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Agricultural Sector and HIV/AIDS Pandemic in Africa: The Economic Retrogression Model

Temidayo Gabriel Apata[1], Moshood Olatunde Oladapo[1], Adetunji Lawrence Kehinde[2], Olasimbo Motunrayo Apata[3], Timothy Olusola Agboola[2]

[1]Department of Agricultural Economics & Extension, Federal University Oye-Ekiti, Oye-Ekiti, Nigeria
[2]Department of Agricultural Economics & Extension, Osun State University, Ejigbo Campus, Ejigbo, Nigeria
[3]Department of Agricultural Economics & Extension, Ekiti State University, Ado Ekiti, Nigeria
Email: dayo.apata@fuoye.edu.ng

Abstract

Objective: Agricultural activities in most African countries demand human labour, the supply of labour to agriculture may be threatened if humans could no longer farm because of HIV/AIDS pandemic. Past studies have identified the alarming situation and challenges the spread of HIV/AIDS endemic poses to human existence and agricultural growth. Examining these interactions, and their direction, is useful for informing policy directives. Therefore, the general objective of this study is to examine interactions between HIV/AIDS pandemic and agricultural growth in Africa using a model of retrogression. Methods: Twenty countries in Africa identified as HIV/AIDS ravaged countries were taken as the areas of study. These countries are spread over four zones of the Northern Africa, the Eastern, the Southern and the Sub-Saharan Africa. A combination of analytical tools was employed to meet the study objectives. Results: The results revealed that long run economic cost of HIV/AIDS had a statistical positive significant relationship with agricultural/economic growth. The results suggest that there is a curvilinear relationship between the course of the HIV/AIDS epidemic and agricultural/economic growth in terms of human capita development. Conclusions: HIV/AIDS pandemic interactions and agricultural growth have demonstrated that a more balanced approach is necessary for effective policy.

1. Introduction

Economy of most African countries is predominantly agricultural and the agricultural sector is a major contri-

butor to the country's Gross Domestic Product (GDP). This sector contributes about 80 percent to the GDP annually and it provides employment for about 80 percent of the population [1]-[3]. Studies have revealed that poverty prevalence at the homes of those who take agriculture as a source of livelihood [4] [5]. Agricultural activities in most African countries demand human labour, the supply of labour to agriculture may be threatened if humans could no longer farm because of the influence of HIV/AIDS prevalence that weakened human strength needed for labour. The increasing incidence and spread of HIV/AIDS epidemic has created drastic changes in the society and the economy of nations. Past studies have shown that HIV/AIDS affects people in their productive age groups (15 - 49 years old), resulting in a loss of agricultural labour [6]-[9]. In addition, caregivers who have to give up working in the fields in order to take care of the sick deprived labour for agricultural activities [10] [11].

For example, it has been estimated that on average two person-years of labour are lost (an active labour loss to death) in an AIDS-affected household in Africa [12]-[14]. Literature has revealed that HIV/AIDS pandemics are commonly found among productive age groups [15]-[17]. These studies noted that resulting effects of this is loss of agricultural labour not only from the people who die, but also from caregivers who have to give up working in the fields in order to take care of the sick. According to FAO global estimates (2006) 25.5 million agricultural workers have died of AIDS since 1985 to 2006 and 16 million more will die by 2020. A projection made by World Bank in 1997 on adult's deaths due to infectious diseases in developing countries revealed that HIV/AIDS would have the highest rate of growth in death from infection, and by 2020, the death rate is expected to rise by 37.1%. FAO (2001) estimated that in the 27 most affected countries in Africa, 7 million agricultural workers had died from HIV/AIDS, and 16 million more deaths were likely to occur in the next decade [18]. If the rate is not checked, this disease will continue to devastate farm labour force, thus put the food security at risk, agriculture and the GDP of many countries will be adversely affected.

Therefore the challenge that the spread of HIV poses to the rural community and agriculture in particular calls for urgent attention. There is a huge volume of literature on poverty and on HIV/AIDS. In order to capture the relationship between HIV epidemic and agriculture, Overlapping Generations (OLG) model was used. The Overlapping Generations model (OLG) describes the live of human activities in two periods, the young and the old. When young they work and divide their labour income between consumption and savings. When old they consume their savings. As the name of the model implies, generations overlap, so in each period there are young agents saving and old agents consuming [19]-[21]. This model allows us to consider two issues, the consequences of finite time horizons and the consequences of difference between agents. Past studies have shown that OLG is a type of representative agent economic model in which agents live a finite length of time long enough to overlap with at least one period of another agent's life. All OLG models share several key elements:

• Individuals receive an endowment of goods at birth,
• Goods cannot endure for more than one period,
• Money endures for multiple periods,
• Individual's lifetime utility is a function of consumption in all periods.

Consequently, in order to analyze the long-term economic effects of HIV/AIDS on Agricultural sector, some of the specific features of the relationship between health and economic growth must be treated in detail. In particular, there must be a link between the course of the epidemic and economic growth, in the form of feedbacks from premature mortality to education, the formation of human capital and output. For this purpose, the extension of the Overlapping Generations (OLG) model of past studies were adopted and modified to suit the purpose of the study [22]-[25]. This model analyzes the nexus of child labor, education and growth; investigate the causes of some existing level of premature adult mortality and its effects on economic growth.

However, literature explaining the interactions between the two especially in agricultural sector is almost non-existent. Examining these interactions, and their direction, is useful for informing policy instructions. Interventions are required at individual, family/community and policy levels. Consequently, empirical evidence requiring both qualitative and quantitative approaches to this interaction between Agricultural Sector and HIV/AIDS Pandemic becomes pertinent for effective agricultural policy.

1.1. Problem Statement

Agriculture has been a late starter in responding to HIV/AIDS, Ministries of Agriculture generally are not part of national AIDS authorities [26]. Even when a multi-sectoral approach is recommended, approaches remain

within a health framework [27] [28]. It has been identified that HIV/AIDS impoverishes rural households by increasing the cost of health care and funeral expenses as a result of HIV/AIDS victim death. This intervention often depletes household savings and reduces labour availability for agricultural production, making the affected households shift to less costly and labour-intensive farming [29]-[34]. This implies that affected households will experience increased impoverishment and if not checked it would continue into the future. Hence, a vicious circle is forming, linking together HIV/AIDS pandemic and penury.

