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# Effect of Disease Burden on Technical Efficiency among Lowland Rice Farming Households in North-Central Nigeria

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**Abstract:** This study investigated the effect of diseases among rice farming households and how these affect technical efficiency in rice production. A total of 188 rice farming households were sampled through a multi-stage random sampling procedure. Data were analyzed using descriptive statistics, cost of illness (COI) analysis, t-test of difference of two means and Stochastic Frontier Analysis (SFA). The average areas cultivated to rice was 3.01ha. About half of the illnesses in the households were due to malaria. An average COI of N12,411.12 was incurred during the rice production cycle (4months). About half of these costs were due to time costs, with households losing an average of 17 man-days to illnesses during the period. The return to scale estimation revealed that farmers were operating in stage II of the production surface which is the normal region of operation for rational producers. The mean technical efficiency was 0.696. This implies that rice farmers can still increase output or save cost without the need to change existing technology. Days lost by households to disease attack affected technical efficiency negatively. Extension contact and seed variety affected technical efficiency positively. The study recommended among others that extension and health education services be strengthened to reach more farming households.

**Key words:** Diseases · Burden · Households · Production · Rice · Efficiency

## INTRODUCTION

In the Sub-Sahara Africa, including Nigeria, agriculture is the principal source of food, livelihood and foreign exchange earnings [1]. From Nigeria's independence in 1960 and throughout the sixties, over 70 percent of the Nigerian populace had agriculture and allied occupations as their means of livelihood. In those years, Nigeria production met the bulk of her food need and a sizable export of agricultural commodities such as cocoa, palm produce, rubber, groundnut, cotton and hides and skins, which together accounted for 60-70 percent of the nation's foreign exchange earnings. The problems of poverty, unemployment, crime and many other socioeconomic problems confronting the nation today were then at their lowest ebbs.

In reaction to the worrisome performance of the agricultural sector afterwards, the federal government had made various attempts aimed at reforming the sector and put it back to its enviable position in the Nigerian economy. Some of these programmes include: National Accelerated Food Production Projects (NAFPP) 1980; River Basin Development Authority (1970); Operation Feed the Nation (1976); Green Revolution (1980); Agricultural Development Project, (ADP) (1975), Directorate for Food, Road and Rural Infrastructure (DFRII) (1986), National Agricultural Land Development Authority (NALDA) 1991 and National Directorate of Employment (NDE), (1986), the National Fadama Development Project in the early 1990s whose Phase III just took off in 2009 and the Commercial Agricultural Development Project (CADP) which also started in 2009. However, government efforts over the years did not seem to yield sufficient desired result as the country still witnessed increasing high cost of food, generally high cost of living and perpetual poverty.

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Of all the staple crops in Nigeria, rice has risen to a position of preeminence. Since the mid-1970s, rice consumption in Nigeria has risen tremendously, at about 10% per annum due to changing consumer preferences. Domestic production has never been able to meet the demand, leading to considerable imports which today stand at about 1,000,000 metric tons yearly. The imports are procured on the world market with Nigeria spending annually over US$300 million on rice imports alone [2].

Combinations of various factors seem to have triggered the structural increase in rice consumption. Like elsewhere in West Africa, urbanization appears to be the most important cause of the shift in consumer preferences towards rice in Nigeria. Rice is easy to prepare compared to other traditional cereals, thereby reducing the chore of food preparation and fitting more easily to the urban lifestyles of rich and poor alike. Rice indeed is no longer a luxury food in Nigeria and has become a major source of calories for the urban poor. For example, the poorest third of urban households obtain 33% of their cereal-based calories from rice and rice purchases represent a major component of cash expenditures on cereals [3]. Rice availability and prices have become a major welfare determinant for the poorest segments of the countries' consumers who also are the least food secured. Thus, rice has become a strategic commodity in the Nigerian economy. For instance, in addition to the 4.677million tonnes produced in the country in year 2007, 1.6million tones were imported [4].

Nigeria has the potential to produce enough rice for consumption and still have more than enough to export. In order to tackle this problem and for the country to achieve the much desired food self-sufficiency, aggressive policies and actions are needed to fill the food supply gap. One of the several ways of achieving this is through improved production efficiency.

