Community-level Relationships between Prime Age Mortality and Rural Welfare: Panel Survey Evidence from Zambia

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Abstract

Governments and development agencies require accurate information on the impacts of increased mortality rates caused by AIDS on the agricultural sector and rural livelihoods. Several previous studies have estimated the effects of prime-age mortality on afflicted households in relation to non-afflicted households. Given that HIV prevalence rates exceed 15-20 percent in many parts of southern Africa, we question whether non-afflicted households are a valid control group in hard-hit communities because non-afflicted households may nevertheless be adversely affected by the mortality occurring in neighboring households.

Using nationally representative household panel data from rural Zambia, we measure the effects of prime-age adult mortality rates on changes in a set of community level welfare indicators. We find that a rise in community mortality rates from zero to 24.4 percent (which is the difference in mortality rates between the 25th and 75th percentile of all 393 communities) is associated with a 5 percent decline in the land area cultivated at the community level. We find little evidence that cropped area is shifting toward labor-saving crops such as cassava in hard-hit areas as is sometimes contended. Other factors related to agricultural policy need to be considered when examining the impact of HIV/AIDS on the agricultural sector. Most notably, many countries in eastern and southern Africa had formerly implemented state-led maize promotion policies featuring pan-territorial producer prices, major investments in marketing board buying stations, and subsidies on fertilizer distributed on credit to small farmers along with hybrid maize seed. These maize marketing policies in Zambia were either eliminated or scaled back significantly starting in the early 1990s as part of economy-wide structural adjustment programs. These policy changes clearly reduced the financial profitability of growing maize in the more remote areas where maize production was formerly buoyed by pan-territorial pricing, and has shifted cropping incentives toward other food crops such as cassava (Jayne et al).

We also find relatively small independent effects of prime-age mortality on community indicators of crop production, income, and income per capita. The effects of mortality appear to be complex in that they depend importantly on initial community conditions such as the level of mean education, wealth, connectedness with markets and infrastructure, and dependency ratios. In the case of changes in community crop production per hectare, prior mortality rates have a greater impact than more recent mortality rates, potentially indicating strong lagged effects. In general, the findings of this study offer limited support for the view that prime-age mortality is decimating agrarian-based economic systems in regions that are hard-hit by the HIV/AIDS pandemic. However, this in no way implies that great hardship is not being wrought by the disease in ways that are not measured in this data, and further research from other areas and/or time periods will be necessary before strong conclusions can be generated about the effects of AIDS-related mortality in regions of the world where prevalence rates are very high.

Acknowledgements

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Introduction

A growing literature has focused on understanding the effects of the HIV/AIDS pandemic on rural livelihoods and the agricultural sectors in Africa (Ainsworth, Fransen, and Over; Barnett and Whiteside; Gillespie and Kadiyala; Mather et al.). In some parts of southern Africa, HIV prevalence rates are as high as 30 percent among individuals between 15-45 years of age. Several nationwide household panel surveys from relatively hard-hit countries (Kenya, Tanzania, and Zambia) indicate that, over a 3-year survey interval, roughly 6-10% of rural households suffer one or more disease-related deaths of a prime-aged individual (Yamano and Jayne; Beegle; Chapoto and Jayne), and there is overwhelming evidence that most of the mortality in these age ranges are related to AIDS (Ngom and Clark).

However, efforts to accurately estimate the economic impacts of AIDS-related mortality are fraught with difficulties. To date, almost all of the quantitative micro-level studies have studied the effects of mortality at the household level, even though it is likely that mortality shocks are transmitted across households. This situation, in which a relatively small percentage of households incur a shock, but the shock is spread across households in a community presents methodological challenges for estimating the full effects of the shock using household survey data. Most household-level panel studies, using difference-in-difference, household fixed-effects, or random-effects models, have measured the effects of mortality *in afflicted households* on differenced household-level outcomes, typically over a 2–5 year time frame, compared to differenced outcomes on non-afflicted households. Yet if non-afflicted households are likely to be indirectly affected by the mortality occurring around them, non-afflicted households may not be a valid control group. In communities hard-hit by HIV/AIDS, households not directly incurring a death may nevertheless be affected by taking in orphans, losing access to resources owned by kin-related "afflicted" households, intra-household resource transfers to afflicted households, and broader effects of high mortality rates on communities' economic and social structures. To date, little quantitative economic analysis has attempted to measure the effects of mortality on rural welfare other than at the household level.

This study measures the effects of prime-age mortality on rural welfare using the "community" as the unit of observation. Data is drawn from a panel of 5,420 households surveyed in 393 communities in Zambia in 2001 and 2004. We compute community-level adult mortality rates from household data along with mean household welfare indicators for all communities. OLS difference models are estimated to measure the relationship between mortality rates and indicators such land cultivation, crop output, and per capita income at the community level, controlling for time-invariant unobservables and initial community conditions. This study is the first approach, as far as we know, to estimate the impacts of AIDS-related mortality on entire rural communities, including afflicted and non-afflicted households alike, using micro survey data. The findings should be important for governments and development agencies especially in southern Africa where HIV prevalence rates are the highest in the world and where the full impacts of the disease remain largely speculative.

