RESEARCH REPORT

HIV/AIDS Mortality and the Role of Woodland Resources in the Maintenance of Household Food Security in a Rural District of South Africa.

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SUMMARY

This study examined food security among HIV/AIDS-impacted households (compared to non-HIV/AIDS-impacted households) in rural South Africa, with a particular focus on the role of savanna woodland resources (e.g. wild foods) in shaping household resilience following the death of a prime-age adult. The study was conducted in the Agincourt health and demographic surveillance site in the rural north-east of South Africa. A cross-sectional survey was conducted in 290 rural households in May and June 2006. Households were stratified by their experience of an HIV-related death of a prime-age adult in the previous two years as follows: HIV death (n=109), quick non-HIV death (n=71) and no adult death (control) (n=110). Experience of a mortality, as well as household socio-demographic data, were provided by the Agincourt Health and Demographic Surveillance System which is run by the University of the Witwatersrand/Medical Research Council's Rural Public Health and Health Transitions Research Unit (Agincourt Unit). A survey questionnaire was used to quantify household food security, livelihoods, use of woodland resources, and impacts of the experience of an adult death on the household. Food security was assessed in terms dietary diversity, experience of hunger, short-term coping strategies, and longer term adaptive strategies. Survey interviews were conducted in the local language by experienced local fieldworkers from the Agincourt Unit. Detailed qualitative interviews were also conducted by the researchers, with assistance from local interpreters, in 17 mortality-impacted households. Satellite imagery was used to quantify woodland cover around each of the study villages.

HIV-impacted households tended to be poorer than those impacted by a non-HIV death, although their socio-economic status, indexed by wealth ranking, did not decline during the two years subsequent to the adult HIV death. Dietary diversity was significantly lower in HIV-impacted households than in control households with no death. However, this pattern largely disappeared when socio-economic status was factored into the analysis. Mortality-impacted households were more likely than households in the control group to have experienced hunger in the last 30 days. However, this was more pronounced in households which had experienced a quick *non*-HIV adult death. Similarly, although both categories of mortality-impacted households were more likely to have engaged in coping strategies in response to food shortages in the last seven days, this was more prevalent in 'non-HIV death' households. Both experience of hunger and engaging in coping strategies were also positively related to poverty. The deceased household member among mortality-impacted households had more often contributed income or had been engaged in tending food gardens or fields in 'non-HIV mortality' households, while they had more often been involved in resource collecting in HIV-impacted households.

The use of woodland resources, such as indigenous wild vegetables, wild fruit, edible insects, and firewood, was very widespread, and did not differ between mortality categories, although HIV-impacted households were less likely to use wild vegetables on a regular basis. This was possibly due to labor constraints. However, in many cases, mortality impacted households had become more reliant on wild vegetables since the death of the adult member. A striking result was the widespread use of woodland resources to save money among mortality-impacted households compared to the control households. However, we did not detect a unique HIV impact in this regard. Few households sold resources to earn income, but most of those which did, had experienced a recent adult death.

The use of wild foods made a positive contribution to household dietary diversity, but only the use of edible insects, and to a lesser degree, the use of wild vegetables, mitigated against running out of food. Relying more on wild vegetables after the death of the adult household member did not diminish experiences of hunger, such as worrying about food, running out of food or going hungry. Households were not more likely to use natural resources at home if their village had better woodland cover in the immediate vicinity, although such households were more likely to use at least one resource to save money.

Overall, we conclude that while adult mortality can have a serious impact on household food security, HIV/AIDS is not unique in this regard. Furthermore, we found that poverty had a very important negative effect on food security, often more pronounced than the 'mortality effect'. We note that while the use of woodland resources certainly plays an important supplementary 'safety net' function with regard to food security, especially in terms of dietary diversity and cost savings, it alone does not adequately mitigate the impacts of poverty and adult mortality. Based on these insights, we recommend that food security policy and interventions should not focus exclusively on households impacted by HIV/AIDS, but should target vulnerable households more generally. Poverty reduction should be at the core of such strategies. Given the centrality of woodland resources in rural livelihoods, greater support should be given to local communities to manage their natural resources and use them sustainably. This should include building capacity of local institutions and exploring low-input intensification of wild food production.

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INTRODUCTION

Background context

HIV/AIDS is increasingly becoming a critical development issue in Africa, with far-reaching implications in a variety of arenas beyond health, including social, political, and environmental. As Vogel (2002) states (emphasis added): "Alongside poverty, population and climate change, AIDS is one of the *great problems* of the late 20th and early 21st centuries, and primarily affects the developing world." Nowhere is this more evident than in sub-Saharan Africa, where average life expectancy is reaching an all-time low due to AIDS (Pilgram & Kees 2002). Once a mainly urban phenomenon, AIDS has become a "formidable social problem" in rural sub-Saharan Africa, with major implications for rural development (Rugalema & Khanye 2002; Hargreaves & Pronyk 2003). The impacts of AIDS at the household level include changing household size, composition, and income. Many rural households are dependent on remittances from employed migrant family members, and illness and death of breadwinners thus has major impacts on rural households with few other potential sources of income (Rugalema & Khanye 2002; Hargreaves & Pronyk 2003). Morbidity or mortality of a household member may also result in the necessary development of a variety of coping strategies, such as divesting family assets, spending savings, and withdrawing children from school (especially girls) to compensate for income loss. These strategies may be more appropriately referred to as "Response Strategies", since AIDS-impacted households which are in distress often respond by adopting irreversible strategies, indicating that they are in fact not coping (Loevinsohn & Gillespie 2003). This exacerbates the existing spiral of poverty which is so prevalent in many rural African communities.

With specific attention to food security in Africa, sub-Saharan Africa is the only region in the world which faces widespread chronic food insecurity with famine as an ever-present threat (Devereux & Maxwell 2001). In our study context of South Africa, more than 14 million people (about 35% of the population) are estimated to be vulnerable to food insecurity (HSRC 2004:16). Linking HIV/AIDS and food security, South Africa's Human Sciences Research Council (HSRC 2004:16) aptly states that, "All dimensions of food security – availability, stability, access and use of food – are affected where the prevalence of HIV/AIDS is high." The substantial financial strain often placed on households by the illness and death of a household member, especially a breadwinner, have potentially serious implications for household food security (Haddad & Gillespie 2001; Gillespie & Kadiyala 2005). AIDS morbidity and mortality also significantly impact on household human capital needed for producing food (Barnett & Blaikie 1992; Haddad & Gillespie 2001; Jackson 2002).

The implications of this for food security in rural communities reliant on small-scale agriculture for survival can be severe. Rural households are often worst hit by the impacts of HIV/AIDS, and "are highly vulnerable to the multiple impacts of the illness and death of a household member" (Hargreaves & Pronyk 2003: 94). Some argue that the HIV/AIDS pandemic as related to food security has yielded a "new variant famine" (deWaal & Whiteside 2003) and that the influence of HIV/AIDS has worsened and exacerbated existing vulnerabilities to food insecurity resulting in a "dual tragedy" (HRSC 2004:16). Gillespie and Kadiyala (2005) provide a comprehensive review of evidence of interactions between HIV/AIDS and food and nutrition security, using a multi-scale livelihoods approach. While it is clear that HIV/AIDS has significant impacts on all dimensions of rural livelihoods, the authors conclude that these "vary significantly among different geographical area and livelihood systems, and with the degree of resilience demonstrated by households and communities".

Especially relevant to this project, the sustainability of natural resources may also be undermined by the HIV/AIDS pandemic (Hammarskjold 2003). Such threats may take the form of lessened ability of communities and user groups to collectively manage common property resources such as rangelands (Haddad & Gillespie 2001). In addition, recent research by the investigators of the project outlined here suggests that additional pressure may be placed on natural resources as HIV-impacted households require sustenance from communal woodlands in the face of declining purchasing power (Hunter *et al*. 2007).

Rationale for this study

Rural households across Africa rely heavily on the natural environment for their livelihoods (Neefjes 2000). Besides using the land for raising livestock and growing crops, rural communities also harvest natural resources such as fuelwood, wild leafy vegetables, wild fruit, edible insects and bushmeat, both for basic provisioning and generating income (e.g. Shackleton & Shackleton 2000; Twine *et al.* 2003). In their review of use of non-timber forest products across 14 rural sites in South Africa, Shackleton and Shackleton (2004) calculated that a mean of 95.6% of households ate leafy wild vegetables, 88.2% ate wild fruit, 53.5% ate edible insects (e.g. locusts) and 51.6% ate bushmeat. The level of use of wild foods can also be substantial. Rural South African households consume a mean of 58.2 kg of wild vegetables per year (Shackleton & Shackleton 2004), and the more commonly eaten species may be consumed as often as twice a day (Shackleton *et al.* 1998).

In the face of difficult economic conditions, natural resources bring substantial value to household economies. They offer inexpensive alternatives to otherwise purchased goods (Letsela *et al*. 2002; Twine *et al*. 2003) and present opportunities for poor rural household to generate income from trade in raw or processed natural products (Shackleton 1996). The combined value of these wild natural resources to rural livelihoods has largely been undervalued in the past. However, evidence from southern Africa demonstrates that the direct use value of natural resource use is comparable to that of crop and livestock production (Adams *et al.* 2000; Dovie *et al.* 2005). In our study area, Shackleton and Shackleton (2000) calculated the annual direct use value of natural resources used for domestic consumption to be $386 per household, or $141 per hectare. Edible herbs accounted for the highest proportion of this value (33%), followed by fuelwood (21%). Within these settings, this value represents a cash savings. Resource use is thus an important buffer against poverty and household shocks (Shackleton *et al.* 2001). This is especially important in the current era of rising HIV/AIDS mortality - a critically important household shock (Baylies 2002).