Labour is central to any agricultural production activity, rice production inclusive. Meanwhile, common diseases such as malaria, tuberculosis, guinea worm, HIV/AIDS, cough, yellow fever, typhoid fever, onchocerciasis, musculoskeletal disorder, diarrhorea, skin diseases, schistosomiasis, respiratory diseases and many other diseases including those due to malnutrition prevent people from putting in their maximum effort in form of labour input into farm production. Labour is needed to cultivate and maintain rice farm and it is a known fact that rice production is highly labour intensive.

Whatever affects labour supply will affect production. Given the importance of rice in the food basket of an average Nigerian, emphasis should be placed on researches aimed at understanding the intrinsic relationship between diseases episodes among households in relation to production efficiency.

**Specifically, The Study Sought To:**

- Identify various diseases prevalent and health seeking behaviours among rice farming households.
- Estimate economic burden due to diseases through cost of illness (COI) among rice farming households in the study areas.
- Estimate efficiencies of rice farms and determine farming household characteristics and health indices affecting efficiencies of rice production in the study area.

**Theoretical Framework:** Production is defined as the process whereby some goods and services, called inputs are transformed into other goods and services called output [5]. In agriculture, the physical inputs which are usually dealt with are land, labour, capital and management and of recent, water resources. The production function stipulates the technical relationships between inputs and output in any production schema or processes. The neoclassical theory of production is based on the notion of efficiency. This idea emphasized in the textbook definition of a production function, which gives the maximum possible output of a given quantity of inputs [6].

The term productivity refers to the efficiency with which production inputs are transformed to output in a production process. It measures the rate of technical change (i.e technical progress) in production [7]. Growth in productivity implies an expansion of the production possibility frontier, implying that a given stock of fixed and variable inputs will be able to produce more of a particular output without having to reduce outputs of other commodities.

Farrell [8] introduced a methodology to measure economic, technical and allocative efficiencies. In this methodology, *Economic Efficiency (EE)* is equal to the product of *Technical Efficiency (TE)* and *Allocative Efficiency (AE)*. According to Farrell, *TE* is associated with the ability to produce on the frontier isoquant, while *AE* refers to the ability to produce at a given level of output using the cost-minimizing input ratios. Meanwhile, given that farmers or producers are allocatively efficient (i.e they take the best decision in resource allocation vis-à-vis input prices, then economic efficiency is equal to technical efficiency.

Farrel's measures of efficiency depend on the existence of the efficient production with which observed performance of a firm can be compared. A production function based on the best practical results would have to be used as a reference for measuring individual performance. However, due to complication, Farrel considered it better to compare performance with the 'best' obtained.

Over the years however, Farrell's methodology has been applied widely, while undergoing many refinement and improvement. One such improvement is the development of a stochastic frontier model of parametric approach that enables one to measure firm level technical efficiency using maximum likelihood techniques. The stochastic frontier model dates back to Meeusen and van den Broeck [9], Aigner *et al.*[10] and Battese and Corra [11].

**Specification of the Stochastic Frontier Production Model:** The stochastic frontier production function model for estimating farm level technical efficiency is specified as:

$$Y_i = f(X_i; \beta) + \varepsilon_i \quad i = 1,2,\ldots\ldots n \tag{1}$$

Here Yi is output, Xi denotes the actual input vector, $\beta$ is vector of production function and $\varepsilon$ is the error term that is composed of two elements, that is:

$$\varepsilon = V_i - U_i \tag{2}$$

Where Vi is the symmetric disturbances assumed to be identically, independently and normally distributed as $N(0,\sigma^2_v)$ given the stochastic structure of the frontier. The second component Ui is a one-sided error term that is independent of $V_i$ and is normally distributed as $(0,\sigma^2_u)$, allowing the actual production to fall below the frontier but without attributing all short falls in output from the frontier as inefficiency.

$$\sigma^2 = \sigma^2_u + \sigma^2_v \tag{3}$$

Furthermore,

$$\gamma = \frac{\sigma_u^2}{\sigma^2} \tag{4}$$

The value of the variance ratio parameter $\gamma$ (Gamma) according to [11] ranges between zero and one.

