DYNAMICS OF THE IMPACTS OF HIV/AIDS DISEASE-RELATED PRIME-AGE MORBIDITY AND MORTALITY ON RURAL FARM HOUSEHOLDS IN ZAMBIA

BY

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DECLARATION

I **Shipekesa Arthur Mbasela**, hereby declare to the best of my knowledge and understanding that the originality of the findings in this thesis is my work and has never been presented to Makerere University or any other University for the award of a degree.

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DEDICATION

To

Catherine and Elias, my dear parents.

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ACRONYMS AND ABBREVIATIONS

AIDS Acquired Immune-Deficiency Syndrome

CSO Central Statistical Offices

FAO Food and Agriculture Organization of the United Nations

FSRP Food Security and Research Project

HIV Human Immuno-Virus

MACO Ministry of Agriculture and Cooperatives

NGO Non-Governmental Organization

SADC Southern African Development Community

UNAIDS United Nations Joint Programme on AIDS

UNICEF United Nations Children’s Fund

USAID United States Agency for International Development

WFP World Food Programme

ABSTRACT

The impacts of HIV/AIDS disease-related Prime age (15-59 years) morbidity and mortality and the corollary dynamism among the five facets of rural welfare in Zambia pose detrimental outcomes to small-holder rural farmers. The study examines the short and long run dynamics of the impacts of morbidity and mortality due to HIV/AIDS disease-related on household composition, total cultivated land, value of crop production, value of productive assets and household income for a period extending from three years *ex ante* mortality and five years *ex post* mortality. A nationally representative panel data of 4,286 rural farm households surveyed in Zambia between 2001 and 2008 is utilized.

By incorporating *dip-drop-recovery* modelling of the dynamics in fixed effects models, the study highlights four major findings over the five household outcomes. *First*, the *dip-drop* effect of prime-age mortality is predominantly negative and begins to emerge significantly in the second year prior to death. *Second*, mortality impacts are dynamic and persistent over time. *Third*, households seem to strive to cope and adjust with prime-age mortality as shown by the positive *recovery* path. However, this path is not commensurate and equal in magnitude with the *dip-drop* negative effects leaving a number of households vulnerable. *Fourth*, there exists differential impacts by gender and position of the deceased household member. Reduction in household size, disposal of assets and participation in off-farm income generation are cardinal coping strategies observed.

Hence, early and targeted welfare assistance to curb instinctive migration, reduction in area cultivated and disposal of assets becomes critical for mitigation and poverty reduction strategies.

KEY WORDS: HIV/AIDS Diseases-related, Prime-age Mortality, Welfare, Dynamics, Fixed Effects, Dip-drop-recovery, Households, Zambia

CHAPTER ONE
INTRODUCTION

1.1 Background

The great majority of the population in the countries most affected by HIV/AIDS disease-related illness live in rural areas (UNDESA, 2004). According to Food and Agriculture Organization (FAO) of the United Nations, in a number of sub-Saharan African countries, farming and other rural occupations provide a livelihood for more than 80 per cent of the population (FAO, 2009). Additionally, FAO (1994) shows that this tragedy affects the rural social and economic fibre through various pathways such as absenteeism, loss of labour, loss of knowledge and expertise, reduction or total loss in remittances and changes in cropping systems. Hence, it is to be envisaged that the HIV/AIDS epidemic is likely to cause serious detriment to the agriculture sector in those countries, especially in countries that rely heavily on labour for production such as Zambia.

Initially viewed as a human health phenomenon that is concerned with epidemiological aspects, HIV/AIDS has become multi-sectoral and is challenging various social, economic and institutional structures of households and the nation at large (UNAIDS, 2004). Incidentally, there is growing concern about the increase of Prime Age (15-59 years) adult morbidity and mortality in rural Africa and its impact on farm households (Beegle, 2005). On the subject of changes in welfare and rural household’s responses to disease-related prime-age mortality, Yamano and Jayne (2004) examines the impact using panel data and shows that in some cases these impacts are large and significant. The insight shown is that the onset and spread of HIV/ AIDS is a major attribute in the rise of this phenomenon amongst rural households.

Consequently, the important impacts of the HIV/AIDS epidemic on agriculture are food insecurity caused by the reduction of production, and loss of income from household members employed in the sector (de Waal, 2003). Furthermore, the impacts of HIV/AIDS present a unique and menacing threat to the availability of productive agricultural resources and resilience to other types of shocks which may face rural households. Henceforth, research in this area should incorporate the appreciation of micro-level understandings of the epidemic.

The dearth of micro-level analysis and the knowledge gap thereof becomes of great interest to both the policy maker and the researcher. According to Chapoto (2006), a growing number of applied studies in Africa are beginning to provide micro-level insights on the impacts of HIV/AIDS on rural households and their responses. Casale and Whiteside (2006) equally show that much of the research conducted, especially regarding effects on the household economy, has been country or sector specific. The study underscores earlier challenges of limited availability and "fragmentation" of relevant data. However, the review indicates that recent studies support models with empirical data, considers information from a number of surveys and combine quantitative and qualitative data.

Nonetheless, these applied studies are subject to at least three major limitations to this effect: (i) Specific geographic sites; (ii) Limitation of panel data and (iii) Endogeneity of mortality to outcomes (Chapoto, 2006). *Primarily*, the study notices that the few available micro-level studies of the impacts of HIV/AIDS on rural households are usually drawn from specific geographic sites. The major limitation with such site-specific analyses is that they cannot be extrapolated to provide general estimates of national-level impacts. *Second* and closely related to the first one is a limitation of longitudinal data. The argument is that cross-sectional surveys fall short of adequately measuring the dynamic impacts of mortality or even control for unobserved heterogeneity, which are unquestionably important in this framework. Cross-sectional studies are inherently static and generally unable to provide accurate insights on impacts. Such studies only allow comparison of *ex post* conditions of afflicted versus non-afflicted households [1] since they cannot compare household characteristics *ex ante* and *ex post* upon incurring mortality shocks. *A third* major difficulty in measuring the impact of prime-age mortality, especially mortality attributable to AIDS, is that it is influenced by behavioural choices rather than by random events. The implication is that the impact of prime-age mortality from AIDS on agriculture may be endogenous to outcomes even though there is a tendency to treat mortality as exogenous (e.g. Ainsworth and Dayton, 2000; Beegle, 2005; Yamano and Jayne, 2004). However, it is envisaged that 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.

1.2. Prime-age mortality and agriculture in Zambia

Prime-age (15-59 years) morbidity and mortality erodes the labour force necessary to propel the agriculture sector in Zambia. Over the last decade Zambia has witnessed some of the high rates in HIV prevalence in the region. For instance, the Nation once fell among the seven countries in the world where HIV-prevalence rates for prime-age adults exceeded 20% (UNAIDS, 2003). With improvements in health care and awareness, Zambia's

[1] The study 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

estimated HIV prevalence rate has plummeted from 21.6% in 2003 to 15.2% in 2007 and 14.3% in 2010 (UNAIDS, 2007; SNDP, 2011). Against this backdrop, Kadiyala and Chapoto (2010) have shown an existence of a strong relationship between prime-age mortality and HIV prevalence rates that suggests that a large proportion of prime-age mortality observed in rural households is indeed due to AIDS-related causes. Henceforth, the study uses this proxy to understand the impacts of HIV/ AIDS disease-related on the welfare of rural households via its composition, production, asset base and income generation.

Zambia has over the last two and half decades witnessed high poverty levels since the emergence of HIV/AIDS (Jayne *et al* 2007). Although, the interrelationship between HIV/AIDS disease-related and agricultural productivity has not been clearly defined, it has clearly had some telling effects on the livelihood strategies of most Zambians, especially in rural households. The presence of HIV/AIDS leads to low productivity and poverty, while poverty creates vulnerability to HIV/AIDS (Gillespie, 2006). An emerging strand of the literature on the AIDS epidemic in Africa posits that poverty (possibly itself being fuelled by AIDS) is increasingly associated with the spread of the disease (Gillespie and Kadiyala 2005). However, this conclusion is somewhat contentious, as other recent studies find mixed evidence of a poverty-AIDS connection (Gillespie, Kadiyala, and Greener 2007).

The greater majority of the population in Zambian depends on agriculture-related activities for their livelihoods. According to the Central Statistical Offices (CSO), agriculture supports more than 60 percent of the population and employs 67 percent of the labour force. Over the past decade, the sector contributed an average of 18 percent to GDP (CSO, 2008). Nevertheless, agriculture is performing far below expectations and is largely unable to keep pace with population growth, in spite of its immense potential and the many interventions that have been applied. Although the sector has abundant natural resource endowments and plenty of available labour, only 14 percent of the arable land and 12 percent of the total irrigable land is being utilized. The sector is one with a characteristic of labour-intensity and as such a dwindling in the availability of labour through high prime-age adult mortality necessitates interventional studies.

1.3 Problem Statement and Rationale

Owing to the preceding cardinal caveats, a number of interests and concerns arise to both the policy-maker and researcher. From this study, the knowledge gap concern of the researcher and policy-makers' argument over the importance of developing appropriate mitigation measures to assist afflicted households, communities and the nation at large will be filled adequately. In order to contribute to the literature on mitigation interventions in the light of the epidemic, it becomes important to further understand long-run measurements of the impact of HIV/AIDS on households as the limited short run effects may lead to inconclusive analysis and intervention strategy. For starters, how does one understand the dynamism and/ or trajectories inherent in the impacts of prime-age mortality on rural farm households' outcomes? This becomes crucial especially in designing policy measures that mitigates impact and improves welfare of rural households. Statistical and econometric measurements of the extent of the impact of prime-age mortality on indicators of farm household welfare in Zambia in the light of nationally representative panel data become cardinal in the quest to fill up quantitative and methodological evidence on the matter (Beegle and De Weerdt, 2008). The dynamics in rural household welfare and the responses thereof, because of prime-age morbidity and mortality are critical to the understanding of HIV/AIDS in agriculture. Short-run effects of the epidemic may lead to inconclusive analysis as they fail to capture recovery periods from death shocks and therefore, the study examines the long-term impacts. How do household's outcomes flow overtime? Do they recover or decline with time? The issue of gender and position of the deceased with respect to the recovery path becomes pivotal to the study. Arguably, the potential persistence of mortality effects over time has important implications for policy makers on current and future policies and intervention strategies to mitigate these effects. Incidentally, the pillar of livelihoods could suffer portentous downstream negative effects from prime-age mortality. Therefore, sound research that analyses the complex longer-term impacts and short-term effects of the pandemic becomes a necessary condition to assist towards policy.

1.4 Objectives of the study

Broadly, the study examines the long-run dynamics of the impacts of morbidity and mortality, due to HIV/AIDS, on rural-farm households in Zambia.

1.4.1 Specific objectives are:

- To assess the short- and long run impacts of prime-age mortality on household composition, agricultural production, productive assets and income
- To assess the extent to which gender and position of the deceased affects the recovery path involved in household composition, agricultural production, productive assets and income
- To establish the long-term coping strategies that rural-farm households employ

1.5 Hypotheses:

1. Prime-age mortality does not affect household composition, agricultural production, productive asset base and income both in the short and long-term
2. Household composition, agricultural production, productive assets and income do not deteriorate overtime with prime-age mortality
3. Households with male prime-age mortality have similar recovery paths as those with female prime-age mortality

CHAPTER TWO

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Impact of HIV/AIDS Prime-age mortality

HIV/AIDS has been characterised over the past two decades as an extraordinary kind of crisis that is both an emergency and a long-term developmental issue (UNAIDS, 2004). It is not just an epidemiological human-health challenge, but also spans through the social, economic and institutional fibres. The pandemic has become multi-sectoral cutting across developmental and economic wellbeing of households and the nation at large thus no longer remaining a health domain. This pandemic began as an urban phenomenon, but has progressively filtered to rural areas as well (UNAIDS, 2002).

Gillespie (2006) underscores that agriculture, which is the mainstay of many livelihoods, is severely affected by HIV/AIDS and in turn, agriculture affects HIV/AIDS. Hence, growth is hindered in this iterative cycle. Two issues become critical in this iterative process: susceptibility and vulnerability. The livelihood upon which households are governed and depend has degrees of susceptibility to HIV/AIDS. Upon contraction of the virus, the household’s vulnerability determines the type and severity of the impact on assets and institutions. Household’s responses and outcomes are in turn determined by the impacts and they themselves condition future susceptibility and vulnerability.

O’donnell (2004) further explains that the impact of HIV/AIDS results in a double loss due to chronic illness and eventual mortality. Morbidity and mortality are envisaged to cause a double loss in the form of loss of direct income and loss of output from agricultural productivity. As total expenditure on health care increase, expenditure on food and nutrition is likely to fall and may thus be compensated by disposal of assets for cash.

2.2 Empirical evidence on Impact of HIV/AIDS Prime-age mortality

The impact of economic shocks, such as price changes, sudden climatic changes, loss of work, morbidity and mortality on household welfare is the subject of an extensive literature in development economics. Incidentally, much of the research that has been done on economic impact of prime-age mortality can broadly be categorised in two types: macro-economic level studies that estimate impacts on economic growth and development, and micro-economic studies that focus on impacts at the household level.

2.2.1 Macro-level research

Early empirical impact studies comprised of simulations on GDP or GNP per capita and their rates of growth under various levels of projected HIV prevalence rate. These studies depicted mixed conclusions and wide variations in predictions. For instance, Cuddington (1993) employed a single sector, full employment Solow-type growth model to simulate impacts of HIV/AIDS on the growth of GDP and GDP per capita in Tanzania. The simulation results show that AIDS reduced the average real GDP growth rate by 0.6-0.9 percent. Sachs et al (2002) estimated that Sub-Saharan Africa faces a 35 percent loss in GDP due to HIV/AIDS. Most of the existing estimates of the macroeconomic costs of AIDS in Africa range between 0.3- 1.5 percent reductions in the growth rate of GDP annually. However, Bell *et al* (2003) argue that these estimates may greatly under-estimate the impact of HIV/AIDS since they fail to account for the potential impact on human capital formation and the mechanisms through which knowledge and abilities are transmitted from one generation to the next.

2.2.2 Micro-level research

Household-level impacts of HIV/AIDS that examines how the epidemic affects the behaviour of rural households and farming systems is emerging in most of the studies. However, evidence is still modest on the impacts of adult mortality and HIV/AIDS on various aspects of the rural farm households. Chapoto and Jayne (2008) and Kirimi (2008) underscores that much of the evidence is at best anecdotal and speculative, where the impacts are hypothesized and conjectured but hardly quantified.

Prime-age mortality adversely affects agrarian-based economic systems in regions hard hit by the AIDS epidemic, yet the severity of these impacts varies greatly according to communities' specific characteristics and initial conditions (Jayne *et al*, 2005). According to the study done on community-level impacts in Zambia, relatively small independent effects of prime-age mortality on community crop output, mean income, and income per capita were observed. However, the estimated effects become large in some communities displaying particular initial community conditions. Various factors influencing communities' resilience, or ability to withstand the impacts of increased AIDS-related mortality were observed. In particular, the study observed that communities' initial levels of wealth, education, and population (a proxy for labour scarcity) influence the relationship between adult mortality rates and changes in community indicators of welfare. These came out to be some of the important benchmarks for coping strategies.

In the light of the above, one thing stands out in all literature that household welfare is affected by a myriad of shocks and it is often very difficult to isolate the impact of one specific shock (Thomas, 2009). The impacts may depend on each household's initial welfare position such as initial asset endowments that may potentially determine the household's capacity to respond to morbidity and subsequent mortality. Evidently, a number of studies have recently provided support on the impacts of mortality vis-a-viz household composition, agricultural production, wealth and asset base, and the various coping strategies being utilised in the short run.

2.3 Household composition, size and structure

It is conventional wisdom that household composition changes as a result of death in any given household. Beegle (2005), notes that the death does not necessarily imply a reduction of household size by a single adult. On the contrary, such a death introduces dynamics in the composition or structure and size, which include in-and-out migration, an increase in dependency ratios, higher rates of remarriage for surviving spouses, etc. These changes in the household structure have been shown to be part of coping strategies to distribute the burden of the impact over several households. As regards gender and position of the deceased in the household, Yamano and Jayne (2004) found that household composition is affected in different ways. The study found that the death of a household head or spouse resulted in the changes of the household size and possible dissolution due to loss of the breadwinner. On the other hand, the death of the other prime-age adults was partially compensated by the entry or return of other members since these deaths implied a loss of labour supply and thus needed replenishment.

However, changes in size and composition depend on the initial conditions prevailing in the households. If wealth status remains constant, non-poor households are more likely to replenish their size to pre-death levels than poor households are, mainly by attracting young boys and girls (Chapoto, 2006). Therefore, a household's flexibility is a critical component in successfully responding to extreme crises such as morbidity and mortality of prime-age adults. The death of the sick adult implies permanent loss of one source of household labour but at the same time frees time and cash that were previously devoted to care giving. Singh *et al* (1986) and Benjamin (1992) show that dynamics in the household composition and the attendant changes in intra-household labour allocation have implications for a farm household's wealth and assets base, income sources and crop production, as households changes their demand for and supply of labour.

2.4 Agricultural production

Agricultural production tends to be affected in one way or the other as a prime-age death is associated with a temporary loss of labour, labour reallocation, potential loss of farming knowledge and skills and an increased medical and funeral expenses. Conventional wisdom depicts that some of the hypothetical ways in which production may be affected are through changes in cropping patterns, land use, area cultivated, input use, farm output and income. Increased dependency ratio and lower labour availability are hypothesized to cause households to shift from labour-intensive crops to less labour-intensive ones which may be less nutritious or productive (Kirimi 2008). The shift in area cultivated from maize to root tubers in most parts of Africa may be an indication of labour shortages and hence a need to shift to less labour-intensive crop systems (FAO 1995). However, Beegle (1997, 2005) using panel data from Kagera in Tanzania shows that afflicted households do not shift towards subsistence crops even though there is a temporal scaling-back of cash cropping and a fall in wage income because of prime-age death. She argues that this result is consistent with the high labour-land ratios in the region. Nevertheless, this study was based on a short panel (1991-1993) and is therefore unable to assess the longer time impacts.

Evans and Miguel (2007) have on the other hand shown that dynamics can be captured by considering both parental pre-death and post-death effects on child school participation. In this light, mortality dynamics (*ex ante* and *ex post)* can be captured by considering the period ranging from before death to several years after death and avoid the one-time, average and permanent effects which is commonplace in most studies measuring impacts of mortality.

2.5 Household Productive Asset base and Income

Productive asset base tends to be corroded through the general loss of financial capital emanating from the loss of human capital and the complementary medical and funeral expenses as well as labour diverted from economically productive activities to care giving. Topouzis and du Guerny (1999) and Stokes (2003) argue that most of the households respond initially by disposing off assets that are reversible such as savings, remittances and credit and where the effects of mortality are severe, households may follow with the sale of productive assets, a strategy that may be costly in the long-run.