To-date, the environmental dimensions of the HIV/AIDS pandemic remain little explored, despite the centrality of the natural environment in the livelihoods of the rural poor across Africa. As pointed out by Hammarskjold (2003:6), "What has been published hitherto on the subject is therefore based on fragmentary and anecdotal information…" It is important that this information gap be addressed, given that sub-Saharan Africa is generally typified by the interlinked phenomena of rapidly rising rates of HIV infection, high levels of food insecurity, high dependence on natural resources for rural livelihoods, climatic variability and environmental degradation (Barany *et al*. 2001; Holden & Shiferaw 2004; Misselhorn 2005). Nowhere is there a more urgent need for improved understanding of these linkages than in southern Africa, which has the highest rates of HIV infection in the world (UNAIDS 2004).

Focusing specifically on food security, data are lacking on the specific role of natural resources in the maintenance of household food security among HIV-impacted households (Barany *et al.* 2001) despite the fact that woodland resources (also referred to as non-timber forest products) are a standard dietary component in Africa (Gockowski *et al.* 2003; Shackleton *et al.* 2000; Steyn et *al.* 2002; Twine *et al*. 2003). A recent paper by Kaschula (2008), published in a special issue of *Population and Environment* focusing on the environmental dimensions of HIV/AIDS (Hunter *et al*. 2008), is thus an important contribution in this regard. Her results suggest that the use of wild foods may render households more economically resilient, but that households impacted by an HIV/AIDS death may make less use of wild foods due to labor shortages, possibly contributing to the observed negative

relationship between household food security and household proxies for AIDS. In this context, it is unknown what the influence might be of cash savings or income generated through the use or sale of woodland resources as coping strategies (e.g. using fuelwood instead of paraffin or electricity to be able to afford to buy food) in shaping food security after an AIDS death. However, early evidence from ongoing work by the authors suggesting that HIV/AIDS-impacted households may collect natural resources to supplement previously purchased goods (Hunter *et al*. 2007).

In this study, we examine the interactions among several factors shaping household vulnerability and food security: the death of an adult household member, poverty, the use of natural resources, and the state of the local natural environment. We explore how HIV/AIDS intersects with these other factors to shape food security, while also examining the possibility that the use of natural resources contributes to household resilience.

Objectives and key research questions

Objective:

To examine food security among HIV-impacted households in rural South Africa (compared to non-HIV-impacted households) with a particular focus on the role of woodland resources (e.g. wild foods) in shaping household resilience following the death of a prime-age adult.

Key questions:

1) What role do woodland resources play in contributing to household food security following the death of a prime-age adult due to HIV/AIDS?
2) Are otherwise similar HIV/AIDS-impacted households more food secure if they make greater us of local woodland resources?
3) How does the death of a prime-age adult intersect with poverty, the use of natural resources, and the state of the local natural environment, to shape household vulnerability to food insecurity?

Working hypothesis:

Greater household use of woodland resources enhances food security of poor, HIV-impacted households.

METHODS

Study design

Study site

The study site comprises the Agincourt sub-district of the Bushbuckridge rural municipality, South Africa. This border region previously fell under Limpopo Province, but has recently been transferred to Mpumalanga Province. The field site, named after one of the local villages, consists of 21 villages, comprising over 12 000 households and 70 000 people. Village population size ranges from 480 to 6 834. Approximately a quarter of the population are former Mozambican refugees, most of whom fled to South Africa during the civil war in Mozambique in the 1980's. The mean household size in the Agincourt field site ranges from 6.2 in the South African population to 6.5 among the former Mozambican refugees.

The area is typical of rural communities across South Africa, being characterized by poverty and high human densities. Few households are able to support themselves on agriculture alone, primarily due to the shortage of land and declining interest in agriculture as a result of the previous government's forced relocation and separate development policies for black South Africans (Hargreaves & Pronyk 2003). Due to poor local employment opportunities, a large proportion of adults are migrant labourers, working on commercial farms and in towns and cities across the country. Of all males 30-49 years of age, 50% are migrant workers, as are 14% of females of the same age group. A significant proportion of households depend on the state pension of an elderly resident as the only reliable source of household income.

HIV prevalence in the region, estimated from antenatal surveillance data, was 19% in 1998 (DOH 1998), while HIV/AIDS and TB (often associated with HIV) are the leading causes of death among adults between the ages 15-49 in the study site (Kahn *et al.* 1999). Furthermore, mortality among young adults increased fivefold in the study site over the decade between 1992-1993 and 2002-2003, and this was attributed largely to the emerging HIV/AIDS pandemic (Kahn *et al*. 2007a).

In terms of environmental conditions, the area is characterized by poor soils and highly variable rainfall. The underlying geology is primarily coarse granite and gneiss, giving rise to leached, sandy soils. The region is semi-arid, with a mean annual rainfall of 650mm. Rainfall pattern is uni-modal, the summer months from October to April, receiving the most rain. The

Agincourt field site is characterised by an east-west gradient in rainfall, the west being moister. The natural vegetation is predominantly broad-leaf savanna woodland.

Data sources

We used four data sources for this study:

Data Source #1, Agincourt Health and Demographic Surveillance System (HDSS): Data on the demographic characteristics of Agincourt households and individuals was provided through the longitudinal health and demographic surveillance system (HDSS) of the University of the Witwatersrand/Medical Research Council's Rural Public Health and Health Transitions Research Unit (abbreviated hereafter as the Agincourt Unit). Since 1992, the Agincourt Unit has collected census data at 12-18 month intervals from all 12 000 households in the Agincourt sub-district. The resulting data are incredibly rich in socio-demographic detail, allowing identification of key household characteristics (e.g. size, male/female headship, age composition, socio-economic status). The HDSS also provided data on individual mortality, which was crucial for our study design which required the differentiation between households with different types of adult mortality experience.

Data Source #2, Quantitative Survey: We surveyed 290 households with differing experience of an adult HIV/AIDS-related mortality, collecting data on food security and use of woodland resources (refer to household survey and sampling design below).

Data Source #3, Qualitative Interviews: We undertook 17 in-depth qualitative interviews with a sub-sample of mortality-impacted households, with representation across the spectrum of socio-economic status.

Data Source #4, Remote Sensing: The state of the local natural, in terms of woodland cover, was assessed for the study villages using satellite imagery.

Detailed methodology

Household mortality experience

Our primary analytical variable was mortality experience and, as such, we made use of the Wits/MRC Agincourt Unit's demographic surveillance data to identify households that had experienced the death of an adult member during the past two years. Cause of death was obtained from the HDSS. This is ascertained by the Agincourt Unit from 'verbal autopsies' that are undertaken for each mortality experience within the study site after each annual census (Kahn *et al*. 2000; 2007b). A trained lay fieldworker interviews the closest available caregiver of the deceased in the vernacular, using a structured questionnaire. The interview is then assessed independently by two medical doctors to assign a probable cause of death.

If these correspond, the diagnosis is accepted. If they differ, the two doctors discuss the case to try to reach consensus. If they cannot agree, the interview is sent to a third doctor who has not seen the diagnoses of the first two. If there is agreement between the third assessment and one of the other two, this is accepted as the most probable cause of death. If consensus can still not be reached between at least two doctors, cause of death is logged as "ill-defined". This tool was validated locally using hospital records in the 1990's (Kahn *et al*. 2000), and has recently (2001-2005) been re-validated for HIV/AIDS assessment (Kahn *et al*. 2007b). The data from the verbal autopsies thus allowed us to classify HIV/AIDS-related deaths (which are not reflected on death certificates) and other mortality experiences.

We focused on mortality of prime-age adults (15-49), as this age range represents the period of largest economic contribution to the household, as well as being the ages of those most susceptible to HIV/AIDS. Deaths occurring in this age group over the past two years were classified as either HIV/AIDS-related (abbreviated hereafter as 'HIV death') and non-HIV/AIDS-related (abbreviated hereafter as 'non-HIV death'). Non-HIV deaths were further classified as 'quick' (e.g. heart attack, motor vehicle accident) or 'slow' (e.g. cancer). We used these mortality classifications to sample households from three mortality strata: 1) HIV mortality: experienced a prime-age adult death due to HIV/AIDS in the last two years, 2) non-HIV mortality: experienced a prime-age adult *quick* death, where cause of death was not related to HIV/AIDS, in the last two years, and 3) no mortality: experienced no death of a prime-age adult in the last two years. We included non-HIV mortality households in the survey since we were not able to directly address the question of HIV morbidity, given the cross-sectional nature of the study. More specifically, by comparing households with HIV and quick non-HIV deaths, we hoped to be able to indirectly capture some of the unique impacts of HIV mortality, which often includes a preceding long period of illness.

Household survey

The survey instrument was developed based upon central literature in the relevant fields, as well as the investigators' previous experience in the Agincourt field site. The survey instrument focused on 1) food security, 2) livelihood strategies, and 3) use of woodland resources, especially in relation to meeting household food requirements (see Appendix 1).