The variance ratio parameter $\gamma$ has two important characteristics:

- When $\sigma^2_v$ tends to zero, then u is the predominant error in equation (1) and $\gamma$ tends to 1, implying that the output of the sampled farmers differs from the maximum output mainly because of difference in technical efficiency.
- When $\sigma^2_u$ tends to zero, then the symmetric error v is the predominant error in equation (1) and so $\gamma$ tends to 0. Thus based on the value of $\gamma$, it is possible to identify whether the difference between a farmer's output and the efficient output is principally due to random errors ($\gamma$ tends to 0) or the inefficient use of resources ($\gamma$ tends to 1) [12].

Jondrow *et al.* [13] pointed that the technical efficiency estimation is given by the mean of the conditional distribution of inefficiency term Ui given $\varepsilon_i$; and thus defined by:

$$E(U_i \mid e_i) = \frac{\sigma_u \sigma_v}{\sigma}\left[\frac{f(\varepsilon_i \lambda/\sigma)}{1-f(\varepsilon_i \lambda/\sigma)} - \frac{\varepsilon_i \lambda}{\sigma}\right] \tag{5}$$

Here $\lambda = \sigma_u/\sigma_v$, $\sigma^2 = \sigma^2_u + \sigma^2_v$ while $f$ and F represents the standard normal density and cumulative distribution function respectively evaluated at $\varepsilon_i\lambda/\sigma$

The farm specific technical efficiency is defined in terms of observed output ($Y_i$) to the corresponding frontier output ($Y_i$*) using the available technology derived from the result of equation (5) above as:

$$TE = \frac{Y_i}{Y_i*} = \frac{E(Y_i|u_i, X_i)}{E(Y_i|u_i = 0, X_i)} = E\left[\exp(-Ui/\varepsilon)\right] \tag{6}$$

Therefore, TE = exp ($-U_i$)

TE takes values within the interval zero and one (i.e between 0 and 1), where 1 indicates a fully efficient farm.

## Methodology

**The Study Area:** The study was carried out in Niger State which is located in the North Central region of Nigeria (middle belt). It was created in February 1976 from the then North-Western state. It is located between latitudes 9°18'N and 11°30'N and longitudes 5°03'E and 8°30'E within the Northern Guinea savanna vegetation zone of Nigeria. The state covers a land area of about 76,363 sq km, the largest in the country. It is bounded in the west by Benin Republic, in the north by Kebbi, Zamfara and Kaduna States, in the west by the Federal Capital Territory and in the south by Kwara and Kogi states. The total population is 3,950,249 (Population Census, 2006). It has a total of 25 Local Government areas.

The state experiences distinct dry and wet seasons with annual rainfall varying from 1,100mm in the North to 1,600mm in the south. Duration of dry season commences in October and the humidity could be up to 140 percent in December and February. The climate, soil and hydrology of the state permits the cultivation of most Nigeria's staple crops e.g rice, maize, beans, cassava, yam e.t.c It still accommodates extensive animal grazing, fresh water for fishing and forestry. Farming is the major occupation of the inhabitants of the state while others engage in white collar job, trading, arts and crafts. The three major ethnic groups in the state are Nupe, Gwaris and Hausa. While other minorities like Kadara, Koro, Barriba, Kakanda, Gana-Gana, Dibo, Kambari, Kamuku, Panga, Dukkawaa, Gada and Ingwai and also tribes from other States like Igbo, Yoruba and others also settle in the state.

**Sampling Technique and Sample Size:** Multi-stage sampling technique was used to select rice farming households from whom data were collected for this study. The first stage involved a purposive selection of Bida zone noted for lowland rice cultivation from the three agricultural zones in the state. The second stage was the random selection of Mokwa and Bida Local Government Areas among the eight Local Government Areas in the zone. The third stage was the random selection of ten villages from each of the Local Government Areas. The fourth stage was a random selection of ten rice farming households from each village. This gave a total of 200 rice farming households. A total of 188 rice farming households were used for analyses as others were discarded due to incomplete information, outrageous data e.t.c. The total number of questionnaires used for analyzes represented 94 percent of the total number of sampled rice farming households. Data were collected on socio-economic characteristics of rice farmers, household disease prevalence including data on variables which constitute costs of illness (direct and indirect costs) due to diseases episodes within households, response to disease incidence and rice production data.