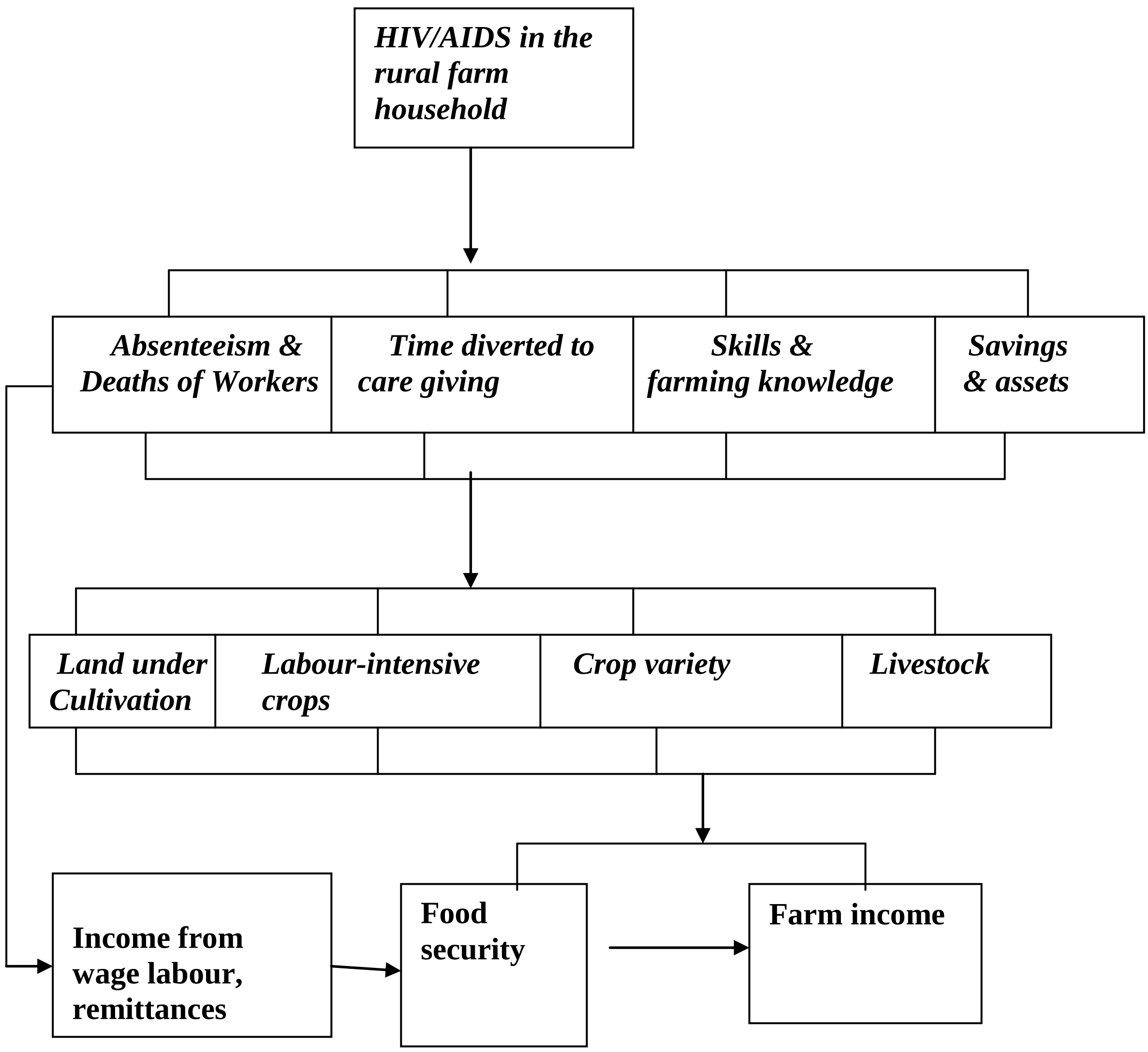
Chapoto (2004) equally shows that households liquidate small animals to mitigate the impact of mortality. However, concern looms over these coping strategies' greater longer-run adverse consequences on households' future welfare. If these coping strategies are not sustainable or viable in the long-run, households may be forced to adopt other coping strategies (Yamano and Jayne, 2004). The implication is that the long run impacts of mortality may be different from the short run effects and the capacity of households to recover from adult mortality shocks even in the long run, may be eroded. Generally, as few households cope or even merely survive, there may be increased vulnerability to other shocks or households may pursue more damaging strategies (Mather *et al*., 2004).

2.6 Conceptualization of the Impacts of Prime-age Mortality

The key transmission mechanisms that the epidemic potentially poses on the rural-farm household and agriculture sector conceptually flow from absenteeism to loss of labour leading to declines in productivity and income. Absenteeism on the farm field due to morbidity and funerals may lead to the reduction of the area of land cultivated and declining yields. Death of workers also implies less land cultivated for households that utilise labour. Consequently, the labour-intensive crops are negatively affected and crop variety diminishes generally. Additionally, there exist changes in cropping systems from more labour intensive to less labour intensive. Households with livestock may curtail weeding and pruning and concentrate on livestock production that is less labour intensive. Generally, households make choices on productive systems that have low average yields but lower variances and less nutritious diets from less varied crops.

The loss of labour due to mortality at crucial periods of planting and harvesting may reduce the size of harvest, thus affecting food production. This is coupled with the loss of knowledge about farming methods and productive assets. The attendant loss of income and remittances may worsen production levels of households. Figure 2.1 shows these transmission mechanisms through which rural farm households experience HIV/AIDS prime-age morbidity and mortality impacts.

Figure 2.1: Conceptual Framework for the Impact of Prime-Age Adult Mortality on rural farm household



Source: United Nations, Department of Economic and Social Affairs, Population Division

CHAPTER THREE

METHODOLGY AND EMPIRICAL ANALYSIS

3.1 Data and Methodology

3.1.1 Data Sources

This study uses secondary panel data that is nationally representative over a seven-year period (2001-2008) on 4286 rural households in Zambia. The study surveyed 393 standard enumeration areas (SEAs)[2] in Zambia. The Central Statistical Office (CSO) in conjunction with the Ministry of Agriculture and Cooperatives (MACO) and Michigan State University's Food Security Research Project (FSRP) carried out the survey. See Megill (2001 and 2004) for survey design and data collection. Nonetheless, as indicated in the appendix the observations in 2008 will not be used and as such, the panel shall comprise of 2001 and 2004 observations.

3.1.2 Data Analysis

The study makes use of both descriptive and inferential statistics in the analysis of data. Data management was done in SPSS. MS Excel or SPSS was used in the generation of descriptive data analysis. STATA provided the fixed effects tools for the econometric model and inferential statistics.

[2] "Standard enumeration areas" (SEAs) are the lowest geographic sampling unit in the Central Statistical Offices sampling framework for its annual Post Harvest Surveys. Each SEA contains roughly 150 to 200 rural households and at least 20 households were surveyed from each SEA

3.2 Theoretical specification

The study of impacts of prime age morbidity and mortality involves a comparison between afflicted and non-afflicted households. Households experiencing morbidity potentially suffers a loss in their welfare. Hypothetically, it is the treatment of prime age illness that leads to different impacts and/or outcomes on the household. Henceforth, it is imperative that any observed changes in household welfare for the period before and after mortality be attributable to morbidity and mortality apart from other shocks or initial conditions affecting afflicted and non-afflicted households alike (Beegle and De Weerdt, 2008). The theoretical structure of measuring the impacts of prime-age mortality and morbidity on outcome Y_i, emanates from the *ex ante* and *ex post* method in double differencing approach or the two period panel model.

Theoretically, the aim is to eliminate the unobserved fixed effects using the time-demeaned fixed effects transformation in panel studies as given in Wooldridge (2004). Consider the following model transformation below:

$$y_{it} = x'_{it}\beta + a_i + u_{it} \tag{1}$$

Averaging equation (1) overtime for each i and taking the difference of the mean from the actual observation yields the time-demeaned model as shown below:

$$\ddot{y}_{it} = \ddot{x}'_{it}\beta + \ddot{\varepsilon}_{it} \tag{2}$$

where, a_i is the unobserved fixed effects and is eliminated during the transformation. The within transformation on outcome variables is given as $\mathbf{\ddot{y}_{it} = y_{it} - \tilde{y}_i}$. Equally the same transformation occurs for observable variables and the error term.

Imbens and Wooldridge (2009) note that the simplest setting is one where outcomes are observed for households in one of two groups, in one of two time-periods. Therefore, the double differencing simply removes the biases in the second period comparisons between the afflicted and non-afflicted group that could be the result from permanent differences between the groups, as well as biases from comparisons over time that could be the result of the time trend typically unrelated to the afflicted group. Henceforth, the study employs the fact and counterfactual strategy approach.

In order to incorporate the dynamics of prime-age mortality overtime the study borrows from Jacobson et al (1993) dip-drop-recovery approach, a feature of virtually all impact studies on training and adult education programs. The exposition in this regard is that the time pattern of earning losses occurs mainly along three dimensions: (i) the rate at which earnings 'dip' in the period before job loss, (ii) the size of the 'drop' that occurs at the time of the job loss, (iii) the rate of 'recovery' in the period following job displacement. Similarly, Kirimi (2008) has shown that rural farm households' outcomes with respect to mortality may be characterized by this pattern and the impact thereof can be diagrammatically modelled as below. Figure 3.2.1 generally shows the dynamics whereas Figure 3.2.2 accounts for: (i) the 'dip' *ex ante* mortality depicted by Φ_1 and Φ_2 for one and two years, respectively; (ii) the 'drop' δ_0 during year of death and 'recovery' δ_1 *ex post* mortality.

Figure 3.2.1: Modeling Impact of Prime-Age Adult mortality on Household outcomes over time

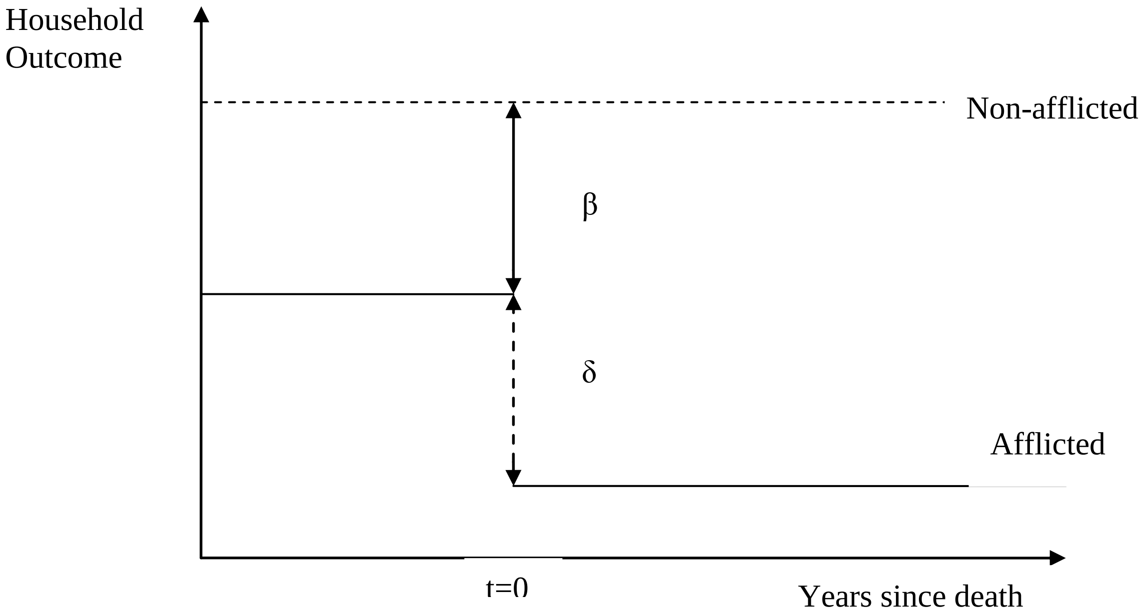
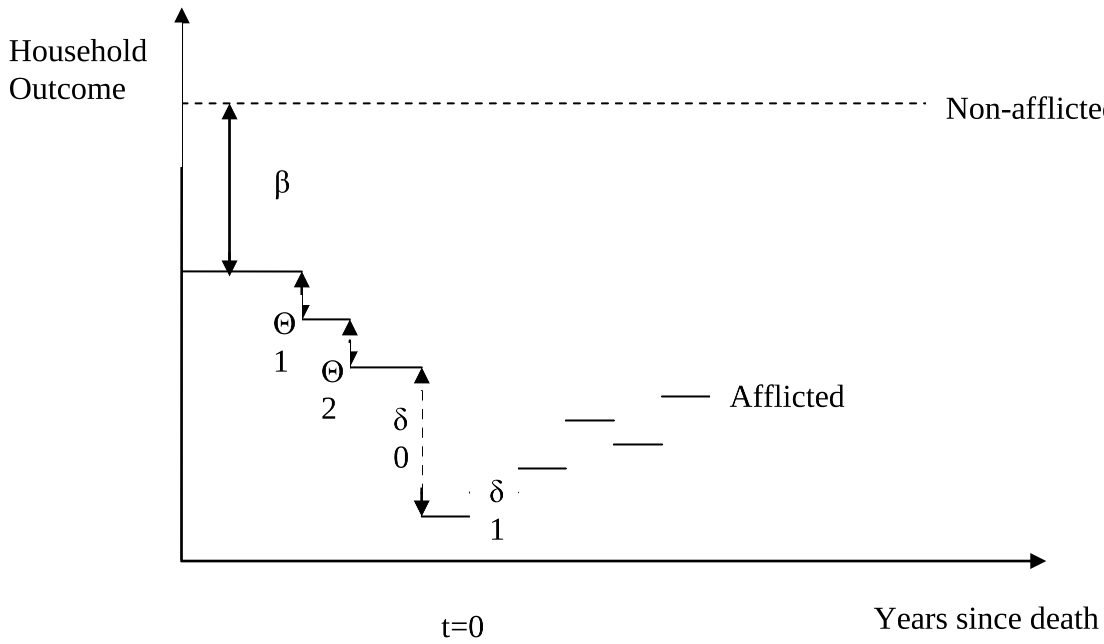


Figure 3.2.2: Modeling Impact of Prime-Age Adult mortality with binary variables *ex ante* and *ex post* mortality



3.3 Empirical Specification and Model estimation

a) General Prime-age Mortality Dynamic Model

Essentially, the estimation of a panel model contains binary variables for prime-age mortality as explanatory variables. The following dynamic model shall be formulated:

$$Y_{it} = a_i + \sum_{v=0}^{v=3} Dpre_{it}\theta^{v} + \sum_{w=0}^{w=5} Dpost_{it}\delta^{w} + \tau ELD_{it} + \varphi X_{it} + \lambda Prov_{it} + \varepsilon_{it} \quad (3)$$

where Y_{it} denotes an outcome, such as household composition, area under cultivation, value of farm output, or non-farm income for household *i* at time *t*. $DPre^{v}_{it}$ is equal to 1 if household *i* experienced death *v* years after the year of survey for both 2001 and 2004. The coefficient θ capture effects on household outcomes preceding death. $DPost^{w}_{it}$ is equal to 1 if in the year of the survey (*t*), household *i* experienced a death *w* years earlier (i.e. w years have elapsed since a household experienced death). δ will then reflect the persistence of the effects of death over time, for up to five years after death implying that the impacts may not necessarily remain constant or decay or grow linearly over time during the post-death shock stage. Conventionally, the model consists of two binary variables since v takes the value of 1 or 2 for deaths occurring one and two years after the survey, respectively[3]. However, due to the spacing of the survey years $DPre^{v}_{it}$ takes three binary variables to capture the effect three years prior. Eld_{it} is variable for elderly or seniors' (60+ years old) deaths overtime. The coefficient τ measures the effect of seniors' death on the outcomes since it is assumed that they are productive to an extent despite not falling in the prime-age category. X_{it} is a vector of exogenous time-invariant and time-varying initial household and

[3] AIDS deaths may be typically by 4 to 17 months of illness and so negative effects might be expected up to two years before death due to AIDS-related morbidity (Evans and Miguel, 2007).

community conditions that influence household outcomes but are not themselves affected by death[4]. The coefficient ψ measures the effect of a vector of household's, community and district initial conditions. The parameter 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 (household incurring prime-age / elderly mortality) and the control group (household not incurring mortality) will provide an estimate of the impact of prime-age mortality. This is achieved by the time-demeaned fixed effects approach. The approach eliminate unobserved effect a_i by taking mean differences overtime. The model assumes that the idiosyncratic errors are uncorrelated with each explanatory variable across all time-periods. Provided this assumption holds, the fixed effects estimator is unbiased. However, there is no free lunch because the model allows for arbitrary correlation between unobserved effects and the explanatory variables in any time-period. Henceforth, all explanatory variables that are constant over time such as distance and gender are swept away by the FE transformation. Therefore, these variables are interacted with the year dummy to ensure that the fixed effects transformation leaves them unchanged. The demeaned fixed effect estimator is therefore, considered a plausible methodology for estimating ceteris paribus effects incorporated in the dynamics framework.

Using Jacobson *et al* (1993) approach as depicted in Figure 3.2.2, equation 2 examines whether the estimated mortality impacts differ over time and whether they tend to decay or persist. A series of binary variables accounting for *ex ante* and *ex post* impacts of prime-age adult mortality are included via the pre and post variables. The generation of this series

[4] A priori, Xi may contain variables such as age, education of the head and community characteristics that are likely to remain unaffected by mortality like distance to the market.

took into account of the limitation imposed on the third (2008) supplemental survey. Data on mortality occurring after that survey is unavailable as it is the latest survey. This is shown in the appendix.

Since there is an assertion that these impacts depend on the gender and position of the deceased, the analysis shall consider differential impacts by including interaction variables. The first model shall analyse the interaction with gender alone and then position of the deceased shall follow in the subsequent model.

b) Dynamic Model showing Differential Impacts of Gender alone

The binary variables F_{it} and M_{it} denoting female and male prime-age death respectively are interacted with pre and post variables to measure *ex ante* and *ex post* impacts of such mortality overtime. The coefficient β in both binary variables in equation (3) measures the impact of only male or female mortality overtime and yields the differential impact by gender. It can take on positive values as well though Figures 3.2.1 and 3.2.2 above depict negative values.

$$Yit = \alpha i + \beta_1 F_{it} + \beta_2 M_{it} + \sum_{v=0}^{v=3} Dpre_{it}\delta_1^{\ v} + \sum_{w=0}^{w=5} Dpost_{it}\theta_1^{\ w} + \sum_{v=0}^{v=3} Dpre * F_{it}\delta_2^{\ v} + \sum_{v=0}^{v=3} Dpre * M_{it}\delta_3^{\ v} + \sum_{w=0}^{w=5} Dpost * F_{it}\theta_2^{\ w} + \sum_{w=0}^{w=5} Dpost * M_{it}\theta_3^{\ w} + \tau Eld_{it} + \phi Xit$$
$$+ \lambda \operatorname{Pr} ov_{it} + \varepsilon it \quad (4)$$

c) Dynamic Model showing Impact of Gender and Position

Equation (4) below shows the model depicting differential effects of the interaction between pre, post mortality variables with male-head mortality *(MH)* or Non-head mortality *(NH)* variables.

$$Yit = \alpha i + \gamma_1 MH_{it} + \gamma_2 NH_{it} + \sum_{v=0}^{v=3} Dpre_{it}\delta_1^{\ v} + \sum_{w=0}^{w=5} Dpost_{it}\theta_1^{\ w} + \sum_{v=0}^{v=3} Dpre*MH_{it}\delta_2^{\ v} + \sum_{v=0}^{v=3} Dpre*NH_{it}\delta_3^{\ v} + \sum_{w=0}^{w=5} Dpost*MH_{it}\theta_2^{\ w} + \sum_{w=0}^{w=5} Dpost*NH_{it}\theta_3^{\ w} + \tau Eld_{it}$$
$$+ \phi Xit + \lambda \mathrm{Pr}ov_{it} + \varepsilon it \qquad (5)$$

The coefficients γ_1 and γ_2 measure the impact of male-head mortality and non-head mortality on the outcome variables respectively. MH equal to 1 if the deceased person is a male head and zero otherwise.

3.3.1 Household Attrition

Panel data is prone to selection bias emanating from attrition problems. Households tend to fall out and do not make it to the next reinterview due to a number of shocks, dissolution, migration, etc. Henceforth, studies using panel data must be aware of the need to weight the variables so as to avoid selection bias. The inverse probability weighting (IPW) method[5] shall be used to correct for attrition bias. The re-interview Probit model shall be specified as follows:

$$Prob(R_{it} = 1 | R_{it*-1} = 1) = f(X_{it}, HIV_{it-1}, E_{it}) \qquad (6)$$

[5] The IPW method assumes that the probability of being re-interviewed (non-attrition) as a function of observable information is the same as the probability of being re-interviewed as a function of observables, plus unobservables that are only observed for non-attrited observations (Wooldridge, 2002).

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 1996 and 2005. X_{it} is a set of household characteristics in the 2001 and 2004 survey.

Preliminary results show that attrition seems to be rife over the 7-year long run period with a rate of 40% of 6,922 households in the initial survey plummeting by the third supplemental survey. Table 3.1 shows that the lowest rate of about 15.8% was between 2004 and 2008 whilst 2001-2004 periods yielded a rate of 21.7%.

There are several reasons that result in households' attrition and include some of the following: dissolution or moving away of households from their initial dwelling place, refusal of some households to participate in the subsequent surveys and cases where enumerators find no one to interview at a given household. Thus, it is envisaged that dissolution resulting from mortality greatly influences the re-interview rates of the households (Urassa *et al*., 2001).

Table 3.1 Reinterviewed households and attrition rates by province

	Survey years			Rates of attrition		
Province	**2001**	**2004**	**2008**	**2001-2004 (%)**	**2004-2008 (%)**	**2001-2008 (%)**
Central	714	573	504	19.75	12.04	29.41
Copperbelt	393	312	269	20.61	13.78	31.55
Eastern	1331	1126	987	15.40	12.34	25.85
Luapula	777	619	401	20.33	35.22	48.39
Lusaka	214	161	117	24.77	27.33	45.33
Northern	1363	1027	918	24.65	10.61	32.65
Nwestern	472	324	281	31.36	13.27	40.47
Southern	872	689	614	20.99	10.89	29.59
Western	786	588	479	25.19	18.54	39.06
Total	**6922**	**5419**	**4570**	**21.71**	**15.67**	**33.98**

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Frequent and considerable migration of rural households reinforces attrition bias. Noteworthy, lack of accounting for attrition may pose underestimates of the incidence and impact of prime-age mortality. Therefore, the depiction from Table 3.1 stresses the need to closely examine attrition issues.