The three topical sections of the survey were as follows:

1) *Household food security* was assessed using accepted proxy indicators and methodologies (see Hoddinott (1999) for a useful comparison of most commonly used methods and Hendriks (2005) for a good overview in the South African context). Our choice of methods, based on trade-offs between time, cost, accuracy and the expertise required,

was as follows: i) Dietary Diversity Index for 99 food items, including commonly used species of wild foods, recording whether the item was eaten at least once in the last week, month, year, or not at all (see Hoddinott & Yohannes 2002; Swindale & Bilinsky 2005), ii) Household Experience of Hunger and Access to Food, such as number of times in the last 30 days in which the household worried about food or ran out of food (see Household Food Insecurity Scale (FANTA 2004) or the Food Access Survey Tool (Coates *et al*. 2003)), and iii) Coping Strategies based on frequency of short-term responses to food shortage, such as asking neighbors for food or skipping meals (see Maxwell 1996, Maxwell *et al*. 1999). All of the above methods were adapted for local conditions through insight gained from three focus groups with local women. The focus group participants assisted in the development of lists of foods eaten locally, as well as coping strategies used when facing food shortages.

2) *Adaptive livelihood strategies*, which are longer term livelihood strategies in contrast to short-term 'coping' strategies, was assessed in the context of food security for all households. This section dealt with household livelihood strategies which relate directly to household food provisioning, including agricultural production, purchasing food, and gathering wild foods. Indirect provisioning, such as when resources are used as sources of household income, were also quantified. The role of social capital in livelihoods and coping strategies was assessed in terms of reliance on social networks, such as borrowing food from neighbours, friends or family. Participation in social groups such as women's groups, churches or burial societies was also be recorded in the survey's livelihoods section.

3) *Household use of woodland resources* for a) direct provisioning of food, b) selling to earn money, and c) saving money through not having to buy commercial alternatives, was recorded. There was a certain degree of overlap between the food security, adaptive livelihood strategies and woodland resource use sections, and this was purposeful to ensure thorough coverage and allow triangulation of the collected data.

A major analytical challenge in this study was that we could not track household food security and resource use through time, given its cross sectional nature. For this reason, we asked all households about recent changes in their food security, livelihoods and resource use, and for those households in the sample which had experienced an adult mortality in the last two years, we also asked carefully phrased questions about changes in food security, livelihood strategies, and use of woodland resources specifically as a result of the passing of the household member. It is important to note that the data collected on current food security status and resource use was collected and archived in such a way that it can serve as a

baseline study for a possible future longitudinal panel study, although this is beyond the scope of the project outlined herein.

The survey was conducted by experienced local fieldworkers from the Agincourt Unit. The respondents were typically the female primarily responsible for food acquisition and preparation, and acquisition of woodland resources. The survey was conducted in May and June 2006, using the dominant local language of the field site (Shangaan).

Qualitative interviews

Because additional questions often arise from quantitative exploration, qualitative interviews were used to further examine food security, adaptive strategies and resource use issues facing particular households. The qualitative interviews were particularly important in supplementing, enriching and corroborating results from the survey questions. Due to budgetary constraints, only households impacted by an HIV/AIDS death of a prime-age adult were interviewed. Seventeen households were interviewed in June 2006. These were conducted by the investigators, and with the assistance of an experienced fieldworker from the local community fluent in both the local language and English. The interviews ranged in length from 45 to 80 minutes and the data were fully transcribed by the translator/fieldworker.

Woodland cover

We used Normalised Difference Vegetation Index (NDVI) as an index of woodland cover around villages. Landsat 5 TM images (May 2004) were used to calculate NDVI in ERDAS Imagine. The NDVI was averaged across all 30m x 30m pixels in 1 km buffers around each village, giving a mean village NDVI value per village. It was assumed that the higher the mean NDVI value, the higher the woodland cover around the village. Although woodland cover cannot be used as a direct measure of abundance of specific resources, it is useful as an index of the general state of the local environment (Fung & Siu 2000).

Sampling design

We interviewed 290 households with the quantitative survey. A stratified random sample of households was drawn from the Agincourt HDSS database across the three mortality strata as follows: 1) HIV mortality: n=109, 2) non-HIV mortality: n=71 and 3) no mortality: n=110. The third category constituted a control stratum. This sampling frame enabled us to quantify and compare food security and resource use across these three strata. We originally intended to interview 100 households in each of the strata, based on resources available for the project. However, insufficient households met the criteria for the 'non-HIV mortality'

households. This enabled us to increase the sample size slightly for the other two strata. Households sampled from the database were located in the field using their unique identifier number on digital aerial photographs used by the Agincourt Unit in their annual census. Linking with a HDSS is a particular strength of this study, because it enabled us to a) draw a random stratified sample from a known population, b) incorporate actual cause of death, rather than AIDS proxies, and c) include other household data, such as size and socio-economic status, in our analyses.

Socio-economic status (SES) from wealth ranking was obtained for households from the Agincourt Unit's database. Wealth ranking is based on household ownership of assets (e.g. appliances) and access to services and amenities (e.g. a water tap in the yard). Household SES score is derived from principal component analysis of the wealth ranking and is a relative value. These scores are then used to classify households into SES quintiles. We did not stratify our sample by SES, since variation representative of the population and the region was expected to occur within the sample. Examination of variation by SES was undertaken during the analysis.

Data analysis

Quantitative data

Dietary diversity, experience of hunger, coping strategies and resource use variables were expressed as both ordinal and binary outcomes. As an example, inclusion of a food item (e.g. beef) in the household diet was expressed as 1) an ordinal scale of frequency (at east once in the last week, month, year, or not at all) and 2) as a binary yes/no response for each of these frequency categories individually.

We took several steps to calculate a dietary diversity score, reflecting both diversity and frequency of particular foods. First, frequency per food item was converted to a weekly fraction as follows:

1) At least once in the last 7 days (1 week): 1/1 = **1**
2) At least once in the last 30 days (30 days/7 days = 4.29 weeks): 1/4.29 = **0.23**
3) At least once in the last 12 months (365 days/7 days = 52.14 weeks): 1/52.14 = **0.02**
4) More than 12 months ago/never: **= 0**

These values were then summed for all 99 food items to give an absolute dietary diversity score out of 99, which incorporated both the range of food items eaten and the frequency of consumption. This was then converted to a *proportional dietary diversity score* by dividing the absolute value by the maximum possible value (99).

Bivariate associations were explored first between food security, adult mortality experience, woodland cover, household use of woodland resources for consumption or sale, and socio-economic status, as well as other household characteristics such as household size and composition. Statistical tests included Chi-squared test, logistic regression and one-way analysis of variance (ANOVA) with Tukey post hoc test. Multivariate models, such as multifactorial ANOVA and analysis of co-variance (ANCOVA) with Tukey post hoc test, multiple regression analysis and multivariate logistic regression analysis, were then estimated to predict food security as a function of adult mortality experience, household characteristics, resources use, and environmental context simultaneously. These models allowed a more nuanced understanding of the interactions of the many factors shaping household food security.

Qualitative data

The interview data were transcribed and the resulting narrative data analyzed separately by two individuals, including the interviewer. Two thorough readings of the complete transcripts were undertaken, the first guided by our project research questions. This initial reading was intended to familiarize the analysts with the data and to identify themes for coding. The second read was undertaken to verify all data relevant to these themes had been identified and to allow additional themes or sub-themes to emerge. Although some themes were pre-determined by our research questions (e.g. use of wild resources), others were emergent (e.g. centrality of gender of deceased in shaping household mortality impacts).

Ethical considerations

The research project was closely linked to the Agincourt HDSS which is covered by a generic clearance certificate, M960720. However, ethics clearance was obtained for this specific study (certificate number M060459) from the research committee on human subjects (medical) of the University of the Witwatersrand. Verbal consent, as opposed to written, was obtained from respondents because of the high level of illiteracy among respondents, especially the aged. The Agincourt Unit has been conducting household surveys every year since 1992 – hence residents of the study communities are familiar with giving verbal consent. A subject information sheet explaining the project and the respondents' rights was read to the respondent, and verbal consent requested. If consent was given, the field worker signed against the name of the respondent on a log sheet, to record the consent. The respondents were under no obligation to participate in the study. The consent process was applied in both the quantitative and qualitative research components of this project.

The identity of individuals or households sampled in this study was kept confidential, as was their health status or the probable cause of death of particular individuals. Sensitivity was shown around questions relating to a deceased household member and to issues relating to household poverty and hunger. As is standard practice within the Agincourt Unit, any households encountered in the study sample which were clearly in dire situations (e.g. orphans, destitute) were referred to the unit's LINC Office, who reports the household's situation to local social service providers.

RESULTS

Structure of the results section

Presentation of results is structured as follows: First, we describe the general characteristics of the study households within the three mortality strata. We then explore the associations between household food security and recent experience of an adult mortality, followed by an analysis of associations between mortality and household use of natural resources. The next section assesses whether use of natural resources had a discernable influence on household food security. Then, focusing specifically on HIV-impacted households, we analyze the simultaneous influences of household characteristics, use of key natural resources, and woodland cover, on food security. Finally, we investigate the multivariate relationships between adult mortality, households characteristics, food security, use of key resources, and woodland cover. Explanations and implications of observed relationships are explored in the discussion section.