Methods and Data

Our approach in this paper is to determine the relationship between mortality and economic outcomes at the community-level, based on panel survey data of 5,420 households in 393 communities, or "Standard Enumerations Areas (SEAs)," the lowest geographic cluster used by the Central Statistical Office (CSO) of the Government of Zambia. In 2001 and 2004, the CSO conducted two linked nationally-representative household surveys (for sampling procedures see Megill) containing information on agricultural production and input use, assets, income, and demographic and socioeconomic information, including mortality and chronic illness. Of the 6,922 households interviewed in 2001, 5,420 (78.3%) were re-interviewed in May 2004. If we exclude attrition caused by enumerators not re-visiting several SEAs in 2004 that were included in the 2001 survey, the re-interview rate rises to 88.7%. And if we exclude attrition caused by adult household members being away from home during the enumeration period and those refusing to be interviewed, the re-interview rate rises to 94.5%.

Of the 5,420 households successfully re-interviewed, 547 of these households (10.1%) had at least one disease-related prime-age death over the three-year period (Table 1). Of these 547 households, 52 (9.6%) of them suffered multiple prime-age deaths. Adult mortality rates, defined as the number of disease-related mortalities in the 15-59 year age category per 1000 person years between May 2001 and May 2004 were computed for each community. AMRs among the 393 communities ranged from zero to 97, with the mean being 16.3.

We compute mean household welfare indicators for each community in the panel sample and use SEA-fixed effects by differencing these welfare/outcome variables ($Y_{2004} - Y_{2001}$). To measure the impacts of PA mortality on the community level outcome Y_i, we consider the following model:

$$Y_{it} = \gamma_t + D_{it}\alpha + X_{it}\beta + R_{it}\phi + t * P\varphi + \mu_i + \varepsilon_{it} \quad i = 1,..., N \quad t = 1,..., T \qquad [1]$$

where Y_{it} denotes changes in community outcomes, such as land cultivated and gross value of output in community at time t; D_{it} is the prime-age mortality rate (AMR) between 2001 and 2004; the parameter γ_t denotes a time-varying intercept; X_{it} is a vector of mean of time-varying characteristics among all households in community *i*, such as assets and landholding size; R_{it} is a vector of community time-varying factors such as rainfall; μ_i captures the community-level fixed effects (assumed constant over time); P is a vector of eight provincial dummies and ε_{it} is an error term.

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

$$\Delta Y_i = \gamma + \Delta D_i\alpha + \Delta X_i\beta + \Delta R_i\phi + P\varphi + \Delta\varepsilon_i \quad i = 1,..., N \qquad [2]$$

Estimation of equation 2 by OLS gives the impact of AMR on outcome ΔY as α. Since we are considering AMR between 2001 and 2004, at t=0 AMR is zero and at t=1, AMR takes into account all deaths occurring between t=0 and t=1. Also, because ΔX_i is likely to be influenced by PA mortality rates in the community and is hence endogenous, we only control for initial pre-death mean household characteristics. These initial pre-death mean household community variables (X_{0i}) are introduced into equation 1 as follows:

$$Y_{it} = \gamma_t + D_{it}\alpha + t * X_{oi}\beta' + R_{it}\phi + t * P\varphi + \mu_i + \varepsilon_{it} \quad i = 1,..., N \quad t = 1,..., T \qquad [3]$$

Differencing equation 3 yields:

$$\Delta Y_i = \gamma + D_i\alpha + X_{oi}\beta' + \Delta R_i\phi + P\varphi + \Delta\varepsilon_i \quad i = 1,..., N \qquad [4]$$

X_{0i} contains the distance to the district capital, distance to the nearest tarmac road, proximity to the line of rail (all proxies for degree of interaction between members of the community and people from outside the community), effective dependency ratios (the number of household members under 14 or over 59 plus chronically ill members divided by the number of healthy prime-age members), the percentage of adults spending at least 2 months away from home, a proxy for migration and mobility, which has been shown to be positively associated with HIV contraction (Epstein), community population, and initial assets in 2000 (stock of animals and draft equipment).

To test whether the impact of prime-age mortality rates on changes in community outcomes is influenced by and initial conditions (X_{0i}), we introduce interaction terms between AMR and variables such as initial assets in 2000 (stock of animals and draft equipment), the distance to the district capital and nearest tarmac road, and proximity to the line of rail (proxies for degree of interaction between members of the community and regional centers and transport routes, which are the main HIV transmission vectors in southern Africa). We also interact AMR with annual deviations in rainfall in each year between 1999/2000 and 2002/2003 from the 10-year average between 1992/03 and 2002/03, to capture the potential interactions between drought and mortality on communities' economic indicators. We also tested for potential non-linearities in AMR, based on the hypothesis that the marginal impacts of mortality on community outcomes may be more severe as mortality rates rise. Therefore, the resulting model estimated by OLS is as follows:

$$\Delta Y_i = \gamma + D_i\alpha + R_i\phi + X_i^o\beta' + \delta C_i + D_i * R\phi' + D_i * X_i^o\beta'' + D_i \bullet C_i\delta' + P\varsigma + \Delta\varepsilon_i \qquad [6]$$

