

Full Length Research Paper

Effects of HIV/AIDS and drought on changing cropping patterns: A case study of Zambia

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Accepted 9 July, 2010

The HIV/AIDS pandemic and changing climate patterns in southern Africa are expected to alter cropping patterns in the region. In this research, an attempt is made to measure and compare the effects of HIV/AIDS and drought on cropping patterns using econometric models and time series data. The research focused on Zambia as a case study and used data taken from 1961 - 2007. The study's results indicated that while the effect of HIV/AIDS was statistically significant in explaining changes in cropland allocations for both cassava and maize, the effect of drought was only significant in explaining changes in cassava's cropland allocations. They showed that although the absolute effect of drought on cropping pattern changes was higher in both crops, HIV/AIDS presented a stronger explanatory power. Based on these results, it is recommended that the pursuit of drought-tolerant technologies must continue in countries depending on rain-fed agriculture technologies for their food supply. However, because of the labor supply risk posed by HIV/AIDS to agricultural production, it is important that governments develop partnerships with non-governmental organizations, corporations and foreign governments to help control its spread, reduce the prevalence rate and secure effective therapeutic solutions for infected rural populations.

Key words: HIV/AIDS, crop patterns, drought, food security, cassava, maize.

INTRODUCTION

Fourie and Schontiech (2001) estimate that Sub-Sahara Africa will lose more than 23 million of its agricultural population to HIV/AIDS between 1980 and 2020. Additionally, Gautam (2006) notes that changing climate conditions—longer and more intense droughts—will have potential adverse effects on agricultural production in the region. The combined effects of mortality and morbidity associated with the HIV/AIDS pandemic and droughts associated with climate change could exacerbate the already dire food and nutrition security problem confronting many Sub-Sahara African countries because their agricultural production is primarily subsistence in nature, rain-fed and labor-intensive.

Governments and non-governmental organizations in the region have been attempting to deal with the problems presented by HIV/AIDS and climate change for some time. For example, various policies have been implemented in Zambia, Malawi, Botswana and other southern African countries over the past two decades to

encourage the adoption of drought-tolerant crops, such as cassava, to provide insurance against famine (Prudencio and Al-Hassan, 1994; Haggblade, 2007). Significant efforts are also being pursued to curb the spread of HIV/AIDS (UNAIDS, 2008). However, the fragility of the region's economies and the radical and sustained impact of HIV/AIDS on labor supply suggest that governments and their partners need to do more if HIV/AIDS and climate change food and nutrition security crisis is to be averted. Understanding how the agricultural sector is responding to these problems over time would be helpful in guiding public policymaking and provide clear paths for effective implementation.

The overall objective of this research, then, was to measure and compare the effects of HIV/AIDS and drought on changing agricultural cropping patterns using a national time series modeling approach and Zambia as a case example. This study departs from previous studies that have used cross-sectional data to measure the

relationships between HIV/AIDS and agricultural production (Chapoto and Jayne, 2006; Foster, 1993; Hlanze et al., 2005), or climate change and food security (Gregory et al., 2005), using local or regional cross-sectional data or relatively short period panel data. The study offers a comparative measure of the relative effects of HIV/AIDS and drought on producers' responses through shifts in production resource allocations to different crops. It contributes to earlier work by showing that these factors do affect agricultural production and demand urgent, consistent and coherent efforts to ameliorate their potential adverse socio-economic impacts on Sub-Sahara Africa.

MATERIALS AND METHODS

The study area

The study focuses on Zambia as a case study evaluating the effects of HIV/AIDS and drought on changing cropping patterns. Zambia is a landlocked country in southern Africa with an estimated population of about 12.8 million in 2009, about 56% of which lives in rural areas, and over 90% of the rural population dependent on agriculture (Central Statistics Office, 2009). A number of factors make Zambia a good case study choice. For example, although Zambia's economy grew at about 5.6% between 2005 and 2008, there has been very minimum reduction in poverty because this growth was concentrated in the mineral sector while the majority of the population worked in the agricultural sector (Government of the Republic of Zambia, 2008). As a result, the Zambian government, like many others in Sub-Sahara Africa, is targeting new economic growth opportunities, and agriculture has emerged as an important focus area because of its potential to contribute to broader poverty reduction.

