EFFECT OF HIV/AIDS INFECTION ON LABOUR SUPPLY AND AGRICULTURAL PRODUCTIVITY IN BENUE STATE, NIGERIA

M. A. Ojo , J.E. John, A.I. Odine, A. O. Ojo and Y. Mohammed
Department of Agricultural Economics and Extension Technology,
Federal University of Technology, Minna, Niger State, Nigeria
Corresponding author e-mail: akinmikky@yahoo.co.uk
Cell phone number of corresponding author: +2348033674308

ABSTRACT

The study examined the effect of HIV/AIDS infection on labour supply and agricultural productivity in Benue State, Nigeria. Data used for the study were obtained with structured questionnaires administered to 89 randomly selected infected farmers in the study area. Data were analyzed using ordinary least square (OLS) regression and stochastic frontier production function. The results of showed that the poor health status of the farmers had significant and negative effect on farm supply of labour and agricultural productivity in the study area. The study revealed that an increase in the poor health status of the farmers in the study area led to 5% and 14.03% decrease in farm labour supply and agricultural productivity, respectively. The study further showed a mean technical efficiency of 0.51 meaning that the HIV/AIDS infected farmers in the study area were not fully technically efficient and therefore there is allowance of efficiency improvement by addressing some important policy variables that could positively influence their levels of technical efficiency in the area. It is therefore recommended that programmes aimed at preventing HIV/AIDS infection should be targeted more at the youths both the single and married by government at all levels and stakeholders in Health Ministry. The infected farmers should be encouraged to visit the available HIV/AIDS counseling and treatment centers so that the infection can be managed appropriately and therefore reduces its effect on agricultural labour supply and productivity.

KEY WORDS: Effect, health, HIV/AIDS infected farmers, agricultural productivity

INTRODUCTION

Agriculture can be regarded as the single most important sector in Africa providing livelihood for at least 53% of the economically active population while the rural small scale farmers are the main people involved in the production of food and income for most of the population (World Bank, 2007). Agriculture has been linked to health and the rural communities bear the greatest burden of this health issues especially the Human Immune Virus (HIV) and the Acquired Immune Deficiency Syndrome (AIDS). Illness and death from HIV/AIDS, malaria, tuberculosis, and other diseases give rise to a reduction in agricultural productivity through the loss of labour (e.g. rural men, women and children) and assets to cope with illness, the inability to cultivate traditional crops due to illness, more households headed by children, and consequential adoption of less-productive farming strategies (World Bank, 2007).

According to Robert *et al*. (2006), Kermyt and Beutel, (2007), AIDS is a profound human tragedy, which has gone beyond mere health problem to a real threat to economic growth and development. In Nigeria, an estimated 3.3 million people were living with aids, while 220,000 people died from AIDS in 2009 (UNAIDS 2010). The effect of this disease HIV/AIDS in Africa now cuts across all sectors of human development, posing serious challenges to the survival of several vulnerable poor, whose livelihood depend solely on agriculture. This, according to Hawkes and Ruel (2006), is due to the fact that poor health reduces income, labour supply and productivity and further decreases people's ability to address poor health thereby inhibiting economic development. Indeed, improvements in health care increase the productivity of labour, especially if people move from low to high productivity jobs as their health improves (Ulimwengu, 2009). Egbetokun *et al*. (2012), also reported that good health as related to labour output or better production organization, which can enhance farmer's income and economic growth. Poor health results in loss of work days or decreases workers capacity, innovation ability and ability to explore diverse farming practices, and by such makes farmers to capitalize on farm specific knowledge. Also, higher agricultural productivity affects family earnings and nutrition which in turn improves labour productivity and results in better health and well-being which further translates to higher agricultural productivity (Oshaug and Haddad, 2002).

Most previous studies focused generally on the effect of ill health on agricultural production without been disease specific. This approach undermined or limited the usefulness of the results when assessing the effect of HIV/AIDS on the farmers' productivity in the study area. There is need for a disease specific study in order to fill the huge gaps in understanding, and to identify the scale and scope for policy response. In view of this, the study examined the effect of HIV/AIDS on farm labour supply and farmers' productivity in Benue State of Nigeria.

