011*
	(2.57)	(2.55)	(1.86)	(1.73)	(2.05)	(2.12)
Age 25-29	0.027**	0.031**	0.028**	0.031**	0.026**	0.030**
	(5.83)	(6.06)	(4.00)	(4.25)	(4.03)	(4.17)
Age 30-34	0.027**	0.033**	0.018**	0.021**	0.036**	0.043**
	(5.07)	(5.31)	(2.72)	(2.89)	(4.14)	(4.21)
Age 35-39	0.034**	0.041**	0.030**	0.035**	0.037**	0.044**
	(5.35)	(5.76)	(3.69)	(3.93)	(3.88)	(4.08)
Age 40-44	0.039**	0.048**	0.054**	0.064**	0.030**	0.037**
	(5.02)	(5.26)	(4.48)	(4.77)	(3.27)	(3.46)
Age 45-49	0.036**	0.041**	0.065**	0.076**	0.022*	0.024*
	(4.25)	(4.22)	(4.70)	(4.84)	(2.26)	(2.19)
Age 50-54	0.041**	0.046**	0.079**	0.090**	0.017*	0.020*
	(5.20)	(5.34)	(5.28)	(5.45)	(2.02)	(2.09)
Age 55-59	0.047**	0.057**	0.084**	0.099**	0.025**	0.031**
	(5.62)	(5.97)	(5.70)	(5.98)	(2.59)	(2.87)

Table A2.3. continued.

Years of Education in 2000 (=1)							
1-3 years		0.001	0.002	0.006	0.011	-0.002	-0.001
		(0.21)	(0.61)	(1.45)	(1.93)	(0.60)	(0.39)
4-6 years		-0.001	-0.000	0.005	0.008	-0.005	-0.005
		(0.34)	(0.02)	(1.32)	(1.79)	(1.70)	(1.42)
7 years		0.000	0.002	0.007	0.011*	-0.005	-0.005
		(0.14)	(0.54)	(1.68)	(2.37)	(1.61)	(1.45)
8 years and above		-0.001	-0.000	0.002	0.004	-0.003	-0.002
		(0.28)	(0.06)	(0.72)	(1.17)	(0.78)	(0.54)
Salary wage income in 2000 (=1)		-0.000	0.001	0.004	0.006	-0.008*	-0.009
		(0.10)	(0.42)	(1.52)	(1.86)	(2.04)	(1.86)
Business activity in 2000 (=1)[b]		-0.001	-0.000	0.000	0.000	-0.001	-0.001
		(0.41)	(0.20)	(0.05)	(0.18)	(0.51)	(0.24)
Resided at home throughout the year in 2000 (=1)		-0.028**	-0.025**	-0.016**	-0.014**	-0.038**	-0.036**
		(8.90)	(7.58)	(5.32)	(4.43)	(7.97)	(7.03)
One month spent away from home in 2000 (=1)		-0.008**	-0.009**	-0.004	-0.004	-0.010**	-0.012**
		(3.75)	(3.45)	(1.57)	(1.12)	(3.42)	(3.55)
Polygamous household in 2000(=1)		-0.001	-0.001	-0.003	-0.003	0.001	0.001
		(0.60)	(0.62)	(1.42)	(1.32)	(0.29)	(0.24)
Prior PA death in household in 1996 -2003[c](=1)		0.156**	0.137**	0.143**	0.117**	0.164**	0.153**
		(31.26)	(28.15)	(18.43)	(16.89)	(21.40)	(19.77)
ln(Landholding size (hectares) in 2000)		-0.002**	-0.002*	-0.001	-0.001	-0.003*	-0.003*
		(2.67)	(2.36)	(1.01)	(0.84)	(2.14)	(2.02)
Quartiles of value of household assets	Mid-Low	0.002	0.002	0.002	0.002	0.000	0.002
		(0.81)	(1.08)	(0.99)	(0.85)	(0.13)	(0.67)
	Mid-High	0.001	0.001	0.000	0.000	0.002	0.004
		(0.58)	(0.61)	(0.18)	(0.01)	(0.80)	(1.12)
	Highest	-0.000	0.000	-0.002	-0.002	0.002	0.004
		(0.20)	(0.15)	(0.75)	(0.68)	(0.42)	(0.87)

Table A2.3. continued.

District HIV prevalence rate in 1999	0.001	0.001	0.000	0.000	0.001**	0.001*
	(1.86)	(1.60)	(0.22)	(0.61)	(2.72)	(2.13)
District on the line of rail (=1)	-0.003	-0.003	-0.000	-0.001	-0.005	-0.005
	(1.23)	(1.23)	(0.15)	(0.39)	(1.51)	(1.45)
Distance to the nearest tarmac road (km)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.59)	(0.61)	(0.44)	(0.40)	(0.43)	(0.49)
Distance to the district Town/Boma (km)	0.000	0.000	-0.000	0.000	0.000	0.000
	(0.68)	(1.00)	(0.07)	(0.23)	(1.02)	(1.19)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	15126	15120	7411	7408	7715	7712

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ** indicates 1 percent significance level; * indicates 5 percent significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

Table A2.4. Probit Models[a] of PA mortality in 2001-2004 by gender and poverty (income) status (province-fixed effects models): Corrected for attrition

	Deceased Prime-age Adult (=1, 0 otherwise)							
	Income poor (bottom 50%)				Income non-Poor (Top 50%)			
	Male		Female		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Individual Characteristics in 2000								
Head/spouse (=1)	-0.002	-0.003	-0.015*	-0.014*	-0.001	-0.001	0.003	0.004
	(0.44)	(0.62)	(2.39)	(2.49)	(0.35)	(0.40)	(0.62)	(0.80)
Currently married (=1)	-0.008	-0.007	-0.006	-0.006+	-0.007	-0.005	-0.021**	-0.016**
	(1.66)	(1.46)	(1.14)	(1.89)	(1.13)	(0.98)	(3.51)	(3.13)
Never married (=1)	-0.003	-0.002	-0.005	-0.004	-0.003	-0.001	-0.008	-0.005
	(0.57)	(0.33)	(0.91)	(0.69)	(0.40)	(0.11)	(1.21)	(0.84)
Age groups in 2000 (=1)								
Age 20-24	0.016	0.015	0.001	0.000	0.002	-0.000	0.013	0.011
	(1.90)	(1.86)	(0.10)	(0.04)	(0.50)	(0.03)	(1.68)	(1.66)
Age 25-29	0.051**	0.049**	0.028**	0.027**	0.022**	0.018*	0.018	0.022*
	(3.47)	(3.48)	(2.71)	(2.87)	(2.71)	(2.47)	(1.86)	(2.41)
Age 30-34	0.053**	0.049**	0.036**	0.037**	0.011	0.004	0.020	0.022*
	(3.09)	(3.00)	(2.85)	(3.06)	(1.38)	(0.72)	(1.73)	(1.97)
Age 35-39	0.045**	0.043**	0.020	0.018	0.038**	0.031**	0.053**	0.053**
	(2.74)	(2.77)	(1.50)	(1.53)	(2.95)	(2.70)	(2.98)	(3.22)
Age 40-44	0.085**	0.088**	0.032*	0.037**	0.049**	0.043**	0.020	0.019
	(3.60)	(3.70)	(2.28)	(2.68)	(3.59)	(3.53)	(1.49)	(1.61)
Age 45-49	0.110**	0.115**	0.023	0.021	0.050**	0.041**	0.010	0.016
	(3.87)	(4.08)	(1.75)	(1.74)	(3.42)	(3.10)	(0.72)	(1.11)
Age 50-54	0.125**	0.133**	0.007	0.007	0.068**	0.053**	0.018	0.022
	(4.36)	(4.58)	(0.60)	(0.66)	(3.52)	(3.19)	(1.25)	(1.59)
Age 55-59	0.075**	0.078**	0.031*	0.033*	0.110**	0.111**	0.007	0.008
	(3.15)	(3.38)	(2.04)	(2.27)	(5.04)	(5.04)	(0.55)	(0.69)

Table A2.4. continued.

Years of Education in 2000 (=1)								
1-3 years	0.006	0.004	0.002	0.000	0.049*	0.039*	-0.004	-0.004
	(0.78)	(0.67)	(0.29)	(0.09)	(2.32)	(2.18)	(0.62)	(0.76)
4-6 years	0.004	0.002	-0.003	-0.004	0.035*	0.031*	-0.004	-0.003
	(0.76)	(0.52)	(0.69)	(0.96)	(2.31)	(2.28)	(0.68)	(0.70)
7 years	0.013*	0.011	-0.004	-0.004	0.025*	0.021	-0.004	-0.004
	(1.99)	(1.79)	(0.71)	(0.86)	(2.05)	(1.95)	(0.72)	(0.73)
8 years and above	0.010	0.008	0.004	0.003	0.015	0.010	-0.001	-0.004
	(1.55)	(1.32)	(0.52)	(0.50)	(1.65)	(1.35)	(0.17)	(0.84)
Salary wage income in 2000 (=1)	-	0.003	-	-0.006	-	0.009*	-	-0.009
	-	(0.56)	-	(0.65)	-	(2.37)	-	(1.94)
Business activity in 2000 (=1)[b]	-	0.003	-	-0.002	-	0.001	-	0.003
	-	(0.78)	-	(0.39)	-	(0.54)	-	(0.64)
Resided at home throughout	-	-0.017**	-	-0.038**	-	-0.016**	-	-0.041**
the year in 2000	-	(3.17)	-	(4.47)	-	(3.75)	-	(6.26)
One month spent away from	-	-0.002	-	-0.010	-	-0.005	-	-0.011**
home in 2000	-	(0.50)	-	(1.61)	-	(1.53)	-	(3.43)
Household Characteristics in 2000								
Polygamous household (=1)	-0.007	-0.007	-0.001	-0.001	-0.000	-0.000	0.000	0.000
	(1.63)	(1.82)	(0.17)	(0.16)	(0.10)	(0.15)	(0.03)	(0.05)
Prior PA death in 1996 -2003[c]	-	0.118**	-	0.175**	-	0.091**	-	0.112**
	-	(11.26)	-	(15.19)	-	(10.57)	-	(11.57)
ln(Landholding size (hectares)	-0.000	-0.000	-0.003	-0.003	-0.002	-0.001	-0.002	-0.003
	(0.04)	(0.11)	(1.18)	(1.22)	(1.51)	(0.93)	(1.02)	(1.52)
Community characteristics								
District HIV prevalence rate in 1999	-0.000	-0.000	-0.001	-0.001	0.000	0.000	0.002**	0.002**
	(0.34)	(0.30)	(0.82)	(0.95)	(0.78)	(0.88)	(3.27)	(3.73)
District on the line of rail (=1)	0.004	0.003	0.003	0.002	-0.000	-0.001	-0.010*	-0.010*
	(0.78)	(0.64)	(0.47)	(0.29)	(0.05)	(0.21)	(1.98)	(2.19)

Table A2.4. continued.

Distance to the nearest tarmac road (km)	0.000	0.000	-0.000	0.000	0.000	0.000	0.000	0.000
	(0.25)	(0.28)	(0.06)	(0.07)	(0.37)	(0.56)	(0.85)	(0.78)
Distance to the district Town/Boma (km)	0.000	0.000	-0.000	-0.000	0.000	0.000	0.000*	0.000*
	(0.31)	(0.49)	(0.07)	(0.10)	(0.48)	(0.14)	(2.06)	(2.31)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Predicted Probability of dying from disease-related causes[d]	0.008	0.008	0.015	0.013	0.007	0.006	0.013	0.010
Number of observations	3634	3596	3855	3977	3774	3812	3779	3711

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ** indicates 1 percent significance level; * indicates 5 percent significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis. [d]The probability of dying from disease related causes, setting all explanatory variables at their mean values.

Table A2.5. Probit Models[a] of PA mortality in 2001-2004 by gender and poverty (income) status, (village-fixed effects models): Corrected for attrition

	Deceased Prime-age Adult (=1, 0 otherwise)							
	Poor (bottom 50%)				Non-Poor (Top 50%)			
	Male		Female		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Individual Characteristics in 2000								
Head/spouse (=1)	-0.000	-0.000	-0.005	-0.005*	0.000	-0.000	0.001	0.001
	(1.46)	(1.71)	(1.83)	(1.99)	(0.02)	(0.39)	(0.50)	(0.65)
Currently married (=1)	-0.000	-0.000	-0.002	-0.001	-0.004*	-0.002	-0.011**	-0.008**
	(0.12)	(0.15)	(0.78)	(0.91)	(1.99)	(1.69)	(3.26)	(3.19)
Never married (=1)	0.000	0.000	-0.001	-0.000	-0.004	-0.002	-0.003	-0.002
	(0.07)	(0.09)	(0.34)	(0.26)	(1.33)	(0.98)	(1.24)	(0.90)
Age groups in 2000 (=1)								
Age 20-24	0.000**	0.000**	-0.001	-0.000	0.000	-0.000	0.007	0.004
	(3.57)	(3.45)	(0.23)	(0.27)	(0.16)	(0.72)	(1.78)	(1.65)
Age 25-29	0.000**	0.000**	0.014**	0.011**	0.010**	0.007**	0.005	0.007
	(4.86)	(4.77)	(2.64)	(2.75)	(2.83)	(3.11)	(1.21)	(1.82)
Age 30-34	0.000**	0.000**	0.021**	0.018**	0.003	0.000	0.009	0.012
	(4.10)	(3.99)	(2.97)	(3.10)	(1.15)	(0.05)	(1.52)	(1.96)
Age 35-39	0.000**	0.000**	0.011	0.008	0.018**	0.009*	0.035**	0.040**
	(3.05)	(2.79)	(1.59)	(1.58)	(2.76)	(2.52)	(2.84)	(3.37)
Age 40-44	0.000**	0.000**	0.020*	0.021**	0.031**	0.024**	0.008	0.009
	(4.98)	(5.06)	(2.31)	(2.76)	(2.92)	(3.09)	(1.32)	(1.60)
Age 45-49	0.000**	0.000**	0.018*	0.015*	0.019*	0.013*	0.006	0.011
	(5.31)	(5.64)	(2.00)	(2.05)	(2.24)	(2.50)	(0.91)	(1.45)
Age 50-54	0.000**	0.000**	0.001	0.001	0.018*	0.009	0.008	0.012
	(5.36)	(5.47)	(0.19)	(0.27)	(2.05)	(1.84)	(1.06)	(1.59)
Age 55-59	0.000**	0.000**	0.023*	0.023*	0.084**	0.084**	0.006	0.007
	(3.96)	(4.15)	(2.25)	(2.55)	(4.84)	(5.25)	(0.96)	(1.14)

Table A2.5. continued.