Zambia is also one of many Sub-Sahara African countries dealing with the devastating effect of HIV/AIDS on its labor supply and productivity. The HIV/AIDS prevalence rate among 15 - 49 year olds in Zambia is estimated to range from 14.3 to 16.4% (UNAIDS, 2008). However, the Government of the Republic of Zambia (2010) reports that less than 15% of sexually active adults know their HIV status, suggesting that the prevalence rate may be much higher than estimated. The morbidity and mortality effects of the disease on labor supply presents significant challenges for Zambia's agricultural sector, just as has been observed in other countries in the region (Economic Commission for Africa, 2006).

Another reason why Zambia is a good case study for the region is that like other Sub-Sahara African countries, more than 85% of Zambia's farmers are smallholders with average holdings of about 4 ha (Hantuba, 2002; Tembo et al., 2009) and dependent on rainfall for their production (Aregheore, 2007). Analysts show that drought conditions over the past three decades are worsening and project an exacerbation of this trend over the next three to four decades (de Wit and Stankiewicz, 2006). Understanding how HIV/AIDS and drought are influencing cropping patterns in Zambia, then, provides insights for how producers in similar countries are dealing with these challenges and offers opportunities for policymakers to ameliorate the potential adverse effects of these challenges on food security and poverty.

Data

The study used time series data from 1961 to 2007 collected from numerous secondary sources to estimate the effect of HIV/AIDS

and drought on changes in cropping patterns in Zambia. Production and commodity price data for the various crops were obtained from government publications and from Food and Agriculture Organization online database (FAOstats) while rainfall and drought data were obtained from reports published by the Zambia Meteorological Service. HIV/AIDS prevalence rates were obtained from publications by the Joint United Nations Program on HIV/AIDS (UNAIDS) over the last decade and gaps in the prevalence rates data were estimated using estimation and projection package software produced by UNAIDS and the World Health Organization (WHO).

Because of the diversity of data sources, it was necessary to restructure and redefine some variables to ensure definitional consistency and usability. For example, rainfall and drought conditions were reported by the Zambia Meteorological Service at the local and regional levels. However, given that the study was being conducted at the national level, it was necessary to develop a proxy for the national drought

condition. Sichingabula (1998) argues that when cereals consumption in a subsistence economy exceeds production in any year, it is plausible to assume that a national drought condition affecting the nation's ability to produce enough to meet its food security needs has occurred. This approach was used here to define "drought years" as any year in which cereal consumption exceeded production. Zambia's cereal production and consumption data from 1961 to 2007 were secured from the Food and Agriculture Organization's FAOStat database.

Time series data on prices are always challenging in economies experiencing significant economic policy shifts and unstable inflation over time. In Zambia (and many Sub-Sahara African countries), inflationary pressures have often resulted in currency devaluation and revaluation, creating difficulties for analysts seeking to compare prices across time. To sum up the challenges posed by these policy effects on prices and minimize their impact on the study's statistical estimates, price data were obtained from FAOStat and the numerous editions of *The Monthly*, a publication by the Zambian Central Statistical Office. Prices were aggregated and indexed using 2000 prices as the denominator, that is, 2000 = 1.

Ewers et al. (2009) observed a tendency for cropland areas in developing countries to remain unchanged even as yield increased, suggesting that cropland shifts may be influenced by factors other than yield improvements. Therefore, changes in cropping patterns in this study were measured by changes in the shares of allocated land to the different crops over time. Cropland data were obtained from FAOStat for all the major food and cash crops planted in Zambia between 1961 and 2007. Each crop's area in any year was divided by the total national cropland area in that year to estimate that crop's share of total cropland (%) in each year.