In most of Eastern and Southern Africa, where HIV prevalence rates generally exceed 10 percent; there will be many fewer adults in the coming decades compared to a "no-AIDS" scenario [35]. By the year 2010, six countries in the region will be experiencing negative population growth rates: Botswana (−2.1 percent per year), Mozambique (−0.2 percent), Lesotho (−0.2 percent), Swaziland (−0.4 percent), and South Africa (−1.4 percent) and by 2020, AIDS mortality will produce population pyramids in these countries. By 2025, summing across the seven countries where HIV prevalence exceeds 20 percent, there will be roughly 20 million men in the working age years between 20 and 59 years old as opposed to 31.5 million if AIDS had not existed. By contrast, there will be only 18 million women in the 20 to 59 age range as opposed to 32 million in the "no-AIDS" case [36]-[38]. There is now widespread recognition that HIV/AIDS is not simply a health issue. A coordinated approach will be necessary to effectively combat the epidemic and its consequences. While many in the agricultural sector embrace the idea of playing a role in combating HIV/AIDS, there has been very little analysis for agricultural policy analysts to look for directions [39]. Moreover, despite the fact that the pandemic is now in its third decade in Africa, available analysis to date provides a very murky picture as to how HIV/AIDS is affecting the agricultural sector. Until these issues are clarified, policy makers will be inadequately prepared to forecast anticipated changes and respond proactively. For this reasons anticipation of future impacts and proactive policy responses are likely to make a critical difference in averting future crisis and chronic poverty among the countries hardest-hit by HIV/AIDS pandemic.

Therefore, the general objective of this study is assessing interactions between HIV/AIDS pandemic and agricultural sector and its implications for agricultural policy. The specific objectives include:

1) To estimate the long-run economic costs of HIV/AIDS on agricultural sector,
2) To measure the effects of HIV/AIDS pandemics on agriculture/economic growth,
3) To establish linkages between economic costs of HIV/AIDS and economic growth,
4) To investigate the potential implications of HIV/AIDS pandemic on agriculture for agricultural policy directions.

1.2. Limitations of the Study

This research results in this article like any other researches on HIV/AIDS witnessed so restraints, here some as stated below:

1) Measurements in this study seem not to utilize a standard research tool. The article here will be to interpret and explain rather than predict and account for variance.

2) Past studies on HIV/AIDS identified that the methodology on the participant method employed is very time consuming and expensive. However, coupling up with an ongoing donor assisted project considerably lowers the research costs.

3) Studies on HIV/AIDS, like all naturalistic studies will not be on its own provide any comprehensive conclusions. However, through combinations with other later studies or many different sorts of data, it should hopefully be able to appropriately inform the communicating discipline.

2. Methodology

2.1. Overlapping Generation (OLG) Model

In order to analyze the long-term economic effects of HIV/AIDS on Agricultural sector, some of the specific features of the relationship between health and economic growth must be treated in detail. In particular, there must be a link between the course of the epidemic and economic growth, in the form of feedbacks from premature mortality to education, the formation of human capital and output. For this purpose, the extension of the overlapping generations (OLG) model of Bell and Gersbach (2002) was adopted and modified to suit the purpose of the study. This model analyzes the nexus of child labor, education and growth; investigate the causes of

some existing level of premature adult mortality and its effects on economic growth. The model specified that Parents have preferences over current consumption and the level of human capital attained by their children, making due allowances for early mortality in adulthood. The decision about how much to invest in education is influenced by premature adult mortality in two ways: first, the family's lifetime income depends on the adults' health status, and second, the expected pay-off depends on the level of premature mortality among children themselves when they attain adulthood. The outbreak of AIDS leads to an increase in such mortality, and if the prevalence of the disease becomes sufficiently high, there may be progressive collapse of human capital, productivity and economic growth. The policy problem, therefore, is to avoid such a collapse. The instruments available for this purpose are 1) spending on measures to contain the disease and treat the infected, 2) aiding orphans, in the form of income-support or subsidies contingent on school attendance, and 3) taxes to finance the expenditure program. The central policy problem is to find the right balance among these interventions in order to ensure economic growth over the long run without excessive inequality. First, the very nature of the model demands that the available economic and demographic series be long and fairly reliable if there is to be a solid base for calibration. Second, investigate African countries that have experienced substantial growth over years and the resultant effect of HIV/AIDS pandemics. Third, the epidemic has progressed rapidly in these selected African countries, from a prevalence rate among the population aged 15 to 49 of about one per cent in 1990 to over 20-percent a decade later [40].

2.2. The Model Specification

We extend the OLG-model of Bell and Gersbach (2002) by introducing premature mortality among adults. There are two periods of life, childhood and adulthood, whereby the course of adulthood runs as follows. On becoming adults, individuals immediately form families and have their own children. When the children are very young, they can neither work nor attend school. Since the only form of investment is education, the family's full income is wholly consumed in this phase. Only when this phase is over do the adults learn whether they will die prematurely, and so leave their children as half-or full orphans. Early in each generation of adults, therefore, all nuclear families are sorted into one of the following four categories: Both parents survive into old age; the father dies prematurely; the mother dies prematurely and both parents die prematurely.

These states are denoted by s_t $S_t := \{1, 2, 3, 4\}$. The probability that a family formed at the start of period t lands in category s_t is denoted by $\pi_t(s_t)$. The population is assumed to be large enough and the fractions of all families in that state after all premature adult death have occurred. We turn to the formation of human capital. Consider a family at the start of period t. Let λ_t^f and λ_t^m denote, respectively, the father's and mother's endowments of human capital, and let $A_t(s_t)$ denote their total human capital when the family is revealed to be in state s_t. Then,

$$\Lambda_t(1) = \lambda_t^f + \lambda_t^m, \Lambda_t(2) = \lambda_t^m, \Lambda_t(3) = \lambda_t^f, \Lambda_t(4) = 0 \tag{1}$$

An additional source of heterogeneity is ruled out in advance:

Assumption 1. There is assortative mating: $\lambda_t^f = \lambda_t^m V_t$.

Hence, (1) specializes to

$$\Lambda_t(1) = 2\lambda_t, \Lambda_t(2) = \Lambda_t(3) = \lambda_t, \Lambda_t(4) = 0, \tag{2}$$

Human capital is assumed to be formed by a process of child rearing combined with formal education in the following way. In the course of rearing their children, parents give them a certain capacity to build human capital for adulthood, a capacity which is itself increasing in the parents' own human capital. This gift will be of little use, however, unless it is complemented by at least some formal education, in the course of which the basic skills of reading, writing and calculating are learned. Expressed formally, the human capital attained by each of the children on reaching adulthood is assumed to be given by

$$\Lambda_{t+1} = \begin{cases} z(s_t) f(e_t) \Lambda_t(s_t) + 1, & s_t = 1, 2, 3 \\ \zeta & s_t = 4 \end{cases} \tag{3}$$

Beginning with the upper branch of (3), the term $z_t(s_t)$ represents the strength with which capacity is transmitted across generations. It is plausible that the father's and mother's contributions to this process are not perfect substitutes, in which case, $2z(1) > \text{Max}[z(2), z(3)]$ and $z(2)$ may not be equal to $z(3)$. For simplicity,

however, we introduce.