Household characteristics

Mean household size (permanent members) did not differ significantly between the three mortality strata, while socio-economic status (SES) did (Table 1). Households with a non-HIV adult death were significantly wealthier, on average, than either HIV-impacted households or 'no mortality' households. This was true before the focal adult death (2003) as well as after (2005). However, while mean SES declined slightly for households with a non-HIV death during the intervening period, it remained static for HIV-impacted households and increased slightly over the same period for households with no death (Table 1). Most households impacted by a non-HIV death were in the two wealthiest SES quintiles. HIV-impacted households were more uniformly distributed across quintiles, although slightly more were in the poorest quintile than in the others, and the wealthiest quintile had the lowest

number of households (Figure 1). The majority of households with no mortality had a low or intermediate SES, although few were in the poorest category. The odds of a household experiencing an HIV adult death decreased with increasing SES (Odds ratio (OR)=0.81, $p<0.05$), while the converse was true for households experiencing a non-HIV adult death (OR=1.43, $p<0.01$). Household members participated in, or were members of, an average total of roughly three social groups, clubs or organizations (Table 1). There was no significant difference across strata. Membership in social groups increased with household size ($r=0.20$, $R^2=0.04$, $p<0.001$) and SES score ($r=0.33$, $R^2=0.11$, $p<0.001$). Neither time since the death, nor the total number of deaths over the last two years differed between the two mortality strata.

Table 1. Mean household characteristics (standard deviation in brackets). Values which do not share a common superscript letter are significantly different ($p<0.05$ in bold italics).

Variable	HIV Death	Non-HIV Death	No Death
Household size	5.0 (3.2) [a]	5.5 (2.9) [a]	4.5 (2.4) [a]
Socio-economic status score: 2003	***-0.24 (2.38)*** [a]	***1.09 (2.16)*** [b]	***0.04 (2.20)*** [a]
Socio-economic status score: 2005	***-0.24 (2.17)*** [a]	***0.91 (2.12)*** [b]	***0.14 (1.88)*** [a]
Membership of social groups	2.9 (1.8) [a]	3.3 (1.7) [a]	3.1 (1.8) [a]
Time since death (months)	18.5 (6.6) [a]	18.9 (5.2) [a]	-
Total deaths over sample period	1.7(1.0) [a]	1.5 (0.6) [a]	-

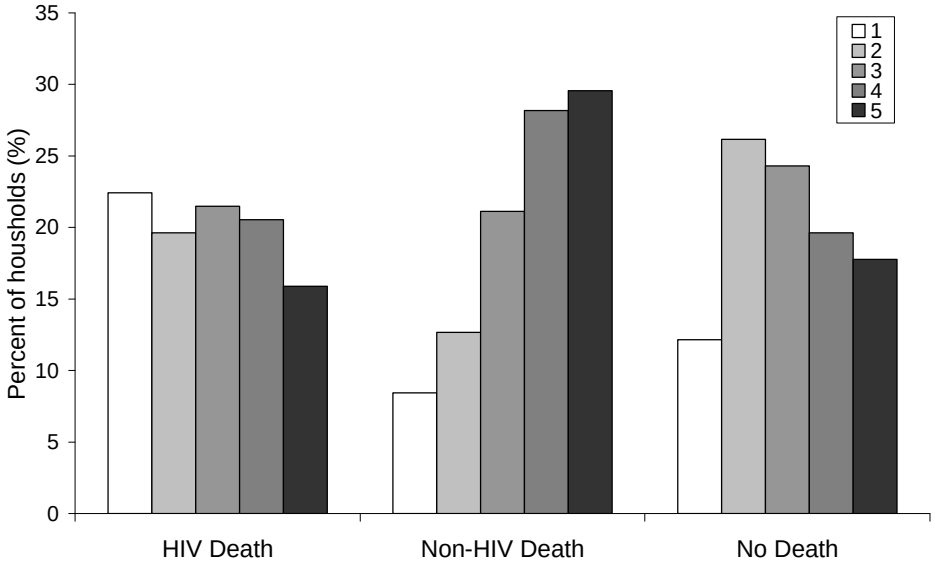

Figure 1. Frequency profile of household socio-economic status quintiles (1 = poorest, 5 = wealthiest) in 2005, differentiated by mortality experience.

The impact of adult mortality on household food security

Dietary diversity

Households experiencing an HIV mortality had a significantly less diverse diet than those with no recent death, on average (Table 2). There was no difference between mean dietary diversity for 'non-HIV death' households and the other two mortality strata. The lower diversity in the diets of HIV-impacted households was most pronounced for cereals, fruit, and wild vegetables. However, number of food items eaten by the household in the last month and year, as well as proportional dietary diversity score, were also all positively related to household SES (Table 3). Thus, when SES quintile was added as an independent variable to the dietary diversity multi-factorial ANOVA models, the influence of experience of HIV mortality was no longer significant for mean number of food items eaten weekly or for mean proportional dietary diversity score ($p=0.069$ in both cases), while SES was ($p<0.05$ and $p<0.001$ respectively). However, mean number of food items eaten in a year *was* still significantly lower in HIV-impacted households than in 'no death' households ($p<0.05$) even when controlling for SES ($p<0.005$). None of the dietary diversity indices were correlated with household size. There were particular foods that were no longer eaten by some households specifically because their breadwinner had passed away. The impact of the loss of a breadwinner, relative to poverty in general, was most pronounced in the case of households no longer eating butter/margarine, and to a lesser extent, cheese and rice (Figure 2).

Table 2. Summary of mean dietary diversity measures (standard deviation in brackets). Means which do not share a common superscript letter are significantly different ($p<0.05$ in bold italics).

Dietary diversity measure	HIV Death	Non-HIV Death	No Death
Food items eaten in the last week	***21.9 (7.9)*** ^{a}	24.2 (7.8) ^{ab}	***24.9 (8.9)*** ^{b}
Food items eaten in the last month	33.2 (9.3) ^{a}	35.7 (8.8) ^{a}	36.1 (9.8) ^{a}
Food items eaten in the last year	***57.9 (10.4)*** ^{a}	61.7 (9.3) ^{ab}	***61.5 (10.5)*** ^{b}
Proportional dietary diversity score	***0.25 (0.08)*** ^{a}	0.28 (0.08) ^{ab}	***0.28 (0.09)*** ^{b}

Table 3. Regression equations for significant associations between dietary diversity and socio-economic status (SES).

Equation	p value	beta	R^2
Food items eaten in the last month = 34.60 + 1.59*2005 SES score	<0.001	0.35	0.12
Food items eaten in the last year = 59.93 + 1.35*2005 SES score	<0.001	0.27	0.08
Proportional dietary diversity score = 0.27 + 0.01*2005 SES score	<0.001	0.35	0.13

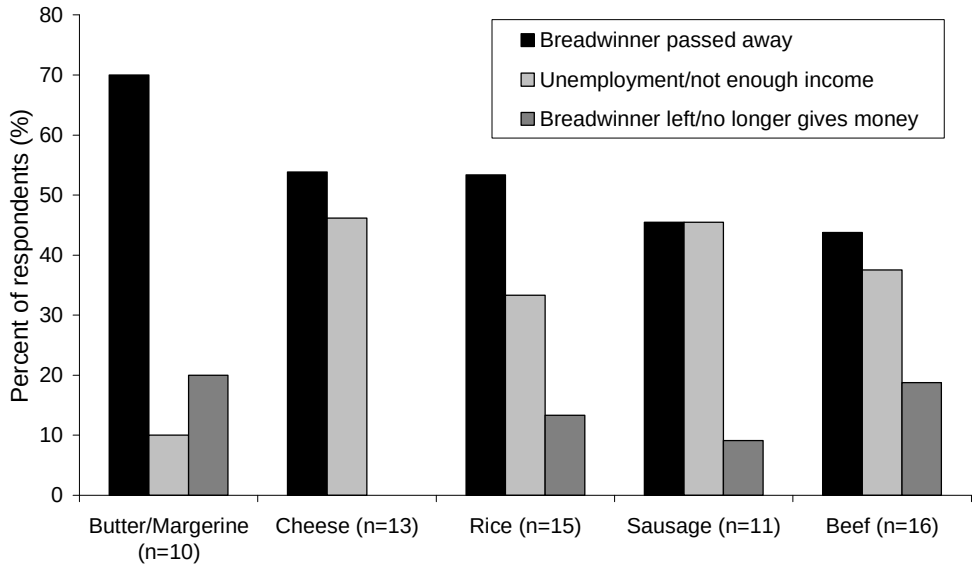

Figure 2. Reasons given for foods no longer being eaten, expressed as percent of respondents per reason per food item no longer eaten.

Experience of hunger

A total of 26% of all households surveyed had experienced severe food shortage (worried about food, run out of food *and* went hungry) in the last 30 days. A greater proportion of mortality-impacted households had either worried about food, run out of food, gone hungry, or had all three experiences (i.e. had severe experience of hunger) in the last 30 days, when compared to non-mortality households. However all four measures of experience of hunger were more prevalent in households with a *non*-HIV death than in HIV-impacted households (Figure 3). In the cases of worrying or running out of food, only households with a non-HIV death were significantly more likely to experience hunger than households with no adult mortality (Table 4). However, households experiencing either HIV or non-HIV mortality were more likely to go hungry and have all three experiences of hunger than households with no adult mortality.