Years of Education in 2000 (=1)								
1-3 years	-0.000	-0.000	-0.002	-0.002	0.022	0.013*	-0.003	-0.002
	(0.21)	(0.41)	(1.04)	(1.49)	(1.90)	(1.98)	(1.54)	(1.38)
4-6 years	0.000	-0.000	-0.003	-0.002*	0.016*	0.009*	-0.002	-0.001
	(0.02)	(0.36)	(1.74)	(2.02)	(2.06)	(2.25)	(0.82)	(0.62)
7 years	0.000	0.000	-0.003	-0.003*	0.009	0.005	-0.003	-0.002
	(1.05)	(0.86)	(1.87)	(2.12)	(1.75)	(1.75)	(1.33)	(1.17)
8 years and above	0.000	-0.000	-0.001	-0.001	0.004	0.001	-0.003	-0.003
	(0.08)	(0.15)	(0.53)	(0.32)	(1.20)	(0.89)	(1.37)	(1.74)
Salary wage income in 2000 (=1)	-	-0.000**	-	-0.001	-	0.000	-	0.002
	-	(2.77)	-	(0.43)	-	(0.08)	-	(0.85)
Business activity in 2000 (=1)[b]	-	0.000**	-	0.187**	-	0.115**	-	0.083**
	-	(10.24)	-	(13.73)	-	(9.58)	-	(8.63)
Resided at home throughout	-	-0.000	-	-0.001	-	0.000	-	-0.001
the year in 2000	-	(0.19)	-	(0.97)	-	(0.19)	-	(0.89)
One month spent away from	-	-0.000**	-	-0.015**	-	-0.000	-	0.004*
home in 2000	-	(3.05)	-	(3.50)	-	(0.25)	-	(2.41)
		-0.000		-0.002		0.013*		-0.002
Household Characteristics in 2000	(0.21)	(0.41)	(1.04)	(1.49)	(1.90)	(1.98)	(1.54)	(1.38)
Polygamous household (=1)	0.000	-0.000	-0.003	-0.002*	0.016*	0.009*	-0.002	-0.001
	(0.02)	(0.36)	(1.74)	(2.02)	(2.06)	(2.25)	(0.82)	(0.62)
Prior PA death in 1996 -2003[c]	-	0.000	-	-0.003*	-	0.005	-	-0.002
	-	(0.86)	-	(2.12)	-	(1.75)	-	(1.17)
ln(Landholding size (hectares)	0.000	-0.000	-0.001	-0.001	0.004	0.001	-0.003	-0.003
	(0.08)	(0.15)	(0.53)	(0.32)	(1.20)	(0.89)	(1.37)	(1.74)
Superior roofing material (=1)	-0.000*	-0.000**	-0.001	-0.001	0.000	0.000	0.003	0.002
	(2.50)	(2.77)	(0.20)	(0.43)	(0.14)	(0.08)	(0.88)	(0.85)

Table A2.5. continued.

Superior floor material (=1)	-0.000	-0.000	0.004**	0.003**	0.003*	0.002*	-0.008**	-0.007**
	(0.68)	(0.89)	(3.62)	(3.36)	(2.15)	(2.44)	(2.95)	(2.86)
Standard door frame and door(=1)	0.000*	0.000*	0.003	0.002	0.000	0.000	0.002	0.002
	(2.25)	(2.07)	(1.64)	(1.55)	(0.18)	(0.61)	(0.88)	(1.06)
Superior wall material (=1)	0.000*	0.000*	0.001	0.000	-0.001	-0.001	-0.004	-0.003
	(2.57)	(2.57)	(0.42)	(0.29)	(0.89)	(0.91)	(1.53)	(1.34)
Village dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1786	1786	2261	2261	1992	1992	2093	2093

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. **indicates 1 percent significance level; * indicates 5 percent significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

Table A2.6. Probit Models[a] of PA mortality in 2001-2004 by gender and wealth status (Province-fixed effects models): Not corrected for attrition

	Deceased Prime-age Adult (=1, 0 otherwise)							
	Asset Poor (bottom 50%)				Asset non-Poor (Top 50%)			
	Male		Female		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Individual Characteristics in 2000								
Head/spouse (=1)	-0.005	-0.005	-0.009	-0.007	0.001	0.001	-0.011	-0.009
	(1.14)	(1.27)	(1.74)	(1.46)	(0.23)	(0.23)	(1.79)	(1.76)
Currently married (=1)	-0.008*	-0.006	-0.009*	-0.008*	-0.006	-0.005	-0.010+	-0.008+
	(1.99)	(1.66)	(2.13)	(2.22)	(0.88)	(0.81)	(1.88)	(1.90)
Never married (=1)	-0.007	-0.005	-0.005	-0.004	0.004	0.005	-0.001	0.001
	(1.75)	(1.37)	(1.16)	(0.99)	(0.46)	(0.67)	(0.10)	(0.22)
Age groups in 2000 (=1)								
Age 20-24	0.015	0.010	0.008	0.006	0.005	0.004	0.010	0.009
	(1.95)	(1.65)	(1.17)	(1.14)	(0.93)	(0.77)	(1.61)	(1.61)
Age 25-29	0.023*	0.017*	0.012	0.012	0.035**	0.035**	0.035**	0.037**
	(2.43)	(2.18)	(1.53)	(1.79)	(3.56)	(3.58)	(3.70)	(4.32)
Age 30-34	0.019*	0.012	0.030**	0.031**	0.027**	0.022*	0.031**	0.033**
	(1.98)	(1.64)	(2.77)	(3.03)	(2.62)	(2.32)	(2.69)	(2.98)
Age 35-39	0.026*	0.020*	0.017	0.016	0.035**	0.033**	0.057**	0.059**
	(2.28)	(2.11)	(1.77)	(1.86)	(2.89)	(2.82)	(3.65)	(4.04)
Age 40-44	0.070**	0.062**	0.021	0.023*	0.044**	0.045**	0.031*	0.033**
	(3.28)	(3.25)	(1.89)	(2.21)	(3.70)	(3.73)	(2.56)	(2.93)
Age 45-49	0.065**	0.057**	0.025*	0.024*	0.067**	0.065**	0.005	0.007
	(2.88)	(2.89)	(2.02)	(2.05)	(4.02)	(3.95)	(0.49)	(0.72)
Age 50-54	0.069**	0.061**	0.001	0.002	0.095**	0.091**	0.036*	0.037**
	(3.32)	(3.24)	(0.17)	(0.24)	(3.91)	(3.89)	(2.35)	(2.58)
Age 55-59	0.082**	0.073**	0.019	0.018	0.091**	0.091**	0.026	0.027
	(3.45)	(3.48)	(1.63)	(1.70)	(4.63)	(4.58)	(1.71)	(1.84)

Table A2.6. continued.

Years of Education in 2000 (=1)								
1-3 years	0.002	0.000	0.004	0.003	0.016	0.015	-0.007	-0.007*
	(0.35)	(0.07)	(0.82)	(0.73)	(1.69)	(1.64)	(1.67)	(1.97)
4-6 years	0.002	0.000	-0.002	-0.002	0.011	0.011	-0.008*	-0.007*
	(0.35)	(0.06)	(0.36)	(0.56)	(1.69)	(1.66)	(2.00)	(2.09)
7 years	0.011*	0.007	-0.005	-0.004	0.006	0.005	-0.005	-0.005
	(2.02)	(1.66)	(1.00)	(1.09)	(0.94)	(0.85)	(1.26)	(1.43)
8 years and above	0.003	0.001	0.007	0.006	0.008	0.006	-0.007	-0.007*
	(0.70)	(0.35)	(1.12)	(1.05)	(1.30)	(1.05)	(1.84)	(2.40)
Salary wage income in 2000 (=1)	-	0.006*	-	-0.007	-	0.001	-	-0.007
	-	(2.08)	-	(1.52)	-	(0.32)	-	(1.81)
Business activity in 2000 (=1)[b]	-	0.002	-	-0.001	-	0.002	-	-0.001
	-	(0.92)	-	(0.35)	-	(0.53)	-	(0.26)
Resided at home throughout	-	-0.014**	-	-0.033**	-	-0.014**	-	-0.044**
the year in 2000	-	(3.77)	-	(4.91)	-	(3.68)	-	(6.75)
One month spent away from	-	-0.002	-	-0.009*	-	-0.006	-	-0.009**
home in 2000	-	(0.79)	-	(2.43)	-	(1.40)	-	(2.73)
Household Characteristics in 2000								
Polygamous household (=1)	-0.005	-0.005*	0.001	0.001	-0.001	-0.001	0.001	0.001
	(1.83)	(2.09)	(0.24)	(0.19)	(0.14)	(0.33)	(0.15)	(0.28)
Prior PA death in 1996 -2003[c]	-	0.189**	-	0.191**	-	0.107**	-	0.123**
	-	(13.23)	-	(16.51)	-	(12.50)	-	(11.81)
ln(Landholding size (hectares)	-0.000	-0.000	-0.001	-0.001	-0.002	-0.002	-0.004*	-0.004**
	(0.27)	(0.23)	(0.40)	(0.62)	(1.56)	(1.59)	(2.51)	(2.74)
Community characteristics								
District HIV prevalence rate in 1999	-0.000	-0.000	0.001	0.001	-0.000	-0.000	0.001*	0.001*
	(0.11)	(0.07)	(1.07)	(1.06)	(0.74)	(0.62)	(2.00)	(2.36)
District on the line of rail (=1)	-0.001	-0.001	-0.003	-0.003	-0.000	-0.000	-0.005	-0.006
	(0.34)	(0.57)	(0.59)	(0.56)	(0.02)	(0.06)	(1.30)	(1.70)

Table A2.6. continued.

Distance to the nearest tarmac road (km)	-0.000	-0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.71)	(0.44)	(0.04)	(0.12)	(0.74)	(0.73)	(0.49)	(0.53)
Distance to the district Town/Boma (km)	0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.000*
	(0.06)	(0.03)	(0.07)	(0.12)	(0.26)	(0.15)	(1.75)	(2.05)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Predicted Probability of dying from disease-related causes[d]	0.006	0.005	0.011	0.010	0.007	0.008	0.012	0.010
Number of observations	3596	3596	3977	3977	3812	3812	3711	3711

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ** indicates 1 percent significance level; * indicates 5 percent significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis. [d]The probability of dying from disease related causes, setting all explanatory variables at their mean values.

Table A2.7. Probit Models[a] of PA mortality in 2001-2004 by gender and wealth status, (Village-fixed effects models): Not corrected for attrition

	Deceased Prime-age Adult (=1, 0 otherwise)							
	Poor (bottom 50%)				Non-Poor (Top 50%)			
	Male		Female		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Individual Characteristics in 2000								
Head/spouse (=1)	-0.001*	-0.001*	-0.002	-0.001	-0.000	-0.000	-0.006	-0.005
	(1.84)	(2.29)	(0.95)	(0.74)	(0.11)	(0.06)	(1.69)	(1.88)
Currently married (=1)	-0.001	-0.000	-0.002	-0.002	-0.003	-0.001	-0.005	-0.004
	(1.65)	(1.43)	(1.26)	(1.44)	(0.59)	(0.20)	(1.50)	(1.55)
Never married (=1)	-0.001	-0.000	-0.000	0.000	0.003	0.006	0.000	0.001
	(1.84)	(1.52)	(0.14)	(0.01)	(0.59)	(1.05)	(0.13)	(0.55)
Age groups in 2000 (=1)								
Age 20-24	0.004**	0.002**	0.000	0.000	0.004	0.002	0.009*	0.006*
	(3.33)	(3.05)	(0.06)	(0.02)	(0.95)	(0.68)	(2.33)	(2.30)
Age 25-29	0.015**	0.008**	0.003	0.003	0.028**	0.028**	0.021**	0.021**
	(3.72)	(3.47)	(1.08)	(1.30)	(3.22)	(3.53)	(3.35)	(3.90)
Age 30-34	0.005**	0.002*	0.018**	0.017**	0.027**	0.019**	0.021**	0.022**
	(2.63)	(2.26)	(3.04)	(3.30)	(3.29)	(2.86)	(2.70)	(3.31)
Age 35-39	0.015**	0.008**	0.006	0.006	0.035**	0.029**	0.054**	0.057**
	(3.13)	(2.84)	(1.61)	(1.88)	(2.87)	(2.85)	(3.73)	(4.38)
Age 40-44	0.061**	0.050**	0.007	0.007	0.061**	0.055**	0.016*	0.022**
	(4.44)	(4.56)	(1.42)	(1.84)	(3.49)	(3.54)	(2.08)	(3.00)
Age 45-49	0.072**	0.076**	0.018*	0.017**	0.099**	0.094**	0.004	0.005
	(4.00)	(4.44)	(2.54)	(2.89)	(3.70)	(3.96)	(0.71)	(1.00)
Age 50-54	0.019**	0.017**	-0.002	-0.001	0.111**	0.088**	0.027*	0.032**
	(3.26)	(3.54)	(0.93)	(0.81)	(3.89)	(3.81)	(2.33)	(2.75)
Age 55-59	0.178**	0.170**	0.014*	0.013*	0.118**	0.116**	0.007	0.010
	(4.69)	(4.85)	(2.22)	(2.39)	(5.04)	(5.17)	(1.04)	(1.44)

Table A2.7. continued.