Interestingly, a close observation of the attrition rates prevailing by province over the seven-year period shows that Luapula, Lusaka, North Western and Western provinces exhibited higher rates of attrition equal to 48.4%, 45.3%, 40.5% and 39.5%, respectively. Possible reasons other than the ones highlighted above will suffice for these apparent phenomena. Luapula province is characterised by seasonal fishing activities that contributes to households migrating to the fishing camps and potentially disturbs their post-fishing settlement. Similarly, Western province is characterised by the seasonal movements of the Lozi people to highlands during the post-rains flooding of the Zambezi plains, which creates different resultant households' location thereafter. The boom in the mining areas of North Western province could well explain the relocation of some of the initial households that migrate to seek employment opportunities in Lumwana and Kansanshi mines. Households not re-interviewed in Lusaka province are likely to be those exhibiting rural-urban migration in search of livelihoods in the industries other than rural agriculture.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Descriptive Analysis

The relationship between prime-age mortality, attrition, dissolution and initial household size shown in Table 4.1a show that larger households having a higher percentage of incurring prime-age mortality. Overall, 10.5% of the households in 2001 had experienced prime-age death. Households that dissolved during the survey wave accounted for 5.6% of the initial households in 2001. Dissolution was prevalent with smaller households indicating a more likelihood to disintegrate given a mortality shock. However, for larger households despite having incurred prime-age death, dissolution only accounted less than 5% of the total attrition rate. The results show that dissolution is a critical rationale for attrition among smaller households than it is for larger households. Other than dissolution, households tend to migrate thus contributing to attrition within a given panel overtime. Overall, 10.2% of the initial households in 2001 moved out of the SEA. Again, the results show that smaller households were more likely to move out of their initial SEA as at the second supplemental survey. Generally, households with family size ranging from 1 to 6 accounted for more than 21% of attrition between 2001 and 2004 supplemental surveys.

Table 4.1a Relationship between prime-age mortality, household attrition, dissolution and initial household size for the 2001-2004 periods

Household size in 2001	Households in 2001 survey	Households attriting in 2004	%	Households moving out of SEA	%	Households attriting due to dissolution in 2004	%	Households incurring a prime-age death by 2001	%
1	201	68	33.8	24	11.9	30	14.9	16	8.0
2	378	113	29.9	51	13.5	41	10.8	47	12.4
3	792	201	25.4	96	12.1	59	7.4	60	7.6
4	1017	263	25.9	111	10.9	76	7.5	84	8.3
5	1054	225	21.3	107	10.2	48	4.6	79	7.5
6	925	209	22.6	103	11.1	46	5.0	88	9.5
7	737	127	17.2	64	8.7	32	4.3	89	12.1
8	605	108	17.9	48	7.9	24	4.0	86	14.2
9	385	70	18.2	39	10.1	11	2.9	44	11.4
>=10	828	119	14.4	64	7.7	23	2.8	132	15.9
Total	**6922**	**1503**	**21.7**	**707**	**10.2**	**390**	**5.6**	**725**	**10.5**

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

The attrition rate between 2004 and 2008 was 15.7% attrition. Table 4.1b depicts larger households having a lower rate of attrition over the period with moderate numbers incurring prime-age mortality. Smaller households dissolved more as compared to larger households with rates not less than 6%. However, migration was well distributed with an average of 12.8% of the initial households in 2004 moving out of the SEA.

Table 4.1b Relationship between prime-age mortality, household attrition, dissolution and initial household size for the 2004-2008 periods

Household size in 2004	Households in 2004 survey	Households attriting in 2008	%	Households moving out of SEA	%	Households attriting due to dissolution	%	Households incurring a prime-age death between 2001-2004	%
1	185	9	4.86	34	18.4	32	17.3	26	14.1
2	363	62	17.1	46	12.7	36	9.9	42	11.6
3	468	92	19.7	70	15.0	43	9.2	44	9.4
4	719	200	27.8	102	14.2	47	6.5	69	9.6
5	797	199	25.0	100	12.5	48	6.0	67	8.4
6	770	129	16.8	96	12.5	36	4.7	70	9.1
7	651	28	4.3	87	13.4	28	4.3	60	9.2
8	499	41	8.2	57	11.4	20	4.0	43	8.6
9	354	29	8.2	55	15.5	11	3.1	35	9.9
>=10	613	60	10.0	48	7.8	19	3.1	86	14.0
Total	**5419**	**849**	**15.7**	**695**	**12.8**	**320**	**5.9**	**542**	**10.0**

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Table 4.2 shows the breakdown of number of households afflicted by prime-age morbidity and mortality by survey wave. Column (1) indicates that morbidity is higher in the initial survey wave where 370 households having male head morbidity compared to 78 households in the second wave. Despite this and the similar case in non-male head illness, column (3) shows the opposite case where mortality of prime-age adults is 12 households lower in the initial wave than the second wave. Additionally, there are lower numbers of households incurring male head, female head and other male prime-age death in the initial wave with respect to the second wave as depicted in columns (4 to 6). These results place some interests on the progression of disease and subsequent death in the households. There is also an indication of some dynamism at work in these households whereby mortality experienced in the second wave mainly becomes a function of morbidity in the initial wave.

Table 4.2 Number of households incurring prime-age mortality and morbidity by survey period[a]

Survey Period	Households incurring Prime-age morbidity		Households incurring Prime-age mortality	Number of PA deaths							
	Male head morbidity	Non-male head morbidity	Prime-Age death	1	2	3	4	Male Head PA death	Female Head PA death	Other Male PA death	Other female PA death
	(1)	(2)	(3)					(4)	(5)	(6)	(7)
2001-2004	370	425	542	491	43	6	2	93	113	257	316
2004-2008	78	143	554	513	36	4	1	122	89	280	292
Total	**448**	**568**	**1096**	**1004**	**79**	**10**	**3**	**215**	**202**	**537**	**608**

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Note: [a] The numbers relate to individuals who were in the households at the start of each survey and excludes those joining whilst ill and later dying within the period.

Table 4.3 shows the mean prime-age adult mortality per 1000 prime-age person years who were listed in the demographic roster at the beginning of each period. Overall mean mortality rate was 13.1% between 2004 and 2008 survey periods whereas 2001-2004 only experienced 8.7% on average. Lusaka province leads in both periods with 12.6% and 20.2% for the initial and second wave, respectively. Of the provinces experiencing high attrition rates, Luapula and Western provinces do show substantial mortality rates on average, which potentially explains the attrition rates in these provinces. Equally, the higher mortality rates in the second wave by province generally give the background to higher numbers of households incurring deaths during the second wave with respect to the initial wave.

Table 4.3 Mean levels of Prime-age adult mortality per 1000 prime-age (15-59 years) person years by province

Province	2001-2004	2004-2008
Central	10.50	16.74
Copperbelt	7.03	17.85
Eastern	8.36	10.45
Luapula	9.95	17.00
Lusaka	12.64	20.26
Northern	7.06	9.98
Nwestern	4.39	7.90
Southern	8.44	11.93
Western	12.05	16.49
Total	**8.71**	**13.12**

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

As the preceding discussions have alluded to, the presence of attrition in the econometric analysis of panel data of mortality impacts potentially leads to confounding results due to bias. Due to the substantial attrition rate in our longitudinal data of about 40% over the seven-year period, selection bias arises if there is a presence of high attrition rates. Therefore, Table 4.4 first examines this potential bias by comparing the means between non-attritors and attritors as exhibited by the 2001 households' attributes that stand as control variables. Secondly, using 2004 household attributes as control variables the study compares the means of the two groups. The results show that the means of the variables have statistically significant differences between households re-interviewed and those attriting.

Households that attrited in either 2004 or 2008 exhibit slightly younger (43 vs. 46 or 44 vs. 47) and more educated heads (5.9 vs. 5.71 or 5.93 vs. 5.63). These households are also characterised by smaller household size with fewer under five children as well as children in the 6-14 age-ranges. The number of prime-age males, prime-age females, elderly males and elderly females is also lower in the attriting group for both survey waves. However, there is significant negative mean difference in the number of chronically ill adults in the first wave as compared to the insignificant mean difference in the second wave. In terms of landholding size and land cultivated, the attriting group exhibits much lower hectarage than the re-interviewed cohort does. Asset value is equally lower for attriting households in both survey waves. These differences signify that households attriting have initial conditions that enable them to be fluid and mobile enough to migrate out of the SEAs. Dissolution is another possible case in that attriting households in the first wave actually poses a significant number of chronically ill adults, which make these households open to mortality shocks.

Table 4.4 Mean levels of 2001 household attributes by attrition status

Household Attributes	Reinterviewed in 2004	Attrited in 2004	Mean Difference	t-stat	Reinterviewed in 2008	Attrited in 2008	Mean Difference	t-stat
Age of household head (years)	46.69	43.88	2.81**	6.35	47.01	44.56	2.45**	6.51
Years of schooling of HH head	5.71	5.90	-0.19+	-1.71	5.63	5.93	-0.30*	-3.16
Years of schooling of spouse	3.12	2.19	0.93**	8.35	3.22	2.43	0.78**	8.25
Size of household	6.26	5.35	0.91**	9.63	6.37	5.57	0.80**	9.99
Num. children under age 5	1	1	0.11**	4.08	1	1	0.11**	4.71
Number of children age 6 to 14	2.12	1.81	0.31**	5.84	2.16	1.88	0.28**	6.19
Prime-age adult male members (number)	1.35	1.15	0.20**	6.54	1.37	1.21	0.16**	6.22
Prime-age adult female members (number)	1.42	1.26	0.16**	5.77	1.45	1.28	0.16**	6.75
Elderly males age 60 and above (number)	.18	.12	0.05**	4.95	.18	.14	0.05**	5.07
Elderly females age 60 and above (number)	.14	.11	0.03*	3.02	.14	.13	0.02+	1.84
Chronically ill adult members (number)	0.14	0.18	-0.05**	-3.53	0.15	0.16	-0.01	-1.13
Dependency ratio	1.38	1.34	.04	1.13	1.38	1.35	.03	.97
Landholding size (ha)	2.70	2.05	0.65**	5.53	2.81	2.15	0.67**	6.64
Land cultivated (ha)	1.95	1.55	0.40**	6.82	2.04	1.57	0.47**	9.41
Value of assets ('000 ZKw per HH)	805	472	333**	4.63	857	527	330**	5.55
Distance to nearest tarred/main road (km) from centre of SEA	24.5	24.0	0.58	.58	25.2	23.1	2.18*	2.58
Distance to nearest district town from centre of SEA (km)	34.1	35.3	-1.19+	-1.78	33.8	35.2	-1.36*	-2.41

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

These systematic differences between attritors and non-attritors may potentially lead to attrition bias. In the light of the above, the inverse probability weighting (IPW) method is used to correct for the bias (Wooldridge, 2002). The method 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. Generally, 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, 57 enumeration teams are used to predict re-interview. The study employs Probit regressions based on equation (5) to provide the predicted probabilities of re-interview. For attrition between the 2001 and 2004 surveys, the predicted probability, Pr_{2004} is obtained while Pr_{2008} is obtained as the predicted probability between 2004 and 2008. The inverse probability weight for households in the 2004 survey is given by $R_{2004} = 1/Pr_{2004}$. Since the households in 2008 survey survived attrition twice, the inverse probability weight R_{2008} is a product of $1/Pr_{2004}$ and $1/Pr_{2008}$. Essentially, all the models on dynamics of impacts of prime-age adult mortality are estimated using these inverse probabilities as weights.

4.1.1 Determinants of Household Re-interview

This section builds on the descriptive analysis discussed earlier in the chapter. The empirical examination of the determinants of re-interview and the dynamics of the impacts of mortality on households' outcomes become the focal point of the section. The preceding analysis shows that attrition is an apparent problem and explains the need to generate inverse probability weights to solve the possible problem of selection bias.

The results of the Probit re-interview models in terms of households' characteristics in 2001 and 2004 are presented in Table 4.5 below. They show that households that were in the non-attritors group differ from those attriting in their attributes. Household characteristics, community attributes, agro-ecological zone and supervisor (team) effects were included as explanatory variables in the analysis. Household attributes showed joint significance as determinants of re-interview. These results coherently follow the mean level differences given earlier where households with less educated older heads and a larger composition, in terms of numbers, of prime age males, prime age females, children below 5 years old, children between 6 and 14 years old having a higher probability of re-interview. The coefficient for years of schooling of spouse indicate a positive relationship implying that households with less educated spouses are likely to attrite than those with more educated spouses. Larger compositions of household members indicate a large household size, which makes it less likely for a given household to move away or dissolve under various circumstances, mortality shocks inclusive. Households' productive asset base and landholding size show positive relation with respect to probability of re-interview.

Table 4.5 Probit models for household re-interview, 2001-2008 periods

Explanatory variables	Re-interviewed in 2004, and is in 2001 survey (=1)	Re-interviewed in 2008, and is in 2001 and 2004 survey (=1)
Polygamous Household (=1)	-0.004	0.023
	(-0.0177)	(-0.0185)
Female head (=1)	-0.0361*	-0.0463**
	(-0.0146)	(-0.0162)
Age of household head	0.000	0.00559*
	(-0.00223)	(-0.00244)
Age of household head squared	0.000	0.000+
	(-0.0000)	(-0.000)
Years of schooling of head	-0.00529**	-0.00619**
	(-0.00159)	(-0.00176)
Years of schooling of spouse	0.00596**	0.00317+
	(-0.00181)	(-0.00184)
Number of male adults	0.008	-0.004
	(-0.006)	(-0.00593)
Number of female adults	0.009	0.0196**
	(-0.00654)	(-0.00657)
Number of children (<6 years)	0.0193**	0.0146*
	(-0.00608)	(-0.00598)
Number of children (6-14 years)	0.00646*	0.006
	(-0.00324)	(-0.00425)
Ln (Asset value)	0.00345**	0.00286**
	(-0.00102)	(-0.0011)
Ln (Landholding size)	0.0282**	0.0274**
	(-0.00608)	(-0.00728)
Distance to tarred/main road (km)	-0.000*	-0.00110**
	(-0.000248)	(-0.00028)
Distance to nearest district (km)	0.000	0.000
	(-0.000)	(-0.000)
District on rail line (=1)	-0.0943**	-0.027
	(-0.0306)	(-0.0309)
HIV prevalence rate	0.004	0.0113**
	(-0.00259)	(-0.00274)
Agro zone dummies included [a]	Yes	Yes
Team dummies included [b]	Yes	Yes
Chi-square joint test for[c]		
Household characteristics	84.85 (0.00)	67.73 (0.00)
Community characteristics	11.62 (0.02)	34.46 (0.00)
Agro zone and Team effects	158.81 (0.00)	293.39 (0.00)
Observations	6922	5419

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Estimated coefficients are marginal changes in probability. [a] Agro zone and [b]Enumeration teams are included but not reported in the table. [c]Joint test for household characteristics, community characteristics, agro zone and enumeration team effects are significant at 5 percent significance level. Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

The community characteristics are jointly significant as determinants of re-interview at 5 percent level of significance. The probability of re-interview reduces as distance to tarred/ main road increases. The implication is that enumerators may have found it more difficult to reach households falling in remote areas. An increase in distance to the nearest town/ boma/ district from the centre of the SEA increases the probability of re-interview.

The 1996 and 2000 HIV prevalence rates are positively related to re-interview with the latter being significant at 1 percent level of significance. In this sample, the indication could be that AIDS does not necessarily exacerbate dissolution or migration. On the contrary, these households may be comprised of elderly and younger children. Equally true also is the possibility of the prevalence rates picking up other spatial factors that may be negatively correlated with district level attrition rates as well as mobility and migration. There is joint significance in the team and agro zone effects in determining re-interview. Team effort and strong supervisory greatly influences follow up of households and are strong predictors of household re-interview. Therefore, the implication of these results suggests the importance of controlling for attrition. Chapoto (2004) however showed that the magnitudes of the results between models corrected for attrition versus those not-corrected for attrition did not differ significantly. The models following the same approach in this seven year panel study equally show no significant differences in terms of the magnitudes, which suggests that, at least in this particular national sample, attrition bias does not create major problems for statistical inference. Nonetheless, the study employs the IPW method for the demeaned fixed effects models to ensure that not even minor attrition bias rises.

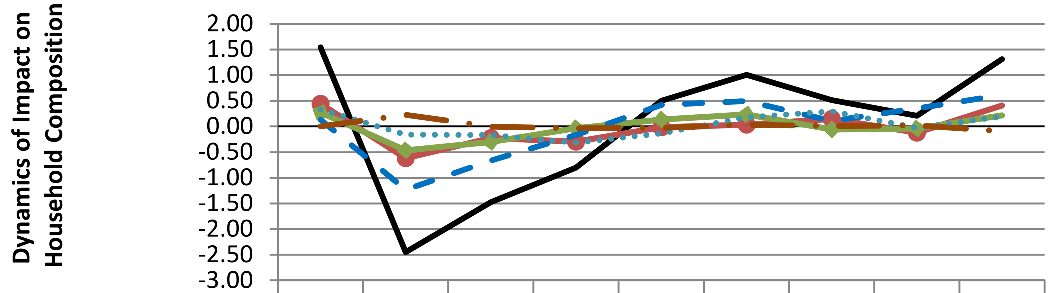
4.2 Dynamics of the impacts of prime-age mortality on household composition

Household composition largely determines the direction of households' welfare and productivity. The abundance of productive labour creates potential surpluses for the agrarian fields and other agricultural activities, which are pivotal to the generation of income and escape from the poverty trap that rural households find themselves shelled. This readily available cheap source of labour may potentially act to the detriment of the progression of rural households if the presence of dependency syndrome characterises the farm households. If we adhere to conventional wisdom that welfare and productivity are a positive function of household composition then the study is justified by furthermore adhering to the understanding that as mortality shocks enter, households exhibit deteriorating changes, in their structures. These structural changes do comprise a variety of coping mechanisms and adjustments to prime-age mortality. Noteworthy, households faced with morbidity *ex ante* start to make structural changes that affect their composition. The implication is that dynamics actually enter these households before the actual shock sets in, around the year of mortality. Morbidity poses financial and labour constraints on the household thus *dipping* and weakening the household's capability to hire labour, purchase inputs as sums of financial resources are spent on caring for the sick. The year of the shock sees a *drop* in a number of the household's attributes, with composition being a function of them. During the *ex post* era the household continues to make these adjustment to cope with the shock. This section therefore, examines these dynamics in the light of household composition and structural changes and explains the hypothesis that deteriorating outcomes in household composition are experienced with mortality shock.

Table 4.6 presents demeaned fixed effects results based on the model specification in equation 3. The impacts and outcomes of the general *dip-drop-recovery* model emanate in the presentation of the dynamics. Incidentally, the dynamics show that three years prior to mortality household size significantly increases by 1.5 members at 5 percent level of significance. The number of female PA is positively related to this period as well at 1 percent level of significance. This increase is offset by significant declines of 2.5 and 1.5 at 1 percent level of significance occurring two and one year prior to the shock, respectively. The two periods before death shows a decline of more than one-person and by the actual year of the shock, the decline is less than one-person. Generally, household size declines during the period of morbidity to the point of mortality shock. Therefore, adjustments significantly enter the rural farm household as Kirimi (2008) and Chapoto and Jayne (2008) have shown. In our study, these adjustments begin to emerge about two years prior to the actual shock. The table shows that one and two years after the shock, households replenish their numbers by more than one-person in the second year mainly by attracting additional prime-age males and children between 6-14 years old. Five years after death, household size significantly increases by 1.3 at 1 percent level. Earlier findings show that it is this flexibility within households that is crucial in coping with mortality shocks (Chapoto, 2006).

Figure 4.2.1 shows that the general outcome on household composition is that of partial replenishment of household numbers overtime. The *dip-drop-recovery* process is observed in the figure showing the efforts being made by households to recover in numbers to initial levels.

Figure 4.2.1: Trend of Dynamics of Impacts on Household Composition



	-3	-2	-1	0	1	2	3	4	5
Household size	1.54	-2.45	-1.48	-0.81	0.50	1.00	0.52	0.21	1.31
Female Prime-age	0.44	-0.62	-0.23	-0.30	-0.02	0.03	0.14	-0.12	0.40
Male Prime-age	0.27	-0.47	-0.30	-0.04	0.13	0.23	-0.06	-0.05	0.21
Children 6-14 yrs	0.13	-1.23	-0.67	-0.17	0.42	0.49	0.11	0.35	0.61
Children 0-5 yrs	0.33	-0.16	-0.17	-0.32	-0.14	0.18	0.29	-0.03	0.20
Elders 60+	0.00	0.22	-0.01	-0.04	-0.03	0.03	0.01	0.02	-0.09

Year of Shock

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Generally, household composition is positively related to male-headed households and age of household head significantly. A significant non-linear relationship between age of the head and composition exists. As households mature, more adults and older children begin to emerge. However, later in the lifecycle the opposite occurs as these may themselves start new families. Education shows a negative path significant at 10 percent level. An increase in distance to main road indicating less mobility increases household composition at 1 percent level of significance.