Theoretical Framework:

Health, labour supply and agricultural productivity

Health capital is both a result and a determinant of labour and hence income level (Weil, 2004). The mechanism is that richer nations have on average healthier workforce. The healthiness of the country's labour force determines importantly her level of productivity and hence economic growth. Labour productivity varies as a function of the health capital of the economy amongst other factors of production and the efficiency with which these inputs are utilized (Umoru and Yaqub, 2013). Chakraborty (2004) hypothesized that an economy with a high rate of survival (measured by many years of life expectancy) will converge faster to steady-state growth paths. This justifies role of health capital in the productivity of the labour force of a nation, because healthier-nation is a wealthier-nation. By implication, ill-health has adverse effects on national savings (capital accumulation) and productivity of the labour force (Umoru and Yaqub, 2013).

According to Lori *et al*. (1999), health challenge, like HIV/AIDS infection, has two major economic effects which are a reduction in the labor supply and increased costs. Effect on labour supply includes the loss of young adults in their most productive years which will affect overall economic output, while the cost effect includes increase in the direct costs of HIV/AIDS such as expenditures for medical care, drugs, and funeral expenses. Indirect costs include lost time due to illness, recruitment and training costs to replace workers, and care of orphans. If costs are financed out of savings, then the reduction in investment could lead to a significant reduction in economic growth. The importance of the role of health in promoting economic development was highlighted by Sachs (2001) in the report of the Commission on Macroeconomics and Health. Indeed, improvements in health care increase the productivity of labour, especially if people switch from low to high productivity jobs as their health improves.

HIV/AIDS reduces agricultural productivity and diminishes the availability of food through direct loss of family labour, reduction in time allocated to family, loss of farm assets, cultivation of marginal land and marginalization of surviving widow from land ownership by customary land tenure system. The farmer loses on the average 22 working days when incapacitated by one sickness or the other per time (Ugwu, 2006 and Ashagidigbi, 2004). Hawkes and Ruel (2006) reported that, in agricultural communities poor health reduces income and productivity, further decreasing people's ability to address health problems and inhibiting economic development. Good health enhances work effectiveness, efficiency and productivity of an individual through increases in physical and mental capacities. It is therefore extremely difficult to separate efficiency in agriculture from the agricultural producer and health stock.

Measurement of productivity

Productivity could be measured in terms of marginal physical product (MPP) in which case, the interest is in the addition to total product resulting exclusively from a unit increase in the use of that input i.e., total factor productivity (TFP) growth, which is measured using the frontier and non-frontier approaches. It therefore suffices to say that productivity can only be measured and ascertained from farm-level efficiency (Udoh and Falake, 2006). According to Arthur Ha *et al.* (2001), an important concept of productivity analysis is technical efficiency. Productivity is generally measured in terms of the efficiency with which factor inputs, such as land, labour, fertilizer, herbicides, tools, seeds and equipment, are converted to output within the production process (Umoh and Yusuf, 1999).

Farrell, (1957) distinguishes between technical and allocative efficiency through the use of a frontier production and cost function respectively. He defined technical efficiency as the ability of a firm to produce a given level output with a minimum quantity of inputs under certain technology and allocative efficiency as ability of a firm to choose optimal input levels for a given factor prices. In Farrell's Framework, economic efficiency (EE) is an overall performance measure, and is equal to the product of TE and AE (that is EE = TE x AE).

However, over the years, Farrell's methodology has been applied widely, while undergoing many refinements and improvements. Such improvement is the development of stochastic frontier model that enables one to measure firm level efficiency using maximum likelihood estimate. The stochastic frontier model incorporates a composed error structure with a two sided symmetry and one sided component. The one sided component reflects inefficiency while two sided component captures random effects outside the control of production unit including measurement errors and other statistical noise typical of empirical relationship.

