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The Impact of Farmers' Health and Nutritional Status on Agricultural Technical Efficiency: Evidence from Masvingo Rural Communities

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Abstract
Agricultural productivity is the cornerstone to increasing rural household welfare in Masvingo region (Munongo 2012). However the spread of diseases especially HIV and AIDS prevalence in the area threaten to reduce the gains the government of Zimbabwe had made in improving the rural livelihoods. This paper uses a structured questionnaire that had 123 respondents in Masvingo rural to investigate the efficiency effects of health status. Data were collected on health status and production characteristics of the farmers and analyzed using the Maximum Likelihood Estimation Method of Stochastic Production Frontier model. The result of the effect of ill-health on technical efficiency of the farmers showed that land, labour, fertilizer and seed were positively related to output. In the inefficiency model, adverse health, age, household sizes have positive effects on inefficiency of the farmers. It could be concluded that it is possible to increase productivity through improvement on the stock of health status of the farmers.
Keywords: household, health status, inefficiency, stochastic frontier and welfare.

Introduction

Zimbabwe's statistical indicators for health and education were once among the best in Africa. But the political and economic crisis since year 2000 has brought rising poverty and social decline in its wake. The 2003 Poverty Assessment Study Survey II showed a substantial increase in poverty; between 1990 and 2003 the poverty rate rose from 25 per cent to 63 per cent (*IFAD 2004*).

There are significant differences in poverty rates among the provinces. Matabeleland North has the highest poverty rate in the country, with 70 per cent of its inhabitants classified as poor or extremely poor. Poverty is also concentrated in the south-eastern provinces of Manicaland and Masvingo, which are among the driest and least productive areas in the country. Thus our study will help in trying to find solutions to improving household output in Masvingo province.

The economic crisis of the past decades (1990-2010) has prevented substantial capital investment, and new enterprises have been slow to emerge. Agricultural production in general has suffered as a result of weak support services, lack of credit, and acute shortages of essential inputs such as seeds, fertilizer and fuel. In drier areas water scarcity is a major challenge for farmers. Productivity can be improved only through investment in agriculture water management, particularly small-scale irrigation and water harvesting. Many smallholders are struggling to continue farming, and only a minority in some areas has been able to establish viable enterprises (*IFAD 2004*).

Drought has exacerbated an already difficult situation and has made it harder for farmers in dry areas to raise their productivity. Food insecurity continues to worsen both for urban and rural areas of the province. Masvingo province has become a net importer of food products and many people are now dependent on food aid as evidenced by the number of food distributing NGOs in the province.

Most of the districts of Masvingo are vulnerable to drought. Poverty, reflected in vulnerability to food and income shocks, particularly due to drought, is endemic in the province. The characteristics of Masvingo Communal Areas are similar to those of most communal areas of Zimbabwe. Its characteristics include poor soils, which cannot sustain reasonable crop returns without application of fertilizer or manure. Drought has been occurring frequently in the past decade; almost in three years out of every five thus irrigational technology is very useful in the area to increase output (Munongo 2012)

The land pressure in Masvingo is high and accompanied by a high population growth rate (Murwira, 1995). Most of the agricultural production relies on rain, with extremely low use of external inputs, particularly among the poorest households, who also depend more on agricultural income. Thus increased productivity would require that household labour be at its best all the time. As pointed out by Hawks and Ruel (2006), in agricultural communities, poor health reduces income; efficiency and productivity, further decreasing people's ability to address health problems inhibit economic development.

Health affects agricultural systems by affecting the health of the farm principal operators. Poor health results in loss of work days or decreases workers capacity, decrease innovation ability and ability to explore diverse farming practices and by such makes farmers to capitalize on farm specific knowledge. Clifford *et al.*(2006), Donald (2006) and Bradley (2002) opined that health capital is affected by a number of preventable diseases such as malaria fever, HIV/AIDS, farm injuries, cholera fever, schistosomiasis, diarrhoea, respiratory diseases and skin disorders.

Health raises physical capacities like strength and endurance, mental capacities and reasoning abilities. These enhance workers' productivity (FAO/WHO, 1992) and having a great impact on the number of hours worked by humans everywhere (Currie and Madrian, 1999). Developing countries need good health and productive agriculture to fight against poverty because, lowered productivity by agricultural workers due to poor health, affects their income and further deepens the incidence of poverty and ill health (IFPRI, 2007). Despite this finding, previous studies failed to adopt a holistic approach to the problem of farmers' health status and efficiency in rural communities.