Table 4.6 Fixed Effects Model of impacts of PA mortality on household composition, 2001-08

Explanatory variables	Number of: Household size	Female Prime-age	Male Prime-age	Children 6-14 yrs	Children 0-5 yrs	Elders 60+
	(1)	(2)	(3)	(4)	(5)	(6)
Three years before shock	1.543*	0.440+	0.272	0.130	0.332	0.00145
	(0.757)	(0.248)	(0.280)	(0.455)	(0.295)	(0.103)
Two years before shock	-2.451**	-0.620**	-0.468*	-1.233**	-0.160	0.223**
	(0.571)	(0.209)	(0.196)	(0.351)	(0.226)	(0.0818)
One year before shock	-1.479**	-0.231	-0.302+	-0.665+	-0.169	-0.00589
	(0.553)	(0.165)	(0.154)	(0.346)	(0.183)	(0.0492)
Year of mortality shock	-0.806+	-0.298*	-0.0386	-0.165	-0.316*	-0.0367
	(0.466)	(0.146)	(0.151)	(0.289)	(0.160)	(0.0666)
One year after shock	0.503+	-0.0164	0.130	0.420*	-0.138	-0.0347
	(0.274)	(0.100)	(0.0923)	(0.183)	(0.105)	(0.0406)
Two years after shock	1.004*	0.0314	0.234*	0.491+	0.176	0.0323
	(0.405)	(0.127)	(0.116)	(0.256)	(0.148)	(0.0347)
Three years after shock	0.515+	0.143	-0.0639	0.108	0.292*	0.00528
	(0.308)	(0.107)	(0.115)	(0.201)	(0.115)	(0.0489)
Four years after shock	0.209	-0.123	-0.0452	0.349	-0.0311	0.0151
	(0.416)	(0.122)	(0.147)	(0.260)	(0.166)	(0.0541)
Five years after shock	1.311**	0.404*	0.212	0.612*	0.198	-0.0943
	(0.444)	(0.167)	(0.145)	(0.261)	(0.174)	(0.0636)
Elderly male mortality	-0.145	0.00769	-0.0694	-0.261+	0.00592	-0.209**
	(0.273)	(0.101)	(0.0856)	(0.158)	(0.103)	(0.0534)
Elderly female mortality	-0.436	-0.290**	-0.118	-0.140	-0.0217	-0.289**
	(0.278)	(0.0994)	(0.0990)	(0.159)	(0.104)	(0.0532)
Gender of head (=1)	0.862**	-0.0806	0.548**	0.259*	0.231**	0.0973**
	(0.213)	(0.0695)	(0.0785)	(0.129)	(0.0787)	(0.0340)
Age of the head	0.206**	0.0157+	0.0321**	0.141**	0.0277*	-0.0244**
	(0.0343)	(0.00933)	(0.00814)	(0.0209)	(0.0126)	(0.00404)
Age of the head squared	-0.00211**	-0.000194*	-0.000185*	-0.00141**	-0.000420**	0.000397**
	(0.000331)	(9.06e-05)	(8.41e-05)	(0.000198)	(0.000138)	(4.59e-05)
Education of the head (years)	-0.0327+	-0.0194**	-0.0185**	-0.00363	0.00872	-0.00206
	(0.0181)	(0.00616)	(0.00623)	(0.0114)	(0.00724)	(0.00240)
Distance to tarred/main road (km)	0.00332**	0.000589	0.00101*	0.00182*	8.38e-05	-3.72e-06
	(0.00124)	(0.000427)	(0.000450)	(0.000802)	(0.000553)	(0.000157)
Distance to nearest district (km)	0.00161	0.000399	-0.000715	0.000591	0.00204*	0.000159
Distance to fertilizer depot (km)	0.00175	3.93e-05	0.000430	0.00190	-0.000731	-3.58e-05
	(0.00180)	(0.000555)	(0.000649)	(0.00118)	(0.000784)	(0.000172)
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.616	1.194**	-0.0746	-1.400**	0.416	0.447**
	(0.871)	(0.240)	(0.216)	(0.537)	(0.300)	(0.0947)
Observations	8,572	8,572	8,572	8,572	8,572	8,572
R-squared	0.052	0.037	0.067	0.087	0.025	0.157

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

Table 4.7 presents results based on equation (4) taking into account interaction effects due to male and female mortality. Essentially, the analysis is one of the impacts of male or female mortality on household composition. The extent of the impact of gender alone becomes pivotal in this part. Negative relations emerge between household size and gender. Female mortality accounts for a reduction of about 0.4 numbers of Female PA and Male PA at 10 percent level of significant. This less than one member reduction suggests partial replenishment A *dip* takes place one year before male mortality with a significant decline of 4.0 household members at 5 percent level. However, the pattern takes on an immediate *recovery* path in the year of the shock for both male and female mortality on the household. Both male and female mortalities are offset by an increase of 3 household members at 5 percent level of significance in the year of death. Again, households endeavour to replenish themselves following mortality shock.

Table 4.7 Fixed Effects of impacts of PA mortality on household composition by gender of the deceased alone, 2001-2008

Explanatory variables	Household size	Female Prime-age	Male Prime-age	Children 6-14 yrs	Children 0-5 yrs	Elders 60+
	(1)	(2)	(3)	(4)	(5)	(6)
Male mortality	-0.268	0.0568	-0.351	-0.284	-0.105	-0.0236
	(0.803)	(0.234)	(0.215)	(0.497)	(0.345)	(0.0715)
Female mortality	-0.832	-0.389+	-0.331+	-0.159	0.0456	-0.0533
	(0.866)	(0.217)	(0.199)	(0.495)	(0.223)	(0.0739)
Three years before shock	2.574	0.785	1.209+	0.712	-1.310*	-0.231
	(1.970)	(0.656)	(0.731)	(1.170)	(0.613)	(0.318)
Two years before shock	-3.501+	-0.569	-1.693**	-1.860+	0.192	0.0577
	(1.835)	(0.690)	(0.593)	(0.986)	(0.849)	(0.265)
One year before shock	2.201	0.690	0.401	0.903	0.330	0.194
	(2.018)	(0.492)	(0.579)	(1.162)	(0.471)	(0.210)
Year of mortality shock	-3.806*	-0.716	-1.318**	-1.593+	0.266	-0.0410
	(1.551)	(0.504)	(0.479)	(0.901)	(0.416)	(0.280)
One year after shock	1.945*	0.110	0.694*	1.467*	-0.143	-0.0610
	(0.903)	(0.341)	(0.294)	(0.574)	(0.366)	(0.182)
Two years after shock	-0.495	-0.677+	-0.231	0.379	-0.158	-0.0449
	(1.200)	(0.381)	(0.320)	(0.753)	(0.356)	(0.119)
Three years after shock	1.580+	0.262	0.581+	0.0838	0.404	0.142
	(0.816)	(0.325)	(0.313)	(0.469)	(0.341)	(0.115)
Four years after shock	1.466*	-0.226	0.244	1.198**	0.485	0.0666
	(0.713)	(0.271)	(0.314)	(0.424)	(0.365)	(0.108)
Five years after shock	0.467	0.434	0.456	0.266	-0.150	-0.0321
	(1.634)	(0.557)	(0.473)	(0.823)	(0.725)	(0.196)
Three years before shock*male mortality dummy	-0.881	-0.609	-1.386+	0.453	1.342*	0.156
	(2.009)	(0.628)	(0.713)	(1.187)	(0.614)	(0.300)
Two years before shock*male mortality dummy	0.784	0.448	1.038+	-0.0612	-0.675	0.0480
	(1.713)	(0.643)	(0.574)	(0.945)	(0.696)	(0.249)
One year before shock*male mortality dummy	-4.066*	-0.649	-1.130*	-1.773	-0.350	-0.296
	(1.992)	(0.483)	(0.562)	(1.149)	(0.439)	(0.199)
Three years before shock*female mortality dummy	-0.937	-0.126	-0.646	-1.129	1.706**	0.305
	(2.005)	(0.646)	(0.733)	(1.175)	(0.615)	(0.301)
Two years before shock*female mortality dummy	0.730	-0.591	0.921	0.942	-0.117	0.189
	(1.723)	(0.678)	(0.573)	(0.940)	(0.785)	(0.251)
One year before shock*female mortality dummy	-3.141	-1.009*	-0.278	-1.383	-0.572	-0.115
	(1.966)	(0.489)	(0.572)	(1.126)	(0.453)	(0.201)
Year of mortality shock*male mortality dummy	2.927+	0.663	1.272**	1.306	-0.588	0.109
	(1.568)	(0.514)	(0.471)	(0.909)	(0.403)	(0.252)
One year after shock*male mortality dummy	-1.410	-0.111	-0.406	-0.923	0.139	0.0590
	(1.111)	(0.405)	(0.328)	(0.653)	(0.397)	(0.198)
Two years after shock*male mortality dummy	1.837	0.632	0.676+	0.586	0.305	0.151

	(1.274)	(0.406)	(0.355)	(0.755)	(0.384)	(0.114)
Three years after shock*male mortality dummy	-0.923	-0.212	-0.366	0.211	-0.00451	-0.208+
	(0.973)	(0.347)	(0.341)	(0.570)	(0.394)	(0.115)
Four years after shock*male mortality dummy	-1.447	-0.0950	0.0745	-0.803	-0.616	-0.0111
	(1.057)	(0.308)	(0.338)	(0.602)	(0.466)	(0.152)
Five years after shock*male mortality dummy	1.129	-0.346	-0.149	1.005	0.639	0.0217
Year of mortality shock*female mortality dummy	3.134*	0.315	1.293**	1.539+	-0.498	-0.0811
	(1.549)	(0.511)	(0.475)	(0.890)	(0.403)	(0.260)
One year after shock*female mortality dummy	-0.537	0.114	-0.148	-0.773	-0.0218	0.0634
	(1.081)	(0.388)	(0.315)	(0.651)	(0.400)	(0.190)
Two years after shock*female mortality dummy	1.851	0.935*	0.697*	0.0385	0.358	0.0715
	(1.295)	(0.412)	(0.355)	(0.780)	(0.375)	(0.120)
Three years after shock*female mortality dummy	-0.394	0.179	-0.375	0.159	-0.210	-0.00864
	(1.000)	(0.350)	(0.340)	(0.580)	(0.378)	(0.111)
Four years after shock*female mortality dummy	-0.476	0.451	-0.143	-0.617	-0.431	-0.0260
	(1.026)	(0.315)	(0.345)	(0.581)	(0.434)	(0.137)
Five years after shock*female mortality dummy	1.165	0.376	0.151	0.0638	0.0911	-0.0635
	(1.572)	(0.534)	(0.465)	(0.836)	(0.650)	(0.181)
Elderly male mortality	-0.164	0.0205	-0.106	-0.258	0.00884	-0.211**
	(0.275)	(0.102)	(0.0859)	(0.160)	(0.103)	(0.0531)
Elderly female mortality	-0.449+	-0.304**	-0.118	-0.142	-0.0274	-0.295**
	(0.269)	(0.0957)	(0.0963)	(0.155)	(0.104)	(0.0532)
Gender of head (=1)	0.824**	-0.0303	0.490**	0.248+	0.226**	0.0931**
	(0.210)	(0.0703)	(0.0774)	(0.128)	(0.0786)	(0.0348)
Age of the head	0.210**	0.0159+	0.0341**	0.143**	0.0278*	-0.0241**
	(0.0346)	(0.00936)	(0.00804)	(0.0211)	(0.0126)	(0.00401)
Age of the head squared	-0.00215**	-0.000193*	-0.000205*	-0.00144**	-0.000420**	0.000394**
	(0.000334)	(9.09e-05)	(8.39e-05)	(0.000200)	(0.000138)	(4.55e-05)
Education of the head (years)	-0.0350+	0.0204**	0.0193**	-0.00265	0.00858	-0.00177
	(0.0180)	(0.00615)	(0.00623)	(0.0113)	(0.00723)	(0.00242)
Distance to tarred/main road (km)	0.00328**	0.000644	0.000948*	0.00185*	5.12e-05	-2.52e-06
	(0.00124)	(0.000427)	(0.000448)	(0.000800)	(0.000556)	(0.000158)
Distance to nearest district (km)	0.00154	0.000335	-0.000735	0.000678	0.00197*	0.000137
	(0.00205)	(0.000694)	(0.000704)	(0.00134)	(0.000902)	(0.000269)
Distance to fertilizer depot (km)	0.00174	3.59e-05	0.000457	0.00184	-0.000731	-2.67e-05
	(0.00180)	(0.000568)	(0.000645)	(0.00117)	(0.000788)	(0.000171)
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.556	1.138**	-0.0732	-1.428**	0.417	0.447**
	(0.878)	(0.241)	(0.212)	(0.542)	(0.302)	(0.0948)
Observations	8,572	8,572	8,572	8,572	8,572	8,572
R-squared	0.058	0.049	0.083	0.092	0.029	0.161

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

An estimation of the model in equation (5) suffices in order to analyse and determine the variation of the changes in household composition by gender and position of the deceased *ex ante* and *ex post*. The results presented in Table 4.8 show that prime-age females and males migrate out of the household by 0.3 and 0.4 with the death of male head, an indication of the economic hardships that rock the household due to morbidity on the breadwinner. On average, household composition declines by 2.8 in this model. Two years before male head mortality the number of males significantly declines by 2 with an attendant significant emigration of 1.6 children 6-14 and 2.4 children below five years of age. The impact of non-head morbidity shows an influx of male PA and children into the household changing its composition and structure. In the year of male head death, male PA significantly drops together with children below five years of age. Recovery sets in around the second year after mortality shock with an increase in household size of 4.6 members at 1 percent level of significance. Therefore, the impact of gender and position of the deceased equally follows the *dip-drop-recovery* path.

Table 4.8 Fixed Effects of impacts of PA mortality on household composition by gender and position of deceased, 2001-2008

	Number of:					
Explanatory variables	Household size	Female Prime-age	Male Prime-age	Children 6-14 yrs	Children 0-5 yrs	Elders 60+
	(1)	(2)	(3)	(4)	(5)	(6)
Male head mortality	-0.874	-0.347+	-0.413*	-0.228	0.0162	-0.0236
	(0.657)	(0.197)	(0.173)	(0.375)	(0.179)	(0.0522)
Non- head mortality	-0.0298	-0.271	-0.319	0.0940	-0.0462	-0.155
	(0.694)	(0.220)	(0.235)	(0.376)	(0.336)	(0.104)
Three years before shock	0.0938	-0.385	0.991	-0.224	-1.451+	-0.430
	(2.460)	(0.845)	(0.940)	(1.467)	(0.776)	(0.573)
Two years before shock	-2.847*	-1.887+	-2.861**	-0.0542	-2.718**	0.571
	(3.237)	(1.064)	(0.849)	(1.944)	(0.688)	(0.380)
One year before shock	1.986	0.894	0.184	0.202	0.571	0.247
	(2.639)	(0.666)	(0.675)	(1.661)	(0.749)	(0.388)
Year of mortality shock	-1.733	0.483	-1.532*	-1.188	0.758	0.0555
	(1.994)	(0.520)	(0.746)	(1.124)	(0.539)	(0.525)
One year after shock	0.852*	-0.00252	1.014**	0.755	-0.788	-0.0949
	(0.403)	(0.465)	(0.312)	(0.743)	(0.546)	(0.138)
Two years after shock	-2.203	-1.180+	-0.726*	0.324	-0.531	-0.165
	(1.362)	(0.608)	(0.287)	(1.005)	(0.581)	(0.243)
Three years after shock	0.159	-0.531+	0.568	-0.431	-0.175	-0.0963
	(0.875)	(0.277)	(0.391)	(0.572)	(0.455)	(0.141)
Four years after shock	0.857	-0.345	-0.231	1.138*	0.380	0.0567**
	(0.662)	(0.328)	(0.316)	(0.445)	(0.418)	(0.0180)
Five years after shock	4.405	1.455	1.185	-0.724	3.030**	-0.450
	(3.022)	(0.917)	(0.724)	(1.694)	(0.0896)	(0.336)
Three years before shock*male head dummy	1.495	0.935	-0.701	0.468	1.914*	0.422
	(2.689)	(0.912)	(1.004)	(1.594)	(0.874)	(0.583)
Two years before shock*male head dummy	3.517	1.111	-2.110*	-1.630	-2.425**	-0.225
	(3.342)	(1.105)	(0.892)	(2.010)	(0.738)	(0.392)
One year before shock*male head dummy	-4.177	-1.266+	-0.502	-1.191	-1.084	-0.298
	(2.744)	(0.695)	(0.700)	(1.731)	(0.780)	(0.392)
Three years before shock*non-head dummy	2.034	0.685	-0.901	0.814	1.945*	0.583
	(2.689)	(0.918)	(1.079)	(1.622)	(0.959)	(0.618)
Two years before shock*non-head dummy	5.329	1.073	2.398**	-0.574	2.948**	-0.715+
	(3.372)	(1.112)	(0.923)	(2.034)	(0.828)	(0.414)
One year before shock*non- head	-2.475	-0.897	-0.422	-0.360	-0.207	-0.180
	(2.763)	(0.722)	(0.724)	(1.724)	(0.814)	(0.399)
Year of mortality shock*male head dummy	0.856	-0.832	-1.609*	0.827	-1.201*	-0.0636
	(2.125)	(0.566)	(0.771)	(1.202)	(0.585)	(0.529)
One year after shock*male head dummy	0.447	0.202	-0.509	-0.0536	0.663	0.0251
	(0.808)	(0.518)	(0.369)	(0.844)	(0.580)	(0.151)
Two years after shock*male head dummy	4.656**	1.615*	1.354**	0.680	0.976	0.226
	(1.551)	(0.661)	(0.361)	(1.088)	(0.621)	(0.251)
Three years after shock*male head dummy	1.174	0.955**	-0.328	1.010	0.440	0.0915
	(1.093)	(0.347)	(0.442)	(0.684)	(0.495)	(0.154)
Four years after shock*male head dummy	0.0760	0.467	0.554	-0.695	-0.402	-0.0731
	(1.011)	(0.390)	(0.391)	(0.634)	(0.478)	(0.0775)
Five year after shock*male head dummy	-2.175	-0.818	-0.681	1.636	-2.707**	0.336
	(3.112)	(0.953)	(0.761)	(1.752)	(0.243)	(0.345)
Year of mortality shock*non-head	1.277	-0.752	1.624*	1.450	-1.039+	-0.154
	(2.122)	(0.565)	(0.787)	(1.213)	(0.603)	(0.540)

One year after shock*non-head dummy	-0.582	0.357	-0.719+	-0.710	0.674	0.317
	(0.826)	(0.521)	(0.402)	(0.870)	(0.647)	(0.194)
Two years after shock*non-head dummy	2.328	1.341*	1.213**	-0.438	0.357	0.342
	(1.519)	(0.653)	(0.384)	(1.098)	(0.659)	(0.264)
Three years after shock*non-head dummy	0.0868	0.964**	-0.495	0.0137	0.608	0.284
	(1.140)	(0.359)	(0.479)	(0.720)	(0.589)	(0.182)
Four years after shock*non-head dummy	-1.125	0.514	0.297	-0.998	-0.575	0.165
	(1.041)	(0.427)	(0.423)	(0.631)	(0.607)	(0.154)
Five years after shock*non- head dummy	-3.727	-0.923	-0.800	1.142	-3.182**	0.541
	(3.124)	(0.958)	(0.778)	(1.755)	(0.393)	(0.361)
Elderly male mortality	-0.140	0.00900	-0.0752	-0.255	0.0201	-0.208**
	(0.274)	(0.102)	(0.0866)	(0.158)	(0.103)	(0.0534)
Elderly female mortality	-0.452+	-0.288**	-0.115	-0.153	-0.0290	-0.287**
	(0.273)	(0.0987)	(0.0979)	(0.156)	(0.104)	(0.0535)
Gender of head (=1)	0.854**	-0.0639	0.530**	0.276*	0.232**	0.103**
	(0.210)	(0.0717)	(0.0780)	(0.129)	(0.0800)	(0.0357)
Age of the head	0.209**	0.0166+	0.0327**	0.142**	0.0291*	-0.0246**
	(0.0344)	(0.00939)	(0.00808)	(0.0210)	(0.0126)	(0.00402)
Age of the head squared	-0.00215**	-0.000203*	-0.000194*	-0.00142**	-0.000429**	0.000399**
	(0.000332)	(9.05e-05)	(8.36e-05)	(0.000198)	(0.000137)	(4.58e-05)
Education of the head (years)	0.0347+	0.0206**	0.0196**	-0.00322	0.00892	-0.00185
	(0.0181)	(0.00617)	(0.00624)	(0.0113)	(0.00726)	(0.00239)
Distance to tarred/main road (km)	0.00335**	0.000620	0.00101*	0.00186*	6.25e-05	-1.35e-05
	(0.00124)	(0.000425)	(0.000450)	(0.000805)	(0.000554)	(0.000157)
Distance to nearest district (km)	0.00164	0.000471	-0.000632	0.000476	0.00210*	0.000177
	(0.00206)	(0.000695)	(0.000711)	(0.00135)	(0.000896)	(0.000268)
Distance to fertilizer depot (km)	0.00175	5.26e-05	0.000453	0.00182	-0.000672	-2.62e-05
	(0.00181)	(0.000560)	(0.000652)	(0.00116)	(0.000792)	(0.000171)
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.559	1.152**	-0.0790	-1.415**	0.366	0.445**
	(0.879)	(0.243)	(0.216)	(0.541)	(0.299)	(0.0957)
Observations	8,572	8,572	8,572	8,572	8,572	8,572
R-squared	0.059	0.043	0.076	0.092	0.031	0.163

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

The foregoing analyses do show that on average, household composition undergoes changes in its size and structure due to mortality. The study conforms with earlier findings that adjustments in the households begin to emerge earlier during morbidity (Kirimi, 2008). Incidentally, a *dip-drop-recovery* temporal pattern in the dynamics of the impacts characterises the pathway of the composition of households from the second year *ex ante* mortality until about the fifth year after death. Owing to the epidemiological nature of the disease, debilitating effects begin to emerge about 17 months prior death and as such the study observes significant negative effects in the second year *ex ante* mortality. Evidently, the finding suggests that households are not just making *ex post* responses to cope with mortality. Rather, dynamics are such that they are making *ex ante* morbidity adjustments in household composition. Up until the year of death, household composition generally declines on average and recovers after death. This flexibility to respond to economic hardship is critical for households' success (Beegle, 2005 and Chapoto, 2006). Reduction in household members though releasing some extra field labour, in a sense relieves the household of that extra burden to provide for members in terms of daily needs. Later on, the additional labour is required in the fields and new members enter to facilitate work arrangements and allow core household members to reallocate more time to income-generating activities (Slater and Wiggins, 2005). Another possible explanation as to why members leave the households could be due to the existence of parasitic members who jump off ship when hardships enter the family.