In this study, Battese and Coelli (1995) model was used which builds hypothesized efficiency determinants into the inefficiency error component so that one can identify focal points for action to bring efficiency to higher levels.

The general form of the model is expressed as:

$$Q_1 = \beta_0 + \beta_1 X_1 + (V_I - U_I) \qquad (1)$$

Where

Q_i is the production (on the logarithm of the production) of the *ith* firm;

X_i is a vector of (transformations of the) input quantities of the *ith* firm;

β is a vector of unknown parameters;

The V_i are random variables which are assumed to be iid $(N, \delta^2 v)$ and independent of the U_i which are non-negative random variables which are assumed to account for technical inefficiency in production and are often assumed to be iid $(0, \delta^2 u)$.

It is further assumed that the average level of technical inefficiency, measured by the mode of the truncated normal distribution (i.e. *Ui*) is a function of factors believed to affect technical inefficiency as shown below:

$$U_i = \delta_0 + \delta_1 Z_1 \qquad (2)$$

Where

Z_1 is a column vector of hypothesized efficiency determinants and δ_0 and δ_1 are unknown parameters to be estimated. It is clear that if U_i does not exist in equation (1) or $U_1 = \delta_0^2 = 0$, the stochastic frontier production function reduces to a traditional production function. In that case, the observed units are equally efficient and residual output is solely explained by unsystematic influences. The distributional parameters, U_i and δU^2 are hence inefficiency indicators, the former indicators, the former indicating the average level of technical inefficiency and the latter the dispersion of the inefficiency level across observational units.

Given functional and distributional assumptions, the values of unknown coefficients in equations (1) and (2), i.e β_0, β_1, δ_0, δu^2 and δv^2 can be obtained jointly using the maximum likelihood method (ME). An estimated value of technical efficiency for each observation can then be calculated as

$$TE_I = \exp(-U_i). \qquad (3)$$

The unobservable value of V may be obtained from its conditional expectation given the observation value of ($V_i - U_i$)

METHODOLOGY

Study Area: The study was conducted in Benue State of Nigeria. It is located in the heart of the middle belt or central zone of Nigerian longitudes 6^o 35'E to 10^{o}E and latitude 6^o 30'N to 8^o 10'N. Benue State with a total land mass of 69.740 million square kilometres, has estimated arable land of 5.09 million hectares representing 5.4 of the nation's total land mass (Benue Agricultural Development Agency, 1998), The annual rainfall varies from 1750mm in the southern part to 1250mm in the north, the average annual temperature varies from 32^{o}C-38^{o}C (Ogbodo, 2004). The State is administratively divided into 23 Local Government Areas, with a population of 5.2 million people (National Population Commission 2006), Food and cash crops produced in the State include yam, cassava, sweet potato, sorghum, maize, millet, groundnut, soya beans, rice, sweet orange, mangoes and cashew.

Sampling Technique: Primary data were collected with the aid of a questionnaire designed in line with the objectives of the study. Multi-stage sampling technique was used for the purpose of this study. The first stage was the purposive selection of Makurdi and Wannuneh Local Government Areas (LGAs) because of the prevalence of HIV/AIDS infection in these areas. In the second stage a random selection of random selection of HIV/AIDS infected farmers through the help of community health workers and records obtained from health information centres situated within the Local Government Areas. Fifty farmers from each of the two LGAs were selected making a total of 100 farmers; however only 89 responded and were therefore used for the final analysis.

Data Collection

The data were collected with the use of structured questionnaire designed in line with the objectives of the study. Data collected included total crop output produced per annum in kilogram or tonnes (rice, maize, cowpea, millet sorghum, beniseed yam and cassava), while the inputs included the size of farm land in hectare, quantity of seeds as planting materials in kg; quantity of fertilizer used in kg; quantity of herbicides used in litres and total labour in man-days which include family and hired labour utilised pre and post planting operations and harvesting; prices of crops in Naira. Also, data collected include the farmer's socio-economic variables and the extent to which they had been affected by chronic illness and death. The data were collected with the use of structured questionnaire designed in line with objectives of the study.