**Analytical Techniques:** ***(i) Economic Burden of Diseases*** among households was calculated using the Costs of Illness procedure adopted by Sauerborn *et al.*[14] as follows:

Let:

$F$ = Total financial costs of health care during the four-month rice growing period (in Naira)

$F_d$ = Financial cost of drugs, herbs etc (in Naira)

$F_f$ = Financial cost of medical consultancy (in Naira)

$F_{tr}$ = financial cost of travel (in Naira)

$F_l$ = Financial costs of subsistence (in Naira)

$T$ = Total time costs (days of forgone production)

$T_s$ = Time costs of the sick person (days of forgone production)

$T_c$ = Time costs of the caretaker(s) (days of forgone production)

$w$ = Daily wage rate in Naira

$n$ = Number of illness episodes

$a$ = Age coefficients

$_s$ = Related to the sick individual

$_c$ = Related to the caretaker(s)

Then, according to Sauerborn *et al.* [14]:

Financial costs of Illness

$$F = \sum_{i=0}^{n} \left( F_{id} + F_{fi} + F_{tri} + F_{li} \right) \quad (7)$$

Time cost of illness

$$T = \sum_{i=0}^{n} \left[ \left( T_{si} + {}^{*}a_{si} * w \right) + \left( T_{ci} * a_{ci} * w \right) \right] \quad (8)$$

The age coefficient "a" values (which represents productivity coefficient) was assigned following the assertions of Sauerborn *et al.* [14] and World Bank [15] that economic productivity of individual rises from very early twenties to around age 40 and decline steadily afterwards. Therefore, for the purpose of this study coefficient "a" took on the following values:

Ages Less than 17 years = 0.5; 18 to 40 = 1; 41 to 55 = 0.75; 56 to 65 = 0.67; Above 65 = 0.5

**Economic Cost of Illness:**

$$E = \sum_{i=0}^{n} \left( F_i + T_i \right) \quad (9)$$

But a minor modification/addition to this model in this study is the inclusion of Prevention cost $P_c$. Therefore, the Economic cost of illness to be adopted for this study is stated thus:

$$E = \sum_{i=0}^{n} \left( F_i + T_i + p_c \right) \quad (10)$$

**The Stochastic Production Frontier Approach:** The Cobb-Douglas functional form for the rice farms in the study areas is specified as follows for the production functions:

$$Y_i = \beta o + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \ldots + \beta_7 \ln X_{7i} + V_i - U_i \quad (11)$$

Where: Y = Output of rice (kg); $X_1$ = Farm Size in hectares; $X_2$ = Family labour in man-days; $X_3$ = Hired labour in man-days; $X_4$ = Seed in Kg; $X_5$ = Fertilizer in Kg; $X_6$ = Pesticides in litres; $X_7$ = Herbicides in litres

Vi = random variable which is assumed to be independently and identically distributed (iid) $N(0,\sigma_v^2)$ and independent of U

Ui = non-negative random variable associated with technical inefficiency in production and is assumed to be independently and identically distributed half normal (iid) $N(0,\sigma_u^2)$ where the conditional mean $\mu$ is assumed to be related to farm and farmers-related socioeconomic characteristics as follows:

**The Inefficiency Model Is Specified Thus:**

$$\mu = \delta_0 + + \theta_1 Z_1 + \theta_2 Z_2 + \theta_3 Z_3 + \delta_1 W_1 + \delta_2 W_2 + \ldots + \delta_8 W_8 \quad (12)$$

Where,

$Z_1$ = Number of household members attacked by diseases (both workers and dependants)

$Z_2$ = Number of days lost by farm workers due to illness

$Z_3$ = Medical bills

$W_1$ = Age of Household head in years

$W_2$ = Age-squared

$W_3$ = Educational level of household head (number of years spent in school)

$W_4$ = Household Size

$W_5$ = Years of Rice farming experience

$W_6$ = Extension contact (1 if the farming household has extension contact, 0 if otherwise)

$W_7$ = Access to credit (1 if farmer has access to credit, 0 if otherwise)

$W_8$ = Gender of the household head (1 if male, 0 if otherwise)

$W_9$ = Type of seeds planted (1 if improved, 0 if otherwise)