HIV/AIDS prevalence rates are collected every other year (UNAIDS, 2008), but this has only been done consistently in the last decade or so in Zambia. Therefore, annual prevalence rates from the onset of the pandemic were estimated using the UNAIDS/WHO (2007) estimation and projection package software, the standard tool used for estimating and projecting country-specific HIV/AIDS prevalence rates. Data inputs for this estimation protocol (e.g., number of people with HIV/AIDS in the country, percent of population, new infections and male-female ratio) were obtained from national and regional HIV/AIDS survey results for Zambia published by UNAIDS and by the U.S. Agency for International Development's HIV/AIDS surveillance database (<http://hivaids-surveillancedb.org/hivdb/RecordSelPage.aspx>). The statistical package STATA™ 10.1C was employed for all econometric analyses.

The summary statistics of the principal variables used in addressing the research question are presented in Table 1. This shows that while the decennial mean cropland share for cassava, cotton and oilseeds have been increasing over time, maize's decennial mean

Table 1. Mean estimate of principal variables by decades indicating trend.

Period	1961-1970	1971-1980	1981-1990	1991-2000	2001-2007	1961-2007
Cassava Share (%)	2.30	3.17	6.41	10.30	12.89	6.64
Maize Share (%)	70.58	68.14	59.25	49.46	46.48	59.57
Cotton Share (%)	0.25	1.20	4.71	4.86	7.08	3.40
Oilseeds (%)	6.07	8.66	14.97	16.43	16.15	12.22
Cassava Price Index*	0.003	0.005	0.023	1.246	3.893	0.406
Maize Price Index*	0.004	0.012	0.047	1.661	4.171	0.522
Cotton Price Index*	0.006	0.016	0.052	1.380	2.380	0.413
Groundnut Price Index*	0.007	0.022	0.070	1.948	4.125	0.600
HIV/AIDS Prevalence (%)	0.00	0.00	3.55	16.42	15.48	6.55
Drought**	0.00	0.20	0.50	0.80	1.00	0.47

Sources: FAOStats Database (www.faostat.org) for cropland shares and prices; Central Statistical Office (www.zamstats.gov.zm) for prices; USAID HIV/AIDS surveillance database (<http://hivaidssurveillance.org/hivdb/RecordSelPage.aspx>), UNAIDS (www.unaids.org) and own estimates for HIV/AIDS prevalence rates. * Nominal price index (2000 = 1)

** Dummy variable for drought $\begin{cases} 0 = \text{Cereal consumption} < \text{Production} \\ 1 = \text{Cereal consumption} > \text{Production} \end{cases}$

cropland share has been declining. For example, the mean cropland share for cassava increased from 2.3% in the first decade (1961 - 1970) to 12.9% in 2001 - 2007 compared to the mean cropland share for maize declining from 70.6 - 46.5%. Between 1961 and 2007, total cropland in Zambia increased by about 58% from approximately 1.05 million ha to about 1.66 million ha in 2007. The foregoing trends in the decennial mean cropland shares suggest that despite its historic importance in Zambia's agriculture, maize has been receiving a decreasing share of increasing total cropland. It is also instructive to note that the total share for maize and cassava decreased from 72.9% in 1961 to 59.3% in 2007, indicating an increase in the share of cash crops, such as cotton, soybeans and groundnuts. This increase in production resources to cash crops may be indicative of producers' attempts to manage food security risks by generating cash to procure food, particularly maize (Sitko, 2008). The cropland share for soybeans and groundnuts, for example, was 16.1% in 2001 - 2007 compared to only 6.1% in 1961 - 1970 while cotton's increased to 7.1 and 0.25% over the same period. The effects of inflation, devaluations and other economic forces on commodity prices are visible in the average price indices across the decades. For example, while average maize price index in the 1991 - 2000 decade was 66.1% higher than the reference period (2000), it was 317% higher in 2001 - 2007. Similarly, the cassava price index in the first decade was only 3% of the reference period's compared to almost 290% higher in 2001 - 2007.