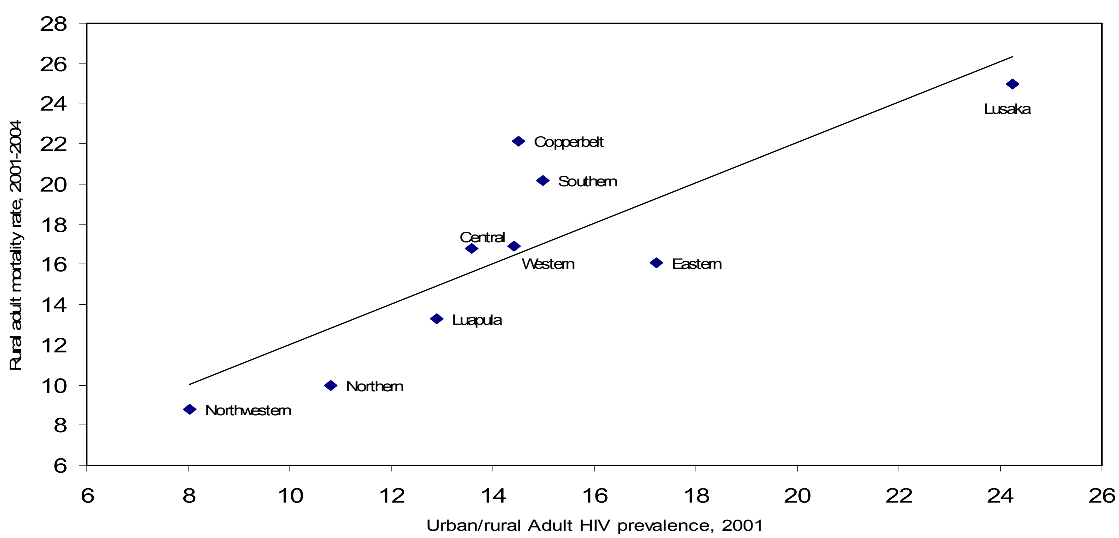
Model [6] was estimated using OLS for changes in logged (1) cropped area (including separate models for area to cereals, roots and tubers, and other crops); (2) the gross value of agricultural output, (3) gross value of agricultural output per hectare; (3) total household income; and (4) household income per capita. While information on assets and consumption would have been useful in this study, comparable data was not available from the two surveys.

For each dependent variable, we report three models to assess the robustness of results. The first model in each of the Tables 2 through 5 shows results including all covariates in the D_i, R_i, X^0_i, C_i, and P vectors, with no interaction terms (columns 1 and 4). Because of space limitations, we cannot report all parameter estimates on one page so confine the tables to the main variables of interest. The second model (columns 2 and 5) includes all interaction terms, and the third model (columns 3 and 6) show results after including a squared adult mortality rate term to account for potential non-linearities in impacts.

We start by investigating whether spatial differences in prime-age mortality observed in the survey data accurately track spatial differences in HIV prevalence rates. Provincial HIV prevalence rates for 2001 were obtained from antenatal clinics as reported in Zambia's Demographic Health Survey (Ministry of Health).[1] A strong relationship between prime-age mortality and HIV prevalence rates would suggest that a large proportion of prime-age mortality observed in our household data is indeed due to AIDS-related causes.

Figure 1 presents a scatter plot of provincial HIV prevalence and rural adult mortality rates between 2001 and 2004 from our provincially-representative household data. The strength of these correlations is notable, especially considering that the provincial HIV prevalence rate is not disaggregated by urban/rural classification. The Pearson correlation coefficient of 0.84 suggests that the adult mortality rates observed in our survey data is closely associated with HIV-prevalence.

Figure 1. Correlation between Provincial adult mortality rates from CSO 2001 and 2004 household survey data and 2001 HIV + Prevalence Rates, Zambia



Notes: Pearson correlation coefficient is 0.84.
Sources: Adult mortality rates derived from the 2001 and 2004 household surveys. HIV+ prevalence rates are from 2001 Sentinel Surveillance Site information published by CSO, MoH, and Macro International 2003.

Model results

Effects of mortality on land cultivation

Table 2 presents the estimated relationships between community adult mortality rates and area cultivated. The log-level specifications provide estimates of percentage changes in the dependent variable as adult mortality rates vary. To put these impacts into perspective, we report the estimated differences in Y_i evaluated at the 25th percentile (zero) and at the 75th percentile (24.4 percent) of community mortality rates. All three models in columns 1, 2, and 3 indicate that total land cultivated in the community is negatively related to mortality rates, although this relationship is statistically significant only at the 10 percent level. Results in Column 1 indicate that a rise in community mortality rates from zero to 24.4 percent (which is the difference in mortality rates between the 25th and 75th percentile of all 393 communities) is associated with a 5.2 percent decline in the land area cultivated at the community level. Models 2 and 3 indicate that the negative impact of mortality on land cultivation is greater in areas where mean educational attainment is higher, possibly representing the differential loss of human capital-adjusted labor on outcomes. The negative impact of mortality on land cultivation is mitigated in relatively wealthy communities, as indicated by the positive coefficient on the interaction between asset levels and mortality rates. Relatively wealthy communities presumably have greater reserves and stocks of wealth to draw upon to cope with mortality-related shocks. When evaluated at mean levels for all other variables, models 2 and 3 indicate that a rise in community mortality rates from the 25th to 75th percentile is associated with a 6.0 to 9.7 percent decline in land area cultivated over this three-year time frame.

The effects of adult mortality on the area specifically under cereal crops (Table 2, columns 4, 5, and 6) are similarly negative but smaller. Holding all other variables at their mean level, a rise in community mortality rates from the 25th to 75th percentile is associated with a 2.5 to 4.1 percent decline in area cultivated to cereals. Results in Table 3 show a somewhat weaker relationship between adult mortality rates and cultivation of roots and tubers, as well as other crops (primarily cotton, groundnuts, soybeans, and vegetables). The findings on roots and tubers are particularly interesting because of the common perception that labor shocks associated with the HIV/AIDS pandemic has led greater cultivation of less labor-intensive crops such as cassava and sweet potato. The results of the models presented in Table 3 indicate that high adult mortality rates, if anything, negatively influence root and tuber cultivation in Zambia, although this relationship is imprecisely measured.