Assumption 2. $z(2) = z(3) \geq z(1) \geq z(2)/2 = z(3)/2$

$z(1) = z(2) = z(3)$ holds when parents are perfect complements and $2z(1) = z(2) = z(3)$ when they are perfect substitutes. Assumptions 1 and 2 allow the upper branch of (3) to be rewritten as

$$\lambda_{t+1} = (3 - s_t) z(s_t) f(e_t) \lambda_t + 1, \quad s_t = 1, 2 \tag{4}$$

both types of single-parent families being identical in this respect. The function $f(\cdot)$ may be thought of as representing the educational technology – translating time spent on education into learning.

Assumption 3. $f(\cdot)$ is a continuous, strictly increasing and differentiable function on [0,1], with $f(0) = 0$.

The Household's Behavior: It is assumed that all allocative decisions lie in the parents' hands, as long as they are alive. We rule out any bequests at death, so that the whole of current income, as given by (5), is consumed. Concerning the allocation of consumption within the family let the husband and wife enjoy equality as partners, and let each child obtain a fraction $\beta \in (0,1)$ of an adult's consumption if at least one adult survives. Full orphans ($s_t = 4$) do not attend school, and consume what they produce as child laborers.

From (2), the budget sets of single-mother and single-father households with the same endowments of human capital and the same number of children are identical. In the absence of any taxes or subsidies, the household's budget line may therefore be written as

$$\left[(3 - s_t) + n_t \beta\right] c_t(s_t) + \alpha n_t \gamma e_t(s_t) = \alpha \left[(3 - s_t) \lambda_t + n_t \gamma\right], \quad s_t = 1, 2, 3 \tag{5}$$

where $c_t(s_t)$ is the level of each adult's consumption. The expression on the LHS represents the costs of consumption and the opportunity costs of the children's schooling. The expression on the RHS is the family's so-called full income in state $s_t = 1, 2, 3$, whereby assumption 1 ensures that states 2 and 3 are identical where the budget set is concerned. Observe that single-parent households not only have lower levels of full income than their otherwise identical two-parent counterparts, but they also face a higher relative price of education, defined as $\alpha n_t \gamma / (3 - s_t) + n_t \beta$

Parents are assumed to have preferences over their own current consumption and the human capital attained by their children in adulthood, taking into account the fact that an investment in a child' education will be wholly wasted if that child dies prematurely in adulthood. Let mothers and fathers have identically preferences, and for two-parent households, let there be no 'joint' aspect to the consumption of the pair $(c_t(1), e_t(1))$: each surviving adult derives (expected) utility from the pair so chosen, and these utilities are then added up within the family. In effect, whereas $c_t(1)$ is a private good, the human capital of the children in adulthood is a public good within the marriage. Since all the children attain $\lambda_t + 1$, the only form of uncertainty is that surrounding the number who will not die prematurely as adults, which is denoted by $a_t + 1$. Let preferences by separable, with representation.

$$EU_t(s_t) = (3 - s_t) \left[u(c_t(s_t)) + E_{ta+1} v(\lambda_t + 1)\right], \quad s_t = 1, 2 \tag{6}$$

where the contribution $v(\lambda_t + 1)$ counts only when death does not come early, E_t is the expectation operator and $E_t a_t + 1$ is the expected number of children surviving into old age. The sub-utility functions $u(\cdot)$ and $v(\cdot)$ are assumed to be increasing, continuous, concave and twice-differentiable. Denoting by $\pi t_{+1}(s_t + 1)$ the parents subjective probability that a child will find itself in state $s_t + 1$ in period $t + 1$, so that: $\sum_{s_t+1=1}^{4} \pi_{t+1}(s_t + 1) = 1$, and recalling assumption 1 and that all children are treated identically, we obtain

$$E_t a_{t+1} v(\lambda_t + 1) = n_t \kappa_{t+1} v(\lambda_t + 1),$$

where

$$\kappa_{t+1} \equiv \left[1 + \pi_{t+1}(1) - \pi_{t+1}(4)\right]/2 \tag{7}$$

We are interested in the question: how does the outbreak of the disease affect the subsequent development of the society? Children who are left as unsupported orphans ($s_o = 4$) fall at once into the poverty trap. Assumption 7 also implies that $e^0(2\xi, 1) = 0Vt$: even if both parents survive but have been orphans in childhood, they cannot afford to send their children to school. In the absence of support, therefore, all orphans fall into the poverty trap, and their succeeding lineage remains there. In order to discover what happens to the rest, we introduce the

critical value function $\lambda^*(s, k_t)$ for $s \in \{1, 2, 3\}$, $n_t + 1 = n_t, Vt$ and $\kappa_t = \kappa$, Vt defined by:

$$\lambda^*(s, k) = z(s) f\left(e^0\left(\Lambda^*(s), s, k\right)\Lambda^*(s) + 1\right)$$ (8)

Vt is the Long-run economic costs of HIV/AIDS on human capital. These are the associated factors responsible for premature mortality among adults due to the influence of HIV/AIDS and the spillover effect on the children, the environment and the country at large.

The study believe that by killing mostly young adults, AIDS does more than to destroy the human capita embodied in them; it also deprives their children of those very things they need to become economically productive adults-their parents' loving care, knowledge and the capacity to finance education. To capture Vt, there is the need to look at variables influences it, that is at state Vt, what happens and what variables determines this state of Vt. Reviews of past studies and literature on HIV/AIDS and Human capita development clearly indicated what combination of measures should be adopted to promote the formation of human capita and good health. These measures are partly complementary; for the maintenance of good health means that the human capital embodied in individuals during childhood and training will survive and pay off into old age, not only for them, but also for their children. In order to estimate the long-run economic cost of HIV/AIDS on human capital (agriculture was used as proxy for human capita, since studies have established that over 70 percent of labour are involved in agriculture) the OLG model was used. The long-run economic cost of HIV/AIDS on agricultural sector is therefore conceptualized through the model of OLG.

2.3. Modeling

$$Vt = f\left(X_1, X_2, X_3, \cdots, X_{15}, \mu_i\right)$$ (9)

The estimating equation is represented as:

$$Vt = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_2 X_3 + \cdots + \beta_{15} X_{15} + \mu$$ (10)

where Vt = Long-run economic costs of HIV/AIDS on agricultural sector.

β_o = Constant term
X_1 - X_{15} = Independent variables.
U = Error term assumed to have normal distribution with zero mean, and constant variance *i.e* $U \sim N\left(0, \sigma^2\right)$ and $E\left(Ui, Uj\right) = 0ij$.

The following variables are hypothesized as having significant influence on the economic cost of HIV/AIDS: Household size (X_1), level of education (X_2), age (X_3), information on HIV/AIDS, protective and preventive measures (X_4), hired labour (X_5), inputs (X_6), expenses on food (X_7), opportunity cost of own labour (X_8), income (X_9), number of non-farm rural activities (X_{10}), market facilities (X_{11}), access to extension facilities (X_{12}) cost and access to credit facilities (X_{13}), cost of health services (X_{14}) and frequency of visit to hospital for care or medications (X_{15}). The selection of these variables is based on economic theory and suggestions of previous/similar studies. The OLS technique was used to estimate the model.