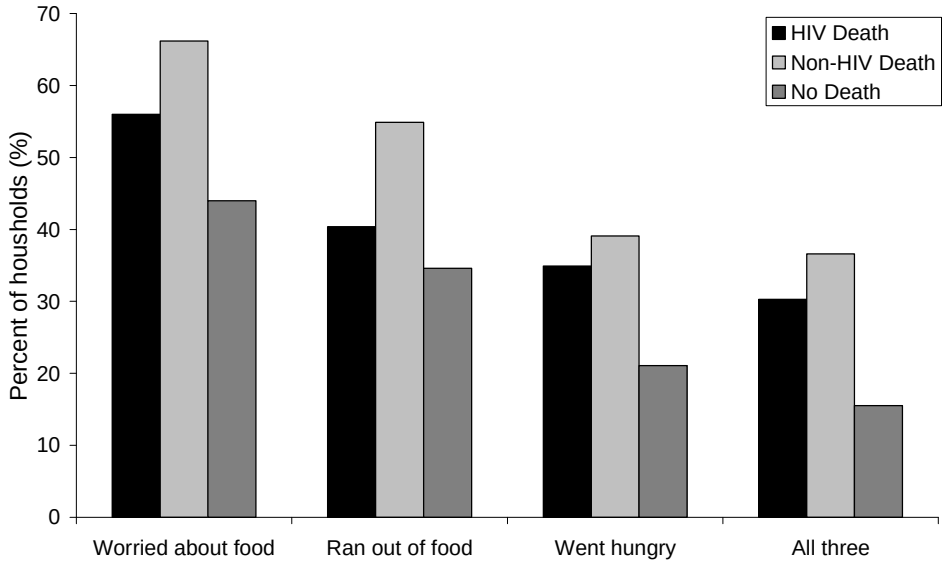

Figure 3. Relative frequency of types of household experience of hunger in the last 30 days across mortality strata.

The likelihood of a household experiencing any of the indicators of experience of hunger was lesser among those households with higher SES. However, the influence of mortality on household experience of hunger summarized in Table 4 changed little when SES was controlled for in the logistic regression models. The only exceptions were that 'non-HIV death' households became significantly more likely than 'HIV death' households to run out of food (OR=2.33, $p<0.05$) and the likelihood of going hungry was no longer significantly lower for a household with no death than for an HIV-impacted household (OR=0.57, $p=0.072$).

Although the number of months since the passing of the deceased had no significant impact on experience of hunger, the total number of deaths experienced by the household over the sample period did. Households with greater numbers of deaths were more likely to have worried about food in the last 30 days (OR=1.27, $p<0.05$). However, this relationship was no longer significant when controlling for SES.

Table 4. Comparison of the likelihood of a household experiencing hunger in the last 30 days. 'Ref' is the reference category with which the other two were compared. Values are odds ratios: >1 indicates an increase in likelihood and <1 indicates a decrease in likelihood compared to the reference category ($p<0.05$ in bold italics).

Experience of hunger	HIV Death	Non-HIV Death	No Death
Worried about food	Ref	1.54	0.62
	0.65	Ref	***0.40***
Ran out of food	Ref	1.80	0.78
	0.56	Ref	***0.43***
Went hungry	Ref	1.20	***0.50***
	0.83	Ref	***0.42***
All three experiences	Ref	1.33	***0.42***
	0.75	Ref	***0.32***

Coping strategies

Of the 290 households surveyed, 13% had engaged in all three coping strategies related to food shortages (eaten foods they did not enjoy, asked neighbors for food, *and* skipped meals for a day) at least once in the last seven days. Greater proportions of mortality-impacted households had engaged in coping strategies than households with no mortality (Figure 4). However, as in the case with experience of hunger, these were more common among households with a *non*-HIV death than those with an HIV death, although slightly more HIV-impacted households had engaged in *all three strategies* in the last seven days. Households impacted by a non-HIV mortality were significantly more likely to eat foods they did not enjoy or skip meals for a day than those not impacted by an adult death (Table 5). HIV-impacted households were also more likely skip meals for a day. The odds of asking a neighbor for food or engaging in all three strategies did not differ significantly between any of the strata.

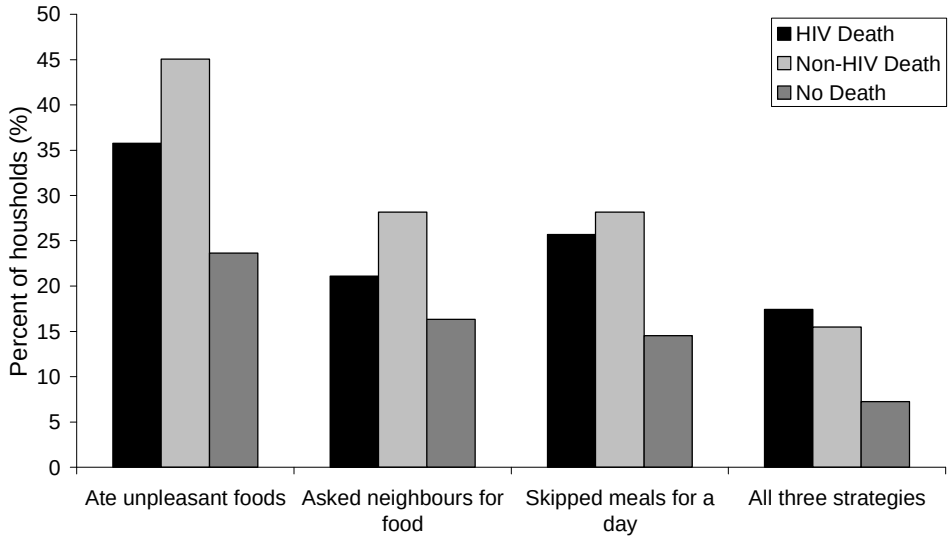

Figure 4. Relative frequency of coping strategies used by households in the last seven days due to food shortages across mortality strata.

Skipping meals for a day and engaging in all three coping strategies were negatively related to SES. Hence, when including SES in the logistic regression models, HIV-impacted households were no longer significantly more likely to skip meals than households with no death. However, households in both the HIV and non-HIV mortality strata were close to being significantly more likely than households with no death to engage in *all three strategies* ($p=0.53$ and $p=0.51$ respectively).

The time since the adult death did not have an effect on the coping strategies pursued by households. However, households with greater numbers of recent deaths were more likely to eat foods they did not enjoy ($OR=1.33$, $p<0.05$). This relationship still held after controlling for SES.

Table 5. Comparison of the likelihood of a household engaging in coping strategies relating to food shortages in the last seven days. "Ref" is the reference category with which the other two were compared. Values are odds ratios: >1 indicates an increase in likelihood and <1 indicates a decrease in likelihood compared to the reference category ($p<0.05$ in bold italics).

Experience of hunger	HIV Death	Non-HIV Death	No Death
Ate unpleasant foods	Ref	1.47	0.56
	0.68	Ref	***0.38***
Asked neighbours for food	Ref	1.47	0.73
	0.68	Ref	0.50
Skipped meals for a day	Ref	1.13	***0.49***
	0.88	Ref	***0.43***
All three strategies	Ref	0.87	0.37
	1.15	Ref	0.43

Contribution of the deceased to household food provisioning

The mechanisms behind the observed associations between household experience of an adult death and food insecurity are hinted at through investigation of the deceased's previous role in the household economy, with relevance to food security (Table 6). In the majority of mortality-impacted households, the deceased had contributed income and/or contributed to food production by tending food gardens and/or fields. Conversely, the deceased had also collected natural resources (including wild foods) in a greater proportion of HIV-impacted households. This is explored further in the discussion

Table 6. The role that the deceased had played in the household economy, with relevance to food security, expressed as percent (%) of households in which the deceased had played the given role.

Role of deceased	HIV Death	Non-HIV Death
Contributed income	59.6	70.8
Tended food gardens and/or fields	59.6	64.6
Collected natural resources	51.9	46.2

Associations between adult mortality & household use of woodland resources

Use of wild natural resources as a source of food, cooking energy and medicine

Indigenous wild vegetables, fruit and insects were part of the diet of the vast majority of households, with no statistically significant differences in prevalence of use between mortality strata (Figure 5). Wild birds, fish and mammals were much less commonly used. Although fuelwood was the dominant energy source for cooking across all three mortality strata, a higher percentage of HIV-impacted households (93%) used fuelwood than households experiencing a non-HIV mortality (85%) or no mortality (83%). Nevertheless, this difference was not significant at the 95% level. Interestingly, there was no significant difference in relative frequency of households using traditional medicine across the three strata

Most households used wild vegetables and wild fruit more than once a week (when in season), but relatively fewer HIV-impacted households (74%) made frequent use of wild vegetables than households with a non-HIV death (85%) or no death (89%) (Figure 6). A 'no death' household was thus significantly more likely to make frequent use of wild vegetables than an HIV-impacted household (OR=2.82, $p<0.05$). This remained true when controlling for SES (which decreased the odds of a household using wild vegetables often) and household size (which increased the odds). Neither the time since the death of the adult member nor the total number of deaths experienced by the households influenced the likelihood of a mortality-impacted household using wild foods.

Despite being less likely to make frequent use of wild vegetables, both types of mortality-impacted households were more likely than 'no death' households to have eaten greater quantities of wild vegetables in the last twelve months than in the past (HIV death to no death: OR = 0.11, $p<0.005$; non-HIV death to no death: OR = 0.13, $p<0.005$). These patterns persisted when controlling for SES and household size. Approximately 30% of households in both mortality strata indicated that they relied more on wild vegetables after the passing of their adult member than before. Of the eleven households which indicated that they had started eating foods in the last twelve months which they had not previously eaten, all were households which had experienced a recent adult death (HIV=6, non-HIV=5), and all had started eating wild vegetables. Woodland cover, indexed by mean normalised difference vegetation index (NDVI) in a 1 km buffer around each village, had no influence with whether households used any given natural resource.