## RESULTS AND DISCUSSION

**Socioeconomic Characteristics of Rice Farming Households:** Majority (94.7%) of the sampled household heads were male and were mostly indigene of the area with mean age 49.5 years. Majority (59.6 %) had contact with extension service but did not have access to credit. Majority of the farming households obtained their rice farmlands through inheritance and 44 percent of the farmers have only Quranic/Arabic education. About 70 percent of the sampled farmers plant from previous year's harvest and this underscores the need for the farmers to distinguish between grains and seeds in order to enhance higher seed viability and improved efficiency. However, about 60 percent of the farmers plant improved varieties. The average rice output obtained by the farmers was 8845.2 kg on an average farm size of 3.88 ha. The average yield extrapolated from this (2279.6 Kg/ha) is far below the standard literature value of an average of 4tonnes per hectre. The levels of fertilizer, pesticides and herbicide use obtained in this study seemed to be below the recommended levels (Table 1).

**Economic Burden of Diseases**

**Incidence of Disease among Rice Farming Household s:** There were 284 illness episodes among the sampled households within the period covered by the study. One hundred and thirty-five, representing 47.7 percent of the total illness episodes were due to malaria. There were forty episodes (14%) of typhoid and 5 episodes of tuberculosis. Other diseases occurred less frequently (Table 3).

**The Cost of Illness (COI):** The COI approach was used in this study to assess the economic burden imposed on the lowland rice farming households specifically during the 4-month rice production period. According to CDCP (2008) the COI provides the monetary estimate for the economic burden of disease.

Table 1: Summary Statistics of Variables in the Production Function

| Variables | Mean | Minimum | Maximum | Std. Dev |
|---|---|---|---|---|
| Output | 8845.2 | 309.5 | 14025 | 361.3 |
| Hired Labour | 62.7 | 14 | 127 | 23.7 |
| Family Labour | 164.1 | 30 | 315 | 117.2 |
| Household Siz | 14 | 4 | 32 | 6.6 |
| Experience | 28.3 | 5 | 55 | 12.4 |
| Farm Size (ha) | 3.88 | 0.40 | 8.00 | 1.78 |
| Fertilizer (kg) | 469.5 | 25 | 750 | 245.6 |
| Seed (Kg) | 187 | 21 | 400 | 197.8 |
| Pesticide (litre) | 5.24 | 0.5 | 16 | 4.2 |
| Herbicide (litr) | 8.82 | 2.5 | 20 | 6.1 |
| Age of head (years) | 49.5 | 30 | 75 | 12.2 |

Source: Computed from field survey data, 2009

Table 2: Distribution of farmers by some qualitative variables

| Variables | Frequency | Percent |
|---|---|---|
| Gender of household head | | |
| Male | 178 | 94.7 |
| Female | 10 | 5.3 |
| Total | 188 | 100.0 |
| Educational Level of Head | | |
| Quranic/Arabic | 83 | 44.1 |
| Primary School | 56 | 29.8 |
| Junior School | 23 | 12.2 |
| Senior School | 13 | 6.9 |
| NCE/OND | 7 | 3.7 |
| BSc | 7 | 3.7 |
| Total | 188 | 100.0 |
| Varieties planted | | |
| Local | 76 | 40.4 |
| Improve | 112 | 59.6 |
| Total | 188 | 100.0 |
| Indigeneship | | |
| Indigene | 168 | 89.4 |
| Settler | 20 | 10.6 |
| Total | 188 | 100.0 |
| Extension Contact | | |
| Yes | 112 | 59.6 |
| No | 76 | 40.4 |
| Total | 188 | 100.0 |
| Access to credit | | |
| Yes | 69 | 38.6 |
| No | 119 | 61.4 |
| Total | 188 | 100.0 |
| Sources of Land | | |
| Inheritance | 162 | 85.1 |
| Leasehold | 40 | 21.3 |
| Rent | 13 | 6.9 |
| Communal land ownership | 13 | 6.9 |
| Borrowing | 3 | 1.6 |
| Gift | 10 | 5.3 |
| Sources of Seed | | |
| Previous year harvest | 132 | 70.2 |
| Other farmers | 3 | 1.6 |
| Agro-service | 53 | 28.2 |