2.4. List of Independent Variables and Measurements

s/n	Variables	Measurements	Expected signs
1.	Household size (X_1)	Measured in terms of number of member(s) who eats in the same pot	negative relationship
2.	Level of education of household head (X_2)	Education refers to the level of formal and non-formal education and will be measured in terms of ability to read and write and enrolment in primary, secondary schools or above.	Educational level positively affects use of HIV /AIDS information
3.	Age (X_3)	Measured in terms of number of years of age.	negative relationship
4.	information on HIV/AIDS, protective and preventive measures (X_4)	Access to effective information was anticipated as the ability to improve on the level of ignorance. Access to timely information on HIV/AIDS protective and preventive measures could go a long away to contain the spread of HIV/AIDS. This variable was measured using list of items selected through systematic procedure.	Access to effective information was anticipated to have positive relationship

Continued

5	Hired labour (X_5)	Defined as a person's quality to provide specialized labour for an agreed fee. It was measured by man days.	The variable was assumed to have positive relationship
6.	Inputs (X_6)	These are agricultural tools and equipment used in running farming activities. It also include consumables in making agricultural activities functional and it is measured in Naira (N)	The variable was assumed to have positive relationship
7.	Expenses on food (X_7)	This is amount spend in making food available to all members of the farm households. it is measured in Naira (N)	The variable was presumed to have positive relationship
8.	Opportunity cost of own labour (X_8),	This is a tradeoff between one's efforts offered for services that is not paid nor documented. it is measured in Naira (N)	The variable was presumed to have positive relationship
9.	Income (X_9)	Operationally defined as the value of the products of the household after home consumption and income obtained from off-farm and non-farm activities that are expressed in Naira per year.	The income level was anticipated to have a positive relationship
10	Number of non-farm rural activities (X_{10})	This refers to other income generating activities that is not farming. It was assumed in number of activity engaged.	The variable was presumed to have positive relationship
11	Market facilities (X_{11})	This was defined as the degree to which the respondent was eager to get information on how to market farming products and how it can use such information for gains. This was measured in terms of how much information was sought, how frequently and from where the information was sought.	Access to market facilities was assumed to have positive relationship
12	Access to extension participation (X_{12})	It was measured using a weighted index.	variable was assumed to have a positive relationship
13	Cost and access to credit (X_{13})	Access to credit has impact on level of utilization of recommended technological packages and this in turn will expose respondents to different information.	anticipated to have a positive relationship
14	Cost of health services (X_{14})	This is the cost of accessing medical facilities and buying of drugs. This is measured in Naira (N)	anticipated to have a negative relationship
15	Frequency of visit to hospital for care or medications (X_{15}).	Defined as the extent to which respondent visit hospitals either for medical attention or treatment of an ailment. This is measured in times of number of visits and the essence of such visit.	variable was assumed to have a negative relationship

2.5. Economic Retrogression Model

The model of Retrogression was first developed by McPherson & Zinnes (1991), the model links institutional weakness to economic growth via an externality on the production side and a political backlash process on the institutional side. Economic decline is then shown to result from the internal dynamics of a country's sociopolitical and technological characteristics [41]. This model is modified to accommodate the effects of HIV/AIDS on the growth or real output at time t $G\{y(t)\}$. This method of analysis was used to achieve objective 2.

Model Specification

$$G\{y(t)\} = \{G[K(t)], G[Vt(t)], G[I(t)], R(t)\} \tag{11}$$

where $G\{y(t)\}$ = Growth of real output at time *t*

$G[K(t)]$ = Growth of physical capital at time *t*

$G[Vt(t)]$ = Growth of human capital at time *t*

$G[I(t)]$ = Growth of information at time *t*

$R(t)$ = Residual

Why will $G[Y(t)]$ decline?

- $G[Vt(t)]$ declines and may become negative; skill composition changes as well
- $G[K(t)]$ falls due to reduced investment; potential mismatch with available skills as organizations and institutions becoming less effective
- $G[I(t)]$ declines capacity to generate and utilize information— $I(t)$ complementary to $Vt(t)$.

- $R(t)$ may be negative because organizations and institutions cannot adjust in ways that compensate for decline in $Vt(t)$, and $I(t)$.

2.6. Simultaneous Equation Model

To establish linkages (or interactions) between economic costs of HIV/AIDS and economic growth in agriculture, Simultaneous equation model is adopted. The effects of long-run economic cost of HIV/AIDS on agriculture and other variables on economic growth were examined by regression analysis. A two-stage methodology is adapted. This is necessary because long-run economic cost of HIV/AIDS on agriculture and economic growth are jointly depended on similar household socio-economic variables. Moreover, effects of long-run economic cost of HIV/AIDS on agriculture have been used previously as dependent variable in Equation (10). The use of 2SLS has the advantage of estimating all parameters of the structural equation in the model simultaneously [42]. The objective of using 2SLS is to facilitate the use of Ordinary Least Square (OLS) method to each equation of the structural model.

Model specification

$$G[Vt(t)] = G\{y(t)\} = \{G[K(t)], G[Vt(t)], G[I(t)], R(t)\}$$ (12)

where one of the *X*'s is *Vt*

$$Vt = b_0 + b_1 + b_2 X_2 + \cdots + b_{15} X_{15} + vi$$ (13)

$\overline{Vt}$ is an endogenous explanatory variable in Equation (13), it's assumed here that the growth of human capital is as a result of the explanatory variables $(X_1 - X_{15})$, and hence its estimated value from Equation (13) is used in Equation (12) as an explanatory variable. According to Olayemi, (1998), an endogenous independent/explanatory variable has two components a systematic component $\overline{Vt}$ and a random component *V*. Hence,

That is

$$Vti = \overline{Vt} + V$$ (14)

Substituting V*t* Equation (13) with Equation (12) we have

$$G[Vt(t)] = d_0 + d_1(\overline{Vti} + Vi) + d_2(X_2) + \cdots + d_{15} X_{15} + \varepsilon i$$

It becomes

$$G[Vt(t)] = d_o + d_1 \overline{Vti} + d_2 X_2 + \cdots + d_{15} X_{15} + (\varepsilon i + d_1 V)$$ (15)

OLS method can then be used to estimate Equation (15).

The variables above are hypothesized as having significant influence on the growth of real output at time t $(G[Vt(t)])$.