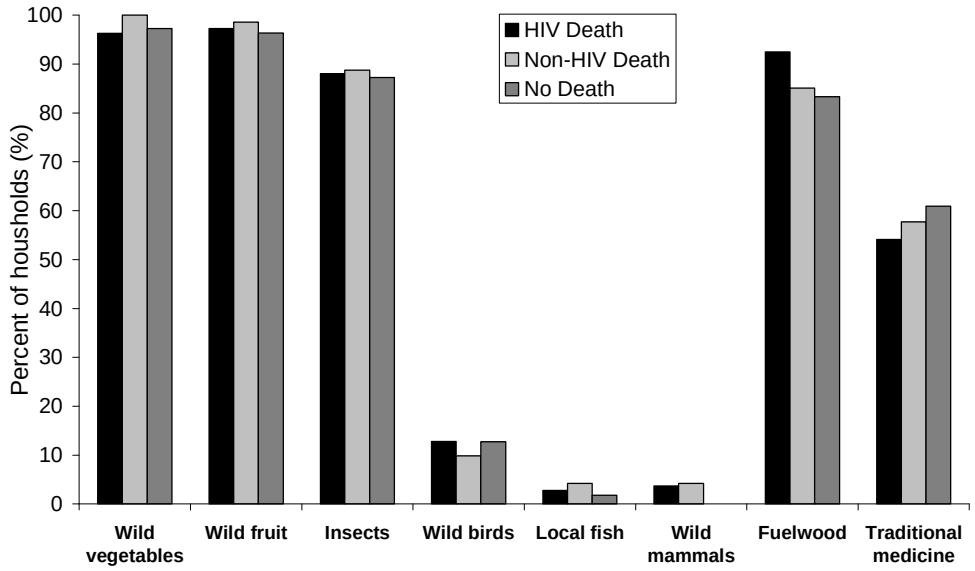

Figure 5. Prevalence of the use of wild foods, fuelwood and traditional medicine across mortality strata.

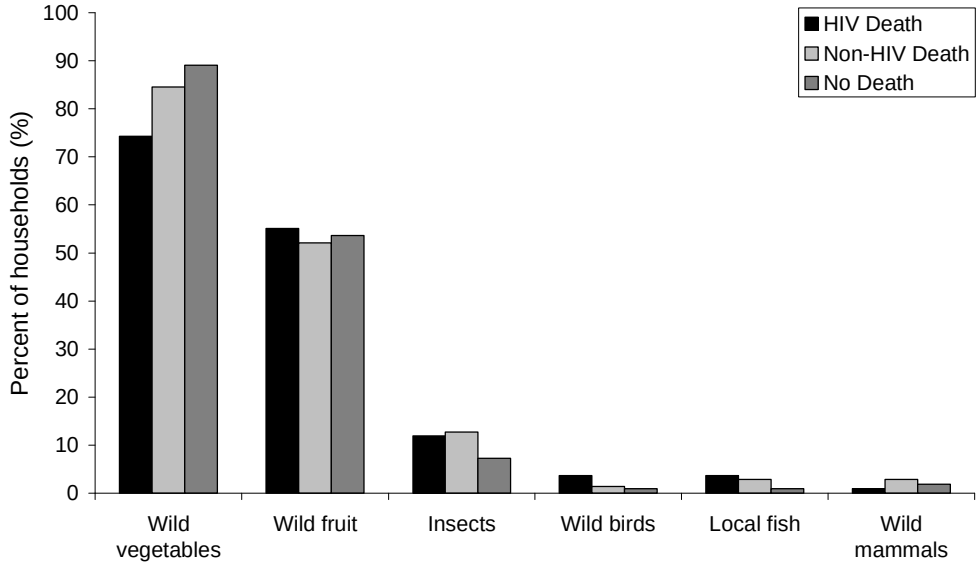

Figure 6. Prevalence across mortality strata of the use of wild foods more than once a week.

Use of wild natural resources to save money

For a total of 13 wild natural resources, significantly more mortality-impacted households indicated that they used the resource specifically to save money as compared to those with no adult death (Figure 7). At least one of the resources was used by 32% and 38% of HIV and non-HIV-impacted households respectively, to save money, compared to only 6% of 'no death' households. The resources most widely used for cost savings were grass hand brooms, fuelwood and wild vegetables. For all resources except traditional medicine and

marula beer, slightly more 'non-HIV death' households than 'HIV death' households used the resource for cash savings. Only households with a non-HIV death were significantly more likely than 'no death' households to use wooden carvings or local fish ($p<0.05$). The odds of a household affected by a non-HIV death using a resource was only significantly higher than that for an HIV-impacted household for grass baskets. These associations still held when controlling for woodland cover (mean NDVI), and the likelihood of any household using at least one of these resources to save money increased with woodland cover.

Households were more likely to use at least one type of resources to save money if they had a higher SES (OR=1.28, $p<0.05$) or had more permanent members (OR=1.10, $p<0.05$). When controlling for these two confounding factors, mortality-impacted households were still more likely than 'no death' households to use at least one type of resource to save money (HIV death to no death: OR=0.12, $p<0.001$; non-HIV to no death: OR=0.11, $p<0.05$). Households in which more time had past since the adult mortality were more likely to use wild fruit (OR=1.10, $p<0.05$), insects (OR=1.10, $p<0.05$), carvings (OR=1.15, $p<0.05$) and reed mats (OR=1.09, $p<0.05$) to save money.

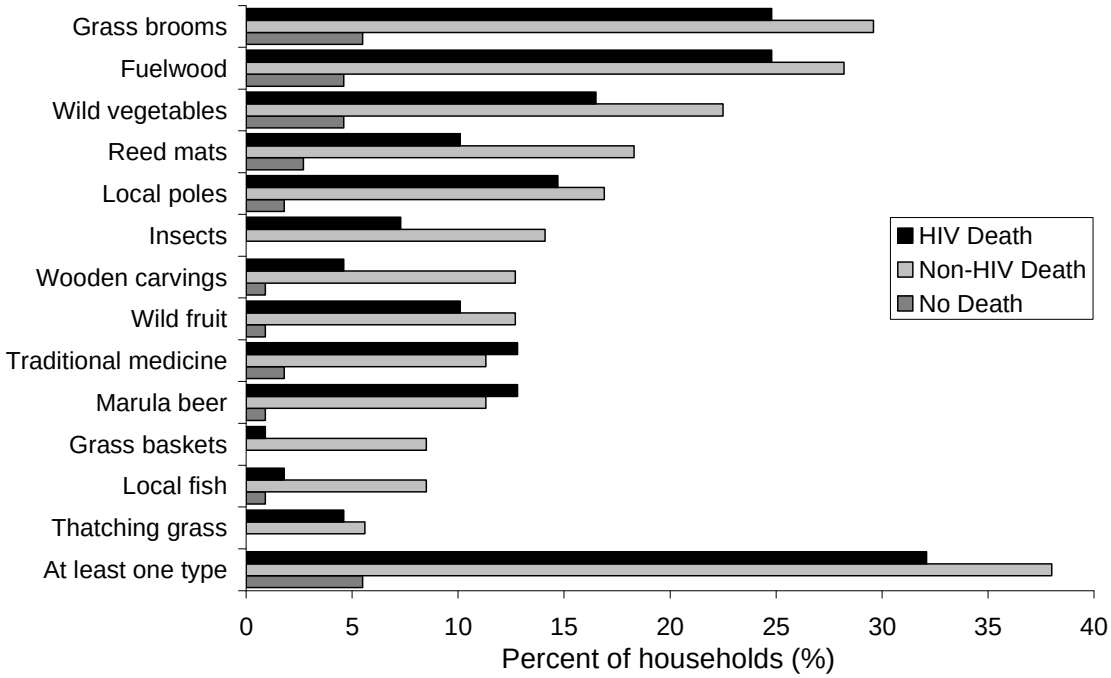

Figure 7. Prevalence of the use of wild natural resources specifically to save money (only those resources for which there was significant variation between mortality strata).

Use of wild natural resources to earn money

Few households (14) sold natural resources, but of those that did, 86% (12) were mortality-impacted households, most of which (7) had experienced a non-HIV mortality. Resources

sold included reed mats, marula beer, and fuelwood. Because of the low incidence, none of the logistic regression models were significant, although the pattern is interesting.

Does using wild natural resources improve food security?

All four measures of dietary diversity were significantly higher in households which ate wild vegetables, wild fruit, and insects, than those which did not (Table 7). Households which ate wild birds had significantly more diverse diets in terms of proportional dietary diversity and number of food items eaten in the last week, while those eating wild mammals had a significantly more diverse diet over the past year. Consumption of fish from local dams or streams was not associated with increased dietary diversity.