Despite the number of studies focusing on the links between health status and economic outcomes, very few focus on the contribution of improvements in health to rural agricultural efficiency. Thus this paper seeks to fill this gap by looking at the effects of health on efficiency in the vulnerable society of Masvingo rural communities.

Literature review

The relationship between good health and economic wealth is well documented. The impact of health can be manifested as increased income, wages, efficiency, and productivity. And hence, this relationship can readily be seen in descriptive statistics in order to disentangle the precise nature of the connection. It is likely that causality runs in both directions. However, both health and prosperity (increase in efficiency and/or productivity) are also affected by many other variables. This makes the analysis more complicated.

Human capital inputs have been recognized as critical factors in achieving recent sustained growth in productivity in some African countries (Schultz 2003). Farmers affected by ill health could experience lower technical efficiency due to impaired work capacity in the field and reduced management and supervision abilities (Antle and Pingali 1994). Farm work, particularly hoe agriculture, is physically demanding; it is thus likely that nutrition affects labour productivity through its effect on the person's energy expenditure level (Strauss 1986).

Weight for height is a human capital attribute of farm household members associated with their current productivity. This form of heterogeneity is to some degree reproducible. Weight for height is formed by the biological process of human growth, in which the inputs of nutritional intakes, protection from exposure to disease, health care, and activity levels combine to yield a net cumulative effect on the individual's realization of his or her genetic potential. This characteristic of farm household members is viewed here as an indicator of human capital because it can be augmented by social or private investments, but also varies across individuals because of genetic and environmental factors that are not controlled by the individual, family, or community (Schultz 2003).

Better health as related to labour productivity or better production organization can increase agricultural production and economic growth. Poor health will results in a loss of days worked or in reduced worker capacity, which, when family and hired labour are not perfect substitutes or when there are liquidity constraints, is likely to reduce output (Croppenstedt and Muller, 2000).

That income and health are interrelated is beyond question. Higher-income countries have better health, and, as incomes grow across populations, their overall health improves. It is also widely known that agricultural productivity has historically played an essential role in economic development. Increases in productivity in the agriculture sector release resources for use in the nascent industrial sector. Some researchers have argued that education has a greater causal impact on agricultural productivity than does health (Huffman and Orazem 2007). Nonetheless, this process of economic development has always been accompanied by improved health.

The health problem has direct and indirect cost on the productivity of the farmer. The adverse health impacts on the outcomes by affecting the capacity of the labour. Egbetokun et.al (2012) assesses the impact of health on agricultural technical efficiency in Nigeria. They selected 120 farm households in multi-stage random sampling technique and carried out the maximum likelihood stochastic frontier analysis. They found that one percent improvement in the health condition of the farmers will increase efficiency by 21 percent.

Methodology

The Stochastic Frontier Production Function

Following the leads of Egbetokun et.al (2012) in their study on Nigeria our methodology will adopt the stochastic production function in particular, Cobb-Douglas functional form to estimate the coefficients of the parameters of the production function and also to predict technical efficiencies of the farmers. The choice of this model is because this model allows for the presence of technical inefficiency while accepting that random shocks (weather or disease) beyond the control of the farmer can affect output.

Stochastic frontiers have been used to measure efficiencies in many areas of production including manufacturing industries since they were independently coined by Aigner *et al* (1977) and Meeusen and van den Broeck (1977). A production frontier represents the maximum amount of output that can be produced given a set of inputs. Since most farms typically fall below this output, the deviation from the maximum output is the measure of inefficiency and is the focus of our empirical work.

The model specifies output (Y) as a function of a set of inputs (Xs) and a disturbance term (e_i). That is:

$$Y_i = f(X_i; \beta) + e_i$$

Where:

Y_i = Output of the ith household (in grain equivalent)

X_i = Vector of actual input quantities used by the ith household

β = Vector of parameters to be estimated

e_i = composite error term

$$e_i = v_i - \mu_i \text{.......... .... 2}$$

v_i = Decomposed error term measuring technical efficiency of the ith farm.