Generally, these findings stimulate a position that household composition changes over time as part of a coping mechanism. Henceforth, this flexibility is crucial in successfully responding to extreme crises such as morbidity and mortality. Evidently, the impacts of prime-age mortality on household composition are not just a one time permanent adjustment. Rather, they follow a series of dynamics to the point of full or partial recovery. This is critical for welfare considerations.

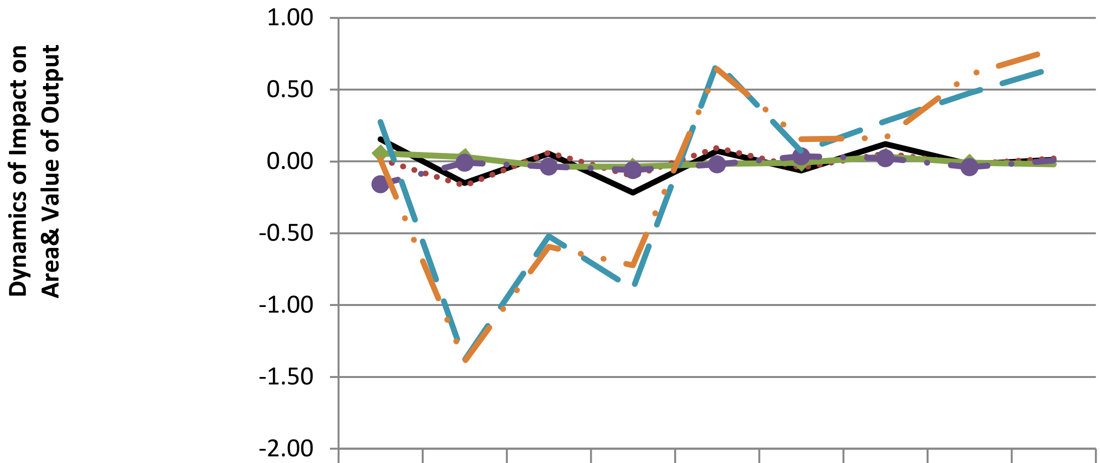
4.3 Dynamics of the impacts of prime-age mortality on farm production

This section examines the dynamics of impacts of prime-age mortality vis-à-vis total cultivated land, area cultivated by crop type and value of crop production. Farm production is mainly affected by mortality through impacts on land, labour, capital and knowledge. In the absence of secure tenure rights, death of male head implies loss of land by widow and her dependents (Mason *et al*., 2009). Reduction in household size may lead to labour shortages and force households to switch to labour-saving crops such as roots and tubers from labour intensive cereals. Cash constraints and financial vulnerability emanating from the death of a productive prime-age member may imply a change of crop mix and intensity of input application such as purchased fertilizers, chemical sprayers in the case of cotton, rental of animal traction services for cultivation. Agricultural husbandry and marketing knowledge suffers a loss following a death of a prime-age adult. Where households attract new members, this loss in specific skills is usually not offset as boys and girls are primarily a function of this new phenomenon. Therefore, farm production faces some changes via these four critical factors of production with the death of a prime-age member.

4.3.1 Dynamics of impacts of prime-age mortality on total cultivated land by crop type

Table 4.9 shows that three years prior to mortality, land cultivated under high value crops declines by 16.0% at 10 percent level of significance. This *dip* is also noticed in area under cereals equal to 16.9% decline two years prior to mortality impact. On average, total land cultivated declines in year of mortality by 21.7% with a 5 percent significance level. A year after death experiences a marginal 10% increase under cereals indicating a *recovery* pattern occurring in the *ex post* era. The results imply that a *dip-drop-recovery* path is taking place though households are not recovering as much as the loss during the dip period. Figure 4.3.1 gives a descriptive trend over time resulting from mortality shocks on farm production. Negative effects are observed two years prior to death in areas under total, cereal and the gross values of output.

Figure 4.3.1: Trend of Dynamics of Impacts on Farm Production, 2001-2008



	-3	-2	-1	0	1	2	3	4	5
Total	0.16	-0.15	0.05	-0.22	0.07	-0.06	0.12	-0.02	0.01
Cereals	0.01	-0.17	0.06	-0.10	0.09	-0.05	0.05	-0.02	0.02
Roots & tubers	0.05	0.03	-0.04	-0.04	-0.02	-0.01	0.03	-0.01	-0.02
High-value crops	-0.16	-0.01	-0.04	-0.06	-0.02	0.03	0.02	-0.04	0.00
Gross value of crop output	0.28	-1.38	-0.52	-0.89	0.68	0.07	0.28	0.48	0.65
Gross value of crop output/ha	0.01	-1.39	-0.59	-0.72	0.64	0.16	0.16	0.61	0.78

Year of Shock

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

As regards the household characteristics, Table 4.11 further shows that male-headed households positively affect 18.1% and 10.4% of total cultivated land and area under cereals, respectively. The age of the household head is shown to be significant and positively related to total hectares, hectares under high-value crops and hectares under cereals. Furthermore, a significant non-linear relationship amongst the three aforementioned categories is observed. Based on the household's life cycle, younger heads command fewer resources; hence, an increase in land as age increases up to a point (Mason *et al*., 2009). Essentially, these young families comprise of children thus posing a limitation on labour and capital for agriculture. Education of the household head significantly affects total area, area under roots and tubers, and area under cereals in a positive manner.

Households generally increase area under cultivation especially that under cereals and roots and tubers as proximity to the main road nears. Input facilitation such as seed and fertilizer enhance this increase in hectares. A negative relationship exists between distance to main road, distance to fertilizer depot and hectares devoted to cereals and roots and tubers. Distance to the nearest district is positively related to high-value crops implying a presence of independent markets that are not based on near-by district markets. Households are thus incentivised to produce for their district markets with the absence of competitive near-by district markets.

Table 4.9 Fixed Effects of impacts of Prime-age mortality on total cultivated land by crop type, 2001-2008

	Natural logarithm of hectares of:			
Explanatory variables	Total	Cereals	Roots and tubers	High-value crops
	(1)	(2)	(3)	(4)
Three years before shock	0.155	0.0130	0.0537	-0.160+
	(0.159)	(0.108)	(0.0777)	(0.0822)
Two years before shock	-0.150	-0.169*	0.0301	-0.0106
	(0.108)	(0.0705)	(0.0554)	(0.0501)
One year before shock	0.0537	0.0614	-0.0355	-0.0360
	(0.0762)	(0.0532)	(0.0421)	(0.0374)
Year of mortality shock	-0.217*	-0.103	-0.0380	-0.0614
	(0.105)	(0.0705)	(0.0527)	(0.0497)
One year after shock	0.0734	0.0944*	-0.0191	-0.0215
	(0.0606)	(0.0410)	(0.0263)	(0.0305)
Two years after shock	-0.0634	-0.0451	-0.00947	0.0338
	(0.0592)	(0.0409)	(0.0305)	(0.0262)
Three years after shock	0.121	0.0544	0.0324	0.0210
	(0.0811)	(0.0577)	(0.0428)	(0.0368)
Four years after shock	-0.0191	-0.0176	-0.0111	-0.0416
	(0.0821)	(0.0523)	(0.0404)	(0.0444)
Five years after shock	0.0115	0.0204	-0.0203	0.00456
	(0.0744)	(0.0466)	(0.0400)	(0.0332)
Elderly male mortality	0.0150	0.0134	-0.00366	-0.0111
	(0.0533)	(0.0353)	(0.0271)	(0.0237)
Elderly female mortality	0.00279	-0.00915	0.0457	-0.0175
	(0.0538)	(0.0379)	(0.0285)	(0.0282)
Gender of head (=1)	0.181**	0.104**	0.0383	0.0245
	(0.0459)	(0.0295)	(0.0246)	(0.0199)
Age of the head	0.0269**	0.0169**	0.00441	0.00821**
	(0.00700)	(0.00378)	(0.00358)	(0.00242)
Age of the head squared	-0.000248**	-0.000154**	-4.02e-05	-9.02e-05**
	(7.05e-05)	(3.69e-05)	(3.61e-05)	(2.47e-05)
Education of the head (years)	0.0137**	0.00512*	0.00589**	0.00177
	(0.00390)	(0.00247)	(0.00207)	(0.00191)
Distance to tarred/main road (km)	-0.000233	-0.000400+	-0.000394*	0.000195
	(0.000313)	(0.000219)	(0.000156)	(0.000192)
Distance to nearest district (km)	8.67e-05	-0.000106	-0.000207	0.000639**
	(0.000463)	(0.000305)	(0.000262)	(0.000210)
Distance to fertilizer depot (km)	-0.000156	-0.000240	-0.000281	0.000366
	(0.000413)	(0.000295)	(0.000172)	(0.000230)
Provincial dummies	Yes	Yes	Yes	Yes
Constant	-0.323+	0.0815	0.0692	-0.0528
	(0.176)	(0.0982)	(0.0899)	(0.0624)
Observations	8,572	8,572	8,572	8,572
R-squared	0.044	0.069	0.054	0.087

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

Table 4.10 shows the interaction of gender alone with mortality to determine the extent of the dynamics of the impacts of the shock. Households experiencing male mortality, on average, reduce area under cereals by 16.3% at 10 percent level of significance. The reduction in area under cultivation comes as a result of the loss in the complementary factor of production being labour and households are thus shrinking in the production frontier (Casale and Whiteside, 2006). Generally, gender alone does not seem to affect total cultivated land significantly in Table 4.12. The resulting overall effect of gender alone though not highly significant is a reduction in cultivated land by crop type which sees improvements four years after male and female mortality of about 20% under roots and tubers and 16% in high value crops.

Table 4.10 Fixed Effects of impacts of Prime-age mortality on cultivated land by gender alone, 2001-2008

	Natural log of hectares of:			
Explanatory variables	Total	Cereals	Roots and tubers	High-value crops
	(1)	(2)	(3)	(4)
Male mortality	-0.110	-0.163+	0.0425	0.0271
	(0.128)	(0.0872)	(0.0733)	(0.0728)
Female mortality	-0.0642	-0.00583	-0.0194	-0.0491
	(0.0975)	(0.0690)	(0.0554)	(0.0491)
Three years before shock	0.295	-0.134	0.234	0.0401
	(0.386)	(0.255)	(0.221)	(0.196)
Two years before shock	-0.00617	-0.289	0.133	0.103
	(0.332)	(0.189)	(0.194)	(0.210)
One year before shock	0.0296	0.00823	0.0230	-0.0826
	(0.250)	(0.147)	(0.149)	(0.132)
Year of mortality shock	-0.171	-0.0168	0.0107	-0.116
	(0.286)	(0.161)	(0.177)	(0.148)
One year after shock	0.125	0.134	-0.0425	-0.0798
	(0.171)	(0.108)	(0.0801)	(0.110)
Two years after shock	-0.147	-0.0158	-0.0484	-0.0823
	(0.185)	(0.114)	(0.113)	(0.0765)
Three years after shock	0.120	0.0797	-0.0169	0.0176
	(0.190)	(0.119)	(0.106)	(0.0881)
Four years after shock	-0.183	0.0188	-0.226	0.0298
	(0.167)	(0.126)	(0.0669)	(0.115)
Five years after shock	0.122	0.257+	-0.0453	0.122
	(0.250)	(0.140)	(0.141)	(0.164)
Three years before shock*male mortality dummy	-0.474	-0.0660	-0.339	0.0911
	(0.380)	(0.248)	(0.215)	(0.193)
Two years before shock*male mortality dummy	-0.308	-0.139	0.0466	-0.0730
	(0.314)	(0.173)	(0.179)	(0.190)
One year before shock*male mortality dummy	0.141	0.0294	0.0180	0.0764
	(0.258)	(0.145)	(0.158)	(0.133)
Three years before shock*female mortality dummy	0.0481	0.238	-0.0793	0.138
	(0.381)	(0.249)	(0.215)	(0.194)
Two years before shock*female mortality dummy	-0.0875	0.197	-0.176	-0.182
	(0.325)	(0.191)	(0.185)	(0.203)
One year before shock*female mortality dummy	-0.0189	0.0844	-0.102	0.0368
	(0.259)	(0.148)	(0.156)	(0.134)
Year of mortality shock*male mortality dummy	0.162	-0.0421	0.0558	0.122
	(0.270)	(0.157)	(0.166)	(0.153)
One year after shock*male mortality dummy	0.0581	0.114	-0.00810	-0.0128
	(0.185)	(0.121)	(0.0918)	(0.127)
Two years after shock*male mortality dummy	0.156	0.147	-0.0249	0.104
	(0.209)	(0.123)	(0.122)	(0.105)
Three years after shock*male mortality dummy	0.0954	0.115	0.0254	-0.0366
	(0.200)	(0.132)	(0.113)	(0.0885)
Four years after shock*male mortality dummy	0.247	0.140	0.208*	-0.161
	(0.212)	(0.150)	(0.0925)	(0.114)
Five years after shock*male mortality dummy	0.0479	0.0373	-0.117	-0.129
	(0.231)	(0.124)	(0.127)	(0.134)
Year of mortality shock*female mortality dummy	-0.153	-0.0979	-0.104	0.0137
	(0.274)	(0.154)	(0.169)	(0.149)
One year after shock*female mortality dummy	-0.0137	-0.0356	0.0252	0.138
	(0.180)	(0.119)	(0.0880)	(0.122)
Two year after shock*female mortality dummy	0.118	-0.0537	0.0588	0.135

	(0.205)	(0.123)	(0.121)	(0.0992)
Three years after shock*female mortality dummy	0.0234	-0.0361	0.0436	0.0474
	(0.195)	(0.125)	(0.111)	(0.0848)
Four years after shock*female mortality dummy	0.217	-0.0484	0.208*	0.00741
	(0.197)	(0.144)	(0.0850)	(0.116)
Five years after shock*female mortality dummy	-0.155	-0.330*	0.0999	-0.0747
	(0.243)	(0.141)	(0.131)	(0.146)
Elderly male mortality	0.0216	0.0173	-0.00135	-0.00771
	(0.0541)	(0.0356)	(0.0271)	(0.0240)
Elderly female mortality	-0.00543	-0.0131	0.0432	-0.0186
	(0.0544)	(0.0379)	(0.0286)	(0.0278)
Gender of head (=1)	0.200**	0.106**	0.0508*	0.0303
	(0.0468)	(0.0301)	(0.0250)	(0.0205)
Age of the head	0.0276**	0.0170**	0.00456	0.00844**
	(0.00690)	(0.00378)	(0.00353)	(0.00243)
Age of the head squared	-0.000254**	-0.000156**	-4.04e-05	-9.13e-05**
	(6.94e-05)	(3.66e-05)	(3.56e-05)	(2.47e-05)
Education of the head (years)	0.0140**	0.00517*	0.00603**	0.00213
	(0.00393)	(0.00248)	(0.00209)	(0.00193)
Distance to tarred/main road (km)	-0.000211	-0.000389+	-0.000387*	0.000195
	(0.000313)	(0.000219)	(0.000155)	(0.000192)
Distance to nearest district (km)	9.09e-05	-0.000114	-0.000211	0.000656**
	(0.000465)	(0.000306)	(0.000263)	(0.000210)
Distance to fertilizer depot (km)	-0.000212	-0.000265	-0.000292+	0.000359
	(0.000424)	(0.000300)	(0.000174)	(0.000231)
Provincial dummies	Yes	Yes	Yes	Yes
Constant	-0.359*	0.0771	0.0522	-0.0679
	(0.174)	(0.0989)	(0.0887)	(0.0632)
Observations	8,572	8,572	8,572	8,572
R-squared	0.049	0.072	0.060	0.092

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

Table 4.11 shows results of the interaction model with male head mortality as part of the explanatory variable affecting cultivated land. Three years before male head death, area under cereals increases to 77.2% at 5 percent level of significance. This is however, met with a decline in the year of death by about 39.4%. Three years after male head mortality, households start to make positive adjustments by increasing area under cereals to about 42.4% and four years later are under roots and tubers increases by about 13.5%. There is also a notable increase in total, area under cereals and that devoted to roots and tubers with respect to non-head mortality O'donnell (2004). Typically, a *dip-drop-recovery* pattern is observed concerning impact of gender and position of deceased on cultivated land. Henceforth, deteriorating effects in the initial stages of morbidity and mortality are met by positive adjustments later on in the years. This ability to make positive improvements after mortality shocks is also critical for welfare considerations. Interventions can at best enter the households production functions earlier in the years with appropriate measures to help farmers reduce less on area under cultivation. Since labour and financial resources are the main vehicles through which the rural farmers are being affected negatively, community rippers and minimum tillage techniques seem to work best in cultivating the land as well as institutions providing cash inputs.