Elasticities were computed for significant variables in both the $(G[Vt(t)])$ and *Vt*. Following past studies efforts, elasticities are calculated as based on the concept of these studies [42] [43]

$$\text{Elasticity} = \frac{dY}{dXi} \cdot \frac{\overline{Xi}}{\overline{Y}}$$ (16)

$$\overline{\overline{C}} = b \frac{\overline{X}}{\overline{Y}}$$

where $\overline{\overline{C}}$ = Elasticity estimate,

b = Parameter estimate (marginal effect associated with each Independent variable),

X = Mean of independent variable,

Y = Mean of dependent variable.

2.7. Area of Study

Twenty countries in Africa as identified as HIV/AIDS ravaged countries were taken as the areas of study.

2.8. Method of Data Collection

Secondary data were collected for this study. The Secondary data was obtained from UNAIDS website (2012), Department of Medical Statistics and Epidemiology, University College Hospital (UCH) Ibadan, Nigeria. Additionally data were obtained from National Action Committee on AIDS (NACA) zonal office in Ibadan and Akure, Nigeria (2007), and relevant websites were visited downloaded, reviewed, used and cited. The websites as follows: www.unaids.org, www.cbnrm.net, www.fhi.org, www.abcg.org, www.who.org.

2.9. Sampling Procedure

Purposive sampling procedure was used in the first stage of sampling. Twenty countries in Africa as identified as HIV/AIDS ravaged countries through the help of literatures, internet and past studies, were purposively selected in this first stage (**Table 1**). These countries are spread over four zones of the Northern Africa, the Eastern, the Southern and the Sub-Saharan Africa. It was observed that the study areas are characterized by high, medium and light HIV/AIDS incidences. The Southern zone has all the three characteristics; the Eastern and SSA zones have medium and light cases while the Northern zone has light HIV/AIDS incidence respectively. In the second stage, communities that were ravaged with HIV/AIDS incidences were purposively selected to represent the three cases in all the zones (**Table 1**). Thus, 520 affected households were randomly picked in the Southern

Table 1. HIV prevalence in Africa and No. of people affected in agricultural industry.

S/N	Country	Population	Position in the World	National HIV Prevalence %	No. of People Affected	No. of People that derived livelihood in Agriculture and in percentages (%)	No of people affected by HIV and derived livelihood in Agriculture
1	Nigeria	140,003,562	9th	6.2	8,680,221	105,002,672 (75)	6,510,166
2	South Africa	43,718,530	27th	15.3	6,688,935	22,733,636 (52)	3,478,246
3	Ethiopia	67,851,781	17th	6.4	4,342,514	42,407,363(62.5	2,714,071
4	Tanzania	36,668,225	33rd	7.8	2,861,682	25,314,875 (69)	1,974,560
5	Congo Dem	58,317,930	22nd	4.9	2,857,579	39,656,192 (68)	1,943,153
6	Kenya	32,021,856	37th	8.5	2,721,868	23,375,955 (73)	1,986,956
7	Egypt	76,117,421	15th	2.2	1,674,583	50,237,498 (66)	1,105,225
8	Zimbabwe	12,671,861	58th	10.3	1,305,202	8,616,865 (68)	887,537
9	Zambia	10,462,436	64th	12.1	1,265,955	6,800,583 (65)	822,871
10	Sudan	39,148,162	30th	2.6	1,017,852	27,795,192 (71)	722,675
11	Morocco	32,209,101	35th	2.3	740,809	19,325,460 (60)	444,486
12	Algeria	32,129,324	36th	1.8	578,328	18,635,008 (58)	335,430
13	Lesotho	1,865,040	94th	21.2	395,388	951,704 (51)	200,697
14	Botswana	1,561,973	99th	23.0	360,815	859,085 (55)	198,449
15	Namibia	1,954,033	89th	18.6	363,450	1,231,040 (60)	228,974
16	Swaziland	1,169,241	112	13.4	156,678	713,237 (61)	95,573
17	Malawi	18,811,731	53rd	12.8	2,407,901	13,356,329 (71)	1,709,610
18	Mozambique	11,906,855	61st	11.2	1,333,568	8,096,661 (68)	906,826
19	Uganda	26,404,543	47th	13.1	3,458,995	19,011,271 (72)	2,490,477
20	Rwanda	7,954,013	79th	15.3	1,216,964	5,885,970 (74)	900,553

Source: U.S. census bureau, 2010. The World Fact Book, 2011.

Zone, 400 in the Eastern zone, 280 households in the Northern zone and SSA, 220 households respectively for a total of 1,420 affected households in the final stage of sampling. However, 1,300 observations were found suitable for the subsequent analysis. Respondents that have taking agricultural livelihood either as primary or secondary occupation were considered. Information was collected on socio-economic characteristics, livelihood activities, access to basic facilities, cost on health care, information on HIV/AIDS protective and preventive measures, treatment and palliative measures adapted, funeral cost in case of burying a loved one's among others. Data were subjected to descriptive statistical, Overlapping Generation (OLG) model, Economic Retrogression Model and Simultaneous equation model.

3. Results and Discussion

3.1. Overlapping Generation (OLG) Model, Results and Discussions

Objective 1 is to estimate the long-run economic costs of HIV/AIDS on Agricultural sectors in the area of study. **Table 2** presents the results of the long-run economic costs of HIV/AIDS of OLG Regression model. The R^2 of 74% and the Standard Error of 0.02514 indicated a good fit for the estimated equation. Results from the long-run economic costs of HIV/AIDS equation indicate that agricultural sector was affected negatively and significantly by age (X_3) information on HIV/AIDS, prevention and protective measures (X_6), and access to credit (X_{13}). Thus, the higher the age, information on HIV/AIDS, prevention and protective measures and access to credit used to raise production variables the lower the spread of HIV/AIDS (**Table 2**). The results also indicated that education (X_2), income (X_6), number of non-farm rural activities (X_{10}), access to extension services (X_{12}) Cost of health services (X_{14}), and frequency of visit to hospital for care or medications (X_{15}). All have significant positive effects on long-run economic cost (**Table 2**). The results reveal that income (X_6) was the most significant factor influencing the spread of HIV/AIDS. This means that poor households struggle for additional income to meet household needs including engaging in commercial/casual sex work. Similarly, educations, NFRA, access to extension services and access to market facilities have positive significant effect on long-run economic cost of HIV/AIDS (**Table 2**). Increases in these variables will lead to increase long-run economic cost of HIV/

Table 2. Ordinary least square for OLG regression analysis.