Table 7. Mean dietary diversity indices (standard deviation in brackets) for those households which consumed wild foods and those which did not. Means in bold italics within a wild food group and dietary diversity variable are significantly different from each other ($p<0.05$)

Resource	Consumed by the household?	Foods items eaten in the last week	Foods items eaten in the last month	Foods items eaten in the last year	Proportional dietary diversity score
Wild vegetables	Yes	***23.7 (8.3)***	***35.1 (9.4)***	***60.6 (10.1)***	***0.27 (0.08)***
	No	***17.6 (4.8)***	***24.7 (4.2)***	***44.9 (6.1)***	***0.20 (0.04)***
Wild fruit	Yes	***23.8 (8.3)***	***35.2 (9.4)***	***60.6 (10.3)***	***0.27 (0.08)***
	No	***16.6 (5.4)***	***24.9 (6.6)***	***45.4 (6.8)***	***0.19 (0.05)***
Insects	Yes	***24.7 (8.3)***	***34.9 (9.4)***	***61.1 (9.9)***	***0.28 (0.08)***
	No	***15.9 (4.8)***	***27.6 (7.2)***	***53.2 (10.6)***	***0.19 (0.05)***
Wild birds	Yes	***27.0 (8.3)***	36.5 (9.7)	67.4 (10.3)	***0.30 (0.09)***
	No	***23.2 (8.2)***	34.7 (9.4)	59.2 (9.9)	***0.27 (0.08)***
Wild mammals	Yes	22.0 (4.3)	33.1 (6.8)	***68.0 (9.6)***	0.25 (0.04)
	No	23.7 (8.4)	34.9 (9.5)	***60.0 (10.2)***	0.27 (0.09)

The likelihood of a household having run out of food or having had severe experience of hunger (worried about food, ran out of food, *and* went hungry) in the last 30 days was lower if they used edible insects (Table 8). However, households were more likely to have worried about food if they used fuelwood for cooking or natural resources to save money. For

mortality impacted households, there was a strong association between using natural resources to save money and the death of the adult member having had a negative impact on the amount of food the household ate. Mortality-impacted households which relied more on wild vegetables after the passing of an adult member were substantially more likely to have had all three experiences of hunger.

Table 8. Significant bivariate associations between household experience of hunger and use of natural resources. Values are odds ratios: >1 indicates an increase in likelihood, <1 indicates a decrease in likelihood ($p<0.05$).

Resource use	Worried about food	Ran out of food	Worried, ran out AND went hungry	Mortality impacted on amount of food
Use insects	-	0.35	0.42	-
Use fuelwood	2.53	2.58	4.03	-
Use resources to save money	2.47	-	-	3.39
Rely more on wild veg. after mortality	-	-	5.45	-

Multivariate determinants of food security among HIV-impacted households

In order to assess if otherwise-similar HIV-impacted households are more food secure if they make use of natural resources and live in villages with better woodland cover, we analyzed food security among HIV-impacted households in relation to use of wild vegetables, wild fruit, and insects, use of natural resources to save money, sale of natural resources, and mean NDVI around their village, controlling for SES and household size, in multivariate models. With regard to dietary diversity, higher weekly, monthly and proportional dietary diversity scores were associated with higher SES, while dietary diversity over 12 months was positively associated with household size (Table 9). All four dietary diversity measures were positively associated with household use of wild fruit and insects, and household using wild vegetables also generally had higher dietary diversity scores for the year. Households using resources to save money had generally eaten a greater number of food items in the last month. Neither woodland cover (mean NDVI) nor using resources to earn money influenced dietary diversity. None of the models for experience of hunger or coping strategy for HIV-impacted households were significant, except that households were less likely to have skipped meals for an entire day in the last week with increasing SES (OR=0.79, $p<0.005$).

Table 9. Results of the multivariate regression models for the four dietary diversity indices among HIV-impacted households (n=109). Values for independent variables are beta coefficients (p<0.05 in bold italics).

Variable	Foods items eaten in the last week	Foods items eaten in the last month	Foods items eaten in the last year	Proportional dietary diversity score
Model	F=3.95 R^2=0.24, p<0.001	F=4.58, R^2=0.27, p<0.001	F=6.02, R^2=0.33, p<0.001	F=4.32, R^2=0.26, p<0.001
SES	***0.20***	***0.21***	0.09	***0.21***
Household size	0.17	0.14	***0.17***	0.16
Use wild vegetables	0.12	0.13	***0.29***	0.13
Use wild fruit	***0.24***	***0.27***	***0.31***	***0.26***
Use insects	***0.30***	***0.25***	***0.36***	***0.30***
Use to save money	0.02	***0.24***	0.09	0.09
Use to earn money	0.11	0.03	-0.01	0.09
Mean NDVI	-0.04	-0.07	-0.04	-0.05

The intersection between HIV mortality, poverty, resource use, woodland cover and food security

Our final set of analyses examine how the death of a prime-age adult due to HIV/AIDS, along with poverty, resource use and environmental context, simultaneously shape household vulnerability to food insecurity when controlling for household size. HIV-impacted households continued to have significantly lower dietary diversity than 'no death' households when factoring in the other variables (Table 10). They did not have lower dietary diversity scores than those households which experienced a non-HIV death, except for the number of food items eaten over the last year. Poorer households (low SES) had significantly lower dietary diversity than wealthier households for all measures of dietary diversity. The use of wild vegetables and insects was associated with higher dietary diversity. In addition, the number of food items eaten in the last month and year was higher in households which used wild vegetables. Dietary diversity over the last month was also higher in households which used natural resources to save money. Neither woodland cover (mean NDVI) nor using resources for income generation influenced household dietary diversity.

The only mortality-related association with experience of hunger was the odds of having simultaneously worried about food, run out of food *and* gone hungry in the last 30 days. Households with no mortality were less likely than HIV-impacted households to have had multiple experiences of hunger (Table 11). Wealthier households were less likely to have worried about food or gone hungry in the last 30 days. Households which used wild vegetables and insects were less likely to run out of food, but slightly more likely to run out if there was good woodland cover around their village. Households which used insects were also less likely to have had all three experiences of hunger. Experience of an adult mortality had no significant effect on household coping strategies in the multivariate models. The only model with any significant independent variables predicted a significant decrease in the likelihood of a household skipping meals for a day with increasing SES (OR=0.63, p<0.001).

Table 10. Results of the analysis of covariance (ANCOVA) models for dietary diversity indices across mortality strata. Adjusted means for mortality strata with common superscripts are not significantly different from each other (p<0.05 in bold italics). Values for independent variables are beta coefficients (p<0.05 in bold italics).

Variable	Foods items eaten in the last week	Foods items eaten in the last month	Foods items eaten in the last year	Proportional dietary diversity score
Model	F=9.26, R^2=0.25, p<0.001	F=9.47, R^2=0.26, p<0.001	F=8.63, R^2=0.24, p<0.001	F=9.73 R^2=0.26, p<0.001
Mortality strata	***F=3.21***	***F=4.38***	***F=2.99***	***F=3.78***
	HIV Death [a]	***HIV Death*** [a]	***HIV Death*** [a]	***HIV Death*** [a]
	Non-HIV Death [ab]	Non-HIV Death [ab]	***Non-HIV Death*** [b]	Non-HIV Death [ab]
	No Death [b]	***No Death*** [b]	***No Death*** [b]	***No Death*** [b]
SES	***0.27***	***0.27***	***0.18***	***0.28***
Household size	0.04	0.061	0.11	0.05
Use wild vegetables	0.08	***0.11***	***0.19***	0.10
Use wild fruit	***0.12***	***0.17***	***0.21***	***0.14***
Use insects	***0.31***	***0.26***	***0.24***	***0.30***
Use to save money	0.02	***0.14***	0.01	0.05
Use to earn money	0.02	0.02	-0.01	0.02
Mean NDVI	0.04	-0.04	0.04	0.02

Table 11. Results of statistically significant multivariate logistic regression models comparing experience of hunger for HIV-impacted households to households with a non-HIV death or no death. Values are odds ratios: >1 indicates an increase in likelihood, <1 indicates a decrease in likelihood ($p<0.05$ in bold italics).

Variable	Worried about food	Ran out of food	Went hungry	All three
Model	LR chi^2=29.09, $p<0.005$	LR chi^2=36.64, $p<0.001$	LR chi^2=19.60, $p<0.05$	LR chi^2=19.60, $p<0.05$
Non-HIV death	1.83	2.29	1.48	1.62
No death	0.78	0.87	0.58	***0.46***
SES	***0.80***	0.77	***0.75***	0.80
Household size	1.02	1.00	1.01	1.02
Use wild vegetables	Dropped by model	***0.26***	0.92	0.78
Use wild fruit	2.03	2.55	1.31	0.87
Use insects	0.53	***0.33***	0.61	***0.43***
Use to save money	1.71	1.05	1.15	0.92
Use to earn money	3.43	2.99	1.51	1.40
Mean NDVI	1.04	***1.05***	1.02	1.02

DISCUSSION

This project was designed to respond to three central research questions relating to the relationships between HIV/AIDS mortality, household food security, and use of woodland resources (refer to introduction). Our findings are discussed in detail below, especially in relation to these questions. On the whole, the study suggests that mortality-impacted households are less food secure than non-mortality households. However, HIV/AIDS-related mortality does not appear to necessarily represent a unique form of impact. Within our examination, HIV-impacted households were indeed worse off in terms of dietary diversity, but non-HIV death households were generally worse off in terms of broader experience of hunger and coping strategies they had to employ in the face of food shortages. Although use of wild foods contributed to better dietary diversity, and hence, to nutrition in mortality-impacted households, this did not necessarily translate into better food security in terms of having sufficient food. A key benefit from the use of woodland resource was cost savings, and this was a strategy widely practiced by mortality-impacted households. Importantly, we

find that socio-economic status was a central determinant of food security, often overriding any relationships between mortality experience, resource use and food security.