Years of Education in 2000 (=1)								
1-3 years	0.001	0.000	-0.001	-0.001	0.010	0.008	-0.004*	-0.003*
	(1.36)	(1.14)	(0.46)	(0.64)	(1.35)	(1.33)	(2.33)	(2.19)
4-6 years	0.000	0.000	-0.002	-0.002	0.009	0.007	-0.004**	-0.003*
	(0.91)	(0.63)	(1.28)	(1.56)	(1.50)	(1.44)	(2.64)	(2.34)
7 years	0.002*	0.001	-0.002	-0.001	0.003	0.002	-0.005*	-0.003*
	(2.13)	(1.75)	(1.30)	(1.16)	(0.72)	(0.62)	(2.29)	(2.22)
8 years and above	0.000	0.000	0.001	0.001	0.004	0.003	-0.005**	-0.004**
	(0.66)	(0.38)	(0.61)	(0.81)	(0.95)	(0.67)	(3.54)	(3.67)
Salary wage income in 2000 (=1)	-	0.000*	-	-0.002	-	0.001	-	-0.002
	-	(2.12)	-	(1.23)	-	(0.57)	-	(1.78)
Business activity in 2000 (=1)[b]	-	0.000	-	-0.001	-	-0.001	-	0.000
	-	(1.46)	-	(1.54)	-	(0.91)	-	(0.18)
Resided at home throughout	-	-0.001*	-	-0.019**	-	-0.020**	-	-0.035**
the year in 2000	-	(2.57)	-	(4.89)	-	(4.29)	-	(6.16)
One month spent away from	-	0.000	-	-0.002*	-	-0.003	-	-0.003**
home in 2000	-	(0.31)	-	(2.31)	-	(0.93)	-	(2.93)
Household Characteristics in 2000								
Polygamous household (=1)	-0.000	-0.000	0.003	0.002	-0.001	-0.001	0.001	0.001
	(0.18)	(0.51)	(0.88)	(0.68)	(0.19)	(0.28)	(0.24)	(0.46)
Prior PA death in 1996 -2003[c]	-	0.131**	-	0.198**	-	0.142**	-	0.106**
	-	(9.35)	-	(13.54)	-	(9.69)	-	(10.12)
ln(Landholding size (hectares)	0.000	0.000	-0.000	-0.000	-0.003**	-0.003**	-0.002*	-0.001
	(1.79)	(1.53)	(0.63)	(0.77)	(3.33)	(3.04)	(2.02)	(1.92)
Superior roofing material (=1)	-0.000	-0.000	-0.005	-0.002	-0.003	-0.002	0.002	0.002
	(0.79)	(0.68)	(1.58)	(0.93)	(0.88)	(0.81)	(1.06)	(1.12)

Table A2.7. continued.

Superior floor material (=1)	0.000	-0.000	0.003*	0.002*	-0.000	-0.000	-0.002	-0.002
	(0.19)	(0.12)	(2.31)	(2.03)	(0.08)	(0.11)	(0.87)	(1.17)
Standard door frame and door(=1)	0.000	0.000	0.001	0.001	0.003	0.002	-0.000	0.000
	(0.88)	(1.05)	(0.78)	(0.66)	(0.99)	(1.06)	(0.18)	(0.15)
Superior wall material (=1)	-0.000	-0.000	-0.000	-0.000	0.002	0.002	-0.002	-0.001
	(0.65)	(0.10)	(0.09)	(0.16)	(0.85)	(0.75)	(1.10)	(0.84)
Village dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1819	1819	2254	2254	1952	1952	2064	2064

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. **indicates 1 percent significance level; * indicates 5 percent significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

Figure A3.1. Zambia's HIV Prevalence Rates, by Province, 2001-2002.

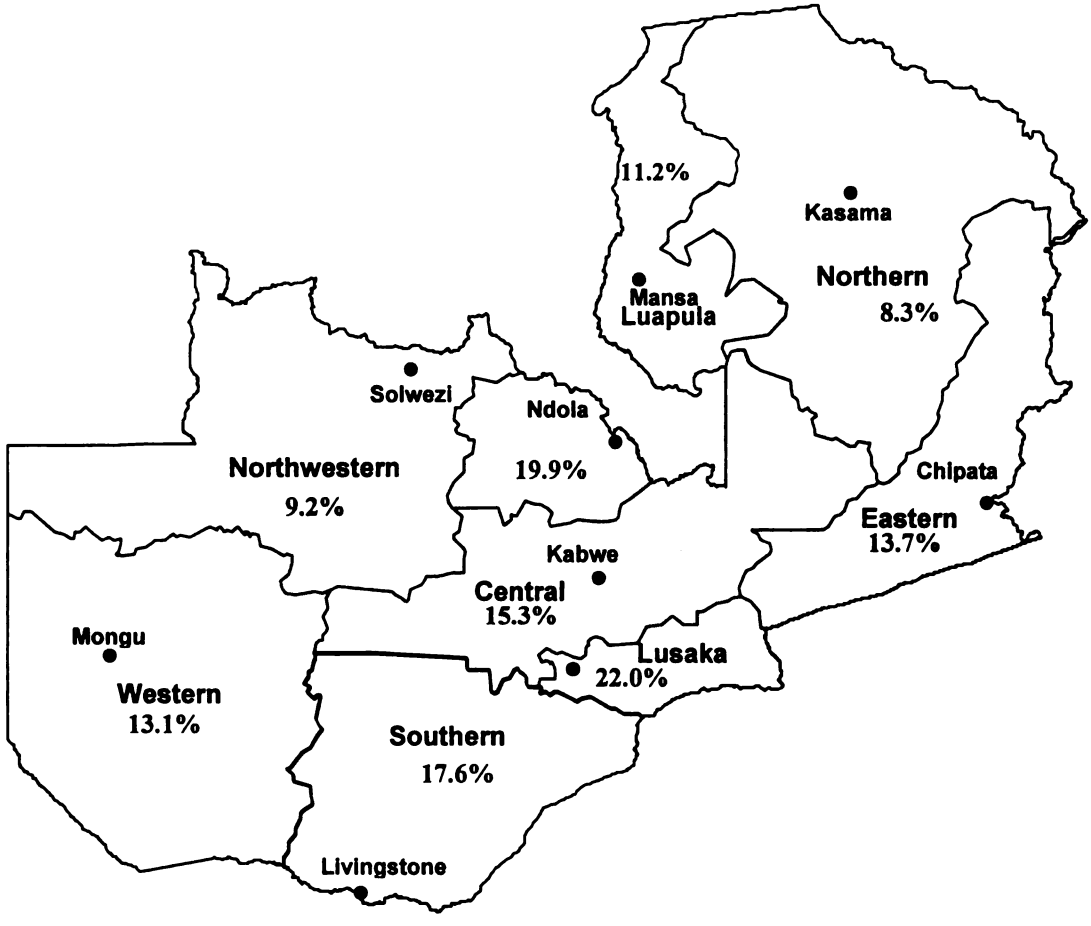


Table A3.1. Mean values by year and whether a household is afflicted by gender of deceased or non-afflicted (1)

	99/00	0304	99/00	0304	99/00	0304	99/00	0304
	Non Afflicted HH		HH with PA death		HH with male death		HH with female death	
	----------Mean value----------							
Household composition								
Effective dependency ratio	1.33	0.99	1.27	0.97	1.31	0.97	1.24	0.97
Household size	5.97	5.88	7.17	6.24	7.20	6.14	7.25	6.41
Male	1.57	1.83	2.01	2.06	2.16	1.90	1.93	2.22
Female	1.62	1.86	2.17	2.15	2.03	2.26	2.31	2.09
Boys	1.34	1.08	1.43	1.02	1.40	1.04	1.45	1.01
Girls	1.43	1.10	1.56	1.02	1.60	0.94	1.56	1.08
Farm production								
Land cultivated	1.91	1.75	2.20	1.81	2.22	1.76	2.25	1.90
Cereals	1.38	1.23	1.66	1.34	1.73	1.28	1.66	1.42
Tubers	0.46	0.39	0.43	0.32	0.38	0.34	0.47	0.30
High value crops	0.07	0.13	0.11	0.15	0.11	0.14	0.12	0.18
Gross value of output ('000 Zkw)	1383.4	1445.2	1495.3	1296.9	1523.0	1328.6	1490.9	1354.3
Gross value of output per ha ('000 Zkw)	927.6	850.9	806.4	744.7	800.1	765.0	790.9	728.6
Land cultivated/adult equivalents ratio	0.65	0.64	0.63	0.66	0.59	0.66	0.68	0.68
Assets and off-farm income								
Values of cattle ('000 Zkw)	766.5	1379.2	1278.0	1580.1	1503.3	1441.7	1542.3	1893.8
Values of small animals ('000 Zkw)	127.3	178.5	145.0	171.3	138.0	154.7	155.2	184.4
Off farm income ('000 Zkw)	991.0	1040.3	1334.7	1271.7	1117.9	1053.4	1491.9	1399.0
Percent with off farm	62.8	51.1	64.6	53.3	61.4	51.6	66.6	54.9
Wealth status in 2000 (% non poor)	50.3		45.6		49.2		41.6	

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Table A3.2. Mean values by year and whether a household is afflicted (by gender and status of deceased) or non-afflicted (2)

	2001	2004	2001	2004	2001	2004	2001	2004	2001	2004
	Non Afflicted HH		HH with male head death		HH with female head or spouse death		HH with other male death		HH with other female death	
			----------Mean value----------							
Household composition										
Effective dependency ratio	1.33	0.99	1.19	0.98	1.00	0.84	1.38	0.97	1.37	1.04
Household size	5.97	5.88	6.07	5.19	6.64	5.69	7.82	6.67	7.72	6.95
Male	1.57	1.83	1.69	1.27	1.82	2.09	2.42	2.25	2.02	2.33
Female	1.62	1.86	1.71	2.04	2.06	1.68	2.21	2.39	2.52	2.36
Boys	1.34	1.08	1.23	0.93	1.36	0.91	1.50	1.08	1.54	1.13
Girls	1.43	1.10	1.44	0.96	1.40	1.02	1.69	0.95	1.64	1.12
Farm production										
Land cultivated	1.91	1.75	1.95	1.28	2.14	1.82	2.37	2.00	2.35	1.98
Cereals	1.38	1.23	1.44	0.93	1.61	1.30	1.89	1.46	1.72	1.51
Tubers	0.46	0.39	0.44	0.28	0.38	0.32	0.35	0.36	0.51	0.28
High value crops	0.07	0.13	0.07	0.06	0.15	0.20	0.12	0.18	0.12	0.20
Gross value of output ('000 Zkw)	1383.4	1445.2	1246.5	994.1	1387.1	1207.8	1666.5	1493.2	1577.5	1503.8
Gross value of output per ha ('000 Zkw)	927.6	850.9	826.2	836.0	818.9	719.7	777.7	725.3	771.4	739.0
Land cultivated/adult equivalents ratio	0.65	0.64	0.60	0.68	0.67	0.75	0.59	0.63	0.68	0.63
Assets and off-farm income										
Values of cattle ('000 Zkw)	766.5	1379.2	555.2	332.2	549.5	1014.9	2085.1	2028.5	2191.5	2479.4
Values of small animals ('000 Zkw)	127.3	178.5	107.8	89.1	142.8	152.3	153.0	188.7	167.3	204.9
Off farm income ('000 Zkw)	991.0	1040.3	1123.2	1590.1	2167.0	1432.1	1140.0	747.1	1034.5	1334.5
Percent with off farm income	62.8	51.1	67.0	59.3	73.0	63.9	59.3	47.9	61.9	48.5
Wealth status in 2000 (% non poor)	50.3		58.2		49.2		44.9		37.6	

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Table A3.3. Descriptive statistics: right hand variables of impact models