Method of Data Analysis: Data were analysed with the use of descriptive statistics such as mean, standard deviation, percentage frequency table. Ordinary Least Square regression (OLS) and the Stochastic Production Frontier (SPF) were also used in the analysis of the data.

Model Specification

Ordinary Least Square regression was used to determine the effect of HIV/AIDS on agricultural labour supply and the model is specified as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6) \qquad (4)$$

Where

Y= Labour (mandays)

X_1= Age (years)

X_2= Gender (1= male; 0 otherwise)

X_3= Health status (measured in the number of days the farmer is absent from farm as a result of the illness)

X_4= Household size

X_5= Level of Education (years spent on formal education)

Stochastic Production Frontier: the SPF was used to determine the effect of HIV/AIDS on farmers' productivity in the study area. The model is specified in its explicit form as;

$$\ln Y = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 Inx_3 + \beta_4 Inx_4 + \beta_5 InX_5 + (V_i - U_i) \qquad (5)$$

Where Y^i = Output of the crop farmers (in tonnes) (crop outputs aggregated using in Grain Equivalent Table)

X_1 = Farm size (hectares).

X_2 = Labour used (man days)

X_3 = Quantity of fertilizer (kg)

X_4 = Quantity of seed (kg)

X_5 = Quantity of insecticides (litres)

V_i - U_i = as defined in equation (2)

$\beta_0 - \beta_5$ = Parameter estimates

i = 1, 2, 3 ….n, farms.

The technical efficiency for individual farm was computed as an index for farmer's productivity. Based on the factors influencing the technical efficiency of the farms, the Coelli and Battese (1996) inefficiency model was employed to estimate the parameters of the variables. The model assumes that the inefficiency effect u_i is independently distributed with mean U_i and variance δ^2.

The model is specified as:

$$\mu = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} + \delta_8 Z_{8i} + e_i \text{ ------- (6)}$$

Where

Z_1 = Actual age (year)

Z_2 = Household size (number of persons)

Z_3 = Education level of farmer (number of years spent on formal education)

Z_4 = Farming experience (years)

Z_5 = Health status of the farmer (number of days not present in the farm due to illness)

Z_6 = Gender of the farmer (dummy variable 1 for male and 0 for female)

Z_7 = Marital status (dummy variable 1 for married and 0 otherwise)

Z_8 = Distance (km)

$d_0 - d_6$ = Regression estimates

e^i = a random disturbance following half normal distribution.

β, δ, δ^2 (Sigma squared) and γ (gamma) are unknown parameters to be estimated. δ^2 And γ coefficients are diagnostic statistics that indicate the relevance of use of the stochastic production frontier function and the correctness of the assumptions of the disturbance of the error term.

The technical efficiency of the farmers is expressed as:

TE_i = exp (-Ui)

(7)

RESULTS AND DISCUSSIONS

Effect of HIV/AIDS infection on labour supply

The result of the regression model used to determine the effect of HIV/AIDS on farm labour supply is shown in Table 1. The value of the coefficient of determination (R^2) indicated that 42.05% of the variation in labour supply was explained by the variables indicated in the regression model. The regression coefficients of household size and gender are positive implying that an increase in the number of male farmers and household size led to increase in farm labour supply. These two variables (gender and household size) were significant at 5% and 1% probability level. The coefficients for health status and age of the farmer were negative implying that a unit increase in the age of the farmer and HIV/AIDS infection among the farmers led to a decrease in the farm labour supply in the study area. This is due to illness and possible death of infected persons. Also, the time spent by other members of the household caring for the sick members of the household affects the supply of labour negatively. The result agrees with the findings of Mutangadura (2000) and Franklin. and Kinkingninhoun-Medagbe (2011) who reported that farm labour supply reduces with high HIV/AIDS infection among farmers. This was also confirmed by Ugwu (2006) and Ashagidigbi (2004) who reported that farmer loses on the average 22 working days when incapacitated by one sickness or the other per time.