Source: Field Survey Data, 2009

Table 3: Illness Episodes among Rice Farming Households

| Illnesses | Frequency | Percentage |
|---|---|---|
| Malaria | 135 | 47.7 |
| Typhoid | 40 | 14.0 |
| Fever | 7 | 2.3 |
| Back ache | 3 | 1.2 |
| Chicken pox | 10 | 3.5 |
| Head ache | 3 | 1.2 |
| Stomach Upset | 15 | 5.3 |
| Tuberculosis | 5 | 1.8 |
| River Blindness | 4 | 1.4 |
| Guinea worm | 3 | 1.2 |
| Rheumatism | 3 | 1.2 |
| Cough | 20 | 7.0 |
| Snake bite | 3 | 1.2 |
| Appendicitis | 3 | 1.2 |
| Measles | 17 | 5.8 |
| Diarrhea | 13 | 4.7 |
| Total | 284 | 100.0 |

Source: Field survey data, 2009

Table 4: Average Cost of Illness among Households

| Cost Items | Cost (N) | % of Total |
|---|---|---|
| Financial Cost of drugs and herbs | 3,856.14 | 31.1 |
| Financial Cost of fee | 200.00 | 1.6 |
| Financial Cost travel | 514.91 | 4.1 |
| Cost of subsistence (feeding) | 1,131.93 | 9.1 |
| Time cost of sick person | 2,853.51 | 22.9 |
| Time cost of caretaker | 3,412.28 | 27.5 |
| Prevention cost | 442.35 | 3.6 |
| Total cost of Illness (COI) | 12,411.12 | 100 |

*Note that N150 = $1.00 as at time of the study*

Source: Field survey data, 2009

Table 5: Break down of Average Household Total Time Lost (Malaria Versus Other Diseases)

| | Days lost by the sick | Days lost by carer | Total |
|---|---|---|---|
| Malaria | 1.89 | 2.95 | 4.84 |
| Other Diseases | 6.49 | 5.32 | 11.81 |
| Total | 8.38 | 8.27 | 16.65 |

Source: Field survey data, 2009

COI can be subdivided into direct, indirect and intangible costs. However, intangible costs were not estimated in this study due to the complexity and subjectivity of its estimation which may include Willingness to Pay (WTP) and can lead to substantial error. Intangible costs are most times excluded from COI estimation (e.g.16 and 14)

The average household's COI was N12,411.12 (Twelve thousand four-hundred and eleven naira twelve kobo. Out of this sum, N3,856.14 (about 31 percent) was spent on drugs and herbs. About 23 percent (N2,853.51k) was due to time cost of the sick person. The time cost of the caretaker was N3,412.28 (about 27.5 percent). It should be noted that the time cost of the sick persons were not estimated for children who were too young to work on the farm (Table 4).

**Time Lost by Households (Malaria Versus Other Illnesses):** Approximately 17 days were lost to disease illness per household. An average of 5 days was lost due to malaria while 12 days were lost to other diseases (Table 5). Furthermore about 8 days each were lost by both the sick persons and caretakers (Table 5).

Table 6: Difference of two means between Household's average COI on malaria versus other disease illnesses

| Malaria Mean (N) | Others mean (N) | Malaria Std.dev. | Others Std. dev. | t-value | Decision |
|---|---|---|---|---|---|
| 2,923.60 | 8,871.49 | 4,005.62 | 14,417.75 | 3.00 | Reject null |

Source: Field Survey data, 2009

Table 7: Distribution of Rice farming Households by Preventive Methods, Health Seeking Behavior and Coping Strategies

| Preventive Measures | Freq. | Percent. |
|---|---|---|
| None | 117 | 62.2 |
| Mosquito coil | 50 | 26.6 |
| Insecticide Treated Net | 12 | 6.4 |
| Insecticides | 9 | 4.9 |
| Prophylactic Treatment | - | - |
| Total | 188 | 100.0 |
| Health Seeking Methods | | |
| Local Herbs only | 79 | 27.9 |
| Orthodox only | 86 | 30.2 |
| Both | 119 | 41.9 |
| Total | 284 | 100.0 |
| Coping Strategies | | |
| None | 201 | 70.9 |
| Hired labour | 30 | 10.5 |
| Labour Substitution from family | 50 | 17.4 |
| Labour from extended family | 3 | 1.2 |
| Communal arrangement | - | - |
| Total | 284 | 100.0 |