The model

The principal model for this exercise is specified as follows:

$$y_{it} = f(P_{it}, P_{jt}, H_t, D_t, T_t, \epsilon_{it})$$

FMACROBUTTON MTPlaceRef * MERGEFORMAT (1)

where y_i is the share of land allocated to crop i with price P_i ; P_j is the price of alternative crops j where $j \neq i$; D is a dummy capturing

the drought situation ($D = 0$ if not drought year and $D = 1$ if drought year); H is the HIV/AIDS prevalence rate, measured as percent of infected adult population 15 - 49 years; T is a dummy capturing the period before and after 1990 indicating when Zambia embarked on its structural adjustment program ($T = 0$ is prior to 1990 and $T = 1$ is post 1990); and t is time. The error term associated with each crop

in each year in the model is captured by ϵ_{it} .

The research focused on two crops: maize, because it is the traditional staple food in Zambia; and cassava, because it is the dominant drought-tolerant crop, and considered less labor intensive (El-Sharkawy and Mwanza, 1993; Nweke, 2004). By theory, it is expected that share of cropland allocated to crop i will be increasing in its own price and decreasing in prices of its competitors. It is also expected that land allocated to labor-intensive crops will be decreasing in H . Given that cassava is a relatively new crop in Zambia and it has been found to be both drought-tolerant and less labor intensive than maize, it is hypothesized that cassava would be gaining cropland if indeed drought and HIV/AIDS are causing shifts in cropping pattern. However, given maize's historical role in Zambia's agricultural and socio-cultural environment (Russell, 2002; Kankolongo et al., 2009) and the fact that drought has been part of the Zambian landscape for centuries (Sichingabula, 1998), it is hypothesized that farmers have already incorporated drought risks into their resource allocation decisions, making drought an insignificant variable in explaining cropland allocation to maize. Contrarily, because HIV/AIDS is a relatively recent phenomenon (Guinness et al., 2003; Chapoto and Jayne, 2006; Walgate and Cullinan, 2002; Kapungwe, 2005), it is expected that its effect on maize cropland allocations will be statistically significant, as observed by Walgate and Cullinan (2002) in southern Africa and by Gebreselassie et al. (2007) in Ethiopia.

The foregoing theoretic framework is summarized in Figure 1. The figure shows the two principal explanatory variables of interest—HIV/AIDS and drought—and the crop prices and explained variables in the study—cropland shares for maize and cassava. The arrows show the causal direction and the signs indicate the *a priori* expectations defined by theory and/or past research findings between the cropland share for each crop and the particular variable. These signs and their statistical significance are tested using econometric models estimated using the data described above.

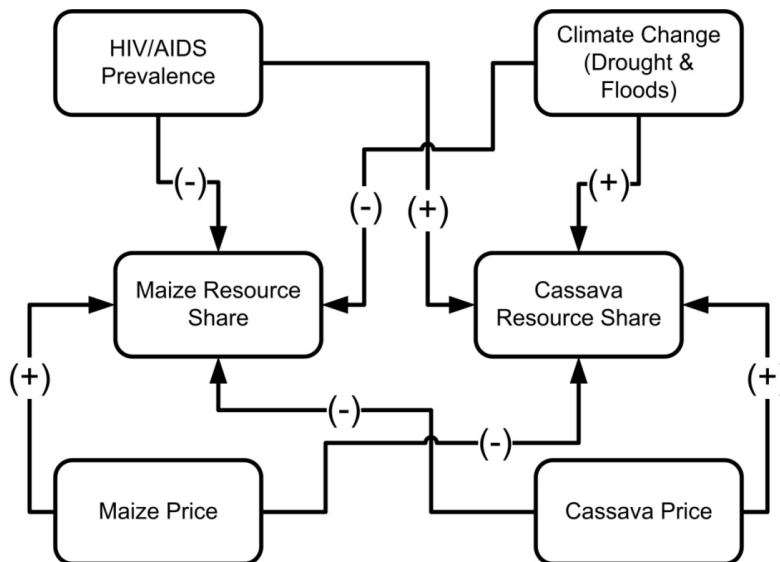


Figure 1. Conceptual model and research hypotheses.

Table 2. Prais-Winsten (AR1) regression results for maize and cassava allocated area models.