Variables	Full sample				Poor				Non poor			
		Percentile				Percentile				Percentile		
	Mean	25	50	75	Mean	25	50	75	Mean	25	50	75
PA male heads/spouses death (=1)	0.017	-	-	-	0.020	-	-	-	0.0142	-	-	-
PA female heads/spouses death (=1)	0.023	-	-	-	0.023	-	-	-	0.0229	-	-	-
PA other males death (=1)	0.031	-	-	-	0.028	-	-	-	0.0345	-	-	-
PA other females death (=1)	0.038	-	-	-	0.028	-	-	-	0.0472	-	-	-
Elderly males death (=1)	0.024	-	-	-	0.022	-	-	-	0.0255	-	-	-
Elderly females death (=1)	0.017	-	-	-	0.015	-	-	-	0.0184	-	-	-
Asset poverty in 2000 (=non poor)	0.499	-	-	-	0.501	-	-	-	0.4993	-	-	-
Land holding size in 2000 (Ha)	3.10	1.06	2.03	4.00	2.47	0.81	1.51	3.03	3.74	1.42	2.63	4.95
Effective dependency ratio in 2000 (number)	1.33	0.60	1.00	1.80	1.29	0.52	1.00	1.78	1.37	0.67	1.12	1.83
Current chronically ill adults (=1)	0.126	-	-	-	0.128	-	-	-	0.124	-	-	-
HIV prevalence rates in 1999 (%)	15.90	13.30	15.90	17.20	15.94	13.20	15.90	17.90	15.87	13.80	15.80	17.10

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Table A3.4. Correlation matrix: First stage regressions variables

	Pdeath	A2s94	a3s94	a4s94	a5s94	a6s94	a7s94	a8s94	a9s94	eldmdth	eldfdth	away	hiv	astpov	lhold	depr
pdeath	1.00															
a2s94	0.02	1.00														
a3s94	0.04	0.03	1.00													
a4s94	0.01	0.06	0.03	1.00												
a5s94	0.00	0.05	0.05	0.02	1.00											
a6s94	0.02	0.00	0.03	0.02	0.06	1.00										
a7s94	0.01	0.01	0.03	0.00	0.00	0.01	1.00									
a8s94	0.00	0.01	0.05	0.00	0.00	0.00	0.00	1.00								
a9s94	0.01	0.05	0.01	0.00	0.00	0.00	0.00	0.00	1.00							
eldmdth	0.03	0.01	0.01	0.02	0.01	-0.01	-0.01	-0.01	-0.01	1.00						
eldfdth	0.02	0.00	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	0.00	0.02	1.00					
away	0.06	0.02	0.05	0.01	0.01	0.05	-0.01	0.02	0.02	0.00	0.00	1.00				
hiv	0.07	0.01	0.03	0.02	0.01	0.01	0.02	0.02	0.01	0.02	-0.01	0.02				
astpov	0.02	0.01	0.01	0.02	0.02	0.03	0.00	0.01	0.00	0.01	0.01	0.06	-0.01	1.00		
lhold	0.04	0.01	0.01	0.00	-0.01	0.00	-0.01	0.00	0.00	0.01	0.02	0.06	-0.14	0.21	1.00	
depr	0.02	-0.01	0.00	0.01	0.01	-0.02	-0.02	0.00	0.01	0.03	0.04	0.03	-0.05	0.04	0.05	1.00

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Key:

Label	Description		Label	Description
a2s94	1994/95 rainfall shock by age group 20-24		eldmdth	Elderly males death (ages 60 and above) (=1)
a3s94	1994/95 rainfall shock by age group 25-29		eldfdth	Elderly males death (ages 60 and above) (=1)
a4s94	1994/95 rainfall shock by age group 30-34		away	Months away from home of all adults in 2000 (number)
a5s94	1994/95 rainfall shock by age group 35-39		hiv	1995 HIV/AIDS prevalence rates (%)
a6s94	1994/95 rainfall shock by age group 40-44		astpov	Household assets poverty status in 2000 (1=non poor, 0=poor)
a794	1994/95 rainfall shock by age group 45-49		lhold	Household landholding size in 2000 (ha)
a8s94	1994/95 rainfall shock by age group 50-54		depr	Effective dependency ratio (number)
a9s94	1994/95 rainfall shock by age group 55-59			

Table A3.5. Correlation matrix: Impact models

	malhdth	Femhdth	modthd	fodthd	eldmdthd	eldfdthd	hiv	lhold	depr	astpov
malhdth	1.00									
femhdth	0.00	1.00								
modthd	0.01	-0.01	1.00							
fodthd	0.03	0.02	0.08	1.00						
eldmdthd	-0.02	-0.02	0.03	0.04	1.00					
eldfdthd	-0.02	-0.02	0.02	0.00	0.02	1.00				
hiv	-0.01	0.06	0.02	0.01	0.02	-0.01	1.00			
lhold	-0.01	-0.01	0.03	0.03	0.01	0.02	-0.14	1.00		
depr	-0.02	-0.05	0.01	0.01	0.03	0.04	-0.05	0.05	1.00	
astpov	-0.02	0.00	0.02	0.05	0.01	0.01	-0.01	0.21	0.04	1.00

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Key:

Label	Description	Label	Description
malhdth	Male heads prime-age death	hiv	1995 HIV/AIDS prevalence rates
femhdth	Female heads/spouses prime-age death	lhold	Household landholding size in 2000 (ha)
modthd	Other females prime-age death	depr	Effective dependency ration (number)
fodthd	Other females prime-age death	astpov	Household assets poverty status in 2000 (1=non poor, 0=poor)
eldmdthd	Elderly males death (ages 60 and above)		
eldfdthd	Elderly females death (ages 60 and above)		

Table A3.6. First stage regression results: Pooled probit[a].

Covariates	Dependent Variables: Death of prime-age adults			
	Heads/Spouses		Other males	Other females
	Male	Female		
	(A)	(B)	(C)	(D)
Excluded variables				
Age group of the deceased				
age 20 to 24	0.002	0.004	0.049**	0.067**
	(0.91)	(1.12)	(5.05)	(6.17)
age 25 to 29	0.008*	0.014**	0.056**	0.049**
	(2.55)	(3.02)	(6.15)	(5.82)
age 30 to 34	0.018**	0.022**	0.039**	0.067**
	(3.70)	(4.46)	(4.93)	(6.88)
age 35 to 39	0.030**	0.025**	0.036**	0.063**
	(5.07)	(4.50)	(4.00)	(6.34)
age 40 to 44	0.009+	0.003	0.047**	0.038**
	(1.81)	(0.95)	(4.03)	(3.45)
age 45 to 49	0.072**	0.044**	0.008	0.025**
	(7.04)	(5.09)	(1.18)	(2.81)
age 50 to 54	0.114**	0.074**	0.009	0.016*
	(7.48)	(6.21)	(1.37)	(2.16)
age 55 to 59	0.067**	0.044**	0.071**	0.073**
	(5.08)	(4.77)	(4.54)	(4.90)
Deviation of 1994 mean rainfall from	0.003	0.007**	0.014**	0.019**
10 year average	(1.35)	(2.97)	(2.62)	(3.93)
Age group and rainfall shock interactions				
1994/95 rainfall shock by age group 20-24	0.001	-0.005	-0.052**	-0.064**
	(0.14)	(0.47)	(4.40)	(5.29)
1994/95 rainfall shock by age group 25-29	-0.008	-0.016**	-0.040**	-0.060**
	(1.35)	(2.82)	(3.85)	(6.00)
1994/95 rainfall shock by age group 30-34	-0.006	-0.020**	-0.058**	-0.043**
	(0.74)	(3.82)	(5.30)	(3.89)
1994/95 rainfall shock by age group 35-39	-0.009+	-0.021**	-0.045**	-0.033**
	(1.65)	(4.33)	(3.26)	(2.95)
1994/95 rainfall shock by age group 40-44	-0.025**	-0.028**	-0.036*	-0.047**
	(3.09)	(3.86)	(2.17)	(2.97)
1994/95 rainfall shock by age group 45-49	-0.015*	-0.026**	-0.046*	-0.035*
	(2.56)	(4.36)	(2.15)	(2.19)
1994/95 rainfall shock by age group 50-54	-0.019**	-0.021**	-0.074**	-0.033+
	(2.59)	(2.66)	(4.23)	(1.82)
1994/95 rainfall shock by age group 55-59	-0.026**	-0.023**	-0.015	-0.022
	(2.79)	(2.69)	(0.65)	(0.94)
Included variables				
1999 HIV/AIDS prevalence rates	-0.000*	0.000	0.000	-0.000
	(2.56)	(1.40)	(1.14)	(0.84)
Landholding size (Ha)	-0.000	-0.000	0.000	0.000
	(1.37)	(1.33)	(1.59)	(0.48)
Asset poverty status (1=non poor, 0=poor)	-0.001*	-0.000	-0.000	0.002*
	(2.50)	(0.47)	(0.21)	(2.10)
Effective dependency ratio(number)	-0.000	-0.001**	0.000	-0.000
	(0.07)	(3.44)	(0.52)	(0.08)

Table A3.6. continued.

Elderly males death (=1)	b	b	-0.000*	0.000
			(2.56)	(1.40)
Elderly females death (=1)	b	b	-0.000	-0.000
			(1.37)	(1.33)
Provincial dummies included	Yes	Yes	Yes	Yes
R-squared	0.113	0.155	0.161	0.164
F-test for instruments				
All excluded variables	147.38**	237.11**	325.19**	273.53**
Observations			10682	

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: [a]Estimated coefficients are marginal changes in probability. Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households in parentheses. + significant at 10%; * significant at 5%; ** significant at 1% [b]Excluded since there was no variation in the dependent variable.

Table A3.7. First stage probit[a] results: for use in the 2nd stage differenced models.

Covariates	Dependent Variables: Death of prime-age adults							
	Heads/Spouses				------Other males-------		------Other females------	
	--------Male---------		---------Female-------					
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Excluded variables								
Age group of the deceased								
age 20 to 24	0.055**	0.055**	0.050+	0.053*	0.382**	0.377**	0.502**	0.501**
	(2.65)	(2.65)	(1.95)	(2.05)	(7.25)	(7.26)	(7.72)	(7.67)
age 25 to 29	0.084**	0.084**	0.120**	0.121**	0.479**	0.470**	0.433**	0.431**
	(4.11)	(4.11)	(3.81)	(3.88)	(8.13)	(8.00)	(8.08)	(8.05)
age 30 to 34	0.111**	0.111**	0.128**	0.135**	0.267**	0.235**	0.402**	0.396**
	(4.46)	(4.44)	(5.23)	(5.33)	(6.49)	(6.17)	(7.25)	(7.14)
age 35 to 39	0.165**	0.165**	0.134**	0.139**	0.239**	0.235**	0.435**	0.436**
	(4.62)	(4.62)	(4.46)	(4.68)	(4.78)	(4.79)	(6.47)	(6.51)
age 40 to 44	0.052+	0.052+	0.025	0.021	0.364**	0.336**	0.383**	0.378**
	(1.72)	(1.72)	(1.25)	(1.12)	(6.14)	(6.08)	(6.20)	(6.15)
age 45 to 49	0.312**	0.312**	0.215**	0.214**	0.013	0.013	0.137**	0.138**
	(5.31)	(5.31)	(4.70)	(4.83)	(0.59)	(0.61)	(3.50)	(3.49)
age 50 to 54	0.530**	0.530**	0.379**	0.404**	0.087*	0.073*	0.124**	0.121**
	(8.17)	(8.14)	(7.28)	(7.38)	(2.49)	(2.22)	(3.36)	(3.32)
age 55 to 59	0.294**	0.294**	0.215**	0.218**	0.341**	0.339**	0.331**	0.330**
	(6.10)	(6.10)	(5.83)	(5.96)	(6.04)	(6.05)	(6.11)	(6.11)
Deviation of 1994 mean rainfall from	-0.011	-0.011	0.000	0.000	-0.015	-0.013	0.000	0.001
10 year average	(1.63)	(1.63)	(0.02)	(0.00)	(1.08)	(0.94)	(0.02)	(0.04)

Table A3.7. continued.