Table 1: Effect of HIV/AIDS on labour supply in the study area

Variables	Coefficients	T-value
Constant	4.516	4.65***
Age (X_1)	-0.090	-2.65***
Gender (X_2)	0.435	2.18**
Health Status(X_3)	-0.050	-2.47**
Household size (X_4)	0.084	4.96***
Education level (X_5)	-0.99	-0.38

R^2 = 0.4205, F-value = 7.83***

******* *= Significant at 1% probability level, ** = Significant at 5% probability level*

Source: Data from field survey, 2012

Production analysis: The summary statistics of the variables use in the frontier estimation is presented in Table 2. The results in Table 2 show that the mean output value per farming season was 1.55 tons per hectare. The average farm size was 1.12 ha indicating that the farmers were small scale farmers. The average labour of 161.56 man-day shows that the respondents rely mostly on human labour to do all or most of the farming operations. The mean quantity of seeds and fertilizer was 56.67kg and 107.29kg respectively. All these findings point to the characteristic nature of subsistence farming which dominates agricultural production in Nigeria. The stochastic frontier production function estimates of HIV infected Farmers in Benue State are presented in Table 3. The results in Table 3 show that the coefficients of land, fertilizer, seed, agrochemicals and capital input had positive signs, which indicated that a unit increase in these variables led to increase in the gross output of the crop farmers in the study area. These variables were statistically significant at 1% level of probability. The estimated elasticity of mean output with respect to land, seed and capital inputs were inelastic (0.3822, 0.1514, and 0.3849 respectively), this implies that a unit increased in these inputs led to less than proportionate increase in output of the farmers in the study area.

Table 2: Summary statistics of the variables in Stochastic Frontier Model

Variables	Mean	Standard Deviation	Minimum	Maximum
Output(tonnes)/ha/year	1.55	3.32	0.5	12.00
Farm size (ha)	1.12	1.93	0.56	5.60
Labour (manday)	161.56	56.23	65.4	296.7
Fertilizer (kg)	107.29	81.97	10.00	250.00
Seed (kg)	56.67	2.34	12.40	86.34
Herbicides (litres)	8.18	5.80	0.50	25.00
Depreciation (Naira)	1,552.21	954.23	110.00	12000.00
Age (year)	38.04	12.02	18.00	72.00
Household size	7.60	7.83	1.00	18.00
Education(year)	8.03	5.61	0.00	19.00
Farming Experience (year)	20.98	9.10	5.00	45.00
Health status (number of days not present in the farm due to illness)	30.80	6.74	15.20	41.20

Source: Data from field survey, 2012

Determinants of Technical Inefficiency

Table 3 also shows the result of the determinants of technical efficiency of the farmers in Benue State. The sigma square is 0.4693 and statistically significant at 0.01 probability level. This indicates a good fit and the correctness of the specified distributed assumption of the composite error term. The gamma (γ) ratio of 0.6999 which is significant at 0.01 probability level implied that about 69.99% variation in the output of the HIV/AIDS infected farmers was due to differences in their technical efficiencies. An explanation for the relative efficiency levels among individuals' farms is provided from the estimated coefficients of the inefficiency function. The negative coefficients for household size, and farming experience implies that increased in farmers' household size and years of farming experience led to increase in the technical efficiency of the farmers in the study area. Also, negative coefficient of farmer's health status (which was measured as days lost to illness) implies that the farmers' level of technical efficiency was negatively affected by poor health status of the farmers in the study area. Also, the health status implies that one percent improvement in the health condition of the farmers will increase efficiency by 14.03 percent. This finding is in line with that of Karamba (1997), who reported that HIV/AIDS significantly affected agricultural production in Zimbabwe. Ulimwengu,

(2009) and Egbetokun *et al*. (2012) also reported that improved farmer's health had a positive effect on their productivity.

Table 3: Maximum Likelihood Estimates of Parameters of the Stochastic Production Function for sampled HIV/AIDS infected Farmers in Benue State.