Source: Field Survey Data, 2009

Table 8: Stochastic Production Function Estimations Result

| Variable | Parameter | Coefficient | T-ratio |
|---|---|---|---|
| Constant | $\beta_0$ | 0.719*** | 11.056 |
| Farm size | $\beta_1$ | 0.130** | 2.444 |
| Family labour | $\beta_2$ | 0.171 | 1.422 |
| Hired labour | $\beta_3$ | 0.105*** | 2.910 |
| Seed | $\beta_4$ | 0.201*** | 5.519 |
| Fertilizer | $\beta_5$ | 0.104** | 2.141 |
| Insecticide | $\beta_6$ | 0.049*** | 2.590 |
| Herbicide | $\beta_7$ | 0.042 | 1.396 |
| Inefficiency model | | | |
| No. of people attacked | $\theta_1$ | -0.321 | -0.451 |
| Days lost to illness | $\theta_2$ | 0.481* | 1.768 |
| Medical bill | $\theta_3$ | 0.810 | 0.978 |
| Age | $\delta_1$ | -0.391 | -1.210 |
| Age-squared | $\delta_2$ | 0.721 | 0.350 |
| Education | $\delta_3$ | -0.621*** | -2.761 |
| Household size | $\delta_4$ | -0.591 | -0.727 |
| Experience | $\delta_5$ | 0.471* | 1.681 |
| Extension contact | $\delta_6$ | -0.432*** | -3.154 |
| Credit | $\delta_7$ | -0.043 | -0.238 |
| Gender | $\delta_8$ | -0.638*** | -2.874 |
| Variety | $\delta_9$ | -0.423* | -1.893 |
| Sigma-squared | $\sigma^2 = \sigma_u^2 + \sigma_v^2$ | 0.316*** | 3.983 |
| Gamma | $\gamma = \sigma_u^2 / \sigma^2$ | 0.977*** | 27.00 |
| Log Likelihood function | LLF | -5.18 | |

*** Significant at 1percent; ** Significant at 5percent

* Significant at 10percent

Source: Computed from field survey data, 2009

**Tests of Difference of Two Means of COI:** There were 135 episodes of malaria and 149 episodes of all other disease illnesses put together among the sampled household within the period covered by the study. An average household incur COI of N2,923.60k and N8,871.49 on malaria and other disease ailments put together within the period covered by the study. The t-test of difference of means rejected the null hypothesis (at 1 percent level) and it was concluded that household spend more on other ailments than on malaria for the period covered by the study.

**Preventive Methods, Health Seeking Behavior and Coping Strategies**

**Preventive Measures:** Table 7 shows the various preventive measures taken among sampled households. It was observed that most of the preventive measures adopted by households focused on malaria prevention. Majority of the sampled households selected did not take any preventive measure and most of those who took preventive measures used mosquito coils. Very few households use the much promoted Insecticide Treated Net (ITN)(Table 7).

**Health Seeking Behaviours:** Various health seeking behaviours were observed among sampled households. The use of local herbs as first line treatment for any ailment was very common. Household members sought orthodox treatment mostly when the ailment was observed not to be responding to herbal treatment. Hence, majority of the episodes of illness were treated with both orthodox and traditional local herbs among the sampled households. This underscores the importance of health education among households and the need for government to make health care delivery available and accessible to rural farming households in order to be able to feed the nation (Table 7)

**Coping Strategies:** Some households employed various coping strategies to cope with the adverse effects of illness episodes in their households. Table 7 showed that most households did not employ any particular coping strategy to counter the effect of illnesses on their rice farming activities. More often than not, they delay operations until they feel better because they believed

Table 9: Elasticities and Return to Scale (RTS) Analyzes of Production Functions

| Variables | Elasticities |
|---|---|
| Farm size | 0.130 |
| Family Labour | 0.171 |
| Hired Labour | 0.105 |
| Seed | 0.201 |
| Fertilizer | 0.104 |
| Insecticide | 0.049 |
| Herbicide | 0.042 |
| Return to Scale (RTS) | 0.802 |