Variable	Cassava			Maize		
	Coefficient	t-Stat	p > t	Coefficient	t-Stat	p > t
Cassava price	2.75	5.49	0.00	-2.51	-3.17	0.00
Cotton price	-2.40	-5.34	0.00	-4.21	-3.48	0.00
Groundnut price	1.26	6.62	0.00	-	-	-
Maize price (F)	-1.49	-2.19	0.04	4.15	5.52	0.00
Cassava share (L)	0.57	1.68	0.10	-	-	-
Maize share (L)	-	-	-	0.36	2.26	0.03
HIV/AIDS (L2)	0.14	3.23	0.00	-0.31	-3.33	0.00
Drought	0.90	2.25	0.03	0.44	0.32	0.75
Dummy (Year)	1.09	0.82	0.42	-6.11	-2.69	0.01
Constant	1.19	1.59	0.12	44.31	3.83	0.00
Rho	0.02			-0.08		
DW (Transformed)	1.98			2.04		
N	38.00			N	40.00	
F(9,29)	2755.67			F(8,32)	5027.45	
Prob > F	0.00			Prob > F	0.00	
R-squared	0.98			R-squared	0.92	
Root MSE	0.59			Root MSE	3.01	

RESULTS AND DISCUSSION

Problems of heteroscedasticity and serial correlation are always expected when long time series are used in econometric analyses (Epps and Epps, 1977). Their presence were tested and confirmed in the study’s data. Therefore, the Prais-Westin autoregressive estimation routine was used to estimate the following models:

$$y_{ct} = a_{ct} + b_{c1}P_{ct} + b_{c2}P_{st} + b_{c3}P_{gt} + b_{c4}P_{m(t+1)} + b_{c5}y_{c(t-1)} + b_{c6}H_{t-2} + b_{c7}D_t + b_{c8}T_t + \varepsilon_{ct}$$

Where all variables are as defined above (Equation 1)

and the subscripts *c*, *s*, *g*, and *m* are respectively cassava, cotton, groundnuts, and maize and the *b*’s are the regression coefficients. Heteroscedasticity was corrected by incorporating STATA™’s robust option in the syntax specification.

The results for both equations (2) and (3) are presented in Table 2. It shows that the overall model for cassava was significant with an F-value (9, 29) of 2,755 (*p* < 0.00), an *R*² of 97.5% and a root mean square error of 0.59. A Linktest procedure in STATA™, used to detect specification errors, revealed that the model was appropriately

specified with the \hat{y} and \hat{y}^2 being statistically significant and statistically not significant at the 5% level respectively.

Cassava's share of total cropland responded positively to the cassava price index, with a unit increase in the cassava price index giving rise to 2.75% points increase in its share of cropland ($p < 0.00$). Contrarily, cassava's share of total cropland exhibited a statistically significant but negative response to expected maize price index. A unit increase in expected maize price index in period $t+1$ causes cassava's share of total cropland to decline by about 1.49% points ($p < 0.036$) in period t . This suggests that future maize price indexes instead of current ones, influence current decisions about cassava cropland allocation. The signs on the own price index and on the competing crop price index were as expected.

There was no *a priori* economic theory for determining the signs on cotton and groundnut prices. However, Table 2 shows that cassava has a statistically significant substitution relationship with cotton and a statistically significant complementary relationship effect with groundnuts. These relationships may be explained by the fact that while groundnuts may be intercropped with cassava, cotton does actually need to be substituted for cassava by allocating resources away from cassava for cotton cultivation. While the relationship between current and past cassava cropland share was positive (suggesting past allocations influenced current allocation decisions), its coefficient was not statistically significant at the 5% level. In this study, HIV/AIDS prevalence rate was deemed to express itself in crop production through the quality and quantity of agricultural labor supply resulting from its morbidity and mortality impacts. It was assumed that the effect of HIV/AIDS on labor supply become visible two years after infection. Therefore, the variable was lagged two periods in the model. The results for cassava showed that a percentage increase in the two-period lag HIV/AIDS prevalence rate led to an increase of 0.14% points in cassava's cropland share ($p < 0.003$). The positive relationship between cassava's cropland share and HIV/AIDS prevalence rate suggests that cassava is indeed a low-labor intensity crop that receives higher cropland allocations as labor supply tightened. The results also showed that drought years caused an increase of 0.9% points ($p < 0.032$) in cassava's cropland share. Because the model's intercept estimate was not statistically significant, the significance of the drought variable suggests that drought years led to significant upward shifts in cassava's cropland share. Finally, the policy dummy, T , was not statistically significant at the 5% level for cassava, suggesting that the structural adjustment program imposed in the 1990s did not affect production decisions affecting cassava. This makes sense because cassava was never the focus of the subsidy policies that prevailed prior to the implementation of the structural adjustment program. It also means that these policy changes are not responsible for the increased allocation of cropland to cassava, supporting the hypothesis that HIV/AIDS and drought are the prime motivating factors in the model. The maize model (Equation 3) was also found to be statistically significant with an F-