The two variables representing the percentage of households in the community with a chronically ill person and the proportion of households suffering from a disease-related death in the 1996-2000 period were both statistically insignificant in all models of cultivated area. The general picture is that the impact of mortality on land cultivated at the community level is negative, but relatively short-lived, since prior death rates do not appear to affect land cultivation or cropping patterns 2-5 years later.

Effects of mortality on crop production

Table 4 reports changes in the gross value of crop output per farm and per hectare. In both of these sets of models, current adult mortality rates have little independent impact on changes in crop output or output per hectare. All the statistically significant effects in these models are due to the interaction between mortality and other community characteristics. For example, in columns 2 and 3, the evidence once again suggests that the effects of mortality are dependent on the degree of education within the community; crop production is more adversely affected by mortality in areas with relatively high initial educational attainment. We also find that the percentage of households in a community having chronically ill prime-age member appears to be statistically unrelated to crop production. The effect of current mortality on crop output per hectare is greater in areas with relatively large landholding sizes, which might be expected to the extent that mortality exacerbates labor shortages in areas where land/labor ratios are already relatively high. The effect of mortality on changes in crop output per hectare appears to be mitigated in areas along the rail line, which are relatively well connected to markets and physical infrastructure.

Prior mortality also appears to have persistent effects on output per hectare. In all three models of output per unit of land (columns 4, 5 and 6), the extent of prime-age mortality during the 1996-2000 period is negatively and significantly related to output per hectare in the 2000-2003 period. An increase in the percentage of households suffering from prior (1996-2000) mortality from the 25^{th} to 75^{th} percentile of communities is associated with a 10.0 to 13.8 decline in the value of crop output between 2000 and 2003. These effects are generally larger than those on more current period morality.

Effects of mortality on changes in total and per capita community income

Table 5 presents results on the effects of mortality on changes in mean household income and per capita income in communities between 2001 and 2004. The main effects of adult mortality rates on changes in total income or income per capita at the community level are through interaction effects with other community characteristics. For example, once again, the adverse effects of mortality are greatest in more educated communities. This is consistent with explanations that the death of more educated people has a greater adverse effect on households and communities than the death of less educated people, especially considering that household income levels are positively correlated with educational attainment in our dataset. The effects of mortality are mitigated in highly populated areas. Overall however, there is little independent impact of mortality or chronic illness rates on community income levels.

Conclusions

Governments and development agencies require accurate information on the impacts of increased mortality rates caused by AIDS on the agricultural sector and rural livelihoods. Several previous studies have estimated the effects of prime-age mortality on afflicted households in relation to non-afflicted households. Given that HIV prevalence rates exceed 15-20 percent in many parts of southern Africa, we question whether non-afflicted households are a valid control group in hard-hit communities because non-afflicted households may nevertheless be adversely affected by the mortality occurring in neighboring households.

Using nationally representative household panel data from rural Zambia, we measure the effects of prime-age adult mortality rates on changes in a set of community level welfare indicators. We find that a rise in community mortality rates from zero to 24.4 percent (which is the difference in mortality rates between the 25th and 75th percentile of all 393 communities) is associated with a 5 percent decline in the land area cultivated at the community level. We find little evidence that cropped area is shifting toward labor-saving crops such as cassava in hard-hit areas as is sometimes contended. Other factors related to agricultural policy need to be considered when examining the impact of HIV/AIDS on the agricultural sector. Most notably, many countries in eastern and southern Africa had formerly implemented state-led maize promotion policies featuring pan-territorial producer prices, major investments in marketing board buying stations, and subsidies on fertilizer distributed on credit to small farmers along with hybrid maize seed. These maize marketing policies in Zambia were either eliminated or scaled back significantly starting in the early 1990s as part of economy-wide structural adjustment programs. These policy changes clearly reduced the financial profitability of growing maize in the more remote areas where maize production was formerly buoyed by pan-territorial pricing, and has shifted cropping incentives toward other food crops such as cassava (Jayne et al).

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References

Ainsworth, M., Fransen, L., Over, M. (Eds.). 1998. Confronting AIDS: Evidence from the developing world. European Commission, Brussels.

Barnett, T., and A. Whiteside. 2002. *AIDS in the Twenty-First Century: Disease and Globalization.* Palgrave Macmillan, Basingstoke, UK.

Beegle, K. 2005. Labour Effects of Adult Mortality in Tanzanian Households. *Economic Development and Cultural Change,* Vol. 53(3): xx-xx.

CSO (Central Statistical Office). 2003. HIV Epidemiological Projections. Central Statistical Office, Republic of Zambia, Lusaka.

Epstein, H. 2003. AIDS in South Africa: The Invisible Cure. New York Times Review of Books, 50(12), July 17, 2003.

Gillespie, S. and S. Kadiyala. 2005. HIV/AIDS and Food and Nutrition Security: From Evidence to Action. Food Policy Review 7, International Food Policy Research Institute, Washington, D.C.

Jayne, T.S., M. Villarreal, P. Pingali, and G. Hemrich. 2005. HIV/AIDS and the Agricultural Sector: Implications for Policy in Eastern and Southern Africa. *Electronic Journal of Agricultural Development Economics,* 2(1).

Mather, D., C. Donovan, T. Jayne, M. Weber, E. Mazhangara, L. Bailey, K. Yoo, T. Yamano, and E. Mghenyi. 2005. *A Cross-Country Analysis of Household Responses to Adult Mortality in Rural Sub Saharan Africa: Implications for HIV/AIDS Mitigation and Rural Development Policies.* MSU International Development Working Paper No. 82. East Lansing: Michigan State University.

Megill, D.J. 2004. *Recommendations on Sample Design for Post Harvest Surveys in Zambia Based on the 2000 Census.* Working Paper 10 Food Security Research Project, Lusaka.