μ_i = The inefficiency component of the error term

The symmetric component (v_i) represents the variation in output due to factors (weather or disease attack) beyond the farmer's control. This symmetric component of the error term is independently and normally distributed as N $(0, \delta V^2)$. A one sided component ($\mu_i \succ 0$) shows technical inefficiency relative to the stochastic frontier. Hence, if $\mu_i = 0$, production lies below the frontier and μ_i is assumed to be independently and identically distributed and truncated at zero with the variance $\delta V^2 (N\,0, \delta V^2)$. The parameter estimators (β) and the variance parameters were obtained by the maximum likelihood estimation method.

According to Coelli (1996), technical efficiency of the individual industry is defined in terms of the ratio of observed output to the corresponding frontier output, conditional on the level of inputs used in the household. Technical efficiency of in *i household,* the stochastic frontier production function equals the ratio of observed output to estimated frontier output:

$$TE_i = \frac{Y_i}{\exp\left(f(X_i, \beta,)\right)} = \exp(-\mu_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Since μ_i is defined as non-negative random variable, the technical efficiencies will lie between zero and unity, where unity indicates that a firm is technically efficient. The empirical model of the stochastic production frontier function is specified as follows:

$$LnY_i = \beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + v_i - \mu_i \ldots\ldots\ldots \quad 4$$

Where Y_i = value of output of the crop farmers

x_1 = Land area cultivated measured in hactares

x_2 = Labour used in man days

x_3 = Quantity of fertilizer used in kg

x_4 = Quantity of seed used in kg

The technical efficiency for individual farm was computed as an index and the average technical efficiency for the production system determined. Based on a number of socio-economic factors identified to be 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 μ_i is independently distributed with mean μ and variance δ^2. The model is specified as:

$$\mu_i = d_0 + d_1 z_1 + d_2 z_2 + d_3 z_3 + d_4 z_4 + d_5 z_5 + d_6 z_6 + d_7 z_7 + e_i \text{..........} \quad \text{..........} \quad 5$$

z_1 = Age of household head

z_2 = Household size

z_3 = Education of farmer measured in years in schooling

z_4 = Farming experience in years of farming

z_5 = Health status of farmer measured in days of incapacitation due to illness

z_6 = Marital status of farmer measured as dummy variable 1 for married and 0 otherwise

z_7 = Gender of farmer measured as a dummy 1 for male and 0 otherwise

$d_0 - d_7$ = Regression estimates

e_i – A random disturbance following half normal distribution

Source and Method of Data Collection

The study was carried in Masvingo rural district communities. The data for this study were obtained mainly from primary source. The tool for collecting the data was a well structured questionnaire.

The information collected in the survey included data on: the sicknesses prevalent in the area, sickness that affected any member of household in the last one year, days stayed off the farm due to illness, the kind of health care services in the study area, the major constraints in seeking health care, age, total number of years spent in school, marital status, sex of the respondents, household size, occupations (primary and secondary occupation). Questionnaires were distributed mainly to household heads except in cases where such heads were not available. We did our estimation of efficiency using stata version 9.0.

Results and policy implication discussions

The Socio-Economic Characteristics of the Farmers

Table 1

Variable	Percentage	Average number of days ill	Average technical efficiency
Sex			
Male	91	50.11	0.58
Female	9	5.78	0.54
Marital status			
Single	4	2.33	0.78
Monogamous marriage	77	35.43	0.53
Widowed	10	50.78	0.33
Polygamous marriage	9	45.33	0.45
Farm size			
1-3hectare	64	30.64	0.41

5-10 hectare	36	13.45	0.64
Age of farmer			
20-34	4	4.76	0.56
35-49	56	45.54	0.67
50-64	28	54.77	0.45
65+	12	67.99	0.36
experience			
1-9	45	56.76	0.54
10+	55	67.89	0.61

Sex of Farmers

91 per cent of the respondents were males while 9 percent were female. This means that majority of the farming households were headed by males. Also, average number of days ill for the male farmers (50.11) was higher than that of female farmers (5.78). This implies that male farmers engaged in most tedious farm operations such as ridging, weeding and ploughing, all these exposed them to farm accident and musculoskeletal disorder. Average technical efficiency of male was 0.58 and average technical efficiency of female was 0.54. This shows that male farmers are slightly more efficient than female farmers in the study area.

Marital Status

4 per cent of the respondents were single, 77 per cent of respondents were married monogamous, 9 percent of respondents were married polygamous and 10 percent of respondents were widowed. Average number of days ill for singe individuals is 2.33 and average efficiency is 0.78 Average number of days ill of married monogamous respondent was 35.43 and average technical efficiency was 0.53. Average number of days ill of married polygamous respondents was 45.33 and average technical efficiency was 0.45. Average number of days ill of

widowed respondents was 50.78 and average technical efficiency was 0.33. It means that married monogamous farmers were most productive farmers and the widowed respondents showed most ill days and more inefficiency due to the high prevalence of HIV in the district and poor referral facilities.