Table 4.11 Fixed Effects Model of impacts of Prime-age mortality on cultivated land by gender and position of deceased, 2001-2008

	Natural log of hectares of:			
Explanatory variables	Total	Cereals	Roots and tubers	High-value crops
	(1)	(2)	(3)	(4)
Male head mortality	-0.0917	-0.0834	0.0110	-0.0201
	(0.0870)	(0.0600)	(0.0454)	(0.0586)
Non- head mortality	-0.220	-0.0649	-0.126	-0.0212
	(0.144)	(0.0802)	(0.0788)	(0.0563)
Three years before shock	-0.384	-0.646*	0.174	-0.118
	(0.508)	(0.302)	(0.319)	(0.233)
Two years before shock	-0.279	-0.364	-0.372	0.0347
	(0.652)	(0.317)	(0.327)	(0.504)
One year before shock	0.0848	0.151	-0.0477	-0.0307
	(0.176)	(0.152)	(0.0925)	(0.151)
Year of mortality shock	0.116	0.242	-0.231	0.163
	(0.425)	(0.165)	(0.271)	(0.157)
One year after shock	0.208	0.167*	0.0422	-0.0924
	(0.135)	(0.0690)	(0.0258)	(0.130)
Two years after shock	-0.358**	-0.195	-0.103	-0.0572
	(0.0923)	(0.145)	(0.0757)	(0.0770)
Three years after shock	-0.291	-0.229**	0.00982	-0.0813
	(0.220)	(0.0868)	(0.156)	(0.100)
Four years after shock	-0.253	-0.00574	-0.144**	-0.120
	(0.164)	(0.141)	(0.0543)	(0.147)
Five years after shock	0.149	0.231	0.291	0.123
	(0.586)	(0.290)	(0.294)	(0.474)
Three years before shock*male head dummy	0.681	0.772*	-0.0378	0.255
	(0.548)	(0.332)	(0.334)	(0.259)
Two years before shock*male head dummy	0.0554	0.0701	0.440	-0.0497
	(0.667)	(0.332)	(0.334)	(0.510)
One year before shock*male head dummy	0.0389	-0.0451	0.00593	0.0186
	(0.201)	(0.168)	(0.107)	(0.158)
Three years before shock*non-head dummy	0.377	0.557	-0.252	0.374
	(0.574)	(0.360)	(0.337)	(0.262)
Two years before shock*non-head dummy	0.0279	0.284	0.314	-0.0772
	(0.681)	(0.342)	(0.343)	(0.510)
One year before shock*non- head	-0.123	-0.150	0.0304	-0.0521
	(0.202)	(0.168)	(0.105)	(0.156)

Year of mortality shock*male head dummy	-0.451	-0.394*	0.112	-0.226
	(0.446)	(0.190)	(0.278)	(0.172)
One year after shock*male head dummy	-0.0635	0.0184	-0.0854	0.0850
	(0.167)	(0.0970)	(0.0569)	(0.148)
Two years after shock*male head dummy	0.335*	0.201	0.0817	0.0930
	(0.144)	(0.163)	(0.0948)	(0.106)
Three years after shock*male head dummy	0.584*	0.424**	0.0675	0.107
	(0.247)	(0.116)	(0.167)	(0.114)
Four years after shock*male head dummy	0.334	0.0539	0.135+	0.0905
	(0.205)	(0.165)	(0.0808)	(0.163)
Five years after shock*male-head dummy	-0.0849	-0.139	-0.351	-0.0982
	(0.596)	(0.300)	(0.300)	(0.478)
Year of mortality shock*non-head	-0.149	-0.290	0.356	-0.238
	(0.464)	(0.211)	(0.285)	(0.183)
One year after shock*non-head dummy	0.0540	-0.0660	0.0692	0.101
	(0.208)	(0.117)	(0.0861)	(0.146)
Two years after shock*non-head dummy	0.563**	0.234	0.223*	0.153
	(0.186)	(0.173)	(0.109)	(0.0957)
Three years after shock*non-head dummy	0.474+	0.247	0.0370	0.145
	(0.283)	(0.151)	(0.179)	(0.126)
Four years after shock*non-head dummy	0.408+	0.0149	0.252*	0.131
	(0.236)	(0.167)	(0.103)	(0.165)
Five years after shock*non- head dummy	0.00889	-0.205	-0.201	-0.131
	(0.605)	(0.305)	(0.305)	(0.477)
Elderly male mortality	0.0141	0.0112	-0.00143	-0.0118
	(0.0536)	(0.0353)	(0.0270)	(0.0237)
Elderly female mortality	0.00508	-0.00942	0.0467	-0.0169
	(0.0539)	(0.0381)	(0.0286)	(0.0280)
Gender of head (=1)	0.177**	0.0960**	0.0424+	0.0274
	(0.0483)	(0.0310)	(0.0256)	(0.0209)
Age of the head	0.0270**	0.0167**	0.00462	0.00808**
	(0.00693)	(0.00379)	(0.00357)	(0.00241)
Age of the head squared	-0.000248**	-0.000154**	-4.06e-05	-8.94e-05**
	(6.99e-05)	(3.68e-05)	(3.59e-05)	(2.46e-05)
Education of the head (years)	0.0145**	0.00553*	0.00625**	0.00182
	(0.00390)	(0.00248)	(0.00208)	(0.00192)
Distance to tarred/main road (km)	-0.000233	-0.000398+	-0.000396*	0.000193
	(0.000314)	(0.000219)	(0.000156)	(0.000192)
Distance to nearest district (km)	0.000123	-9.28e-05	-0.000181	0.000644**
	(0.000465)	(0.000307)	(0.000263)	(0.000210)
Distance to fertilizer depot (km)	-0.000187	-0.000262	-0.000273	0.000359
	(0.000420)	(0.000300)	(0.000174)	(0.000232)
Provincial dummies	Yes	Yes	Yes	Yes
Constant	-0.326+	0.0908	0.0539	-0.0507
	(0.174)	(0.0990)	(0.0898)	(0.0629)
Observations	8,572	8,572	8,572	8,572
R-squared	0.047	0.073	0.058	0.089

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

4.3.2 Dynamics of the impacts of prime-age mortality on gross value of crop output

In Table 4.12, the dynamics indicate that, two years before death morbidity reduces both gross value of output and gross value of output per hectare significantly. The *dip* in both outcome variables extends to the *drop* occurring in the year of death up until *recovery* in the first year after death. The recovery, however, takes place at a much lower pace than the magnitude in the dip. Distance to main road shows significant positive relation with value of output and land productivity at 1 percent level.

Table 4.12 Fixed Effects Model of impacts of Prime-age mortality on gross value of crop output, 2001-2008

Explanatory variables	Natural logarithm of value of: Gross value of crop output	Gross value of crop output/ha
	(1)	(2)
Three years before shock	0.275	0.0114
	(0.735)	(0.712)
Two years before shock	-1.383+	-1.392+
	(0.708)	(0.719)
One year before shock	-0.521	-0.593
	(0.400)	(0.401)
Year of mortality shock	-0.889*	-0.723+
	(0.434)	(0.421)
One year after shock	0.684**	0.642*
	(0.258)	(0.255)
Two years after shock	0.0692	0.155
	(0.355)	(0.360)
Three years after shock	0.278	0.163
	(0.278)	(0.277)
Four years after shock	0.475	0.606
	(0.386)	(0.398)
Five years after shock	0.649	0.779
	(0.645)	(0.661)
Elderly male mortality	0.258	0.230
	(0.227)	(0.229)
Elderly female mortality	0.0716	0.107
	(0.257)	(0.266)
Gender of head (=1)	0.239	-0.0191
	(0.206)	(0.212)
Age of the head	0.0190	-0.0225
	(0.0379)	(0.0373)
Age of the head squared	-0.000146	0.000215

	(0.000343)	(0.000340)
Education of the head (years)	0.0209	0.00164
	(0.0204)	(0.0207)
Distance to tarred/main road (km)	0.00447**	0.00475**
	(0.00163)	(0.00165)
Distance to nearest district (km)	-0.000487	-0.000504
	(0.00216)	(0.00222)
Distance to fertilizer depot (km)	-0.000111	0.000242
	(0.00105)	(0.00103)
Provincial dummies	Yes	Yes
Constant	11.24**	12.44**
	(1.002)	(0.983)
Observations	8,572	8,572
R-squared	0.117	0.117

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

Table 4.13 presents results on the male and female mortality covariates being controlled for in the model. The results indicate a *dip* in both outcome variables in the second year prior to death of a male in the household. Significant *recovery* only sets in five years after male mortality. On the other hand, female mortality causes a significant decline in the first and second year after mortality of a female in the household. Henceforth, the differential impact by gender alone is that of a reduction in gross value of output and productivity in the households up to a point and then experiences improvements beyond that point. Usually males are responsible for most of the market sales and once morbidity sets in there is an interruption in the value of marketable surplus, which stems from a reduction in the incentive to be productive. Females on the other hand constitute a larger proportion in the cultivation and crop production thereby leading to output reducing as female mortality sets in the household.

Table 4.13 Fixed Effects Model of impacts of Prime-age mortality on gross value of crop output by gender alone, 2001-2008

	Natural log of :	
Explanatory variables	Gross value of crop output	Gross value of crop output/ha
	(1)	(2)
Male mortality	-1.081	-0.998
	(0.695)	(0.655)
Female mortality	0.313	0.449
	(0.569)	(0.567)
Three years before shock	2.224	1.945
	(1.444)	(1.354)
Two years before shock	0.356	0.377
	(1.550)	(1.595)
One year before shock	-0.458	-0.428
	(0.946)	(0.901)
Year of mortality shock	-1.277	-1.237
	(0.907)	(0.804)
One year after shock	1.565+	1.522+
	(0.855)	(0.885)
Two years after shock	-0.840	-0.697
	(0.699)	(0.704)
Three years after shock	0.821	0.819
	(0.731)	(0.721)
Four years after shock	-0.178	0.111
	(0.584)	(0.565)
Five years after shock	-0.651	-0.839
	(1.579)	(1.628)
Three years before shock*male mortality dummy	-2.400	-1.665
	(1.579)	(1.514)
Two years before shock*male mortality dummy	-3.192*	-3.105*
	(1.464)	(1.515)
One year before shock*male mortality dummy	0.797	0.617
	(0.993)	(0.943)
Three years before shock*female mortality dummy	-1.701	-2.103
	(1.523)	(1.466)
Two years before shock*female mortality dummy	-0.479	-0.466
	(1.630)	(1.671)
One year before shock*female mortality dummy	-0.421	-0.513
	(0.959)	(0.915)
Year of mortality shock*male mortality dummy	0.796	0.486
	(0.910)	(0.827)
One year after shock*male mortality dummy	0.454	0.390
	(0.790)	(0.781)
Two years after shock*male mortality dummy	1.569	1.475
	(0.986)	(0.993)
Three years after shock*male mortality dummy	0.802	0.717
	(0.748)	(0.724)
Four years after shock*male mortality dummy	1.506	1.268
	(1.058)	(1.061)
Five years after shock*male mortality dummy	2.637	2.833+
	(1.625)	(1.688)
Year of mortality shock*female mortality dummy	0.336	0.735
	(0.893)	(0.814)
One year after shock*female mortality dummy	-1.485+	-1.592+
	(0.902)	(0.912)
Two years after shock*female mortality dummy	0.585	0.426
	(0.892)	(0.902)
Three years after shock*female mortality dummy	-1.329+	-1.607*
	(0.798)	(0.797)
Four years after shock*female mortality dummy	0.362	0.0999
	(0.889)	(0.888)
Five years after shock*female mortality dummy	0.150	0.416
	(1.732)	(1.785)

Elderly male mortality	0.262	0.224
	(0.232)	(0.233)
Elderly female mortality	0.0284	0.0772
	(0.254)	(0.263)
Gender of head (=1)	0.336	0.0543
	(0.207)	(0.212)
Age of the head	0.0228	-0.0198
	(0.0372)	(0.0369)
Age of the head squared	-0.000189	0.000181
	(0.000337)	(0.000338)
Education of the head (years)	0.0203	0.000452
	(0.0204)	(0.0207)
Distance to tarred/main road (km)	0.00461**	0.00487**
	(0.00163)	(0.00165)
Distance to nearest district (km)	-0.000466	-0.000456
	(0.00215)	(0.00221)
Distance to fertilizer depot (km)	-0.000373	4.19e-05
	(0.00113)	(0.00109)
Provincial dummies	Yes	Yes
Constant	11.08**	12.34**
	(0.983)	(0.973)
Observations	8,572	8,572
R-squared	0.123	0.122

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

Table 4.14 presents the dynamics in the light of the interaction term, male head mortality. The observation is that declines seem to persist as regards value of output and land productivity. As for the non-head, a recovery process occurs from the first to the third year after death. Therefore, gender and position of deceased largely does not affect value per hectare and total value of output. During the period of morbidity, households face constraining financial and labour difficulties. In the longer term, the death of male heads implies erosion of the resources and social capital, which impacts negatively on households that are in the process of recovery as evidenced in the fourth year of post-male head death period.

Table 4.14 Fixed Effects Model of impacts of Prime-age mortality on gross value of crop output by gender and position of deceased, 2001-2008

Explanatory variables	Gross value of crop output	Gross value of crop output/ha
	(1)	(2)
Male head mortality	0.375	0.599
	(0.401)	(0.384)
Non- head mortality	-2.413+	-2.311+
	(1.263)	(1.260)
Three years before shock	-0.604	-0.319
	(1.277)	(0.902)
Two years before shock	0.223	0.709
	(1.413)	(1.054)
One year before shock	-0.951	-0.997*
	(0.611)	(0.417)
Year of mortality shock	0.125	-0.0127
	(1.019)	(0.614)
One year after shock	0.132	-0.277
	(0.334)	(0.254)
Two years after shock	-0.465*	0.106
	(0.220)	(0.253)
Three years after shock	-0.418	-0.0129
	(0.575)	(0.375)
Four years after shock	0.334	0.801**
	(0.387)	(0.243)
Five years after shock	0.551	0.483**
	(0.846)	(0.178)
Three years before shock*male head dummy	1.566	0.882
	(1.579)	(1.265)
Two years before shock*male head dummy	-1.874	-2.230+
	(1.581)	(1.276)
One year before shock*male head dummy	0.660	0.528
	(0.720)	(0.559)
Three years before shock*non-head dummy	-0.360	-0.742
	(1.720)	(1.461)
Two years before shock*non-head dummy	-2.549	-3.015
	(2.241)	(2.085)
One year before shock*non- head	0.342	0.481
	(0.952)	(0.856)
Year of mortality shock*male head dummy	-1.298	-0.847
	(1.186)	(0.842)
One year after shock*male head dummy	0.312	0.527
	(0.517)	(0.453)
Two years after shock*male head dummy	-0.00613	-0.650
	(0.501)	(0.500)
Three years after shock*male head dummy	0.345	-0.487
	(0.700)	(0.531)
Four years after shock*male head dummy	-0.428	-1.026+
	(0.622)	(0.552)
Five years after shock*male head dummy	0.0174	0.0151
	(1.089)	(0.727)
Year of mortality shock*non-head	-0.574	-0.522
	(1.327)	(1.055)
One year after shock*non-head dummy	2.665*	2.920*
	(1.349)	(1.328)
Two years after shock*non-head dummy	2.970*	2.302
	(1.426)	(1.457)
Three years after shock*non-head dummy	2.894*	2.477*
	(1.255)	(1.182)
Four years after shock*non-head dummy	2.763+	2.467
	(1.621)	(1.624)
Five years after shock*non- head dummy	1.447	1.674
	(1.780)	(1.620)

Elderly male mortality	0.277	0.255
	(0.232)	(0.234)
Elderly female mortality	0.109	0.142
	(0.253)	(0.262)
Gender of head (=1)	0.264	0.0230
	(0.218)	(0.222)
Age of the head	0.0195	-0.0222
	(0.0374)	(0.0370)
Age of the head squared	-0.000139	0.000225
	(0.000340)	(0.000338)
Education of the head (years)	0.0224	0.00215
	(0.0201)	(0.0205)
Distance to tarred/main road (km)	0.00433**	0.00460**
	(0.00164)	(0.00166)
Distance to nearest district (km)	-0.000100	-0.000138
	(0.00215)	(0.00221)
Distance to fertilizer depot (km)	-5.28e-05	0.000360
	(0.00109)	(0.00107)
Provincial dummies	Yes	Yes
Constant	11.16**	12.36**
	(0.983)	(0.970)
Observations	8,572	8,572
R-squared	0.122	0.122

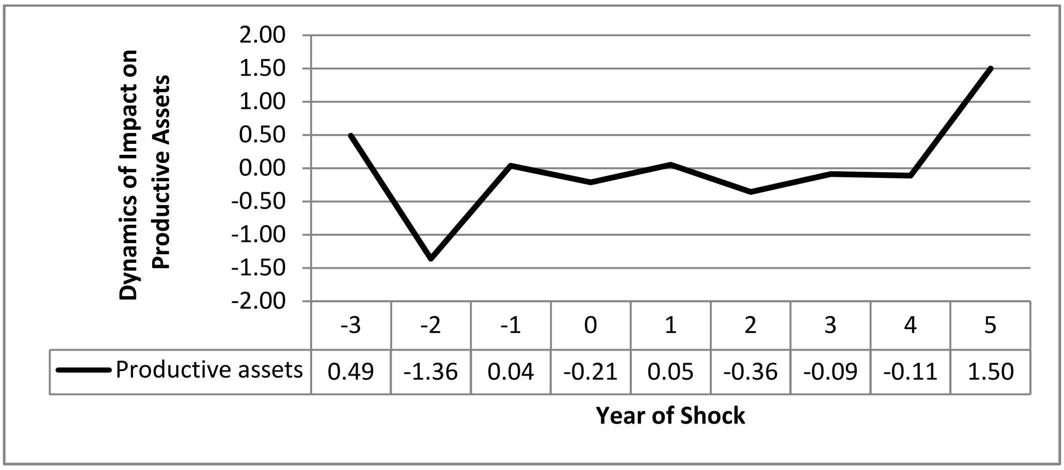
Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008**Notes**: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

4.4 Dynamics of the impacts of prime-age mortality on value of productive assets

The introduction of a shock in households may necessitate households to dispose of some of the productive assets to cope with the shock. Barnett and Blaikie (1992) cite liquidation of assets as one major coping strategy households employ to mitigate the impact of mortality shock. This strategy however poses some serious vulnerability to income shocks and reduces households' use of cash inputs and animal traction leading to lower levels of crop production O'donnell (2004).

This section analyses the impacts and dynamics of prime-age mortality on value of productive assets. Evidently, from Table 4.15 and Figure 4.4.1, households face declining values of productive assets over time with mortality and significant recovery occurs in the fifth year after mortality. There exists a significant positive relationship between value of productive assets and male-headed and older households (Barnett and Whiteside, 2002). The ability of households to accumulate more assets is greater earlier in the life cycle and diminishes as heads grow older indicated by the negatively significant non-linearity of age with respect to value of productive assets (Mazhangara, 2007).

Figure 4.4.1: Trends of dynamics of impacts on productive assets, 2001-2008



Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

As Barnett *et al* (2000) have shown households with more educated heads tend to posses more assets and the study gives evidence to this effect. As distance to fertilizer depots increases, value of productive assets increase among rural farm households.

Table 4.15 Fixed Effects Model of impacts of Prime-age mortality on value of productive assets, 2001-2008

	Natural logarithm of value of:
Explanatory variables	Productive assets
	(1)
Three years before shock	0.488
	(1.319)
Two years before shock	-1.362
	(1.166)
One year before shock	0.0383
	(0.833)
Year of mortality shock	-0.212
	(0.835)
One year after shock	0.0524
	(0.594)
Two years after shock	-0.358
	(0.604)

Three years after shock	-0.0871
	(0.569)
Four years after shock	-0.114
	(0.733)
Five years after shock	1.499+
	(0.910)
Elderly male mortality	0.516
	(0.523)
Elderly female mortality	0.215
	(0.562)
Gender of head (=1)	1.630**
	(0.494)
Age of the head	0.160*
	(0.0761)
Age of the head squared	-0.00166*
	(0.000750)
Education of the head (years)	0.0762*
	(0.0384)
Distance to tarred/main road (km)	0.000149
	(0.00297)
Distance to nearest district (km)	-0.00647
	(0.00484)
Distance to fertilizer depot (km)	0.00459+
	(0.00251)
Provincial dummies	Yes
Constant	3.903*
	(1.950)
Observations	8,572
R-squared	0.150

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

Table 4.16 presents results on the differential impact by gender on productive assets. Households typically experience a reduction in productive assets with male mortality conforming to earlier findings and significant recovery sets in during the second year after male mortality (Chapoto, 2006). Disposal of assets, however, is not statistically significant during morbidity stage and with female mortality. Henceforth,

Table 4.16 Fixed Effects Model of impacts of Prime-age mortality on value of productive assets by gender alone, 2001-2008

Explanatory variables	Productive assets
Male mortality	-0.744*
	(1.266)
Female mortality	0.0165
	(0.928)
Three years before shock	1.811
	(3.608)
Two years before shock	-0.551
	(3.374)
One year before shock	0.883
	(2.746)
Year of mortality shock	0.316
	(2.987)
One year after shock	0.815
	(1.719)
Two years after shock	-1.747
	(1.423)
Three years after shock	0.798
	(1.541)
Four years after shock	-1.685
	(1.753)
Five years after shock	-0.609
	(2.609)
Three years before shock*male mortality dummy	-0.551
	(3.413)
Two years before shock*male mortality dummy	-2.480
	(3.176)
One year before shock*male mortality dummy	-2.180
	(2.606)
Three years before shock*female mortality dummy	-1.905
	(3.515)
Two years before shock*female mortality dummy	0.900
	(3.230)
One year before shock*female mortality dummy	0.529
	(2.626)
Year of mortality shock*male mortality dummy	-0.101
	(2.811)
One year after shock*male mortality dummy	0.619
	(1.728)
Two years after shock*male mortality dummy	2.904+
	(1.680)
Three years after shock*male mortality dummy	0.229
	(1.587)
Four years after shock*male mortality dummy	1.296
	(1.857)
Five years after shock*male mortality dummy	3.159
	(2.614)
Year of mortality shock*female mortality dummy	-0.375
	(2.865)
One year after shock*female mortality dummy	-1.434
	(1.719)
Two years after shock*female mortality dummy	0.311
	(1.548)

Three years after shock*female mortality dummy	-1.610
	(1.605)
Four years after shock*female mortality dummy	1.938
	(1.832)
Five years after shock*female mortality dummy	0.968
	(2.595)
Elderly male mortality	0.471
	(0.526)
Elderly female mortality	0.150
	(0.566)
Gender of head (=1)	1.642**
	(0.506)
Age of the head	0.167*
	(0.0757)
Age of the head squared	-0.00173*
	(0.000743)
Education of the head (years)	0.0781*
	(0.0386)
Distance to tarred/main road (km)	0.000335
	(0.00297)
Distance to nearest district (km)	-0.00693
	(0.00483)
Distance to fertilizer depot (km)	0.00455+
	(0.00255)
Provincial dummies	Yes
Constant	3.749+
	(1.944)
Observations	8,572
R-squared	0.153

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

This section examines whether gender and position of deceased does affect value of productive assets. Table 4.17 shows that male head mortality reduces the value of productive assets significantly. The results in Table 4.17 also show that recovery is significant in the fourth year after death of a non-male head. The possible insignificant dip could be due households disposing off small animals and holding on to cattle and other productive assets (Mazhangara, 2007). Noteworthy, property grabbing is non-common among rural households. Rather, the phenomenon is such that households tend to assist one another when a mortality shock arises. Post death expenditure is less medical bills, which induces these households to accumulate assets. Hence, households get on a recovery path with male-head mortality an indication that position and gender does have effects on impact of mortality on value of productive assets O'donnell (2004).