Ministry of Health. 1999. *HIV/AIDS in Zambia: Background, Projections, Impacts, Interventions*, December. Lusaka, Ministry of Health and Central Board of Health.

Ngom, P. and S. Clark. 2003. Adult Mortality in the Era of HIV/AIDS: Sub Saharan Africa*.* Paper presented to the workshop on HIV/AIDS and Adult Mortality in Developing Countries, Population Division, Department of Economic and Social Affairs, United Nations Secretariat, 8-13 September, New York.

Yamano, T., and T. Jayne. 2004. Measuring the Impacts of Working-Age Adult Mortality on Small-Scale Farm Households in Kenya. *World Development* 32.1: 91-119.

Endnotes:

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

Table 1. Prevalence of prime-age (PA) mortality[a] by province, rural Zambia between May 2001 and May 2004.

Province	Households interviewed in 2001	Households re-interviewed in 2004	Descriptive results in 5,340 valid re-interviewed households					
			Household incurring at least one prime-age death due to illness				Cause of death	
			Male		Female		Disease	Other[d]
	(a)	(b)	(d)		(e)		(f)	(g)
	Number	Number (%)	Number	AMR[c]	number	AMR	number	
Central	714	573 (80.3)	34	14.4	34	16.1	68	4
Copperbelt	393	312 (79.4)	12	14.8	16	14.6	28	3
Eastern	1331	1126 (84.6)	68	14.6	71	18.5	139	7
Luapula	777	619 (79.7)	24	12.1	29	15.1	53	4
Lusaka	214	161 (75.2)	8	19.2	19	16.6	27	1
Northern	1363	1027 (75.3)	42	10.3	46	13.1	88	4
Northwestern	472	324 (68.6)	15	9.3	7	10.0	22	-
Southern	872	690 (79.1)	33	15.1	51	17.3	84	6
Western	786	588 (74.8)	18	16.4	44	17.7	62	1
Total	6922	5420 (78.3)	254	14.0	317	15.4	571	30

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

Notes: [a]Prime-age is defined as ages 15-59 for both men and women. [b]Of the 21.7% not re-interviewed, 0.2% were refusals, 10.2% moved out of SEA, 5.7% were recorded as dissolved, and 5.2% were categorized as "non-contact" (not home but still resident). [c]AMR (adult mortality rate)=Prime-age deaths/1000 prime-age person years for persons between 15-59 years of age. [d] Other deaths were caused by unexpected causes such as accidents, murder and snake bite, and were excluded from the analysis in Section 4.

Table 2. Changes in community land cultivated and area under cereals in 1999/00 and 2002/03

	Changes in natural logs of :					
	--------Total and cultivated------			-------Area under cereals--------		
	(1)	(2)	(3)	(4)	(5)	(6)
Adult mortality rate: 2001-2004[a]	-5.7e-03+	-3.5e-02+	-3.8e-02+	-8.5e-04	-1.6e-02+	-1.8e-02*
	(1.74)	(1.91)	(1.95)	(0.67)	(1.95)	(2.07)
Mortality rate squared			3.8e-05			1.9e-05
			(0.80)			(0.83)
% of households with ill PA adults	-1.1e-05	-3.8e-04	-1.0e-03	3.2e-05	-8.6e-05	4.3e-05
	(0.01)	(0.26)	(0.72)	(0.05)	(0.12)	(0.06)
% of HH with prior prime-age death	4.8e-04	7.7e-04	3.1e-03	-4.4e-04	-2.8e-04	1.0e-03
	(0.24)	(0.41)	(1.64)	(0.48)	(0.31)	(1.05)
Interaction terms						
AMR*1999/2000 rainfall deviations[b]	1.7e-05	1.7e-05	1.8e-05	1.5e-05*	1.3e-05+	1.4e-05+
	(1.08)	(1.13)	(1.17)	(2.11)	(1.69)	(1.86)
AMR*2000/2001 rainfall deviations	2.5e-05	2.4e-05+	2.7e-05+	4.7e-06	3.1e-06	3.7e-06
	(1.61)	(1.78)	(1.80)	(0.68)	(0.45)	(0.51)
AMR*2001/2002 rainfall deviations	1.9e-05	2.6e-05+	2.9e-05*	1.6e-05**	1.8e-05**	2.3e-05**
	(1.37)	(1.92)	(2.04)	(2.90)	(3.12)	(3.71)
AMR*2002/03 rainfall deviations	1.0e-05	1.4e-05*	1.6e-05**	3.9e-06	4.5e-06	6.7e-06*
	(1.63)	(2.35)	(2.59)	(1.38)	(1.43)	(2.07)
AMR*Educated in 2000[c]		-2.0e-03*	-2.0e-03*		-4.4e-04	-3.7e-04
		(2.54)	(2.30)		(1.03)	(0.78)
AMR*Effective dependency ratio in 2000[d]		7.2e-03*	7.1e-03+		3.2e-03*	3.7e-03*
		(2.14)	(1.96)		(2.00)	(2.14)
AMR*Value of assets in 2000		2.1e-03+	2.0e-03		9.0e-04	8.4e-04
		(1.68)	(1.58)		(1.63)	(1.44)
AMR*Landholding size in 2000		8.5e-04	7.9e-04		1.1e-04	5.3e-05
		(1.19)	(1.06)		(0.30)	(0.14)
AMR* Number of PA adult in SEA in 2000		5.2e-07	8.8e-07		2.0e-07	3.9e-07
		(0.95)	(1.39)		(0.64)	(1.18)
AMR*Distance to District Town		4.1e-05	4.4e-05		3.4e-05	2.5e-05
		(0.75)	(0.78)		(1.08)	(0.82)
AMR*Distance to nearest tarmac road		2.2e-05	1.6e-05		5.0e-06	1.4e-06
		(0.48)	(0.36)		(0.20)	(0.06)
AMR*District on line of rail		-5.0e-03	-4.9e-03		-2.5e-03	-2.6e-03
		(1.57)	(1.39)		(1.64)	(1.60)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes
Constant	8.5e-01*	1.2e+00**	1.1e+00*	2.4e-01	4.6e-01*	5.6e-01*
	(2.51)	(2.64)	(2.35)	(1.50)	(2.14)	(2.59)
Joint tests						
AMR and AMR squared	-	-	1.98			2.25+
Mean household pre-death conditions in 2000	0.39	1.07	1.68	0.64	0.77	1.26
Community variables in 2000[e]	0.49	0.49	0.19	1.10	1.83	0.59
AMR*rainfall deviations from 12 year mean	3.45**	3.92**	3.43**	2.93**	3.21**	3.54**
AMR*household characteristics		1.78*	1.99*		1.02	1.21
All interactions		2.33**	3.04**		1.79*	3.08**
R-squared	0.20	0.24	0.17	0.23	0.26	0.17
Observations	393	393	393	393	393	393