Farm Size

There is an indication that land cultivated by farmers is still within small scale which largely affects their productivity in the face of impaired health situation. The average number of days ill of the farmers within the range of 1-3 hectares of farm land was 30.64 and average technical efficiency of 0.41. Farmers within the range of 3-10 hectares of farm land have average number of days ill to be 13.45 and average technical efficiency of 0.64.

Age of farmer

The age group 20-34 years has low average ill days of 4.76 this is than active group and has efficiency average of 0.56. The 35-49 age groups have average ill days of 45.54 and an efficiency average of 0.67 than efficiency is high than the 20-34 age group due mainly to family size and experience. The 50-64 age group has average ill days of 54.77 and efficiency average of 0.45 and the 65+ age group has an average ill days of 67.99 and an efficiency average of 0.36 and at this stage the advantages of experience are overtaken by ill health due to age.

The Effect of Ill Health on Technical Efficiency

The effects of ill health showed the presence of technical inefficiency of the farmers in the study area. This was confirmed by the large and significant value of the gamma coefficient. The gamma value of 0.78 indicated that about 78% variation in the output of the farmers would be attributed to technical inefficiency effects alone while only 22% was due to random effects (Table 2).

A negative sign of the parameters in the inefficiency model indicated that the associated variable have a positive effect on technical efficiency and vice versa. The result obtained from the stochastic production function indicated that the efficiency of the farmers was affected not only by the traditional input variables: land, labour, fertilizer and seed but equally by socio – economic factors: age, size of household, experience, health, sex and marital status. The signs of the estimated coefficients were as expected but education was found to be insignificant which we attribute to the communal nature of the area and ideas are shared and also the existence of extension workers who guide most farmers in the area.

Thus, the elasticity of land, labour, fertilizer and seed were positive. This implies that increasing any of these inputs would increase output. Labour elasticity was 0.65 and significant at 1% meaning that labour has the largest impact on the output of the farmers in the study area. If quantity of labour used on the farm increased by 1 percent; output will increase appreciably by 65 percent. Also, fertilizer has large coefficient 0.54 which was significant at 1%. This implies that 1 percent increase in fertilizer usage would lead to 54 percent increase in output. The coefficient of seed variable was 0.32 thus a 1% increase in seed increase output by 32%. Land has a positive effect to output with a 0.45 coefficient.
It is worthy to note that the health variable which was measured as days lost to incapacitation due to illness has a positive sign and significant at 1%. This follows a prior expectation that ill health has negative effect on technical efficiency of the farmers. From the result, the health coefficient of 0.56 implies that one percent improvement in the health condition of the farmers will increase efficiency by 56 percent. This high return to health is due to the labour intensiveness of the agricultural production processes in the area

Table 2: Maximum Likelihood Estimated and inefficiency function using the stochastic production frontier

Variable production inputs	**Parameters**	**Coefficients**	**p-value**
Constant	β_0	8.56	0.002**
Area in hectares	β_1	0.45	0.000*
Labour in man days	β_2	0.65	0.000*
Fertilizer in kgs	β_3	0.54	0.000*
Seed in kgs	β_4	0.32	0.000*
INEFFICIENCY MODEL			
constant	d_0	0.42	0.756
Age	d_1	0.65	0.000*
Size	d_2	0.35	0.000*
education	d_3	-0.53	0.987
experience	d_4	-0.65	0.000*
Health status	d_5	0.56	0.003**
Marital status	d_6	-0.67	0.000*
gender	d_7	-0.75	0.000*
DIAGNOSTIC STATISTICS			
Sigma Squared	δ^2	0.90	0.000*
gamma	γ	0.78	0.000*
Log-likelihood		-1,54	
L-R test		18.76	

*, ** significant level at 1% and 5% respectively

Conclusions

The study has reaffirmed the importance of health capital to productivity in the rural communities. Thus the government is strongly advised to prioritise health in their quest to develop communities whilst education and knowledge can be shared in communities health is important to every individual for their personal productivity enhancement. A percentage increase in healthy days increases output by 56% which shows that the area needs a great investment in health.

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