Table 4.17 Fixed Effects Model of impacts of Prime-age mortality on value of productive assets by gender and position of deceased, 2001-2008

Explanatory variables	Productive assets
Male head mortality	-1.445*
	(0.682)
Non- head mortality	0.651
	(1.431)
Three years before shock	2.504
	(5.175)
Two years before shock	-3.322
	(3.994)
One year before shock	0.905
	(4.458)
Year of mortality shock	-0.463
	(4.239)
One year after shock	-2.371
	(3.111)
Two years after shock	-3.253
	(2.071)
Three years after shock	-2.171
	(1.758)
Four years after shock	-1.830
	(2.274)
Five years after shock	2.229**
	(0.606)
Three years before shock*male head dummy	-2.344
	(5.434)
Two years before shock*male head dummy	3.701
	(4.175)
One year before shock*male head dummy	0.254
	(4.548)
Three years before shock*non-head dummy	-2.305
	(5.668)
Two years before shock*non-head dummy	-1.516
	(4.638)
One year before shock*non- head	-3.253
	(4.669)
Year of mortality shock*male head dummy	1.029
	(4.380)
One year after shock*male head dummy	3.107
	(3.214)
Two years after shock*male head dummy	3.526
	(2.243)
Three years after shock*male head dummy	2.679
	(1.962)
Four years after shock*male head dummy	1.341
	(2.435)
Five years after shock*male head dummy	-0.728
	(1.153)
Year of mortality shock*non-head	-0.902
	(4.496)

One year after shock*non-head dummy	3.146
	(3.579)
Two years after shock*non-head dummy	3.769
	(2.598)
Three years after shock*non-head dummy	2.451
	(2.240)
Four years after shock*non-head dummy	4.924+
	(2.902)
Five years after shock*non- head dummy	0.0240
	(1.965)
Elderly male mortality	0.416
	(0.522)
Elderly female mortality	0.339
	(0.568)
Gender of head (=1)	1.727**
	(0.514)
Age of the head	0.153*
	(0.0752)
Age of the head squared	-0.00164*
	(0.000738)
Education of the head (years)	0.0786*
	(0.0383)
Distance to tarred/main road (km)	0.000355
	(0.00297)
Distance to nearest district (km)	-0.00669
	(0.00481)
Distance to fertilizer depot (km)	0.00520*
	(0.00255)
Provincial dummies	Yes
Constant	4.093*
	(1.932)
Observations	8,572
R-squared	0.159

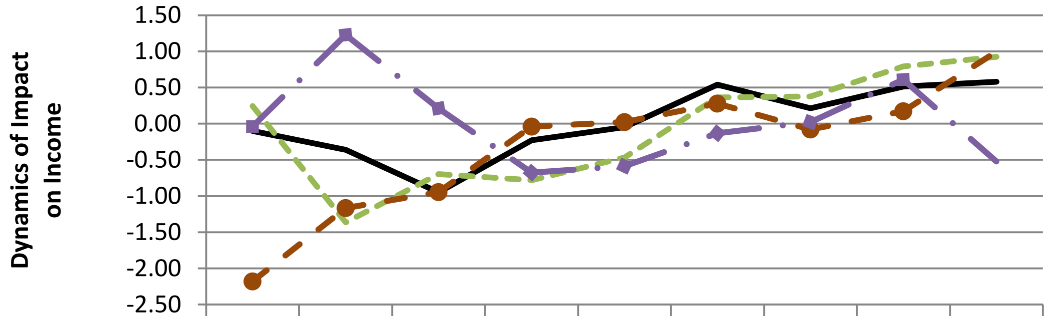
Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

4.5 Dynamics of the impacts of prime-age mortality on household income

This section presents the dynamics on critical household outcomes that determine whether households are falling into bottomless pits of poverty or some coping strategies meet the prime-age mortality shocks. Total household income, crop, livestock and off-farm income comprehensively show the position of households with respect to mortality shocks. Table 4.18 shows that total income declines significantly by over 90% one year before mortality shock affects the household. The *recovery* takes place in the second year after death with an increase of about 54% in total income for the households. The *dip* in total income is mainly due to medical bills that rock households during the period of morbidity. Figure 4.5.1 shows the trend in household income with off farm being negatively affected by the year of death.

Figure 4.5.1: Trends of dynamics of impacts on Household income, 2001-2008



	-3	-2	-1	0	1	2	3	4	5
Total	-0.10	-0.36	-0.95	-0.23	-0.05	0.54	0.21	0.51	0.58
Crop	0.24	-1.36	-0.70	-0.78	-0.47	0.36	0.38	0.79	0.93
Livestock	-2.18	-1.17	-0.94	-0.04	0.02	0.28	-0.08	0.17	1.00
Off farm	-0.04	1.23	0.22	-0.68	-0.59	-0.13	0.02	0.61	-0.52

Year of Shock

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Table 4.18 Fixed Effects Model of impacts of Prime-age mortality on household income, 2001-2008

	Natural logarithm of income of:			
Explanatory variables	Total	Crop	Livestock	Off farm
	(1)	(2)	(3)	(4)
Three years before shock	-0.0992	0.244	-2.178	-0.0366
	(0.528)	(1.658)	(1.650)	(1.626)
Two years before shock	-0.360	-1.364	-1.165	1.228
	(0.513)	(1.224)	(1.166)	(1.278)
One year before shock	-0.949**	-0.697	-0.943	0.215
	(0.343)	(0.954)	(0.892)	(1.009)
Year of mortality shock	-0.228	-0.780	-0.0392	-0.675
	(0.236)	(1.014)	(0.932)	(0.993)
One year after shock	-0.0453	-0.468	0.0214	-0.585
	(0.191)	(0.670)	(0.608)	(0.708)
Two years after shock	0.540+	0.362	0.280	-0.132
	(0.300)	(0.726)	(0.679)	(0.757)
Three years after shock	0.214	0.378	-0.0804	0.0235
	(0.145)	(0.718)	(0.665)	(0.776)
Four years after shock	0.514	0.793	0.173	0.611

	(0.346)	(0.879)	(0.876)	(0.838)
Five years after shock	0.580	0.925	0.995	-0.520
	(0.474)	(0.831)	(0.835)	(0.920)
Elderly male mortality	0.195	-0.592	0.414	0.551
	(0.207)	(0.653)	(0.577)	(0.674)
Elderly female mortality	-0.00468	0.131	0.608	1.035
	(0.165)	(0.579)	(0.607)	(0.662)
Gender of head (=1)	0.212	0.846	0.210	0.528
	(0.162)	(0.559)	(0.483)	(0.567)
Age of the head	0.0208	0.316**	0.0138	0.0533
	(0.0177)	(0.0670)	(0.0542)	(0.0752)
Age of the head squared	-0.000189	-0.00334**	-0.000219	-0.000700
	(0.000170)	(0.000721)	(0.000564)	(0.000743)
Education of the head (years)	0.0423**	0.0170	0.105**	0.221**
	(0.0136)	(0.0450)	(0.0394)	(0.0477)
Distance to tarred/main road (km)	0.00130	0.0120**	0.00611*	0.00395
	(0.000795)	(0.00342)	(0.00301)	(0.00365)
Distance to nearest district (km)	-0.00139	0.00931+	-0.00593	-0.00768
	(0.00171)	(0.00522)	(0.00503)	(0.00571)
Distance to fertilizer depot (km)	0.00160	-0.00646	0.000559	0.00170
	(0.00115)	(0.00414)	(0.00434)	(0.00387)
Provincial dummies	Yes	Yes	Yes	Yes
Constant	12.44**	-2.392	2.210	5.153**
	(0.474)	(1.669)	(1.437)	(1.917)
Observations	8,572	8,572	8,572	8,572
R-squared	0.131	0.091	0.085	0.034

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

Incidentally, crop income significantly increases with age of the household head. However, there exists a non-linear relationship between age of head and crop income. Higher education of household heads implies significantly higher total, livestock and off-farm income. These engage in more skilled agricultural activities and business ventures that generate household income (Kirimi, 2008). Remote households that cannot engage in off-farm generating activities characterised by easier access to roads tend to generate income through crop and livestock. Hence, distance to the nearest tarred road is positively related with total, crop and livestock income.

Table 4.19 shows that total and off-farm income are negatively and significantly affected by male mortality whereas female mortality affects both livestock and off-farm income. Two years prior to male mortality households experience a decline in total and livestock income as medical bills increase. A year before male mortality a reduction in off-farm income is observed due to less time devoted in off-farm activities. Female death affects off-farm income three years and one year prior to death. As regards male mortality, households begin to recover almost immediately after male mortality shock whereas the recovery path sets in around the second year for female mortality. Mainly, recovery is observed in total and off-farm income whereas crop and livestock income seem to deteriorate even after mortality.

Table 4.19 Fixed Effects Model of impacts of Prime-age mortality on household income by gender alone, 2001-2008

Explanatory variables	Total	Crop	Livestock	Off farm
	(1)	(2)	(3)	(4)
Male mortality	-0.683+	-1.730	0.306	-3.290*
	(0.379)	(1.450)	(1.279)	(1.516)
Female mortality	0.127	0.0562	-2.495*	2.922*
	(0.309)	(1.633)	(1.063)	(1.278)
Three years before shock	1.777	3.308	-2.674	5.747
	(1.195)	(4.147)	(3.681)	(3.558)
Two years before shock	1.169	-3.078	-7.143*	-1.039
	(1.073)	(3.924)	(3.252)	(4.103)
One year before shock	0.0493	-1.902	-0.0337	6.152*
	(0.748)	(2.888)	(2.656)	(2.445)
Year of mortality shock	-1.671*	-2.292	0.961	-3.833
	(0.755)	(3.008)	(2.470)	(2.866)
One year after shock	0.879	3.481	0.290	3.994
	(0.683)	(2.543)	(2.053)	(2.837)
Two years after shock	-0.959+	-1.236	-1.378	-4.959**
	(0.566)	(1.675)	(2.027)	(1.869)
Three years after shock	1.157*	2.413	-0.999	-2.262
	(0.580)	(2.162)	(1.499)	(1.813)
Four years after shock	0.0977	0.327	1.154	1.134
	(0.526)	(2.193)	(1.805)	(1.477)
Five years after shock	-1.291	1.162	6.376**	-3.148
	(1.171)	(2.329)	(2.459)	(2.381)
Three years before shock*male mortality dummy	-1.770	-1.140	4.188	-3.801
	(1.295)	(4.096)	(3.833)	(3.588)
Two years before shock*male mortality dummy	-2.191*	-0.864	5.808+	-1.006
	(1.078)	(3.801)	(3.079)	(3.712)
One year before shock*male mortality dummy	-0.511	3.725	-0.277	-5.871*
	(0.797)	(2.819)	(2.474)	(2.468)
Three years before shock*female mortality dummy	-1.783	-4.520	-2.580	-6.745+
	(1.276)	(3.998)	(3.812)	(3.629)
Two years before shock*female mortality dummy	-0.814	2.659	3.755	6.021
	(1.138)	(3.867)	(3.180)	(3.994)

One year before shock*female mortality dummy	-1.047	-0.487	-0.995	-5.000*
	(0.741)	(2.818)	(2.580)	(2.395)
Year of mortality shock*male mortality dummy	1.635*	2.145	-1.420	3.285
	(0.782)	(2.966)	(2.489)	(2.816)
One year after shock*male mortality dummy	-0.531	-2.325	-0.882	-0.883
	(0.540)	(2.571)	(2.184)	(2.724)
Two years after shock*male mortality dummy	1.596*	0.910	0.107	7.796**
	(0.769)	(2.118)	(1.967)	(2.078)
Three years after shock*male mortality dummy	-0.357	-0.0542	1.190	4.959*
	(0.521)	(2.357)	(1.667)	(2.094)
Four years after shock*male mortality dummy	0.828	0.530	-2.257	3.323
	(0.856)	(2.442)	(2.249)	(2.092)
Five years after shock*male mortality dummy	2.884*	1.935	-5.041*	4.499*
	(1.306)	(2.467)	(2.409)	(2.197)
Year of mortality shock*female mortality dummy	1.388+	1.337	-0.0200	3.375
	(0.751)	(2.836)	(2.464)	(2.800)
One year after shock*female mortality dummy	-0.850	-3.768	2.112	-7.839**
	(0.648)	(2.546)	(2.201)	(2.786)
Two years after shock*female mortality dummy	1.423*	2.981	4.485*	1.071
	(0.655)	(2.089)	(2.085)	(1.990)
Three years after shock*female mortality dummy	-1.164*	-2.566	2.044	-0.616
	(0.567)	(2.277)	(1.662)	(2.050)
Four years after shock*female mortality dummy	0.262	1.335	1.587	-3.991*
	(0.712)	(2.492)	(2.131)	(1.918)
Five years after shock*female mortality dummy	0.826	-1.054	-3.159	0.130
	(1.298)	(2.573)	(2.410)	(2.541)
Elderly male mortality	0.182	-0.656	0.340	0.408
	(0.210)	(0.649)	(0.587)	(0.681)
Elderly female mortality	-0.0308	0.110	0.620	0.951
	(0.168)	(0.579)	(0.604)	(0.663)
Gender of head (=1)	0.230	0.939+	0.244	0.462
	(0.161)	(0.565)	(0.488)	(0.578)
Age of the head	0.0220	0.322**	0.0146	0.0663
	(0.0179)	(0.0665)	(0.0540)	(0.0753)
Age of the head squared	-0.000212	-0.00342**	-0.000243	-0.000860
	(0.000172)	(0.000709)	(0.000566)	(0.000738)
Education of the head (years)	0.0427**	0.0150	0.111**	0.219**
	(0.0137)	(0.0450)	(0.0393)	(0.0478)
Distance to tarred/main road (km)	0.00130	0.0120**	0.00629*	0.00419
	(0.000799)	(0.00341)	(0.00300)	(0.00365)
Distance to nearest district (km)	-0.00128	0.00994+	-0.00578	-0.00759
	(0.00170)	(0.00524)	(0.00503)	(0.00572)
Distance to fertilizer depot (km)	0.00143	-0.00669	0.00112	0.00164
	(0.00118)	(0.00426)	(0.00437)	(0.00390)
Provincial dummies	(0.142)	(0.372)	(0.362)	(0.421)
Constant	12.42**	-2.568	2.142	4.979**
	(0.485)	(1.668)	(1.436)	(1.929)
Observations	8,572	8,572	8,572	8,572
R-squared	0.139	0.095	0.089	0.041

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

Table 4.20 presents results of the interaction model with male head mortality. Non-head mortality reduces total and off-farm income significantly. Total income seems to recover in two years after male head mortality. It also shows the same pattern with non-head mortality and proceeds through to the third and fourth year after non-head mortality. Total and off-farm income recovers as household members become economically active in replacing lost income streams over time. Though the results show less variation in income of households by gender and position, there is apparent shift to off-farm income as a coping mechanism by households experiencing male head mortality (Casale and Whiteside, 2006).

Table 4.20 Fixed Effects Model of impacts of Prime-age mortality on household income by gender and position of deceased, 2001-2008

Explanatory variables	Total	Crop	Livestock	Off farm
	(1)	(2)	(3)	(4)
Male head mortality	-0.150	-0.0580	-1.308	-0.671
	(0.240)	(1.024)	(0.979)	(1.105)
Non- head mortality	-2.183*	-1.933	-1.329	-4.803**
	(0.941)	(1.700)	(1.373)	(1.202)
Three years before shock	0.133	-3.815	2.447	5.240
	(1.088)	(5.976)	(4.233)	(3.972)
Two years before shock	-0.607	-2.273	-5.685*	-2.699
	(1.162)	(6.365)	(2.338)	(6.648)
One year before shock	-0.150	-3.498	-2.975	0.623
	(0.603)	(3.920)	(4.249)	(2.294)
Year of mortality shock	-1.152	4.983	-1.337	-4.772
	(0.842)	(4.660)	(3.127)	(3.770)
One year after shock	0.588	0.0387	1.332	-0.126
	(0.660)	(5.488)	(0.998)	(6.114)
Two years after shock	-0.832*	-0.682	1.531	0.178
	(0.402)	(2.000)	(3.455)	(2.093)
Three years after shock	0.282	-1.309	-0.855	-3.690+
	(0.581)	(2.920)	(1.900)	(2.144)
Four years after shock	0.263	-0.839	-0.277	0.446
	(0.401)	(2.591)	(1.784)	(1.177)
Five years after shock	-0.215	1.163+	1.155	-0.546
	(0.794)	(0.616)	(0.798)	(0.369)
Three years before shock*male head dummy	0.174	4.043	-5.134	-5.123
	(1.249)	(6.342)	(4.809)	(4.559)
Two years before shock*male head dummy	0.222	0.624	5.067	3.880
	(1.259)	(6.537)	(2.797)	(6.856)
One year before shock*male head dummy	-0.659	3.901	2.141	-0.779
	(0.705)	(4.078)	(4.374)	(2.598)
Three years before shock*non-head dummy	-1.126	3.535	-4.667	-6.016
	(1.379)	(6.768)	(5.134)	(4.734)
Two years before shock*non-head dummy	-0.947	-0.0485	1.527	2.204
	(1.765)	(6.918)	(3.373)	(7.003)
One year before shock*non- head	-0.907	0.891	2.284	0.631
	(0.791)	(4.229)	(4.529)	(2.841)

Year of mortality shock*male head dummy	0.939	-5.902	1.434	4.456
	(0.898)	(4.881)	(3.393)	(4.020)
One year after shock*male head dummy	-0.561	-0.643	-0.756	-0.869
	(0.705)	(5.612)	(1.495)	(6.255)
Two years after shock*male head dummy	1.194*	0.705	0.424	-0.416
	(0.531)	(2.385)	(3.627)	(2.525)
Three years after shock*male head dummy	-0.336	0.338	1.707	2.430
	(0.641)	(3.159)	(2.219)	(2.529)
Four years after shock*male head dummy	-0.0870	1.657	1.666	-1.203
	(0.534)	(2.893)	(2.303)	(1.812)
Five years after shock*male head dummy	0.531	0.613	-0.182	-0.378
	(0.916)	(1.368)	(1.548)	(1.425)
Year of mortality shock*non-head	1.163	-5.993	1.265	3.766
	(0.967)	(4.937)	(3.501)	(4.067)
One year after shock*non-head dummy	0.979	1.580	0.815	3.553
	(1.174)	(5.856)	(1.959)	(6.283)
Two years after shock*non-head dummy	3.361**	3.455	-1.587	2.764
	(1.170)	(2.819)	(3.784)	(2.558)
Three years after shock*non-head dummy	1.935*	5.593	2.243	9.558**
	(0.963)	(3.535)	(2.410)	(2.602)
Four years after shock*non-head dummy	2.492+	3.739	0.933	5.976**
	(1.336)	(3.470)	(2.379)	(1.954)
Five years after shock*non- head dummy	2.633+	-0.282	2.663	3.345+
	(1.447)	(1.860)	(1.952)	(1.744)
Elderly male mortality	0.206	-0.578	0.410	0.626
	(0.207)	(0.658)	(0.582)	(0.675)
Elderly female mortality	0.0274	0.228	0.622	1.144+
	(0.166)	(0.587)	(0.607)	(0.663)
Gender of head (=1)	0.200	0.842	0.184	0.647
	(0.170)	(0.577)	(0.495)	(0.589)
Age of the head	0.0209	0.320**	0.0178	0.0552
	(0.0176)	(0.0661)	(0.0540)	(0.0754)
Age of the head squared	-0.000186	-0.00336**	-0.000262	-0.000705
	(0.000171)	(0.000716)	(0.000565)	(0.000745)
Education of the head (years)	0.0437**	0.0172	0.108**	0.223**
	(0.0136)	(0.0449)	(0.0396)	(0.0478)
Distance to tarred/main road (km)	0.00118	0.0117**	0.00653*	0.00387
	(0.000806)	(0.00343)	(0.00302)	(0.00365)
Distance to nearest district (km)	-0.00109	0.00952+	-0.00621	-0.00740
	(0.00169)	(0.00523)	(0.00504)	(0.00571)
Distance to fertilizer depot (km)	0.00175	-0.00629	0.000733	0.00257
	(0.00114)	(0.00413)	(0.00437)	(0.00393)
Provincial dummies	(0.141)	(0.370)	(0.361)	(0.418)
Constant	12.42**	-2.500	2.126	4.922*
	(0.472)	(1.647)	(1.437)	(1.933)
Observations	8,572	8,572	8,572	8,572
R-squared	0.139	0.096	0.088	0.040

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys 2001, 2004 and 2008

Notes: Robust standard errors in parentheses; +significant at 10%; *significant at 5%; **significant at 1%

CHAPTER FIVE

CONCLUSION AND POLICY IMPLICATIONS

5.1 Conclusion

The presence of threatening prime-age mortality and the attendant dynamism in rural farm households in Zambia poses challenges to stakeholders. The study therefore, shows that econometric tools can potentially solve this enigma and provide appropriate mitigating measures to households afflicted by mortality in the era of HIV/AIDS. Households exhibit coping strategies with respect to prime-age mortality. Evidently, a phenomenon of *dip-drop-recovery* path resembles the rural farm household. Nonetheless, these measures do not exhibit long-term resilience and plunge most households into deteriorating conditions after the death shock. This is crucial as it buffers the theoretical underpinnings that households are negatively impacted by death shocks. Noteworthy is the ability to want to cope and make adjustments in the face such threatening disturbances in the households' equilibrium.