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

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Included but not reported in the table: 8 provincial dummies, all variables interacted with AMR. [a]AMR=prime-age deaths between 2001 and 2004/1000 person years. [b]Rainfall deviations from 10 year mean (1993-2002) . [c]Education is the mean number of years of schooling of the most educated in the household . [d]Effective dependency ratio is given by the sum of the number of elderly, children and chronically ill adults divided by number of prime-age adults. [e]Community characteristics include: Distance to nearest tarmac road, distance to the District town (Boma) and District on line of rail.

Table 3. Changes in community area under roots and tubers and other crops in 1999/00 and 2002/03

	Changes in natural logs of :					
	---Area under roots and tubers--			------Area under other crops-----		
	(1)	(2)	(3)	(4)	(5)	(6)
Adult mortality rate: 2001-2004[a]	-4.1e-03+	-9.2e-03	-1.0e-02	-2.0e-03+	-5.1e-03	-9.1e-03
	(1.83)	(0.91)	(1.01)	(1.80)	(0.83)	(1.38)
Mortality rate squared			1.0e-05			2.6e-05
			(0.41)			(1.47)
% of households with ill PA adults	-1.2e-04	-2.6e-04	-1.1e-03	1.1e-05	-8.7e-05	-2.1e-05
	(0.16)	(0.34)	(1.51)	(0.02)	(0.15)	(0.04)
% of HH with prior prime-age death	5.1e-04	5.2e-04	6.0e-04	3.7e-04	3.5e-04	-8.4e-05
	(0.43)	(0.43)	(0.51)	(0.40)	(0.37)	(0.09)
Interaction terms						
AMR*1999/2000 rainfall deviations[b]	-1.2e-05	-8.2e-06	-9.9e-06	-2.9e-06	-3.2e-06	-4.4e-06
	(1.07)	(0.71)	(0.85)	(0.43)	(0.48)	(0.65)
AMR*2000/2001 rainfall deviations	1.1e-05	1.4e-05	1.4e-05	9.1e-06+	9.2e-06+	1.0e-05+
	(1.17)	(1.55)	(1.60)	(1.84)	(1.89)	(1.95)
AMR*2001/2002 rainfall deviations	-8.4e-06	-6.8e-06	-1.0e-05	1.1e-06	2.3e-06	2.0e-06
	(1.21)	(0.83)	(1.21)	(0.25)	(0.47)	(0.37)
AMR*2002/03 rainfall deviations	1.9e-06	3.2e-06	2.7e-06	1.6e-06	2.4e-06	1.3e-06
	(0.56)	(0.96)	(0.83)	(0.82)	(1.32)	(0.71)
AMR*Educated in 2000[c]		-3.4e-04	-2.6e-04		-4.2e-04	-5.7e-04+
		(0.70)	(0.57)		(1.35)	(1.91)
AMR*Effective dependency ratio in 2000[d]		1.3e-03	6.8e-04		4.5e-04	3.0e-04
		(0.61)	(0.32)		(0.42)	(0.27)
AMR*Value of assets in 2000		2.3e-04	2.3e-04		5.3e-04	7.6e-04+
		(0.34)	(0.35)		(1.29)	(1.79)
AMR*Landholding size in 2000		4.6e-04	5.6e-04		2.1e-05	-6.2e-05
		(1.15)	(1.41)		(0.09)	(0.29)
AMR* Number of PA adult in SEA in 2000		1.6e-07	1.8e-07		-2.2e-07	-1.8e-07
		(0.54)	(0.60)		(0.79)	(0.65)
AMR*Distance to District Town		-1.7e-05	-9.4e-06		9.8e-07	2.1e-05
		(0.60)	(0.34)		(0.05)	(1.18)
AMR*Distance to nearest tarmac road		2.5e-05	1.9e-05		1.5e-06	4.0e-06
		(1.16)	(0.92)		(0.08)	(0.20)
AMR*District on line of rail		-1.5e-03	-1.4e-03		-1.4e-03	-1.0e-03
		(0.55)	(0.54)		(0.98)	(0.69)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-4.6e-03	3.7e-02	6.1e-02	-1.9e-02	2.2e-02	-8.6e-02
	(0.03)	(0.15)	(0.26)	(0.15)	(0.13)	(0.55)
Joint tests						
AMR and AMR squared	-	-	0.53			1.56
Mean household pre-death conditions in 2000	0.22	0.12	0.73	2.19*	0.90	1.44
Community variables in 2000[e]	1.42	0.64	0.76	1.56	0.27	0.36
AMR*rainfall deviations from 12 year mean	2.95**	2.37*	2.02*	0.94	1.07	1.36
AMR*household characteristics		0.51	0.62		2.28	4.10**
All interactions		1.51+	1.71*		1.75*	3.66**
R-squared	0.13	0.14	0.10	0.17	0.19	0.15
Observations	393	393	393	393	393	393