Age group and rainfall shock interactions								
1994/95 rainfall shock by age group 20-24	0.051*	0.051*	0.024	0.025	0.017	0.019	-0.005	-0.005
	(2.17)	(2.17)	(0.92)	(0.99)	(0.59)	(0.72)	(0.18)	(0.16)
1994/95 rainfall shock by age group 25-29	0.017	0.017	0.004	0.003	0.049+	0.048+	-0.003	-0.002
	(1.48)	(1.47)	(0.27)	(0.24)	(1.80)	(1.82)	(0.10)	(0.09)
1994/95 rainfall shock by age group 30-34	0.024	0.024	-0.007	-0.005	-0.013	-0.019	0.019	0.018
	(1.25)	(1.25)	(0.55)	(0.43)	(0.49)	(0.77)	(0.65)	(0.61)
1994/95 rainfall shock by age group 35-39	0.012	0.012	-0.013	-0.012	-0.002	-0.003	0.041	0.041
	(0.83)	(0.83)	(0.97)	(0.94)	(0.06)	(0.09)	(1.32)	(1.33)
1994/95 rainfall shock by age group 40-44	-0.022	-0.022	-0.029	-0.031	0.039	0.035	0.025	0.025
	(0.91)	(0.91)	(1.29)	(1.38)	(1.16)	(1.14)	(0.74)	(0.73)
1994/95 rainfall shock by age group 45-49	0.007	0.007	-0.017	-0.017	-0.066	-0.059	0.003	0.003
	(0.42)	(0.41)	(1.07)	(1.11)	(1.28)	(1.22)	(0.08)	(0.09)
1994/95 rainfall shock by age group 50-54	0.014	0.014	0.002	0.004	-0.053	-0.057	0.019	0.019
	(0.86)	(0.86)	(0.12)	(0.26)	(1.27)	(1.40)	(0.54)	(0.53)
1994/95 rainfall shock by age group 55-59	-0.012	-0.012	-0.010	-0.011	0.071+	0.069+	0.042	0.042
	(0.68)	(0.68)	(0.60)	(0.70)	(1.67)	(1.72)	(0.95)	(0.95)
Prior prime-age death between 1996-2000(=1)	-	-0.000	-	-0.002*	-	0.015**	-	0.002
	-	(0.05)	-	(2.31)	-	(3.97)	-	(0.61)
Included variables								
1999 HIV/AIDS prevalence rates	-0.001**	-0.001**	0.000	0.000+	0.001	0.000	-0.000	-0.000
	(2.69)	(2.70)	(1.48)	(1.66)	(1.43)	(1.24)	(0.64)	(0.65)
Landholding size (Ha)	-0.000	-0.000	-0.000	-0.000	0.001*	0.001*	0.000	0.000
	(1.34)	(1.34)	(1.08)	(0.92)	(2.09)	(1.97)	(0.74)	(0.71)
Asset poverty status (1=non poor, 0=poor)	-0.003**	-0.003**	-0.000	-0.000	-0.000	-0.000	0.006*	0.006*
	(2.65)	(2.64)	(0.39)	(0.43)	(0.15)	(0.20)	(2.48)	(2.49)

Table A3.7. continued.

Effective dependency ratio(number)	-0.000	-0.000	-0.002**	-0.002**	0.001	0.000	0.000	0.000
	(0.19)	(0.19)	(3.49)	(3.41)	(0.59)	(0.63)	(0.18)	(0.19)
Elderly males death (=1)	b	b	b	b	0.003	0.003	0.007	0.007
					(0.49)	(0.48)	(0.88)	(0.87)
Elderly females death (=1)	b	b	b	b	0.028*	0.025*	0.015	0.015
					(2.43)	(2.38)	(1.52)	(1.51)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	44.1	44.1	46.46	46.9	42.6	43.6	50.63	50.7
F-test for instruments								
Prior prime-age death		0.01		0.3		15.7**		5.3*
Age specific and drought shocks	310.1**	303.00**	363.3**	356.7**	468.68**	466.8**	481.5**	472.13**
All excluded variables		328.3**		357.8**		464.6**		465.6**
Observations					5341			

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: [a]Estimated coefficients are marginal changes in probability. Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households in parentheses. + significant at 10%; * significant at 5%; ** significant at 1% [b]Excluded since there was no variation in the dependent variable.

Notes for tables A3.8 to A3.14

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes:

-** 1% level of significance, * 5% level of significance and + 10% level of significance.

-Endogenous variables: Death of prime-age male heads of household, female heads/spouses, other non core males and females.

-Instrumented by:

IV-I: 1994/195 rainfall and age group of the deceased drought shocks.

IV-II: Prior prime-age death in household between 1996 and 2000, 1994/195 rainfall and age group of the deceased drought shocks.

Table A3.8. Tests of endogeneity and overidentifying restrictions of PA mortality on land cultivated and area under cereals

	ln(Land Cultivated)					ln(Area under cereals)				
	Pooled Sample		Differenced Models			Pooled Sample		Differenced Models		
	OLS	IV	OLS	IV-1	IV-II	OLS	IV	OLS-I	IV-I	IV-II
	(A)	(B)	(C)	(D)	(F)	(G)	(H)	(I)	(J)	(L)
PA male heads/spouse death (=1)	-0.215**	-0.074	-0.330**	-0.581+	-0.518+	-0.186*	-0.148	-0.321**	-0.485	-0.420
	(2.83)	(0.23)	(3.53)	(1.88)	(1.70)	(1.98)	(0.45)	(2.79)	(1.33)	(1.19)
PA female heads/spouses death (=1)	0.039	-0.153	-0.015	0.240	0.146	0.004	-0.118	0.031	0.217	0.132
	(0.60)	(0.56)	(0.21)	(0.87)	(0.55)	(0.05)	(0.41)	(0.36)	(0.75)	(0.50)
PA other males death (=1)	0.024	-0.021	-0.046	-0.046	-0.042	0.033	-0.036	-0.095	-0.047	-0.133
	(0.39)	(0.06)	(0.66)	(0.16)	(0.16)	(0.48)	(0.10)	(1.15)	(0.16)	(0.54)
PA other females death (=1)	-0.029	0.236	-0.035	-0.075	-0.057	-0.052	0.240	-0.003	-0.153	-0.072
	(0.52)	(0.87)	(0.55)	(0.32)	(0.26)	(0.88)	(0.81)	(0.05)	(0.64)	(0.33)
Elderly males death (ages ≥60) (=1)	-0.190**	-0.206**	-0.305**	-0.302**	-0.304**	-0.170*	-0.187**	-0.201*	-0.195*	-0.196*
	(2.83)	(3.01)	(3.62)	(3.57)	(3.59)	(2.48)	(2.65)	(2.37)	(2.31)	(2.30)
Elderly females death (ages ≥60) (=1)	0.021	0.016	-0.029	-0.027	-0.028	0.008	0.002	-0.112	-0.111	-0.110
	(0.24)	(0.18)	(0.29)	(0.27)	(0.28)	(0.07)	(0.02)	(0.89)	(0.88)	(0.87)
Lagged HIV/AIDS prevalence rates	-0.012**	-0.011**	-0.010+	-0.011+	-0.010+	-0.012**	-0.011**	-0.012+	-0.013*	-0.012+
	(3.35)	(3.23)	(1.70)	(1.81)	(1.76)	(3.24)	(3.15)	(1.93)	(2.02)	(1.95)
Landholding size (Ha)	0.098**	0.098**	-0.028**	-0.028**	-0.028**	0.094**	0.093**	-0.030**	-0.029**	-0.029**
	(31.75)	(31.48)	(6.20)	(6.19)	(6.20)	(27.73)	(27.54)	(5.83)	(5.78)	(5.77)
Asset poverty (1=non poor, 0=poor)	0.428**	0.427**	-0.179**	-0.181**	-0.180**	0.406**	0.405**	-0.169**	-0.168**	-0.169**
	(26.40)	(26.11)	(6.58)	(6.57)	(6.57)	(22.49)	(22.23)	(5.49)	(5.41)	(5.44)
Effective dependency ratio(number)	-0.010	-0.010	0.005	0.006	0.005	-0.009	-0.009	0.009	0.009	0.009
	(1.44)	(1.50)	(0.42)	(0.51)	(0.47)	(1.07)	(1.10)	(0.66)	(0.73)	(0.70)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.276**	-0.281**	0.298**	0.311**	0.307**	-1.430**	-1.434**	0.225+	0.235+	0.229+
	(4.40)	(4.43)	(2.88)	(2.96)	(2.93)	(21.08)	(20.94)	(1.84)	(1.91)	(1.86)
F-test on prime-age mortality	2.20+	0.76	3.45**	1.67	1.64	1.23	0.69	2.41	1.49	1.42
Durbin-Wu-Hausman chi-sq test		22.26**		0.82	0.38		18.32**		2.09	1.89
Sargan N*R-sq test for Overidentification		14.24		12.72	12.85		9.26		13.36	13.97
Number of observations	10650	10650	5318	5318	5318	10650	10650	5318	5318	5318

Table A3.9. Tests of endogeneity and overidentifying restrictions of PA mortality on area under roots and tubers and other crops

	ln(Area under roots and tubers)					ln(Area under other crops)				
	Pooled Sample		Differenced Models			Pooled Sample		Differenced Models		
	OLS	IV	OLS	IV-1	IV-II	OLS	IV	OLS-I	IV-I	IV-II
	(A)	(B)	(C)	(D)	(F)	(G)	(H)	(I)	(J)	(L)
PA male heads/spouse death (=1)	-0.047*	-0.043	-0.044	0.097	0.104	-0.019	0.009	-0.044*	0.044	0.038
	(2.25)	(0.38)	(1.40)	(0.95)	(0.99)	(1.31)	(0.09)	(2.48)	(0.68)	(0.61)
PA female heads/spouses death (=1)	-0.020	0.015	-0.013	-0.070	-0.088	0.048+	0.068	0.005	0.014	0.019
	(0.92)	(0.18)	(0.44)	(0.73)	(0.90)	(1.84)	(0.77)	(0.23)	(0.31)	(0.40)
PA other males death (=1)	-0.002	0.067	0.038	0.081	0.113	0.010	0.038	-0.010	-0.041	-0.023
	(0.10)	(0.64)	(1.49)	(0.76)	(1.21)	(0.46)	(0.29)	(0.54)	(0.55)	(0.37)
PA other females death (=1)	-0.042*	-0.069	-0.063*	-0.102	-0.119	0.011	0.021	-0.020	-0.014	-0.026
	(2.40)	(0.82)	(2.26)	(1.19)	(1.49)	(0.53)	(0.23)	(1.21)	(0.23)	(0.47)
Elderly males death (ages ≥60) (=1)	-0.032	-0.033	-0.046	-0.044	-0.045	-0.005	-0.006	-0.013	-0.010	-0.010
	(1.44)	(1.48)	(1.45)	(1.40)	(1.41)	(0.29)	(0.37)	(0.67)	(0.54)	(0.54)
Elderly females death (ages ≥60) (=1)	-0.002	-0.004	0.049	0.049	0.048	0.044	0.043	0.021	0.023	0.023
	(0.08)	(0.13)	(1.38)	(1.37)	(1.35)	(1.55)	(1.53)	(0.96)	(1.07)	(1.05)
Lagged HIV/AIDS prevalence rates	0.000	0.000	-0.001	-0.000	-0.000	0.002**	0.002**	-0.003**	-0.003**	-0.003**
	(0.14)	(0.02)	(0.38)	(0.24)	(0.26)	(3.16)	(3.02)	(3.46)	(3.24)	(3.28)
Landholding size (Ha)	0.015**	0.015**	-0.005**	-0.005**	-0.005**	0.010**	0.010**	0.000	0.001	0.001
	(13.25)	(13.18)	(2.61)	(2.58)	(2.60)	(10.05)	(10.00)	(0.35)	(0.42)	(0.41)
Asset poverty (1=non poor, 0=poor)	0.043**	0.043**	-0.046**	-0.045**	-0.045**	0.040**	0.040**	0.014*	0.014**	0.014**
	(6.93)	(6.92)	(4.60)	(4.40)	(4.38)	(11.89)	(11.66)	(2.57)	(2.58)	(2.62)
Effective dependency ratio(number)	0.003	0.003	-0.002	-0.002	-0.002	-0.005**	-0.005**	-0.002	-0.001	-0.001
	(0.97)	(0.99)	(0.39)	(0.41)	(0.44)	(3.87)	(3.78)	(0.81)	(0.68)	(0.68)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.519**	0.520**	0.022	0.017	0.018	-0.063**	-0.063**	0.052**	0.047**	0.048**
	(29.66)	(29.16)	(0.73)	(0.55)	(0.57)	(5.60)	(5.52)	(3.13)	(2.80)	(2.84)
F-test on prime-age mortality	3.17*	0.24	2.72*	0.78	1.14	1.28	0.81	1.99+	0.67	0.62
Durbin-Wu-Hausman chi-sq test		6.17		2.64	3.06		19.41*		5.41	5.51
Sargan N*R-sq test for Overidentification		5.21		6.82	7.25		8.15		9.43	9.57
Number of observations	10650	10650	5318	5318	5318	10650	10650	5318	5318	5318