Variable	Estimate	t-value
Household size (X_1)	−2.1481E-04	−0.1345
Level of education (X_2)	0.7251	2.4131*
Age (X_3)	−7.9135E-03	− 2.2652*
Information on HIV/AIDS, prevention and protective measures (X_4)	−4.5821E-03	−3.3546***
Hired labour (X_5)	−4.5482E-07	−1.0523
Inputs (X_6)	1.7245E-08	3.2543**
Expenses on food (X_7)	−2.4431E-07	−0.2988
Opportunity cost of own labour (X_8)	2.335E-06	0.7654
Income (X_9)	−4.4652E-09	−0.6635
Number of non-farm rural activities (X_{10})	5.5134E-07	2.3852*
Market facilities (X_{11})	0.5192	0.3107
Access to extension facilities (X_{12})	0.6453	2.4127*
Cost of credit facilities (X_{13})	0.00859	−3.0048**
Cost of health services (X_{14})	0.00203	3.1162**
Frequency of visit to hospital for care/medication(X_{15}),	0.0185	2.5643*

Source: Computer Printout of Multiple Regression Analysis; DIAGNOSIS STATISTICS; *** = Significant at $p < 0.001$, ** = Significant at $p < 0.005$, * = Significant at $p < 0.01$; Multiple R = 0.8253, R Square = 0.7691, Adjusted R Square = 0.7432, Standard Error = 0.02514. Constant = −0.0103.

AIDS. As households realize that they can make more money from other sources than farming they may gradually shift away from farming livelihood.

The implication is that interest in farming gradually declining and can lead to scarcity of agricultural products or food shortages, threatening food security and legalize commercial sex work as livelihood in the area of study. Thus, the findings of the study are similar to the past works [44] [45]. These studies examined the impact of HIV/AIDS on food security and household vulnerability in Swaziland and found out that farming labour is becoming expenses as a result loss of labour loss to HIV/AIDS.

3.2. Economics Retrogression Model

The second objective is to estimates the effects of HIV/AIDS and socio-economic factors on economic growth. **Table 3** presents the results of the estimated linear equation for the second stage of the two-stage least squares method. The R^2 of 75% and standard error of 0.8457 indicated a good fit for the equation. **Table 3** reveals that long run economic cost of HIV/AIDS has a statistical positive significant relationship with economic growth (measure through Growth of Real Output) at 5 percent level of significance. This clearly indicates that HIV/AIDS pandemic has an impact on economic growth. The result shows that access to physical capital (Z_2) and Growth of Information (Z_1) have significant positive effect on economic growth. In other words, access to physical capital (Z_2) and Growth of Information (Z_1) in the study area is found to have a positive impact. On the other hand, growth of human capital (Z_3) has a negative and significant impact. This suggests that the higher the growth of human capital, the lower the economic growth. This is because HIV/AIDS is taking advantage of specialization (dead of highly skilled labour), losing complementarities created by skill agglomeration, losing competitiveness as scale shrinks and unit costs rise.

This suggests that most of the times, the farmers/people lack physical capital and information that can meet the objectives of agricultural productivity. The findings of this study conform to the outcome of research [46].

3.3. Consequences of Retrogression

Akin to running an endogenous growth model backwards—retrogression outweighs progress, this is because the Impact of HIV/AIDS reduces investment by:
1) Shorter horizons, which reduces investment in information and networks.
2) Increasing morbidity that disrupts networks and lowers efficiency.
3) Loss of workers that impairs institutions and reduces capacity of organizations.
4) Combination of effects—structured loss of information and capacity that leads to system regress.

3.4. Macroeconomic Impact of HIV/AIDS

- Individuals/farm households have shorter horizons that will increase uncertainty about future, higher current costs that reduce investment.
- Businesses will have higher short term costs—health, training, disrupted work schedules—and prospects of falling future demand, all these lead to reduce investment.
- Government will experience higher recurrent costs (health, education, redundancy payments) and prospects of declining future revenue that reduces investment.
- With all major actors seeking to reduce investment—future income will decline (often sharply).

Moreover, based on the lag between the HIV infection and the emergence of AIDS, this decline is likely to accelerate.

Table 3. Results of regression estimates of economics retrogression model.

Variable	Estimate	t-value
Growth of information (Z_1),	−4.3518	−0.3542
Physical capital (Z_2),	5.3642	3.6734**
Growth of Human capital (Z_3),	−23.456	−0.2546

Source: Computer Printout of Multiple Regression Analysis; DIAGNOSIS STATISTICS; *** = Significant at $p < 0.001$,** = Significant at $p < 0.005$,* = Significant at $p < 0.01$; $R^2 = 0.7962$, Adjusted $R^2 = 0.7461$, Standard Error = 0.8457 Constant = −2.1185.

3.5. Simultaneous Equation Regression Model Results

Table 4 and **Table 5** report the estimates of the empirical analysis of the simultaneous equation regression. **Table 4** presents the pseudo effects of the regression results, while **Table 5** the 2SLS model. These tables convey the estimated production function results with the pseudo-fixed-effect model and the two-stage least-square (2SLS) results respectively. In the 2SLS model, we explored alternative functional forms and found the linear specification to be stronger in terms of number of significant variables and the model predictors' indicator. The results show that the estimated coefficients for information received on HIV/AID, income, number of non-farm livelihood activities engaged in and expenses on health services is positive and statistically significant. On the other hand, expenses on food and opportunity cost of own labour is negative but statistically significant (**Table 4**). This is because respondents who earn modest income with less household size and spend fewer expenses on food consumed could not possibly engaged in risky sex deeds.

In addition, all the convectional inputs exhibit signs consistent with predictions of economic theory and are all statistically significant. As expected, less expenses on food consumed, information received about HIV/AIDS and diversification to non-farm livelihood tended to increase human capital growth. The predictor's estimators of the parameters estimates meant that values of plot-varying variables are significant. This fact justifies the robustness of our pseudo-fixed-effect model over a standard random effect. Past efforts of the interactions of HIV/AIDS on Economic growth, agricultural growth, and hunger and poverty have been a negative. HIV/AIDS pandemic affected human labour which in turn influenced agricultural outputs reducing farming income and food security [47]-[49].

Elasticities were computed for only six continuous variables in the Growth of Human Capital model and Long-run economic cost of HIV/AIDS. These included education (Z_1) for both growths of human capita and long-run of economic cost of HIV/AIDS models respectively, income (Z_7) and non-farm rural activities (NFRA) income (Z_{16}). The others are age (Z_3), opportunity cost of own labour (Z_9) and expenses on health (Z_{15}) **Table 6**

Table 4. Human capital growth model: Pseudo-fixed-effects results.

Variables	Coefficients.	P-Value
Household size (X_1)	87,2813	0.021
Level of education (X_2)	1.7123	0.062
Age (X_3)	0.6216	0.031
Information received about HIV/AIDS through extension/media (1 = yes) (X_4)	0.3110	0.021
Information on HIV/AIDS, prevention and protective measure (X_5)	0.4152	0.042
Hired labour (X_6)	0.8160	0.001
Inputs (X_7),	0.7210	0.002
Expenses on food (X_8)	−0.3130	0.000
Opportunity cost of own labour (X_9)	−0.7103	0.005
Income (X_{10})	116.624	0.002
Number of non-farm rural activities (X_{11})	0.0816	0.001
Market facilities (X_{12})	416.04	0.005
Access to extension facilities (X_{13})	87.18	0.003
Expenses on health services (X_{14})	−0.02610	0.003
Frequency visit to hospital for care/medication		
Sigma_u	173.216	
Sigma_e	811.290	
Rho	0.013	

Table 5. Human capital growth model: Two-Stage Least-Square (2SLS) results.