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

Notes: ** 1% level of significance, * 5% level of significance and [+] 10% level of significance. Included but not reported in the table: 8 provincial dummies, all variables interacted with AMR. [a]AMR=prime-age deaths between 2001 and 2004/1000 person years. [b]Rainfall deviations from 10 year mean (1993-2002) . [c]Education is the mean number of years of schooling of the most educated in the household . [d]Effective dependency ratio is given by the sum of the number of elderly, children and chronically ill adults divided by number of prime-age adults. [e]Community characteristics include: Distance to nearest tarmac road, distance to the District town (Boma) and District on line of rail.

Table 4. Changes in community gross value of output and gross output/ha in 1999/00 and 2002/03

	Changes in natural logs of :					
	-------Gross vale of output-------			----Gross value of output/ha-----		
	(1)	(2)	(3)	(4)	(5)	(6)
Adult mortality rate: 2001-2004[a]	-4.1e-03	9.8e-04	-3.8e-03	3.4e-04	3.1e-02	3.0e-02
	(0.97)	(0.04)	(0.15)	(0.07)	(1.23)	(1.17)
Mortality rate squared			7.5e-05			6.6e-06
			(1.08)			(0.09)
% of households with ill PA adults	-1.1e-03	-1.2e-03	-9.4e-04	-1.7e-03	-1.3e-03	-2.1e-04
	(0.71)	(0.75)	(0.58)	(0.93)	(0.69)	(0.12)
% of HH with prior prime-age death	-3.6e-03	-3.1e-03	-3.7e-03	-6.5e-03*	-6.2e-03*	-8.5e-03**
	(1.39)	(1.21)	(1.48)	(2.12)	(2.09)	(2.99)
Interaction terms						
AMR*1999/2000 rainfall deviations[b]	-2.6e-05	-2.9e-05+	-3.1e-05+	-3.8e-05*	-3.8e-05*	-4.2e-05*
	(1.57)	(1.68)	(1.70)	(2.24)	(2.32)	(2.48)
AMR*2000/2001 rainfall deviations	1.8e-05	1.3e-05	1.2e-05	-4.7e-06	-1.5e-05	-1.9e-05
	(0.92)	(0.59)	(0.52)	(0.22)	(0.72)	(0.86)
AMR*2001/2002 rainfall deviations	-1.7e-06	-2.5e-06	-3.0e-06	-3.0e-05+	-3.4e-05+	-3.9e-05+
	(0.10)	(0.13)	(0.16)	(1.65)	(1.68)	(1.95)
AMR*2002/03 rainfall deviations	-2.0e-06	-2.9e-06	-4.1e-06	-1.4e-05+	-2.1e-05**	-2.5e-05**
	(0.30)	(0.39)	(0.60)	(1.88)	(2.75)	(3.32)
AMR*Educated in 2000[c]		-1.9e-03+	-2.6e-03*		-9.1e-04	-1.5e-03
		(1.82)	(2.57)		(0.62)	(1.04)
AMR*Effective dependency ratio in 2000[d]		6.8e-04	6.8e-04		-5.9e-03	-5.0e-03
		(0.13)	(0.12)		(1.27)	(1.06)
AMR*Value of assets in 2000		4.0e-04	6.5e-04		-1.0e-03	-7.5e-04
		(0.27)	(0.43)		(0.62)	(0.45)
AMR*Landholding size in 2000		-5.7e-04	-9.2e-04		-1.8e-03*	-2.1e-03**
		(0.85)	(1.33)		(2.51)	(2.62)
AMR* Number of PA adult in SEA in 2000		6.4e-07	1.0e-06		3.0e-07	2.8e-07
		(1.03)	(1.41)		(0.35)	(0.30)
AMR*Distance to District Town		2.2e-05	6.3e-05		5.0e-05	8.0e-05
		(0.35)	(0.98)		(0.66)	(1.10)
AMR*Distance to nearest tarmac road		-1.5e-05	-1.3e-05		-3.8e-05	-3.3e-05
		(0.29)	(0.25)		(0.75)	(0.64)
AMR*District on line of rail		-1.9e-03	-6.8e-04		6.5e-03+	7.3e-03+
		(0.47)	(0.15)		(1.80)	(1.93)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes
Constant	6.9e-01+	5.9e-01	6.6e-01	-6.3e-01	-1.0e+00+	-6.8e-01
	(1.80)	(1.13)	(1.37)	(1.41)	(1.78)	(1.25)
Joint tests						
AMR and AMR squared	-	-	0.60			0.76
Mean household pre-death conditions in 2000	1.05	1.31	1.59	0.98	1.20	2.58*
Community variables in 2000[e]	0.61	0.20	0.79	0.74	0.11	0.69
AMR*rainfall deviations from 12 year mean	1.62	1.70*	1.72+	1.70*	2.41*	2.53**
AMR*household characteristics		1.35	1.57+		1.92*	1.91*
All interactions		1.65*	1.95**		1.63*	2.10**
R-squared	0.14	0.15	0.10	0.16	0.18	0.13
Observations	393	393	393	393	393	393

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

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Included but not reported in the table: 8 provincial dummies, all variables interacted with AMR. [a]AMR=prime-age deaths between 2001 and 2004/1000 person years. [b]Rainfall deviations from 10 year mean (1993-2002) . [c]Education is the mean number of years of schooling of the most educated in the household . [d]Effective dependency ratio is given by the sum of the number of elderly, children and chronically ill adults divided by number of prime-age adults. [e]Community characteristics include: Distance to nearest tarmac road, distance to the District town (Boma) and District on line of rail.