Table A3.10. Tests of endogeneity and overidentifying restrictions of PA mortality on values of gross output and gross output per hectare

	ln(Values of gross output)					ln(Values of gross output/ha)				
	Pooled Sample		Differenced Models			Pooled Sample		Differenced Models		
	OLS	IV	OLS	IV-1	IV-II	OLS	IV	OLS-I	IV-I	IV-II
	(A)	(B)	(C)	(D)	(F)	(G)	(H)	(I)	(J)	(L)
PA male heads/spouse death (=1)	-0.166	0.441	-0.255*	-0.049	-0.085	-0.206	0.113+	0.080	0.441	0.345
	(1.62)	(0.96)	(2.35)	(0.12)	(0.21)	(1.05)	(1.74)	(0.77)	(1.29)	(1.03)
PA female heads/spouses death (=1)	-0.080	-0.728+	-0.092	-0.104	0.016	-0.464*	-0.571*	-0.068	-0.262	-0.054
	(0.85)	(1.96)	(0.94)	(0.27)	(0.04)	(2.30)	(2.04)	(0.69)	(0.72)	(0.15)
PA other males death (=1)	-0.106	0.079	-0.064	0.198	-0.095	-0.156	-0.600	-0.039	0.206	-0.068
	(1.32)	(0.16)	(0.74)	(0.49)	(0.29)	(1.30)	(1.21)	(0.48)	(0.54)	(0.21)
PA other females death (=1)	-0.115	-0.043	-0.078	-0.319	-0.144	-0.153	0.767	-0.019	-0.194	-0.053
	(1.51)	(0.11)	(0.90)	(0.98)	(0.49)	(1.30)	(0.70)	(0.23)	(0.62)	(0.19)
Elderly males death (ages ≥60) (=1)	-0.152	-0.167+	-0.162+	-0.155	-0.153	-0.031	-0.035	0.120	0.123	0.127
	(1.64)	(1.78)	(1.67)	(1.58)	(1.56)	(0.25)	(0.26)	(1.41)	(1.41)	(1.48)
Elderly females death (ages ≥60) (=1)	-0.015	-0.025	-0.030	-0.032	-0.025	0.132	0.163	-0.019	-0.022	-0.014
	(0.13)	(0.21)	(0.31)	(0.32)	(0.25)	(1.38)	(1.47)	(0.19)	(0.21)	(0.13)
Lagged HIV/AIDS prevalence rates	0.005	0.006	-0.017*	-0.018*	-0.017*	-0.144*	-0.141+	-0.008	-0.008	-0.008
	(1.17)	(1.29)	(2.57)	(2.57)	(2.54)	(2.16)	(1.94)	(1.26)	(1.20)	(1.20)
Landholding size (Ha)	0.115**	0.115**	-0.034**	-0.034**	-0.034**	-0.019	-0.004	-0.007	-0.007	-0.007
	(30.57)	(30.21)	(6.72)	(6.67)	(6.64)	(1.64)	(0.33)	(1.43)	(1.43)	(1.37)
Asset poverty (1=non poor, 0=poor)	0.542**	0.544**	-0.113**	-0.109**	-0.112**	0.407**	0.432**	0.068*	0.073*	0.070*
	(27.14)	(26.93)	(3.48)	(3.33)	(3.41)	(9.93)	(9.10)	(2.13)	(2.26)	(2.17)
Effective dependency ratio(number)	-0.012	-0.013	0.006	0.007	0.007	0.907	0.409	0.002	0.001	0.003
	(1.46)	(1.59)	(0.46)	(0.46)	(0.52)	(0.11)	(0.05)	(0.14)	(0.10)	(0.18)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.144**	0.133**	0.361**	0.359**	0.353**	0.521**	0.257**	0.073	0.063	0.061
	(35.35)	(24.36)	(2.93)	(2.88)	(2.85)	(4.63)	(4.51)	(0.63)	(0.54)	(0.52)
F-test on prime-age mortality	1.97+	1.34	2.00*	0.81	0.75	256.3**	51.81**	0.34	0.54	0.62
Durbin-Wu-Hausman chi-sq test		5.26		1.32	1.23		9.46+		2.05	5.51
Sargan N*R-sq test for Overidentification		7.14		3.71	3.96		4.28		2.14	3.22
Number of observations	10446	10446	5123	5123	5123	10682	10682	5120	5120	5120

Table A3.11. Tests of endogeneity and overidentifying restrictions of PA mortality on values of cattle and small animals

	ln(Values of cattle)					ln(Values of small animals)				
	Pooled Sample		Differenced Models			Pooled Sample		Differenced Models		
	OLS	IV	OLS	IV-1	IV-II	OLS	IV	OLS-I	IV-I	IV-II
	(A)	(B)	(C)	(D)	(F)	(G)	(H)	(I)	(J)	(L)
PA male heads/spouse death (=1)	-0.523*	-1.203	-0.397+	-0.463	-0.129	-0.334	2.207+	-0.839**	0.162	0.479
	(2.09)	(0.89)	(1.74)	(0.53)	(0.15)	(1.50)	(1.88)	(3.37)	(0.16)	(0.48)
PA female heads/spouses death (=1)	-0.108	0.266	-0.026	0.614	0.065	-0.288	-2.217*	-0.346	-0.285	-0.927
	(0.42)	(0.23)	(0.11)	(0.72)	(0.08)	(1.38)	(2.11)	(1.38)	(0.32)	(1.03)
PA other males death (=1)	0.077	2.488	-0.258	-1.014	-0.749	0.063	0.068	-0.024	-0.889	-0.177
	(0.32)	(1.62)	(1.18)	(1.07)	(0.97)	(0.37)	(0.06)	(0.12)	(1.01)	(0.23)
PA other females death (=1)	0.303	-1.077	-0.158	0.068	0.003	-0.024	0.137	-0.316+	-0.099	-0.442
	(1.30)	(0.90)	(0.77)	(0.10)	(0.01)	(0.16)	(0.17)	(1.85)	(0.15)	(0.70)
Elderly males death (ages ≥60) (=1)	0.303	0.283	-0.342	-0.317	-0.328	-0.266	-0.277	-0.343	-0.309	-0.323
	(1.09)	(1.00)	(1.13)	(1.04)	(1.08)	(1.43)	(1.47)	(1.41)	(1.25)	(1.32)
Elderly females death (ages ≥60) (=1)	0.245	0.184	-0.137	-0.109	-0.120	0.450*	0.447*	0.087	0.123	0.100
	(0.72)	(0.54)	(0.43)	(0.34)	(0.37)	(2.26)	(2.22)	(0.35)	(0.49)	(0.40)
Lagged HIV/AIDS prevalence rates	-0.067**	-0.070**	-0.043**	-0.043**	-0.042**	-0.030**	-0.026**	-0.024	-0.021	-0.021
	(6.73)	(6.83)	(3.28)	(3.19)	(3.14)	(3.58)	(3.13)	(1.62)	(1.41)	(1.39)
Landholding size (Ha)	0.211**	0.209**	0.039**	0.040**	0.040**	0.086**	0.087**	0.070**	0.072**	0.071**
	(19.48)	(19.09)	(2.72)	(2.79)	(2.78)	(13.88)	(13.77)	(6.75)	(6.88)	(6.81)
Asset poverty (1=non poor, 0=poor)	1.899**	1.906**	-0.807**	-0.813**	-0.809**	1.701**	1.710**	-1.283**	-1.280**	-1.272**
	(33.78)	(33.34)	(9.37)	(9.35)	(9.34)	(40.63)	(39.94)	(17.29)	(17.06)	(17.00)
Effective dependency ratio(number)	0.005	0.004	0.049	0.053	0.050	0.031+	0.027	0.001	0.004	-0.000
	(0.20)	(0.18)	(1.26)	(1.36)	(1.29)	(1.83)	(1.59)	(0.02)	(0.12)	(0.01)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.086	0.136	0.773**	0.757**	0.748**	2.663**	2.605**	0.790**	0.724**	0.729**
	(0.50)	(0.78)	(3.38)	(3.25)	(3.24)	(17.91)	(17.27)	(2.97)	(2.69)	(2.71)
F-test on prime-age mortality	1.51	1.04	1.41	1.23	0.94	1.08	1.19	4.30*	1.96+	1.98+
Durbin-Wu-Hausman chi-sq test		20.11**		1.49	0.77		10.4*		4.22	2.99
Sargan N*R-sq test for Overidentification		5.12		6.72	7.85		8.90		7.59	8.12
Number of observations	10446	10446	5123	5123	5123	10682	10682	5120	5120	5120

Table A3.12. Tests of endogeneity and overidentifying restrictions of PA mortality on values of household size and off-farm income

	Household size (number)					In(Off-farm income)				
	Pooled Sample		Differenced Models			Pooled Sample		Differenced Models		
	OLS	IV	OLS	IV-1	IV-II	OLS	IV	OLS-I	IV-I	IV-II
	(A)	(B)	(C)	(D)	(F)	(G)	(H)	(I)	(J)	(L)
PA male heads/spouse death (=1)	-0.730**	-0.377	-0.810**	-0.412	-0.510	0.422	-1.035	0.276	-1.483	-1.535
	(2.60)	(0.20)	(3.02)	(0.35)	(0.44)	(1.23)	(0.68)	(0.72)	(1.03)	(1.05)
PA female heads/spouses death (=1)	-0.327	-0.416	-0.933*	-1.757	-1.340	0.472+	1.001	0.258	-0.049	0.180
	(1.01)	(0.28)	(2.52)	(1.43)	(1.25)	(1.65)	(0.84)	(0.79)	(0.04)	(0.13)
PA other males death (=1)	0.351	-0.157	-0.857**	-0.066	-1.218	-0.233	-1.888	0.030	-1.288	-1.912
	(1.27)	(0.08)	(2.91)	(0.05)	(1.00)	(0.92)	(1.27)	(0.09)	(0.92)	(1.52)
PA other females death (=1)	0.581*	2.242	-0.419+	-0.847	-0.150	-0.458*	1.278	-0.104	1.664	2.038+
	(1.98)	(1.46)	(1.72)	(0.81)	(0.15)	(2.06)	(1.09)	(0.39)	(1.40)	(1.77)
Elderly males death (ages ≥60) (=1)	-1.022**	-1.108**	-0.741*	-0.755*	-0.747*	-1.078**	-1.125**	-0.255	-0.337	-0.332
	(3.14)	(3.42)	(2.24)	(2.28)	(2.25)	(4.13)	(4.14)	(0.78)	(1.00)	(0.97)
Elderly females death (ages ≥60) (=1)	0.033	0.015	-0.433	-0.459	-0.429	-0.075	-0.058	0.473	0.462	0.478
	(0.09)	(0.04)	(1.25)	(1.32)	(1.24)	(0.23)	(0.18)	(1.23)	(1.22)	(1.27)
Lagged HIV/AIDS prevalence rates	-0.003	-0.002	-0.028	-0.027	-0.026	0.095**	0.095**	-0.039+	-0.038	-0.038
	(0.22)	(0.16)	(1.55)	(1.48)	(1.41)	(6.77)	(6.64)	(1.65)	(1.57)	(1.54)
Landholding size (Ha)	0.210**	0.209**	-0.092**	-0.092**	-0.091**	-0.026*	-0.026*	-0.061**	-0.063**	-0.062**
	(14.98)	(14.82)	(5.50)	(5.52)	(5.50)	(2.25)	(2.24)	(3.39)	(3.41)	(3.35)
Asset poverty (1=non poor, 0=poor)	1.123**	1.114**	-0.224**	-0.214*	-0.225**	0.137*	0.121+	0.021	-0.012	-0.018
	(18.81)	(18.39)	(2.67)	(2.50)	(2.64)	(2.05)	(1.79)	(0.19)	(0.11)	(0.16)
Effective dependency ratio(number)	0.424**	0.424**	-0.426**	-0.431**	-0.428**	-0.021	-0.020	-0.045	-0.049	-0.047
	(14.06)	(13.96)	(10.68)	(10.63)	(10.60)	(0.77)	(0.73)	(1.00)	(1.07)	(1.03)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.165**	4.143**	1.337**	1.341**	1.312**	2.521**	2.526**	-0.041	-0.013	-0.029
	(18.77)	(18.05)	(4.22)	(4.16)	(4.07)	(10.21)	(10.03)	(0.10)	(0.03)	(0.07)
F-test on prime-age mortality	3.31*	2.40*	7.63**	3.28*	3.28*	2.32+	0.60	0.31	0.88	1.13
Durbin-Wu-Hausman chi-sq test		29.26**		1.80	0.65		5.01		7.53	8.61
Sargan N*R-sq test for Overidentification		5.01		7.57	3.16		11.99		9.30	9.38
Number of observations	10682	10682	5341	5341	5341	10682	10682	5341	5341	5341

Table A3.13. Tests of endogeneity and overidentifying restrictions of PA mortality on number of males and females