The study shows that the extent of the impacts, outcomes and coping strategies depict a *dip-drop-recovery* path is somewhat similar in all the five facets of rural farm households. Notably, negative impacts seem to emerge in the pre-mortality morbidity. Household composition via its size declines in this period. The extent of the decline reaches year of death and thereafter the household begin to recover from the negative impact. Total cultivated land, gross value of crop output, gross productivity, productive assets and household income similarly show the same trajectory concerning mortality. This phenomenon gives evidence that addresses the objective of examining the extent of morbidity and mortality on aspects of rural farm households. There are negative impacts affecting the fibre of rural farm households and they are not just a one-time permanent impact but persist over time. Equally true are the attendant adjustments that follow these impacts. The findings conform with much work on the impacts of HIV/AIDS on rural farm households and goes a step further to show that there are highs and lows during this period and ultimately households are striving to make adjustments to their initial levels.

Furthermore, the study highlights that household characteristics such as gender, age and education show an effect on the outcome variables as well. Male-headed and older households have a positive influence on household size whereas education is negatively related to fertility. Gender alone shows a similar path with position of the deceased also yielding the same path. With respect to cultivated land, the study reveals that gender, age and education relate positively with the outcome variable. Productive assets decline with male-headed households that face mortality shocks. Spatial and locational variables influence outcome variables with distance to tarred road and fertilizer depot being the most significant. Henceforth, the study underscores that various socio-economic factors have respective and significant influence on household's outcomes with respect to mortality.

Incidentally, the study shows that the demise of a male head exposes households to dynamics in its composition, assets and income that depict a downward trajectory. Gender and position of the deceased reveals a break down of the strong fibre inherent in the households. Household composition and income have shown a dependency to a limited extent on the gender and position of the deceased. A *dip-drop-recovery* path is again followed with gender and position. However, gross value of crop output, gross value per hectare and productive assets show no significant response to gender and position of deceased an indication that households somehow cushion themselves against such mortality shocks.

The study underscores the need for early mitigating intervention in the pre-death periods. As the mantra goes, prevention is better than cure; early intervention during the stressful *ex ante* periods will ensure long-term resilience and enhanced productivity that promotes the welfare and livelihood of the rural farm households in Zambia. Households reduce their sizes with prime-age females and males migrating out to search for economic activities with the advent of morbidity and mortality. Later on after death, the composition is seen to change with size as entrants begin to emerge to provide labour and comfort to the affected households. Other coping measures noted are the disposal of household assets though productive assets are seen to be cushioned from disposal. Usually, the household is depending on small animals as a coping strategy. Household income is predominantly affected in its totality and off-farm income is seen as a mode of coping strategy later in the years.

5.2 Policy Implications

The study has thus far examined the dynamics of the impacts embedded in the household outcomes due to prime-age morbidity and mortality. A comprehensive analysis of the five household outcomes: household composition, area under cultivation by crop type, value of crop production, productive assets and household income over three years *ex ante* and five years *ex post* mortality has been rendered. The seven-year period survey has provided rich information on the temporal pattern of mortality impacts. From the study, the observation is the temporal pattern is such that mortality impacts do differ by gender and position of the deceased member.

The results highlight four sweeping findings over the six household outcomes. *First*, the *dip-drop* effect of prime-age mortality is predominantly negative and begins to emerge significantly in the second year prior to death. *Second*, mortality impacts do not just follow a one time permanent post-death adjustment but rather dynamic and persistent effects over time. *Third*, households seem to strive to cope and adjust with prime-age mortality as shown by the positive *recovery* path taken by most households. However, this path is not commensurate and equal in magnitude with the *dip-drop* negative effects leaving a number of households vulnerable. *Fourth*, there exists differential impacts by gender and position of the deceased household member.

In the light of the above, the study calls for consideration of the implications that affect appropriate existing programs and interventions as well as future interventions aimed at mitigating the impacts of prime-age mortality. The negative *dip-drop* effects which occur very close to the death year pose damaging household outcomes that resound into the post death periods. Therefore, short-term policy interventions to mitigate these menacing effects become critically relevant to the rural farm households. The short run interventions do not only assist households during the pre-death period but also cardinally help households to recover faster over time. As shown, these households show an inclination and desire to adjust to shocks and recover from mortality effects and as such assistance at the right time is key in mitigating impacts.

Welfare considerations and assistance that curb the instinctive migration of adults and sending away of children could be offered by both government and NGOs working in the rural areas. This mitigates labour loss in the household during the pre-death period thereby promoting cultivation. Additionally, more linkages across households characterised by a niche to offer community assistance can be developed in terms of labour-support groups and cash or in-kind remittances. An efficient and affordable health care service that is far reaching into the households is another important tool to help in the coping mechanisms. These will cushion households from disposing off their valuable and productive assets at give away price to meet medical bills. However, the fading away of these institutions over time due to corruption and mismanagement of funds threatens the livelihoods of the households. Morbidity and mortality due to HIV/AIDS equally threatens the continuation of social capital and local institutions, especially in hard-hit communities. Such threats can be quarantined by appropriate and sustainable initiatives emanating from the stakeholders such as government, donor agencies and NGOs.

The declining crop production evidenced in declining hectares of land being cultivated affects the livelihoods of the households. A complementary reduction in household income implies that households face food security problems as they cannot grow more nor use improved technologies to increase production. Deteriorating off-farm income implies worsens the component of income allotted to food expenditure thus exacerbating the *dip-drop* phenomenon. The attendant lack of nutritious food compromises households' immunity and labour quality/quantity. The implication is susceptibility to more disease-related mortality and attendant reductions in agricultural productivity resulting in poverty and food insecurity. A concerted effort to provide sustainable food aid and mutual help funds that specifically target food security and income boosting , respectively, arguably saves these households from the pangs of threatening poverty. Sustainability is ensured by deliberately integrating HIV/AIDS prevention and mitigation into agricultural extension systems, development projects/programs and microfinance (Slater and Whiteside, 2006). Additionally, there may be gains arising from the deliberate provision of improved health care and government facilitated life insurance to the rural households.

Potential gains arise from the removal of distortions that may arise due to increased disparity in access to farm credit vis-à-vis household labour availability. Intricately cardinal are government, donor support, private sector and local institution programs that provide schemes and inter-linked credit arrangements to mitigate households' outcomes in an efficient and robust manner. Access to credit under appropriate institutional and structural arrangements and wider opportunities to farm operations as well as self-employment may provide solutions that are much more lasting (Kirsten *et al.*, 2009).

Targeting of appropriate poverty-reduction programs needs to pay special attention to households experiencing male head mortality since they suffer the greatest. Therefore, the usefulness of a homogeneous conceptualization of "afflicted households," especially in the context of proposals for targeted assistance, technology development, and other programs/ policies is questioned (Barnett and Whiteside, 2002). Effects on the household outcomes evidently become conditioned by gender and position of the deceased member. The death of a male household head is associated with larger negative impacts on household size, productive assets and household income. The implication is targeting mitigating programs to household's scarce resources particularly toward widow-headed households. However, appropriate balance between targeted assistance to AIDS and mortality-afflicted households and investment in long-term economic productivity growth is cardinal for the overall mitigation of the scourge.

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APPENDICES

Appendix A: Generation of dynamics model

Generally, the dynamics model for the pre and post mortality variables is estimated below, ignoring all the non-dynamics related variables:

$$Y_{it} = \alpha + \delta_5 d_{it-5} + ... + \delta_2 d_{it-2} + \delta_1 d_{it-1} + \gamma_1 d_{it} + \phi_1 d_{it+1} + \phi_2 d_{it+2} + \phi_3 d_{it+3} + \varepsilon_{it} \quad (1.0)$$

Where Y_{it} and α_i are defined as in equation 2, d_{it} shows the death variables t years before and after the survey and ε_{it} is the error term.

Suppose t=2004, the second supplemental survey:

$$Y_{i2004} = \alpha + \delta_5 d_{i1999} + ... + \delta_2 d_{i2002} + \delta_1 d_{i2003} + \gamma_1 d_{i2004} + \phi_1 d_{i2005} + \phi_2 d_{i2006} + \phi_3 d_{i2007} + \varepsilon_{i2004} \quad (1.01)$$

The model in equation 1.01 holds with the available data. However, model in equation 1 should hold for estimating death variables for the three survey years. For t=2001 and 2008, the model would respectively be:

$$Y_{i2001} = \alpha + \delta_5 d_{i1996} + ... + \delta_1 d_{i2000} + \gamma_1 d_{i2001} + \phi_1 d_{2002} + \phi_2 d_{i2003} + \varepsilon_{i2001} \quad (1.02)$$

And,

$$Y_{i2008} = \alpha + \delta_5 d_{i2003} + ... + \delta_1 d_{i2007} + \gamma_1 d_{i2008} + \phi_1 d_{i2009} + \phi_2 d_{i2010} + \phi_3 d_{i2011} + \varepsilon_{i2008} \quad (1.03)$$

The problem emanates from the lack of data on the pre-mortality variables: d_{i2009}, d_{i2010} and d_{i2011}. Equation 1.03 can only hold if these variables are coded as zeros coded and imposing the assumption that:

$$d_{i2009} = d_{i2010} = d_{i2011} = 0 \quad (2.0)$$

Following this approach equation 1.0 is estimated using equations 1.01, 1.02 and 1.03 as a panel. However, imposing equation 4 causes a violation and may mis-specify the model, as the zeros do not indicate missing values. The lack of observation of these variables does not justify coding them as zeros. The study goes around this problem by leaving out equation 1.03 in the estimation of equation 1.0. Hence, only supplemental surveys 2001 and 2004 are used in determining short and long-run impacts on outcome variables. The generation of death variables however, makes use of the three surveys.

Appendix B: Results of Hausman Specification Test

The following tables show results of the Hausman (Chi-square) test of whether coefficients do differ systematically. The rule of thumb is we reject the null hypothesis of no systematic differences in coefficients and conclude that the preferred model is the fixed effects model if the p-value $< \alpha$ or the chi-square test statistic is greater than the critical value of the Chi-square. Note that only results of the dynamics prime-age model in equation (3) are presented below for the reader. Nonetheless, all tests rejected the null.

Table 2.1B: Hausman test for dynamic PA model on household size, 2001-2008

	Coefficients (b) fixed	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
pre3	1.736707	1.516472	.2202348	.2956202
pre2	-2.318437	-2.538621	.220184	.2359952
pre1	-1.85247	-1.789405	-.0630652	.1747125
post0	-.904225	-.4475099	-.4567151	.1761317
post1	.3356641	.7569717	-.4213076	.1174786
post2	1.263444	1.757398	-.4939546	.1312358
post3	.4388055	.6160852	-.1772797	.1316098
post4	.1854816	.6873091	-.5018275	.1547106
post5	1.380427	1.540151	-.1597237	.1725489
eldMdthD	-.120831	.3932898	-.5141208	.1295577
eldFdthD	-.5173196	-.1501995	-.3671201	.1166196
sex_head	.9201088	1.43096	-.5108514	.1793889
age_head	.2063589	.2768009	-.0704419	.0234347
agesqd	-.0021638	-.0025109	.0003471	.0002334
educ_H	.027514	.0982094	-.0706954	.0137874
mainroad_ydm	.003112	-.0011651	.004277	.0012099
disttown_ydm	.0024589	-.0021786	.0046375	.0019565
dfert_ydm	.0017436	.0043453	-.0026016	.0008293
provd2	-.900864	-.2247401	-.676124	.1176221
provd3	.3112033	-.2871926	.5983959	.1945204
provd4	-1.06179	-.2064321	-.8553579	.2360707
provd6	.4308225	-.0117544	.4425768	.1144436
provd7	.0325411	-.2230101	.2555512	.1311889
provd8	-1.08342	.6424719	-1.725892	.3264183
provd10	.2141903	.4969647	-.2827744	.1352871
provd13	-1.395543	.8583851	-2.253928	.3923862
provd14	.0746667	.0502393	.0244274	.0968259

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

```
chi2(26) = (b-B)'[(V_b-V_B)^(-1)](b-B)
         =      462.76
Prob>chi2 =      0.0000
(V_b-V_B is not positive definite)
```

Table 2.1B: Hausman test for dynamic PA model on Area Cultivated, 2001-2008

	Coefficients (b) fixed	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
pre3	.1060561	.0820856	.0239706	.0752321
pre2	-.158723	-.1191211	-.0396018	.0595979
pre1	.0565763	.0278471	.0287292	.044241
post0	-.1933371	-.2086543	.0153172	.0447995
post1	.0762393	.1063734	-.0301341	.0297856
post2	-.0647152	-.0351085	-.0296068	.0333262
post3	.1176696	.1842011	-.0665315	.0334924
post4	-.0288991	.078223	-.1071221	.0393499
post5	.0025431	-.0364816	.0390247	.0439579
eldMdthD	.0186841	.1134841	-.0948	.0316552
eldFdthD	.0116888	.0653167	-.053628	.029572
sex_head	.1994791	.2926462	-.0931671	.0408505
age_head	.0281532	.0266603	.0014929	.0053831
agesqd	-.000267	-.000208	-.000059	.0000535
educ_H	.0133117	.0217546	-.0084429	.0032194
mainroad_ydm	-.0004844	-.0003103	-.0001741	.0002753
disttown_ydm	.0002559	.0009192	-.0006633	.0004425
dfert_ydm	-.0001716	.0010187	-.0011903	.0002102
provd2	.0854017	.1123215	-.0269198	.0268014
provd3	.1318824	.2579129	-.1260305	.0438906
provd4	-.0563287	-.0833831	.0270544	.0530016
provd6	.1128587	.2016344	-.0887756	.0259199
provd7	-.0507547	-.0914049	.0406502	.0308385
provd8	.0004968	.0854805	-.0849838	.0727652
provd10	.0108575	-.0534257	.0642832	.0336702
provd13	-.1474031	.0013955	-.1487986	.0874073
provd14	.1919235	.0498387	.1420848	.0228434

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

```
chi2(26) = (b-B)'[(V_b-V_B)^(-1)](b-B)
         =      305.49
Prob>chi2 =      0.0000
(V_b-V_B is not positive definite)
```

Table 2.3B: Hausman test for dynamic PA model on gross value of output, 2001-2008

	Coefficients (b) fixed	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
pre3	.2838013	.5262645	-.2424632	.3418279
pre2	-1.220787	.4223428	-1.64313	.2694879
pre1	-.3907716	.3733507	-.7641224	.2002233
post0	-.7968162	-.3204994	-.4763168	.2033402
post1	.7038776	.2713315	.4325461	.1349877
post2	-.0516558	-.292824	.2411683	.1511543
post3	.2786279	.0873714	.1912565	.1520283
post4	.2846094	.1115953	.1730141	.1785963
post5	.40277	-.4202746	.8230446	.1996569
eldMdthD	.2575723	.5309794	-.2734071	.1409592
eldFdthD	.1248981	.2625534	-.1376553	.134092
sex_head	.2746722	.6987971	-.4241248	.1749289
age_head	.0241391	.078877	-.0547378	.0231796
agesqd	-.0001873	-.0006124	.0004251	.0002303
educ_H	.0233128	.0601482	-.0368354	.0140108
mainroad_ydm	.0033557	.0011731	.0021827	.0011786
disttown_ydm	-.0011291	.0093807	-.0105098	.0018869
dfert_ydm	-.0001646	.0042509	-.0044155	.0009532
provd2	1.051167	.4000419	.6511246	.1144532
provd3	-2.015223	.1042535	-2.119476	.1867713
provd4	1.776121	-.3027826	2.078903	.2248408
provd6	-1.047518	.2640225	-1.311541	.1103312
provd7	-1.170077	-.6419073	-.5281701	.1340782
provd8	3.346024	.1380499	3.207974	.3072251
provd10	.6787507	.3354018	.3433489	.1508873
provd13	3.742451	-.0443244	3.786775	.3688797
provd14	.6215746	-.4083519	1.029926	.0992884

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(26) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 447.95
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

Table 2.4B: Hausman test for dynamic PA model on productive assets, 2001-2008

	Coefficients (b) fixed	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
pre3	.5437406	2.268384	-1.724643	.7302308
pre2	-.9761678	1.016382	-1.99255	.5748725
pre1	-.058729	.8935411	-.9522701	.4271327
post0	.0175523	.2514051	-.2338528	.4341704
post1	.1431655	-.0387837	.1819492	.2881287
post2	-.3641827	-.7204557	.3562731	.322697
post3	-.1785581	-.2196399	.0410818	.324593
post4	-.4212146	-.5275136	.106299	.3813276
post5	1.064068	-.242018	1.306086	.4263579
eldMdthD	.6544486	1.033617	-.379168	.2998521
eldFdthD	.1700839	.642615	-.4725312	.2862977
sex_head	1.653246	1.794521	-.1412746	.3691558
age_head	.1663408	.1632772	.0030635	.0489841
agesqd	-.0016872	-.0011757	-.0005115	.0004866
educ_H	.0711038	.1357257	-.0646219	.0296877
mainroad_ydm	-.0001892	.002072	-.0022612	.0024869
disttown_ydm	-.0053685	.0118542	-.0172228	.003978
dfert_ydm	.004274	.0143882	-.0101142	.0020358
provd2	2.083952	.3066552	1.777297	.2410045
provd3	-5.315592	-.1251728	-5.190419	.3934137
provd4	5.267998	-.4255706	5.693569	.4732505
provd6	-2.947628	.1952813	-3.14291	.232226
provd7	-4.145973	-3.997662	-.1483113	.2834277
provd8	7.347263	.9160034	6.43126	.6459414
provd10	2.145787	1.054577	1.09121	.3210406
provd13	9.104254	2.557266	6.546988	.7754858
provd14	.7129116	-.9882522	1.701164	.2096867

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(26) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 724.66
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

Table 2.5B: Hausman test for dynamic PA model on household income, 2001-2008

	—— Coefficients —— (b) fixed	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
pre3	-.0274866	.3334828	-.3609694	.2617977
pre2	-.1406966	.6985742	-.8392709	.2058348
pre1	-.8640644	-.1422634	-.721801	.1530814
post0	-.2042857	.0695705	-.2738562	.1557132
post1	-.0490472	-.213403	.1643558	.1032563
post2	.4803554	.1850938	.2952616	.1156771
post3	.2290572	.1875054	.0415518	.1164426
post4	.3663596	.2019501	.1644095	.1367686
post5	.3114262	-.1646932	.4761194	.1529747
eldMdthD	.1802253	.371337	-.1911117	.1063357
eldFdthD	.0021016	.1513425	-.149241	.1025814
sex_head	.2250835	.5587435	-.33366	.1274278
age_head	.0187525	.0511865	-.032434	.0169469
agesqd	-.0001691	-.0004235	.0002544	.0001683
educ_H	.0415162	.1067773	-.0652612	.0103209
mainroad_ydm	.0011959	.0007651	.0004307	.0008585
disttown_ydm	-.0018793	.0020348	-.0039141	.0013714
dfert_ydm	.0014676	.0058265	-.0043589	.000729
provd2	.5399037	.1646365	.3752671	.0835349
provd3	-2.02519	-.5595407	-1.465649	.1356586
provd4	1.163446	-.2553586	1.418805	.162978
provd6	-1.036794	-.1346236	-.9021706	.0801781
provd7	-1.054018	-.877198	-.1768201	.0993244
provd8	2.07539	.041165	2.034225	.2217762
provd10	.472116	.5977085	-.1255925	.1145289
provd13	2.468785	.1984887	2.270296	.2662293
provd14	.417756	-.2772001	.6949561	.0735714

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(26) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 552.63
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)