Table 5. Changes in community household income and per capita income in 1999/00 and 2002/03

	Changes in natural logs of :					
	-------Household income-------			--Household income per capita--		
	(1)	(2)	(3)	(4)	(5)	(6)
Adult mortality rate: 2001-2004[a]	-4.9e-03	-8.8e-03	2.5e-03	-5.1e-03	6.8e-03	2.2e-02
	(1.35)	(0.31)	(0.09)	(1.46)	(0.24)	(0.80)
Mortality rate squared			-5.9e-05			-1.0e-04
			(0.75)			(1.35)
% of households with ill PA adults	-2.3e-04	-2.6e-04	-4.5e-04	-3.3e-03+	-3.0e-03+	-2.8e-03
	(0.14)	(0.15)	(0.26)	(1.91)	(1.69)	(1.60)
% of HH with prior prime-age death	-5.4e-03+	-4.4e-03	-3.1e-03	-4.7e-03	-3.7e-03	-3.3e-03
	(1.82)	(1.54)	(1.16)	(1.55)	(1.26)	(1.18)
Interaction terms						
AMR*1999/2000 rainfall deviations[b]	-3.2e-05	-3.6e-05	-2.9e-05	-3.7e-05+	-3.8e-05+	-3.5e-05
	(1.47)	(1.61)	(1.26)	(1.76)	(1.72)	(1.59)
AMR*2000/2001 rainfall deviations	1.9e-05	1.0e-05	5.0e-06	2.2e-05	1.0e-05	2.0e-06
	(0.96)	(0.47)	(0.22)	(1.02)	(0.45)	(0.09)
AMR*2001/2002 rainfall deviations	-2.0e-05	-2.4e-05	-2.2e-05	-1.3e-05	-1.9e-05	-2.7e-05+
	(0.93)	(1.30)	(1.18)	(0.69)	(1.13)	(1.67)
AMR*2002/03 rainfall deviations	-1.2e-05+	-1.5e-05+	-1.1e-05	-8.7e-06	-1.2e-05	-1.3e-05
	(1.68)	(1.72)	(1.31)	(1.22)	(1.36)	(1.52)
AMR*Educated in 2000[c]		-2.3e-03*	-2.8e-03*		-2.2e-03+	-2.7e-03*
		(2.02)	(2.40)		(1.93)	(2.29)
AMR*Effective dependency ratio in 2000[d]		3.1e-03	3.5e-03		-4.8e-05	4.2e-04
		(0.47)	(0.50)		(0.01)	(0.05)
AMR*Value of assets in 2000		3.5e-04	1.1e-04		-6.8e-04	-1.0e-03
		(0.18)	(0.06)		(0.36)	(0.55)
AMR*Landholding size in 2000		-6.7e-04	-6.2e-04		-4.6e-04	-3.8e-04
		(0.81)	(0.71)		(0.54)	(0.42)
AMR* Number of PA adult in SEA in 2000		1.8e-06*	2.0e-06*		1.9e-06*	1.9e-06+
		(2.09)	(1.98)		(2.07)	(1.96)
AMR*Distance to District Town		1.0e-04	5.4e-05		1.2e-04	8.4e-05
		(1.36)	(0.65)		(1.36)	(0.88)
AMR*Distance to nearest tarmac road		-1.3e-05	-1.6e-05		-5.1e-05	-5.0e-05
		(0.23)	(0.27)		(0.78)	(0.70)
AMR*District on line of rail		-3.4e-03	-4.0e-03		2.1e-03	9.6e-04
		(0.68)	(0.79)		(0.45)	(0.20)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-2.8e-01	-2.7e-01	1.9e-01	-4.8e-01	-7.0e-01	-5.2e-01
	(0.52)	(0.42)	(0.35)	(0.97)	(1.05)	(0.87)
Joint tests						
AMR and AMR squared	-	-	0.29			1.09
Mean household pre-death conditions in 2000	1.12	1.17	1.50	2.46*	2.07*	1.70
Community variables in 2000[e]	1.14	0.95	0.60	0.16	0.60	0.73
AMR*rainfall deviations from 12 year mean	1.43	1.31	0.85	1.69+	1.43	0.86
AMR*household characteristics		1.48	1.11		2.01	1.24
All interactions		1.92**	1.66*		1.97**	1.52*
R-squared	0.11	0.14	0.09	0.09	0.12	0.08
Observations	393	393	393	393	393	393

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

Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Included but not reported in the table: 8 provincial dummies, all variables interacted with AMR. [a]AMR=prime-age deaths between 2001 and 2004/1000 person years. [b]Rainfall deviations from 10 year mean (1993-2002) . [c]Education is the mean number of years of schooling of the most educated in the household . [d]Effective dependency ratio is given by the sum of the number of elderly, children and chronically ill adults divided by number of prime-age adults. [e]Community characteristics include: Distance to nearest tarmac road, distance to the District town (Boma) and District on line of rail.