	Males (number)					Females (number)				
	Pooled Sample		Differenced Models			Pooled Sample		Differenced Models		
	OLS	IV	OLS	IV-1	IV-II	OLS	IV	OLS-I	IV-I	IV-II
	(A)	(B)	(C)	(D)	(F)	(G)	(H)	(I)	(J)	(L)
PA male heads/spouse death (=1)	-0.479**	-1.186	-0.670**	-0.895*	-0.954*	0.232*	1.734*	0.123	0.954*	0.952+
	(3.69)	(1.40)	(4.58)	(1.97)	(2.15)	(2.03)	(2.32)	(1.15)	(1.99)	(1.92)
PA female heads/spouses death (=1)	0.262*	0.674	0.057	0.012	0.233	-0.191	-0.697	-0.582**	-1.171**	-1.090*
	(2.03)	(1.09)	(0.47)	(0.03)	(0.56)	(1.37)	(1.21)	(4.41)	(2.71)	(2.48)
PA other males death (=1)	0.367**	1.088	-0.432**	0.484	-0.039	0.487**	-0.118	-0.008	-0.036	-0.362
	(3.14)	(1.33)	(3.94)	(1.00)	(0.09)	(4.11)	(0.15)	(0.08)	(0.07)	(0.82)
PA other females death (=1)	0.426**	0.201	0.132	-0.497	-0.192	0.432**	1.121+	-0.393**	-0.233	-0.028
	(3.66)	(0.36)	(1.42)	(1.28)	(0.55)	(4.04)	(1.92)	(4.22)	(0.61)	(0.08)
Elderly males death (ages ≥60) (=1)	-0.195	-0.215+	-0.756**	-0.758**	-0.753**	0.233+	0.221+	-0.064	-0.071	-0.069
	(1.63)	(1.75)	(5.72)	(5.57)	(5.61)	(1.81)	(1.68)	(0.49)	(0.53)	(0.52)
Elderly females death (ages ≥60) (=1)	0.389**	0.366**	0.077	0.055	0.069	0.231	0.245	-0.488**	-0.487**	-0.479**
	(3.08)	(2.78)	(0.63)	(0.44)	(0.56)	(1.51)	(1.58)	(3.24)	(3.24)	(3.16)
Lagged HIV/AIDS prevalence rates	0.008	0.007	-0.001	-0.003	-0.002	-0.005	-0.003	-0.014*	-0.012+	-0.011+
	(1.55)	(1.20)	(0.09)	(0.35)	(0.29)	(1.08)	(0.65)	(2.18)	(1.80)	(1.71)
Landholding size (Ha)	0.082**	0.082**	-0.009	-0.010	-0.009	0.061**	0.062**	-0.007	-0.007	-0.007
	(16.32)	(16.05)	(1.37)	(1.48)	(1.42)	(11.14)	(11.06)	(1.11)	(1.07)	(1.02)
Asset poverty (1=non poor, 0=poor)	0.482**	0.481**	-0.019	-0.012	-0.017	0.243**	0.243**	0.011	0.015	0.012
	(19.50)	(19.21)	(0.58)	(0.35)	(0.51)	(10.62)	(10.36)	(0.33)	(0.46)	(0.36)
Effective dependency ratio(number)	-0.083**	-0.083**	0.168**	0.167**	0.168**	-0.069**	-0.069**	0.105**	0.102**	0.103**
	(5.94)	(5.86)	(7.36)	(7.14)	(7.27)	(7.09)	(6.96)	(7.73)	(7.49)	(7.52)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.116**	1.141**	0.016	0.053	0.041	1.580**	1.536**	0.341**	0.301**	0.292*
	(11.96)	(11.76)	(0.13)	(0.41)	(0.32)	(19.37)	(18.29)	(3.04)	(2.64)	(2.54)
F-test on prime-age mortality	9.02**	3.60**	9.40**	2.95*	2.85*	10.41**	7.86**	10.13**	3.78**	3.50**
Durbin-Wu-Hausman chi-sq test		22.69**		7.19	2.37		22.87**		6.04	6.88
Sargan N*R-sq test for Overidentification		8.91		5.02	7.67		5.85		8.15	8.72
Number of observations	10682	10682	5341	5341	5341	10682	10682	5341	5341	5341

Table A3.14. Tests of endogeneity and overidentifying restrictions of PA mortality on number of boys and girls

	Boys (number)					Girls (number)				
	Pooled Sample		Differenced Models			Pooled Sample		Differenced Models		
	OLS	IV	OLS	IV-1	IV-II	OLS	IV	OLS-I	IV-I	IV-II
	(A)	(B)	(C)	(D)	(F)	(G)	(H)	(I)	(J)	(L)
PA male heads/spouse death (=1)	-0.730**	-0.377	-0.810**	-0.412	-0.510	0.422	-1.035	0.276	-1.483	-1.535
	(2.60)	(0.20)	(3.02)	(0.35)	(0.44)	(1.23)	(0.68)	(0.72)	(1.03)	(1.05)
PA female heads/spouses death (=1)	-0.327	-0.416	-0.933*	-1.757	-1.340	0.472+	1.001	0.258	-0.049	0.180
	(1.01)	(0.28)	(2.52)	(1.43)	(1.25)	(1.65)	(0.84)	(0.79)	(0.04)	(0.13)
PA other males death (=1)	0.351	-0.157	-0.857**	-0.066	-1.218	-0.233	-1.888	0.030	-1.288	-1.912
	(1.27)	(0.08)	(2.91)	(0.05)	(1.00)	(0.92)	(1.27)	(0.09)	(0.92)	(1.52)
PA other females death (=1)	0.581*	2.242	-0.419+	-0.847	-0.150	-0.458*	1.278	-0.104	1.664	2.038+
	(1.98)	(1.46)	(1.72)	(0.81)	(0.15)	(2.06)	(1.09)	(0.39)	(1.40)	(1.77)
Elderly males death (ages ≥60) (=1)	-1.022**	-1.108**	-0.741*	-0.755*	-0.747*	-1.078**	-1.125**	-0.255	-0.337	-0.332
	(3.14)	(3.42)	(2.24)	(2.28)	(2.25)	(4.13)	(4.14)	(0.78)	(1.00)	(0.97)
Elderly females death (ages ≥60) (=1)	0.033	0.015	-0.433	-0.459	-0.429	-0.075	-0.058	0.473	0.462	0.478
	(0.09)	(0.04)	(1.25)	(1.32)	(1.24)	(0.23)	(0.18)	(1.23)	(1.22)	(1.27)
Lagged HIV/AIDS prevalence rates	-0.003	-0.002	-0.028	-0.027	-0.026	0.095**	0.095**	-0.039+	-0.038	-0.038
	(0.22)	(0.16)	(1.55)	(1.48)	(1.41)	(6.77)	(6.64)	(1.65)	(1.57)	(1.54)
Landholding size (Ha)	0.210**	0.209**	-0.092**	-0.092**	-0.091**	-0.026*	-0.026*	-0.061**	-0.063**	-0.062**
	(14.98)	(14.82)	(5.50)	(5.52)	(5.50)	(2.25)	(2.24)	(3.39)	(3.41)	(3.35)
Asset poverty (1=non poor, 0=poor)	1.123**	1.114**	-0.224**	-0.214*	-0.225**	0.137*	0.121+	0.021	-0.012	-0.018
	(18.81)	(18.39)	(2.67)	(2.50)	(2.64)	(2.05)	(1.79)	(0.19)	(0.11)	(0.16)
Effective dependency ratio(number)	0.424**	0.424**	-0.426**	-0.431**	-0.428**	-0.021	-0.020	-0.045	-0.049	-0.047
	(14.06)	(13.96)	(10.68)	(10.63)	(10.60)	(0.77)	(0.73)	(1.00)	(1.07)	(1.03)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.165**	4.143**	1.337**	1.341**	1.312**	2.521**	2.526**	-0.041	-0.013	-0.029
	(18.77)	(18.05)	(4.22)	(4.16)	(4.07)	(10.21)	(10.03)	(0.10)	(0.03)	(0.07)
F-test on prime-age mortality	3.02*	1.09	1.57	1.40	1.21	6.62**	1.44	2.47+	2.89*	2.67*
Durbin-Wu-Hausman chi-sq test		29.26**		1.80	0.65		14.56**		5.85	6.09
Sargan N*R-sq test for Overidentification		5.01		7.57	3.16		4.76		8.69	8.71
Number of observations	10682	10682	5341	5341	5341	10682	10682	5341	5341	5341

Table A3.15. The impact of PA mortality on HH composition by gender and position in HH by poverty status: Not corrected for attrition

Covariates	Δ Household size		Change in number of: Males		Females		Boys		Girls	
	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor
Prime-age (PA) adult mortality										
Male head/spouse	-0.969**	-0.375	-0.645**	-0.751*	0.256+	-0.071	-0.327+	0.419	-0.253	0.028
	(3.39)	(0.71)	(4.61)	(2.53)	(1.76)	(0.46)	(1.79)	(1.56)	(1.45)	(0.13)
Female head/spouse	-0.702+	-0.942	0.144	-0.150	-0.605**	-0.660**	-0.194	-0.125	-0.047	-0.008
	(1.69)	(1.50)	(0.80)	(0.90)	(3.58)	(3.16)	(1.15)	(0.57)	(0.26)	(0.03)
Male non-head/spouse	-0.684*	-1.168*	-0.212	-0.601**	-0.077	0.035	-0.199	-0.085	-0.196	-0.516*
	(2.09)	(2.46)	(1.51)	(3.63)	(0.53)	(0.21)	(1.25)	(0.52)	(1.15)	(2.45)
Female non-head/spouse	-0.195	-0.631*	0.310*	0.030	-0.333*	-0.421**	-0.103	-0.117	-0.069	-0.124
	(0.52)	(2.01)	(2.18)	(0.25)	(2.29)	(3.43)	(0.71)	(0.89)	(0.50)	(0.82)
Elderly mortality										
Elderly males	-1.159**	-0.528	-0.690**	-0.744**	-0.256+	0.143	0.061	0.238	-0.273+	-0.165
	(3.29)	(0.96)	(3.89)	(4.07)	(1.81)	(0.67)	(0.36)	(1.37)	(1.74)	(0.76)
Elderly females	-0.329	-0.887	0.258+	0.010	-0.527*	-0.399+	0.153	-0.317	-0.213	-0.181
	(0.84)	(1.57)	(1.67)	(0.06)	(2.58)	(1.83)	(0.78)	(1.34)	(1.01)	(0.79)
Constant	0.085	-0.013	0.210**	0.102	0.247**	0.211**	-0.200**	-0.135	-0.173**	-0.192+
	(0.82)	(0.07)	(4.57)	(1.31)	(6.46)	(2.58)	(3.71)	(1.39)	(3.10)	(1.93)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Joint tests for										
Prime-age mortality	5.01**	3.78*	6.91**	5.14**	5.53**	5.69**	1.83	0.91	1.00	1.87+
Elderly mortality	5.81**	1.84	9.08**	8.31**	5.06**	1.85	0.37	1.70	2.05+	0.64
R-squared	0.20	0.17	0.19	0.18	0.17	0.15	0.18	0.16	0.18	0.16
Number of observations	2653	2655	2653	2655	2653	2655	2653	2655	2653	2655

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance

Table A3.16. The impact of PA mortality on cultivated land by gender and position in household: Not corrected for attrition

Covariates	Δ ln(Area cultivated)		Change in natural log of area under (ha):					
			Cereals[a]		Tubers and root crops[b]		High-value crops[c]	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Prime-age (PA) adult mortality								
Male	-0.14*		-0.17*		0.01		-0.02+	
	(2.46)		(2.47)		(0.45)		(1.73)	
Female	-0.05		-0.01		-0.05*		-0.01	
	(0.96)		(0.22)		(2.34)		(0.88)	
Male head/spouse		-0.30**		-0.23*		-0.04		-0.04*
		(3.18)		(2.54)		(1.20)		(2.49)
Female head/spouse		-0.02		-0.02+		-0.01		0.00
		(0.31)		(1.90)		(0.43)		(0.17)
Male non-head/spouse		-0.07		-0.12*		0.03		-0.01
		(0.93)		(2.16)		(1.36)		(0.59)
Female non-head/spouse		-0.07		-0.04		-0.07*		-0.02
		(1.01)		(0.53)		(2.45)		(1.12)
Elderly mortality								
Elderly males	-0.31**	-0.31**	-0.21*	-0.21*	-0.05	-0.05	-0.01	-0.01
	(3.64)	(3.68)	(2.40)	(2.44)	(1.50)	(1.50)	(0.71)	(0.71)
Elderly females	-0.04	-0.04	-0.12	-0.12	0.04	0.04	0.02	0.02
	(0.39)	(0.43)	(0.94)	(0.96)	(1.26)	(1.25)	(1.03)	(1.01)
Constant	0.03	0.03	-0.10	-0.10	-0.01	-0.01	0.00	0.00
	(0.78)	(0.83)	(1.56)	(1.55)	(0.85)	(0.85)	(1.45)	(1.45)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on Mortality	3.76*	3.23*	3.18+	2.38+	2.80+	2.42*	1.80	1.96+
R-squared	0.20	0.20	0.19	0.19	0.25	0.25	0.18	0.18
Number of observations	5305 Households							

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Cereals include: maize, millet, wheat, sorghum and all other minor food crops. [b]Root crops include cassava, sweet potatoes. [c]High value crops include cotton, sunflower, coffee, tobacco, Irish potato, vegetables and fruits.

Table A3.17. The impact of PA mortality on cultivated land by gender and position in HH by poverty status: Not corrected for attrition

Covariates	Δ ln(Area cultivated)		Change in natural log of area under (ha):					
			Cereals[a]		Tubers and root crops[b]		high-value crops[c]	
	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor
Prime-age (PA) adult mortality								
Male head/spouse	-0.214+	-0.465**	-0.123	-0.525**	-0.079+	0.011	-0.037**	-0.052
	(1.73)	(3.48)	(0.79)	(3.37)	(1.78)	(0.26)	(2.60)	(1.40)
Female head/spouse	-0.047	0.004	-0.010	0.058	0.009	-0.043	0.003	-0.004
	(0.46)	(0.03)	(0.07)	(0.49)	(0.25)	(0.95)	(0.25)	(0.10)
Male non-head/spouse	0.006	-0.137+	0.008	-0.230*	0.039	0.032	0.018	-0.034
	(0.05)	(1.71)	(0.06)	(2.29)	(0.90)	(1.10)	(1.17)	(1.14)
Female non-head/spouse	0.041	-0.082	0.020	-0.025	0.021	-0.118**	-0.005	-0.028
	(0.35)	(1.09)	(0.16)	(0.32)	(0.51)	(3.20)	(0.33)	(1.16)
Elderly mortality								
Elderly males	-0.511**	-0.124	-0.283+	-0.141	-0.110*	0.006	-0.007	-0.021
	(3.77)	(1.20)	(1.88)	(1.37)	(2.15)	(0.17)	(0.44)	(0.64)
Elderly females	-0.154	0.048	-0.265	-0.019	0.028	0.053	-0.000	0.037
	(1.10)	(0.35)	(1.45)	(0.11)	(0.52)	(1.12)	(0.03)	(0.97)
Chronically ill adults (=1, 0 otherwise)	0.060	-0.045	-0.091	-0.110	0.003	-0.062+	0.001	0.003
	(1.37)	(0.63)	(1.18)	(0.97)	(0.15)	(1.76)	(0.89)	(1.47)
Constant	-0.214+	-0.465**	-0.123	-0.525**	-0.079+	0.011	-0.037**	-0.052
	(1.73)	(3.48)	(0.79)	(3.37)	(1.78)	(0.26)	(2.60)	(1.40)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Joint tests for								
Prime-age mortality	0.83	4.37*	0.17	4.45**	1.09	3.01*	2.28+	1.21
Elderly mortality	7.75**	0.76	2.91+	0.96	2.42+	0.66	0.10	0.64
R-squared	0.26	0.26	0.26	0.26	0.30	0.33	0.39	0.20
Number of observations	2651	2654	2651	2654	2651	2654	2651	2654

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. [a]Cereals include: maize, millet, wheat, sorghum and all other minor food crops. [b]Root crops include cassava, sweet potatoes. [c]High value crops include cotton sunflower, coffee, tobacco, Irish potato vegetables fruits.