value (8, 32) of 5,027 ($p < 0.00$), R^2 of 91.9% and a root mean square error of 3.01. Share of cropland allocated to maize was found, as expected, to be increasing in the maize price index ($p < 0.00$) and decreasing in both cotton and cassava price indexes. Previous year's share of cropland allocated to maize was statistically significant ($p < 0.035$) in explaining current allocated resource share for maize. The results showed that the coefficient of HIV/AIDS prevalence rate was negative and statistically significant ($p < 0.002$), suggesting that labor supply constraints resulting from the disease have an adverse effect on cropland allocations to maize. They showed that for every percentage point increase in the prevalence rate of HIV/AIDS in Zambia, maize's cropland share declined by approximately 0.31%. This decline was more than twice as big as HIV/AIDS' effect on cassava cropland share, albeit in the opposite direction.

It was hypothesized that while drought conditions will cause declines in share of cropland allocated to maize, their effect would not be significant. This hypothesis was only partially confirmed: the coefficient on the drought variable was positive but it was not statistically significant. This result would underscore the staple food role of maize in Zambia, causing the drought to have no effect on its production. However, that HIV/AIDS presented such a strong effect on maize cropland allocation suggests the pandemic could have a more serious impact on food security than the drought conditions.

The policy dummy in the maize model was negative and statistically significant ($p < 0.01$), indicating that the removal of subsidies targeting maize did cause resources to be moved away from maize production. The maize model's intercept was found to be positive and, unlike in the cassava model, it was statistically significant at the 1% level. This is understandable given maize's position and role in Zambia's society and economy, suggesting that other factors beside prices, HIV/AIDS prevalence and drought define the maize cropland decisions. Despite this, the variables included in the model explained almost 92% of the variability in maize's cropland share.

A Breusch-Pagan test was conducted to determine the independence between the two models used in the study.

The results, ($\chi^2 = 9.57$) ($p < 0.002$), indicated that the maize and cassava models were, indeed, independent, leading to the rejection of the null hypothesis that there was no difference between them. This enhanced confidence in the foregoing results and discussion, allowing us to recognize the impacts of HIV/AIDS and drought on maize and cassava production; decisions are independent activities at the national agricultural production level.

Conclusions

This research was motivated by efforts in recent decades to promote cassava as an alternative food in Zambia in

light of the increasing duration and severity of droughts in the country and the inherent labor supply challenges posed by morbidity and mortality associated with the HIV/AIDS pandemic. It was desirable to measure the extent to which these two conditions were causing changes in cropping patterns, focusing on the principal food crops—maize and cassava—because of their effect on food security.

Recognizing maize's higher drought susceptibility as well as its higher status in Zambia's food economy, it was expected that declining labor supply and increasing drought conditions would lead to the allocation of resources away from maize and towards cassava. It was argued that because Zambian producers have been producing maize and living with drought conditions for decades, they have already incorporated its effects in their resource allocation decisions. Therefore, the effect of drought on maize's cropland share was expected to be lower than the effect of HIV/AIDS.