Variables	Coefficient	P-Value
Household size (X_1)	2.1103	0.010
Level of education (X_2)	0.5117	0.320
Age (X_3)	0.7114	0.203
Information received about HIV/AIDS through extension/media (1 = yes) (X_4)	0.5110	0.018
Information on HIV/AIDS, prevention and protective measure (X_5)	315.1710	0.010
Hired labour (X_6)	−61.023	0.521
Inputs (X_7),	501.82	0.003
Expenses on food (X_8)	0.4112	0.001
Opportunity cost of own labour (X_9)	4.1103	0.033
Income (X_{10})	0.0319	0.051
Number of non-farm rural activities (X_{11})	0.0291	0.000
Market facilities (X_{12})	2.1013	0.021
Access to extension facilities (X_{13})	0.0913	0.003
Expenses on health facilities	0.0182	
Constant	1106.18	0.001

Partial R-squared of excluded instruments: 0.0294

Test of excluded instruments: F (10,018) = 66.52; Prob > F = 0.000; Adjusted R^2 = 0.1629; N = 650

Table 6. Elasticity estimates from the growth of human capital and long-run economic costs of HIV/AIDS.

Variable	Long-run of economic cost of HIV/AIDS Elasticity	Growth of Human Capita Elasticity
Education (Z_1)	0.2863	0.2771
Age (Z_3)	--------	−0.2254
Income (Z_7)	0.0768	--------
Opportunity cost of own labour (Z_9)	0.0199	--------
Expenses on health services (Z_{15})	0.4837	--------
Non-farm rural activities income (Z_{16})	2.1857*	2.3827*

Source: Computed from Multiple Regression Analysis Print out. * = Elastic variable.

reveals that only NFRA income was elastic for both Growth of Human Capital model and Long-run economic cost of HIV/AIDS models out of other variables whose elasticities were computed. The most important factors that significantly long-run of economic cost of HIV/AIDS increase in order of importance included NFRA income, expenses on health services and education. While for Growth of Human Capita model, in order of importance are NFRA income, education and age. Moreover, results from **Table 6** reveals that 10 percent increase in NFRA income would result in about 22 percent increase in Long-run of economic cost of HIV/AIDS. Similarly, an increase of the same magnitude in expenses on health, education and opportunity of own labour would lead to 5 percent, 3 percent and 2 percent increase in Long-run economic cost of HIV/AIDS model respectively. For Growth of Human Capital model, 10 percent increase in NFRA income would result in 24 percent increase in the level of diversification with 8 percent and 3 percent increases in Long-run economic cost of HIV/AIDS model respectively. Growth of Human Capital has significant effect on long-run economic cost of HIV/AIDS at p < 0.05. A one percent (1%) increase in Growth of Human Capital will lead to 1.4% decrease in long-run eco-

nomic cost of HIV/AIDS. This signifies an inelastic relationship. Based on the Growth of Human Capital analysis and taking into consideration the long-run economic cost of HIV/AIDS analysis this outlet seems to be an effective policy measures that can help agricultural policy makers to improve human capital needs. This study examined the influence of Growth of Human Capital analysis on long-run economic cost of HIV/AIDS. Therefore there is a need to carry out simultaneity test between these two models Hence, Hausman specification test was used to determine the extent of the relationship following the methodology adopted by past studies [50]-[52].

3.6. Hausman Specification Test

To test whether agricultural/economic growth and HIV/AIDS pandemic are related in a simultaneous manner, the Hausman specification test was conducted. The procedure for this test is as follows. The endogenous variable in the model, such as compounded Household Income and the long-run economic cost of HIV/AIDS on agricultural sector are analyzed independently in terms of the rest of the predetermined variable using Ordinary Least Square (OLS) method. The unstandardized predicted value and residuals are saved. Having done this, another endogenous variable is created from the residuals and included in the analysis as an explanatory variable. If the t-value for this variable is statistically significant and greater or equal to 2, then it can be concluded that there is simultaneity. The following are the results after performing the Hausman Specification Test.

Hausman test Results for Equations (12) and (13).

$$\Delta Vt = 11.256 - 0.317 \Delta G\{y(t)\}^* + 0.143\varepsilon^*$$
$$t\text{-value} \qquad -5.314 \qquad 2.14 \tag{17}$$

$$\Delta G\{y(t)\} = 28.146 - 1.583 \Delta Vt^* + 0.126\varepsilon^*$$
$$t\text{-value} \quad -5.101 \qquad 2.46 \tag{18}$$

where, ΔVt = long-run economic cost of HIV/AIDS

$\Delta G\{y(t)\}^*$ = estimated unstandardized predicted value of growth of real output from reduced-form equation by OLS

ε^* = saved residual value while estimating unstandardized predicted value of compounded LDI

$\Delta G\{y(t)\}$ = Computed Household Income

ΔVt^* = estimated unstandardized predicted value of compounded ΔVt from the reduce-form equation by OLS

ε^* = saved residual value while estimating unstandardized predicted value of compounded Household income.

These estimates co-efficient for the ε^* variables are statistically significant and greater than 2 in both equation; implying that there is simultaneity between compounded changes in *Vt* and agricultural/economic growth. Equations (17) and (18) present the results from the reduced-form equation (as in $\Delta G\{y(t)\}^*$ and ΔVt^*) express endogenous variables as functions of exogenous or predetermine variables only. Their parameters measure both the direct and in direct influence of exogenous variables on endogenous variables. But these reduced-form parameters are composed entirely of structural parameters [53] [54]. That is, this reduced-form parameter is a combination of some structural parameters. This suggests that policy that can influence HIV/AIDS pandemic can also do same to improve agricultural/economic growth. Thus, this finding suggests that HIV/AIDS pandemic has a significant effect on agricultural/economic growth. The outcomes of this research were confirmed by past works [55]-[57]. These studies revealed that HIV/AIDS impoverishes rural households by increasing the cost of health care and funeral expenses as a result of HIV/AIDS victim death. This implies that affected households will experience increased impoverishment and if not checked it would continue into the future. Hence, a vicious circle is forming, linking together HIV/AIDS pandemic and penury. The results suggest that there is a curvilinear relationship between the course of the HIV/AIDS epidemic and agricultural/economic growth in terms of human capita development. Simultaneous estimation helps sort out the various direct and indirect associations among the key variables. Elasticity of income with respect to changes in life expecting is less than unity. The result from this study revealed a downward spiral because behaviour patterns do not change. This is attributed to

1) Personal and collective behaviour that lead to the spread of HIV/AIDS have to be modified.