Table A3.18. The impact of PA mortality on gross value of output and gross output per hectare by gender and position in household: Not corrected for attrition

Covariates	Δ ln(Gross value of output)				Δ ln(Gross value of output/ha)			
	----------Full sample----------		Poor	Non poor	--------Full sample------		Poor	Non poor
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Prime-age (PA) adult mortality								
Male	-0.134				-0.004			
	(1.63)				(0.06)			
Female	-0.112				-0.043			
	(1.26)				(0.68)			
Male head/spouse		-0.226	-0.239	-0.252		0.078	-0.039	0.266+
		(1.54)	(1.62)	(1.56)		(0.74)	(0.27)	(1.80)
Female head/spouse		-0.101	-0.090	-0.087		-0.070	-0.036	-0.087
		(1.02)	(0.64)	(0.64)		(0.72)	(0.28)	(0.60)
Male non-head/spouse		-0.090	0.064	-0.208+		-0.044	-0.010	-0.062
		(1.04)	(0.49)	(1.88)		(0.55)	(0.08)	(0.65)
Female non-head/spouse		-0.106	-0.082	-0.097		-0.016	-0.083	0.004
		(1.21)	(0.52)	(0.94)		(0.20)	(0.54)	(0.05)
Elderly mortality								
Elderly males	-0.164+	-0.168+	-0.252	-0.075	0.119	0.120	0.216	0.049
	(1.68)	(1.71)	(1.59)	(0.61)	(1.41)	(1.42)	(1.53)	(0.48)
Elderly females	-0.038	-0.041	-0.107	0.006	-0.018	-0.017	0.010	-0.041
	(0.40)	(0.42)	(0.64)	(0.06)	(0.18)	(0.16)	(0.06)	(0.32)
Constant	-0.031	-0.030	-0.021	-0.050	-0.051	-0.053	-0.071	-0.003
	(0.62)	(0.60)	(0.33)	(0.69)	(1.02)	(1.04)	(1.10)	(0.05)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on prime-age mortality	3.30*	2.00*	0.89	1.86	0.24	0.35	0.12	1.02
R-squared	0.15	0.15	0.22	0.23	0.21	0.21	0.27	0.27
Number of observations	5123	5123	2511	2612	5120	5120	2510	2610

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors.

Table A3.19. The impact of PA mortality on assets and off-farm income by gender and position: Not corrected for attrition

Covariates	Change in natural log of:					
	Values of cattle		Values of small animals[a]		Off-farm income[b]	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age (PA) adult mortality						
Male	-0.278+		-0.302+		0.118	
	(1.65)		(1.74)		(0.45)	
Female	-0.184		-0.379*		0.011	
	(1.17)		(2.55)		(0.05)	
Male head/spouse		-0.330+		-0.740**		0.317
		(1.65)		(2.79)		(0.82)
Female head/spouse		-0.071+		-0.368+		0.253
		(1.91)		(1.73)		(0.78)
Male non-head/spouse		-0.252		0.002		-0.022
		(1.14)		(0.01)		(0.06)
Female non-head/spouse		-0.207		-0.393*		-0.135
		(0.99)		(2.21)		(0.50)
Elderly mortality	-0.351	-0.349	-0.345	-0.362	-0.299	-0.278
Elderly males	(1.15)	(1.14)	(1.40)	(1.47)	(0.91)	(0.85)
	-0.127	-0.126	0.085	0.070	0.431	0.444
Elderly females	(0.39)	(0.39)	(0.32)	(0.27)	(1.12)	(1.15)
	0.034	0.032	0.246*	0.250*	-0.877**	-0.882**
Constant	(1.61)	(1.51)	(2.43)	(2.48)	(6.31)	(6.34)
	-0.278+		-0.302+		0.118	
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on mortality	2.26	1.27	5.09**	3.76**	0.10	0.37
R-squared	0.13	0.13	0.18	0.18	0.35	0.35
Number of observations	5309 Households					

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Small animals include goats, sheep, pigs, chicken, ducks and rabbits. [b]Off-farm income include salary and wage income, informal and formal business income.

Table A3.20. The impact of PA mortality on assets and off-farm income by gender and position by poverty status: Not corrected for attrition

Covariates	Change in natural log of:					
	Values of cattle		Values of small animals[a]		Off-farm income[b]	
	Poor	Non Poor	Poor	Non Poor	Poor	Non Poor
Prime-age (PA) adult mortality	(A)	(B)	(C)	(D)	(E)	(F)
Male head/spouse	-0.370*	-0.384	-0.312	-0.12**	0.516	0.087
	(2.15)	(0.79)	(1.41)	(2.85)	(1.11)	(0.13)
Female head/spouse	-0.288	0.145	-0.189	-0.561+	0.184	0.242
	(1.15)	(0.37)	(0.48)	(1.73)	(0.39)	(0.53)
Male non-head/spouse	-0.143	-0.367	0.393	-0.323	-0.322	0.215
	(0.58)	(1.06)	(1.21)	(1.21)	(0.69)	(0.45)
Female non-head/spouse	-0.189	-0.154	-0.259	-0.257	-0.132	-0.139
	(0.79)	(0.51)	(0.78)	(1.36)	(0.30)	(0.40)
Elderly mortality						
Elderly males	0.084	-0.665	-0.388	-0.298	-0.325	-0.203
	(0.31)	(1.31)	(1.02)	(0.95)	(0.71)	(0.44)
Elderly females	0.206	-0.425	0.142	0.087	0.100+	-0.056
	(0.57)	(0.87)	(0.34)	(0.29)	(1.85)	(0.10)
Constant	0.035	0.017	0.615**	-0.816**	-0.876**	-0.906**
	(1.60)	(0.36)	(5.12)	(5.13)	(5.45)	(3.21)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Joint tests for						
Prime-age mortality	1.83	0.66	1.57	3.67**	0.47	0.16
Elderly mortality	0.21	1.35	0.58	0.48	1.95	0.10
R-squared	0.30	0.20	0.28	0.24	0.45	0.35
Number of observations	2651	2654	2651	2654	2651	2654

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Small animals include goats, sheep, pigs, chicken, ducks and rabbits. [b]Off-farm income include salary and wage income, informal and formal business income.

Table A3.21. The impact of PA mortality on cultivated land by gender and position in household: Restricted sample

Covariates	Δ ln(Area cultivated)		Change in natural log of area under (ha):					
			Cereals[a]		Tubers and root crops[b]		High-value crops[c]	
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Prime-age (PA) adult mortality								
Male	-0.20**		-0.26**		0.01		-0.03+	
	(2.77)		(3.01)		(0.42)		(1.77)	
Female	-0.08		-0.05		-0.04+		-0.01	
	(1.38)		(0.72)		(1.78)		(0.93)	
Male head/spouse		-0.22**		-0.20*		-0.03		-0.04*
		(2.68)		(2.25)		(0.96)		(2.18)
Female head/spouse		-0.01		-0.07		-0.00		0.01
		(0.11)		(0.25)		(0.02)		(0.77)
Male non-head/spouse		-0.12		-0.10*		0.05		-0.01
		(1.29)		(2.10)		(1.45)		(0.39)
Female non-head/spouse		-0.15+		-0.11		-0.08*		-0.03
		(1.81)		(1.31)		(2.35)		(1.54)
Elderly mortality								
Elderly males	-0.31**	-0.31**	-0.20*	-0.20*	-0.06+	-0.06+	-0.01	-0.01
	(3.54)	(3.52)	(2.28)	(2.25)	(1.70)	(1.68)	(0.66)	(0.63)
Elderly females	-0.10	-0.10	-0.19	-0.19	0.05	0.04	0.02	0.02
	(0.88)	(0.91)	(1.42)	(1.43)	(1.24)	(1.21)	(0.90)	(0.89)
Constant	0.04	0.04	-0.11+	-0.11+	-0.01	-0.01	0.00	0.00
	(1.09)	(1.10)	(1.66)	(1.66)	(0.69)	(0.69)	(1.50)	(1.32)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.22	0.22	0.19	0.19	0.26	0.26	0.18	0.18
Number of observations	5150 Households							

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Cereals include: maize, millet, wheat, sorghum and all other minor food crops. [b]Root crops include cassava, sweet potatoes. [c]High value crops include cotton, sunflower, coffee, tobacco, Irish potato, vegetables and fruits.

Table A3.22. The impact of PA mortality on assets and off-farm income by gender and position in household: Restricted sample

Covariates	Change in natural log of:					
	Values of cattle		Values of small animals[a]		Off-farm income[b]	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age (PA) adult mortality						
Male	-0.316*		-0.324*		0.238	
	(2.12)		(2.22)		(0.75)	
Female	-0.158		-0.437**		-0.013	
	(0.84)		(3.33)		(0.05)	
Male head/spouse		-0.290+		-0.739**		0.488
		(1.85)		(3.24)		(1.23)
Female head/spouse		-0.144		-0.316+		0.250
		(0.58)		(1.76)		(0.74)
Male non-head/spouse		-0.506		0.056		-0.021
		(1.02)		(0.20)		(0.04)
Female non-head/spouse		-0.161		-0.454**		-0.305
		(0.57)		(3.60)		(0.81)
Elderly mortality						
Elderly males	-0.328	-0.324	-0.332	-0.331	-0.258	-0.232
	(1.13)	(1.11)	(1.23)	(1.22)	(0.76)	(0.68)
Elderly females	-0.100	-0.095	0.067	0.053	0.466	0.480
	(0.30)	(0.29)	(0.24)	(0.19)	(1.17)	(1.20)
Constant	0.031	0.030	0.312**	0.312**	-0.850**	-0.855**
	(1.58)	(1.50)	(3.03)	(3.03)	(6.04)	(6.07)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.15	0.14	0.17	0.19	0.34	0.34
Number of observations	5150 Households					

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors. [a]Small animals include goats, sheep, pigs, chicken, ducks and rabbits. [b]Off-farm income include salary and wage income, informal and formal business income.

Table A3.23. The impact of PA mortality on gross value of output and gross output per hectare by gender and position in household: Restricted

Covariates	Δ ln(Gross value of output)				Δ ln(Gross value of output/ha)			
	----------Full sample----------		Poor	Non poor	--------Full sample------		Poor	Non poor
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Prime-age (PA) adult mortality								
Male	-0.200				-0.014			
	(1.37)				(0.18)			
Female	-0.147				-0.047			
	(1.62)				(0.62)			
Male head/spouse		-0.194	-0.192	-0.225		0.087	-0.037	0.301+
		(1.58)	(1.13)	(1.34)		(0.76)	(0.23)	(1.84)
Female head/spouse		-0.076	-0.082	-0.050		-0.061	-0.037	-0.076
		(0.75)	(0.57)	(0.35)		(0.62)	(0.28)	(0.52)
Male non-head/spouse		-0.213	0.029	-0.396		-0.116	-0.086	-0.135
		(1.80)	(0.19)	(1.59)		(1.12)	(0.55)	(0.96)
Female non-head/spouse		-0.180	-0.108	-0.207		-0.005	-0.029	-0.015
		(1.49)	(0.50)	(1.47)		(0.05)	(0.14)	(0.14)
Elderly mortality								
Elderly males	-0.183+	-0.180+	-0.242	-0.096	0.105	0.106	0.188	0.035
	(1.78)	(1.75)	(1.46)	(0.77)	(1.20)	(1.22)	(1.33)	(0.34)
Elderly females	-0.077	-0.076	-0.144	-0.026	-0.001	0.003	0.004	-0.005
	(0.72)	(0.70)	(0.78)	(0.24)	(0.01)	(0.03)	(0.03)	(0.03)
Constant	-0.019	-0.020	-0.014	-0.037	-0.047	-0.048	-0.065	0.000
	(0.38)	(0.40)	(0.22)	(0.49)	(0.90)	(0.92)	(0.99)	(0.01)
Province x time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.17	0.17	0.24	0.23	0.20	0.20	0.29	0.29
Number of observations	4961	4961	2445	2516	4961	4961	2445	2516

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are t-ratios calculated with Huber-White-Robust standard errors.

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