The results confirmed that both drought and HIV/AIDS caused resources to be shifted to cassava. However, while HIV/AIDS caused resources to be shifted from maize, the effect of drought was not statistically significant at the 5% level. The results showed that the absolute effect of HIV/AIDS on maize cropland share was twice as high as on cassava's, indicating that the pandemic is having a higher impact on maize than it was having on cassava. The results also showed that cotton was a competing crop for both crops but groundnuts were a complement crop for cassava. Both crops responded as expected by theory to their own price indexes.

Emerging empirical household-level studies from southern and eastern Africa show that returning former rural residents from urban areas may be compensating for declines in agricultural labor (Beegle, 2003; Chapoto and Jayne, 2005). Yet, this study indicates a strong impact on cropland share allocations resulting from the prevalence rate of HIV/AIDS in Zambia. This would seem to suggest that the returning former rural residents may be sick with HIV/AIDS and are coming back to their home villages for care they cannot afford in urban areas, not to compensate lost agricultural labor (Villareal, 2010). It is also important to recognize that shifts to low-labor intensity crops can only compensate for the impacts of HIV/AIDS to a point because of the subsistence nature of the region's agricultural production. Furthermore, as Chapoto and Jayne (2006) noted, the disease has been increasing the proportion of households headed by widows in rural Zambia, a situation that increases the risk of these households losing access to agricultural land and exacerbating poverty and food security risks.

The study's results are not limited to Zambia. They are instructive for most countries in Sub-Saharan Africa, especially those in southern Africa experiencing higher HIV/AIDS prevalence rates than Zambia—Swaziland, Botswana, Lesotho and Zimbabwe with 2008 prevalence estimates of 26, 23.1, 28.1 and 24.1%, respectively

(UNAIDS, 2008). Agricultural production systems in all these countries are subsistence and rain-fed, just like in Zambia. The study's results suggest that while investing in drought-tolerant crops is necessary, addressing the challenges presented by HIV/AIDS is critical. The disease's mortality and morbidity effects on labor supply and their implication for food production capacity pose direct food security challenges in these countries and present new public health risks that damper poverty-alleviation efforts by both government and non-governmental organizations operating in these countries. There is, therefore, a need in these high HIV/AIDS prevalence rate countries to make the necessary investments in education to enhance prevention and control the disease (Valfrey and Sass, 2009). It is equally important for governments in these countries to accelerate their work with non-governmental organizations, corporations and foreign governments to secure guaranteed access to antiretroviral drug therapies for those already infected to help them live relatively normal productive lives. It is critical that these governments and their partners make special efforts to ensure people living in rural areas, especially those involved in agricultural production, have access to these preventative and therapeutic resources. Indeed, as observed by Wilson and Blower (2007), it is pertinent that governments and their partners make the requisite investments to get these therapies to the rural areas instead of putting the onus on rural people to come for them. The cost of these investments is nontrivial, but the cost of not making them would be utterly devastating.

The study focused on the effects of HIV/AIDS and drought on changes in cropping patterns at the aggregate level. It is possible for disaggregated household level analysis to produce different results in specific regions, especially where cropping patterns across the country exhibit heterogeneity. For example, this research showed that HIV/AIDS caused shifts in cropland allocation from maize production, but Chapoto and Jayne (2005) reported little change in maize cropland allocations in several Zambian provinces despite high HIV/AIDS prevalence rates. Therefore, further research at the household level to assess the effect of HIV/AIDS and drought on changing cropland shares may be necessary to address any potential over abstraction errors (Castrogiovanni, 1991).

The research question for this study was defined to illuminate the historical effects of HIV/AIDS and drought trends on cropping patterns. It may be instructive to conduct some forward-looking studies that simulated the potential effects of these forces on future cropping patterns under alternative HIV/AIDS policy interventions and drought-tolerant production technologies. Such studies could identify the limits of the cropland shifts given the subsistence nature of agricultural production in Zambia and the region. The results from these future-oriented studies could provide further instruction to

policymakers how to construct policies to achieve the overarching objective of alleviating poverty and increasing food security given the reality of HIV/AIDS and changing climate in Sub-Sahara Africa.

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