Variables	Parameters	Coefficients	T-ratio
Constant	$ß_0$	10.1728	22.2270***
Farm size (ha)	$ß_1$	0.3822	22.9341***
Labour (Man-days)	$ß_2$	-0.1319	-3.6830***
Fertilizer (kg)	$ß_3$	0.0519	0.4897 N.S
Seed used (kg)	$ß_4$	0.1514	3.0564***
Agrochemical (Litres)	$ß_5$	0.0007	0.0262 N.S
Capital input	$ß_6$	0.3849	8.7739***
Inefficiency model			
Constant	δ_0	-0.145	-0.1740 N.S
Age (Years)	δ_1	0.0601	12.6900***
Household size	δ_2	-0.0551	12.2367***
Educational Level (years)	δ_3	0.0451	0.9994 N.S
Farming Experience (years)	δ_4	-0.064	-2.5323**
Health Status	δ_5	-0.1403	-2.4784**
Sex (gender)	δ_6	0.1622	0.1935 N.S
Marital Status	δ_7	0.0323	4.7456***
sigma-squared		0.4693	7.4801***
Gamma	γ	0.6999	8..6330***
Log likelihood function		-70.8105	
LR Test		38.9275	

***, **and* indicate significant at 0.01, 0.05 and 0.10 probability level respectively. NS = Not significant

Source: Data analysis from field survey, 2012

Technical Efficiency Estimates of the farmers

The technical efficiency indices were derived from the MLE results of the stochastic production function, using computer programme FRONTIER 4.1. The distribution of technical efficiency of the sampled HIV/AIDS infected farmers in the study area is shown on Table 6. The technical efficiency of the HIV/AIDS infected farmers was less than one (less than 100%), implying that all the infected farmers in the study area were producing below the maximum efficiency frontier. Some of farmers demonstrated a range of technical efficiency of 0.9951 (99.51%) and the least of them had a technical efficiency of 0.0388 (3.88%). The mean technical efficiency is 0.5116 (51.16%), implying that an average HIV/AIDS infected farmer in the study area was able to obtain a little over 51 percent of output from a given mix of production inputs. Although the HIV/AIDS infected farmers were relatively efficient, they still have room to increase the efficiency in their farming through the use of hired labour activities as about 48.84 percent efficiency gap from optimum (100%) was yet to be attained by all the infected farmers.

Table 4: Distribution of Technical Efficiency of in the Study Area

Efficiency class index	Frequency	Average technical efficiency	Average number of days ill
0.01 - 0.10	5.00	0.06	33.48
0.11 - 0.20	8.00	0.16	31.4
0.21 - 0.30	12.00	0.26	29.75
0.31 - 0.40	9.00	0.35	27.93
0.41 - 0.50	11.00	0.45	32.98
0.51 - 0.60	12.00	0.56	28.9
0.61 - 0.70	9.00	0.66	29.56
0.71 - 0.80	9.00	0.75	30.33
0.81 - 0.90	3.00	0.85	27.67
0.91 - 1.00	11.00	0.97	29.45
Mean		0.51	30.8
Maximum		0.99	41.20
Minimum		0.04	15.20

Source: Data analysis from field survey, 2012

CONCLUSIONS AND RECOMMENDATION

This empirical study is on effect of HIV/AIDS on labour supply and agricultural productivity in Benue State, Nigeria. The findings in this study shows that an improvement in the poor health status of the farmers in the study area led to decrease in farm labour supply and agricultural productivity respectively. The study also revealed mean technical efficiency of 0.51 meaning that the HIV/AIDS infected farmers in the study area were not fully technically efficient, and therefore there is allowance of efficiency improvement by addressing some important policy variables that could negatively and positively influence farmers' levels of technical efficiency in the area. The study therefore recommends that programmes aimed at preventing HIV/AIDS infection should be targeted more at the youths both the single and married by government at all levels and stakeholders in the Health Ministry. The infected farmers should be encouraged to visit the available HIV/AIDS counseling and treatment centers so that the infection can be managed appropriately and therefore reduces its effect on agricultural labour supply and productivity.

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