In our study population, HIV/AIDS mortality was associated with poverty, albeit it rather weekly. This finding concurs with the widely held view that AIDS and poverty are related (Whiteside 2000). This has been contested more recently, with some studies showing that it is the wealthy, being more mobile, who are at greater risk of infection (Shelton *et al*. 2005). However, since wealth and HIV prevalence are higher in urban areas (Shelton *et al*. 2005)), this may be less pertinent to our study of a poor rural population. In contrast to the conventional view that HIV/AIDS systematically erodes household capital and causes poverty (Whiteside 2000; Masanajala 2007), we found that household socio-economic status had not changed among those impacted by an HIV/AIDS-related mortality. That is not to say that such households were not worse off financially after the death, but in terms of household assets, wealth had not been visibly eroded by the mortality. It is also possible that two years was not a long enough period after the mortality to observe the impacts of a long-wave phenomenon like HIV/AIDS on the household asset base. Nevertheless, it is interesting that households impacted by a *non*-HIV adult death, which were generally wealthier households, *did* experience a decline in wealth subsequent to the death. This may reflect the fact that in such households, the deceased was more likely to have been a breadwinner than in HIV-impacted households. Also, for these wealthier households impacted by an non-HIV adult death, decline in SES may actually reflect a cutting back of luxury items or assets. By contrast, poor households impacted by the death of an adult member may already be coping with a limited number of assets, with relatively few to liquidate in times of hardship. The confounding effect of the socio-economic differentiation between households impacted by an HIV death and those impacts by a quick non-HIV death had to be controlled for in our analyses.

While mortality impacts on household food security were observed, it was SES, rather than the mortality *per se*, that was often the underlying determinant. In the case of dietary diversity, only long-term dietary diversity (over the course of a year) was lower in HIV-impacted households than in 'no-mortality' households, when controlling for SES. The lack of evidence of an impact of an HIV death on short-term dietary diversity (e.g. in the last week) concurs with findings by Kaschula (2008) in her study in Kwazulu-Natal, South Africa. However, our results clearly showed that there were certain food items that were dropped from the household diet specifically after a breadwinner had passed away. Adult mortality impacted negatively on household food sufficiency even when controlling for SES. This is in agreement with Kaschula (2008), who found lower food quantity security scores in AIDS-

afflicted households. However, we showed that this impact was not unique to households where the cause of death had been HIV/AIDS-related. If anything, it was households impacted by a non-HIV death that were slightly more likely to experience food shortages. We also found that SES often weakened these mortality - food security associations. We found similar patterns with regard to coping strategies.

The impact of mortality on food sufficiency and household responses to food shortages thus appears to be slightly more severe in households afflicted by a quick *non*-HIV adult death. There are a number for possible explanations for this. Firstly, the deceased was more likely to have been be a breadwinner in wealthier households impacted by a non-HIV death. Their loss would have impacted severely on the household's ability to buy food. A common household response to the increased financial burden associated with the illness and then death of a household member due to HIV is to reduce expenditure on food (Gillespie & Kadiyala 2005). The impact of the death on household food security, especially in terms of having sufficient food, would therefore be expected to be greater among such households which are more reliant on cash for purchasing food. A second possibility is that households afflicted by an HIV death had time during the period of illness to adapt, finding other ways of meeting their food needs such as by relying on social networks or engaging in additional economic activities to supplement the household income. By contrast, those impacted by a sudden non-HIV death were thrust into a state of crisis unexpectedly. In fact, the observed decline in asset status and increased prevalence of coping strategies in response to food shortages among these households may well point to a process of readjustment which may have already happened in the HIV-impacted households before the mortality. That is not to say that HIV-impacted households have necessarily recovered or coped better. HIV-impacted households which are in distress often respond by adopting unsustainable livelihood strategies, indicating that they are in fact not coping in the longer term (Loevinsohn & Gillespie 2003; Masanjala 2007).

Regarding the relationship between household mortality experience and use of woodland resources, our findings point to the centrality of wild foods, especially wild vegetables, fruit and insects, in the local diet. This accounts for the lack of any discernable difference in the prevalence in use of these resources between the mortality strata. However, households which had experienced an HIV death tended to use wild vegetables less frequently. This is probably due to the higher likelihood that the deceased had been a resource collector in such households. Reduced resource collection due to loss of human capital in households characterized by AIDS proxies was also observed by Kaschula (2008). Nevertheless, some mortality-impacted households (regardless of cause of death) became more reliant on wild

vegetables after the passing of the adult member than they had been before, and in some cases, added this as a new item to the household diet. Human resources were less limited in such households. Better woodland cover was not associated with greater use of natural resources. As noted in the methods section, woodland cover is not a reliable proxy of resource abundance, especially for resources such as wild herbs. It also cannot be used as a direct measure of resource availability around the village, as this is also influenced by factors such as institutional regulation of resource use. Nevertheless, our results suggest that domestic resources use is not strongly influenced by the condition of the local natural environment. That being said, households living in villages with poor vegetation cover may have to invest more time in securing some resources, such as wild fruit or firewood (Kirkland *et al*. 2007)

Our finding of a very strong association between mortality experience and use of natural resources specifically to save money is important. It points to the 'safety net' function that natural resources can play in rural livelihoods in times of crisis, in addition to meeting basic needs (Shackleton & Shackleton 2004). The use of resources for cost savings was far more prevalent than using natural resources to generate income. That being said, it is difficult to discern the extent to which this contributed to economic resilience and improved livelihood, given the cross-sectional nature of the study. Once again, we did not find a unique HIV/AIDS effect. The sudden loss of income due to the death of a breadwinner, which was more common among households which had a non-HIV/AIDS death, may account for the generally greater prevalence of this cost-savings livelihood strategy among such households. This use of resources appeared to be a response to worrying about having enough food, suggesting a short term coping response. However, the likelihood of using woodland resources to save money also increased with increasing time since the adult death, suggesting a longer-term adaptive strategy for many households. This is not a contradiction if worrying about food is not limited to the period soon after the death of the adult member, although this could not be assessed in this study. The positive relationship between this strategy and local woodland cover may indicate that better woodland cover is associated with greater resource abundance or opportunities to use these resources in amounts which afford real savings. This needs to be explored further.

Central to this study is the question of whether the use of natural resources translated into improved food security for vulnerable households. Among mortality-impacted households (regardless of cause of death), consumption of wild foods made a positive contribution to dietary diversity. However, only consumption of insects mitigated against actually running out of food. Wild foods, especially wild vegetables, did play a more important role in the diet

of mortality-impacted households following the death of an adult household member. However, this was not associated with increased food security in terms of experience of hunger. Based on these findings, we conclude that wild foods may be seen as an important part of dietary coping strategies of mortality-impacted households, but not necessarily as a fully supportive safety net.

Turning to the intersection between HIV mortality, resources use, woodland cover and food security, we find that households impacted by poverty and HIV mortality were less food secure compared to households with higher SES and no recent adult mortality experience. Use of wild foods, especially wild fruit and insects, and to a lesser degree, wild vegetables, helped buffer some of the impacts of the mortality on food security. Cost savings from natural resource use also made a (modest) contribution to food security (dietary diversity over the last month) even when controlling for SES. Better vegetation cover was weakly associated with a higher likelihood of running out of food. This may reflect less land under cultivation, and therefore less food production, around villages with good vegetation cover. However, it appears that *poverty* is central in shaping food insecurity – as opposed to mortality experience or environmental context – since poor households, regardless of recent adult mortality experience or woodland cover, were simililarly vulnerable. This observation as very important, and echoes the findings of other studies such as Peters *et al*. (2008) that show that much of the observed hardship associated with HIV/AIDS is essentially due to preexisting levels of poverty.

Finally, this study was cross-sectional in design, which has certain limitations. For example, we were not able to shed much light on the impact of HIV-related illness on household food security prior to the death. Also, because non-HIV mortality households were generally wealthier, they may be able to recover more quickly from the household shock, compared to HIV-impacted households, despite possibly being more severely impacted by the death in the short term. Longitudinal studies are thus needed to gain greater understanding of the longer-term dynamics between adult mortality, livelihoods, environment and food security.

POLICY RECOMMENDATIONS

Our findings demonstrate that HIV/AIDS-related mortality is not necessarily a unique household shock with regard to its impact on household food security, at least within the first two years after the death. However, HIV/AIDS is the leading cause of death among prime-age adults and therefore plays a central role in mortality trends and household vulnerability across southern Africa. Even so, we also found that regardless of the cause of the adult

death, poverty was an overriding factor determining levels of food security. Therefore, we recommend that policy and interventions aimed at enhancing food security should target vulnerable households more broadly, rather than limiting their focus to HIV/AIDS impacted households alone. Policy and programmes aimed at poverty reduction would have the greatest impact on food security, including for poor mortality-impacted households, which represent one of a range of vulnerable categories.

The results of this study highlight the centrality of the local natural environment in local diets and livelihoods more generally, as well as the potential importance of natural resources in coping strategies of impoverished, mortality-impacted households. In particular, the use of natural resources allows for cost savings and, in some cases additional income, which could translate into funds available for food. Although the use of woodland resources does not fully mitigate the impacts of poverty or adult mortality on household food security, such resources make important contributions to buffering households. The role of wild natural resources in food security should thus not be viewed in isolation of other livelihood strategies which may increase household resilience to the impacts of poverty or adult mortality. In this way, sustainable use wild natural resources must be considered as one of a number of important complementary strands in any food security strategy.

Policies and programs aimed at sustainable natural resource use and management in rural areas are certainly needed. Such policies/programs might include strengthening local resource management institutions and exploring possibilities for domestication and/or low-input intensification of production of wild foods such as wild vegetables and indigenous fruits. Socially appropriate interventions for addressing the stigma associated with using wild foods may also be necessary. Regarding resource management, the potential consequences of illegal felling of indigenous fruit trees for fuelwood is of particular concern, given the high reliance on wild fruit in the local diet.

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