Source: Computed from field survey data, 2009

Table 10: Predicted Technical Efficiencies of Rice Farms

| Efficiency Range | Frequency | Percent |
|---|---|---|
| ≤ 0.500 | 10 | 17.5 |
| 0.501 - 0.600 | 8 | 14.0 |
| 0.601 - 0.700 | 7 | 12.3 |
| 0.701 - 0.800 | 14 | 24.6 |
| 0.801 - 0.900 | 12 | 21.1 |
| > 0.900 | 6 | 10.5 |
| **Mean** | **0.696** | |
| Minimum | 0.103 | |
| Maximum | 0.959 | |

Source: Computed From Field Survey Data, 2009.

they would be well in just few days. Meanwhile, among those that employed coping strategies, labour substitution from the extended family members was the most common strategy adopted (Table 7).

**Productivity Analysis for Rice Farmers in Selected Ecologies:** Table 8 shows the results of the stochastic production functions estimates for lowland rice farming in the study area. The result revealed that all the variable inputs impact positively on output in conformity with the *a priori* expectations. Meanwhile, the t-ratio test revealed that family labour and herbicide, though positive, were not significant within the acceptable risk level.

The Return to Scale (RTS) value for the function (0.802) show that farmers in the area were operating in the stage II of the production surface where there was a positive decreasing return to scale (Table 9).

**Efficiency Analysis for Rice Production in Selected Ecologies:** Technical inefficiency effects existed among the sampled lowland rice farmers as shown by the gamma value of 0.977 in the production function in table 8 which was significant at 1 percent level. This implies that 97.7 percent of the variations in rice output were due to differences in farming households' inefficiencies. The predicted technical efficiencies of farmers ranged between 0.103 and 0.959 with mean of 0.696 (Table 10). This is close to Okoruwa e*t al.*[17] which reported a mean TE of 76.9 % among the lowland rice farmers in the state. If the average farmer in this study was to achieve the efficiency level of his most efficient counterpart, the average farmer could realize a cost savings or increase in output of about 27.4 percent while most inefficient farmer could realize a cost saving of up to 89.3 percent.

Among several variables included in the technical inefficiency model, days lost to illnesses (at $\alpha = 0.1$) and experience of farming household head (at $\alpha = 0.1$) had significant positive effects on technical inefficiency of the rice farming households in the study area. This implies that these variables decrease technical efficiency. Furthermore, education (at $\alpha = 0.01$), extension contact (at $\alpha = 0.01$), gender in favour of male headed households (at $\alpha = 0.01$) and seed variety in favour of improved seed type (at $\alpha = 0.01$) had significant negative effects on technical inefficiency. This implies that the more educated the household head the more the efficiency of the household in lowland rice farming. Households who claimed to have had contact with extension agent within the last two years were more efficient than those who did not have such contact. Male headed households were also more efficient than female headed households and also farmers who planted improved seed varieties were less inefficient compared with those planting local varieties. These underscore the need for intensification of extension education and strategic introduction of improved varieties of rice for farmers in the area.

**Summary and Conclusion:** Rice farming households in the study area incurred substantial cost of illness and about 17 days were lost by an average household due to illness during the rice production cycle. Malaria occurred most frequently than any other disease illnesses among the rice farming household during the period covered by the study. Households incurred average of N12,411 during the period. This represents an avoidable leakage of disposable income. The finding that majority of the sampled households do not take preventive measures against diseases called for serious policy intervention.

The result of the SFA revealed that basic production variables included in the production functions had positive relationship with rice output. The production function estimations revealed Return to Scale (RTS) value of 0.802 among rice farms in the study area and this implies that farmers were operating in stage II of the production surface.The mean TE value was 0.696. Given the short fall in the technical efficiencies of farmers in the study area, there is substantial potential to improve output or save some costs of an average farm without the need for any change in existing technology if certain corrective measures are taken. Days lost by household during rice production cycle affect technical efficiency negatively. Extension contact, education and extension contact affected Technical Efficiency positively while male headed households were more efficient than their male headed household counterpart.

Based on the findings of this study it is recommended that extension services be strengthened to cover more villages and settlements which should include strategic introduction of improved rice seeds with more desirable traits to rice farming households in order to improve technical efficiency. In addition, health education should be included in extension teaching. This is expected to impact positively on the health status of farming households and reduce the economic and psychological burden of diseases on members of households who are usually the readily available sources of labour for rice farming activities.

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