2) Governments ensure they devote their full attention to promoting and sustaining economic reform.

3) There is also the need to formulate and implement poverty reduction and growth strategies.

In the absence of AIDS, the counter factual benchmark is modest growth, with universal and complete education attained within the next generation. If nothing is done to combat the epidemics, however, a complete economic collapse will occur within the next generations. In this case, the additional fiscal burden of intervention will be large, which reinforces the gravity of the findings. Sensitivity analysis suggests that these findings are robust to changes in a variety of key assumptions and parameter values concerning mortality, the efficiency measures taken to combat it, and the formation of expectations. A delay in responding to the outbreak of the epidemic, however, can lead to a collapse.

3.7. Potential Implications of HIV/AIDS for Agricultural Policy

Macro models from this study has projected that AIDS is affecting national GDP growth, which will affect demand and price levels for some agricultural commodities, especially those relying mostly on local demand as opposed to export demand. Many effects of AIDS on the agricultural sector are likely to operate through the overall economy, and would be neglected in an analysis that focused simply on direct pathways within the agricultural sector. Assemble multidisciplinary teams to project and forecast the effect of HIV/AIDS in the near-term and long-term on the agricultural and rural sector becomes necessary. Identify the major policy strategies/ programs of the Ministry of Agriculture and related government agencies (for example, rural poverty reduction programmes that may fall under different ministries' portfolio) that can improve farmer's income. This paper considers how the design of agricultural policies and programmes might be modified to better achieve policy objectives in the context of severe of HIV epidemics and underscores the central role of agricultural policy in mitigating the spread and impacts of the epidemics. Based on projections of future demographic change in the hardest-hit countries of Eastern and Southern Africa, HIV/AIDS is likely to have the following effects on the agricultural sector: (1) increased rural inequality caused by disproportionately severe effects of AIDS on relatively poor households; (2) a reduction in household assets and wealth, leading to less capital-intensive cropping systems for severely affected communities and households; and (3) problems in transferring knowledge of crop husbandry and marketing to the succeeding generation of African farmers. It is argued that-even though the absolute number of working age adults in the hardest-hit countries is projected to remain roughly the same over the next two decades—the cost of labour in agriculture may rise in some areas as increasing scarcity of capita (notably, animal draft power for land preparation and weeding) will increase the demand for labour in agricultural production or shift agricultural systems to less labour-and capital-intensive crops [58]. To further illustrate the potential linkages between agricultural policy and HIV/AIDS, we provide two examples from a recent FAO study. **In Uganda**, as a result of a government policy to increase production in order to substantially increase the land cultivated with maize by reducing the amount of land dedicated to banana, cassava and millet. By contrast, AIDS affected families are found to reduce the amount of land cultivated in all of the cited crops. **In Zambia**, a government policy sought to increase smallholder agricultural production through the promotion of cooperatives as a means to distribute subsidized agricultural inputs. While roughly one in two households headed by women with a person living with AIDS that were not directly affected by AIDS were members in such cooperatives, only one in ten households headed by women with a person living with AIDS, or fostering orphans were able to obtain subsidized inputs through the cooperatives. Affected male-headed households fared better, especially those fostering orphans [59]. Although the reason for this are complex and involve more dimensions than whether households suffered from AIDS or not, the study hypothesized that these were intact households who took in orphans with some of their land or other property. AIDS will have a delayed and long-wave impact because, according to demographic projections, the full effects of the disease on population and labour will not manifest until the next several decades. Therefore, the framework would be oriented to forecast impacts of these demographic changes on the agricultural/rural sectors in both the near-term (next 5 - 10 years) as well as the long-term (10 - 25 years)

4. Conclusions

The central conclusions of this paper are, first, that the AIDS epidemic will peak far in advance of the economic change. In Southern Africa, where the prevalence rates among the age group 15 - 49 are already 20% and more, the worst is still to come; second, the scale of that damage, in terms of accumulated losses in GDP per capita,

will also be large, even if the measures designed to combat the disease and to ensure the education of half- and full orphans are well chosen and the fiscal means employed to finance them are highly efficient. In the absence of such measures, an economic collapse is on the cards. Agriculture is at the heart of the lives of rural people and it can be made into a powerful tool to reduce the potential of HIV infection, if the root causes of vulnerability in farming systems, communities and households are curbed. Therefore, it is urgent to promote such awareness not only among government decision makers but also among NGOs and the private sectors. It is urgent to identify proactive strategies for the agricultural sector so that it will fulfill both production and rural development objective while contributing effectively to the fight against HIV/AIDS. There is the need to take a cue from countries where major progress has already been made in reducing the spread of HIV (e.g. Uganda). If the ingredients of success can be replicated more broadly, then doing so in a proactive way may be one of the most effective ways by which governments and donors can only support their agricultural and rural development objectives, but also save millions of lives that can contribute to society growth. The main reason for these gloomy findings lies in the peculiarly insidious and selective character of the disease. By killing mostly young adults, AIDS does more than destroy the human capital embodied in them; it also deprives their children of those very things they need to become economically productive adults-their parents' loving care, knowledge and capacity to finance education. This weakening of the mechanism through which human capital is transmitted and accumulated across generations becomes apparent only after a long Lag, and it is progressively cumulative in its effects. If agriculture can contribute to improving food security and increasing the income of farmers, then all efforts must see to its growth. For instance, if women might not have to go into sex work when a crop fails, there must be an alternative to create an income generating activity to keep her going on. Therefore, exiting health approaches to HIV/AIDS need to be strengthened through development strategies in agriculture, transport, construction and industry.

Some studies have revealed that agricultural extension workers possess attributes known to be correlated with HIV contraction: mobility, education and relative affluence. There is a need to focus on attitude and sex behaviour change among agricultural extension workers and utilize them as forces for positive behaviour change in the community. As stated by the Uganda's Ministry of Agriculture, Animal Industry and Fisheries: Extension workers interact regularly with the crop farmers, livestock farmers and the fishing folk. However, despite this regular interaction extension workers are not involved in HIV/AIDS work, as it does not fall within their mandate. Also the extension workers at present lack the knowledge and skills of addressing HIV/AIDS issues since it had long been perceived as health matter. In a way, HIV/AIDS seemed to have been perceived in the agricultural sector as a health issue, but not a development issue. Extension contents need to incorporate conservation agriculture and other labour saving technologies and practices that address the specific labour shortages arising as consequences of the epidemic, especially among the most vulnerable groups and among those rendered vulnerable due to the epidemic. They need to promote crops that are more suitable to the families affected by AIDS. Until now, agriculture has been concerned mostly with increasing production, while neglecting the human and social costs involved. The HIV/AIDS pandemic interactions have demonstrates that a more balanced approach is necessary. This is a challenge to agricultural policy makers; the price of failure is just too high when the lives and welfare of over 1.5 billion rural people are at stage—not to mention the economic dimensions involved.

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