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Malaria and Agriculture: Examining the Cost Implications and Effect on Productivity among Farm Households in Kogi State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors MKI designed the study. Authors MKI and UMS performed the statistical analysis. Authors MKI and JMD wrote the protocol and wrote the first draft of the manuscript. Authors MKI and UMS managed the analyses of the study. Authors JMD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: identify the socioeconomic characteristics of farm households in the study area; determine factors that influence malaria incidence rate among farming households; estimated the costs effect of malaria on farm households; and determine the influence of malaria incidence on farmers' productivity.
Duration of Study: July, 2016 – November, 2016.
Results: of the study showed that 72.5% of the respondents were males and a mean age of 43 years (SD =12.9) was identified among the farm household heads. The average farm size was 2.1 hectares (SD = 0.8) with low access to extension services. The coefficient of farm size (β = 0.123, p=0.05), age (β =-0.048, p=0.05), years spent schooling (β =-0.085, p=0.05), and distance to health facilities (β =-0.043, p=0.05) significantly influenced the incidence rate of malaria among farming households in the State. The mean direct and indirect cost of malaria among farm households in

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the state was 14, 213.58 Naira and 9, 405.97 Naira respectively. The result further revealed that days lost to malaria, distance to health facility, and time lost to malaria reduced agricultural productivity at 5%, while amount spent on treatment and cost of preservation directly influenced agricultural productivity at 5% level of significance.
Conclusion: free distribution and use of mosquito netting (especially the treated nets) to reduce the effects of mosquito on agricultural productivity.

Keywords: Agriculture; malaria; incidence; incapacitation; Tobit; productivity; Kogi State, Nigeria.

1. INTRODUCTION

Malaria remains one of the most severe health problems worldwide and it is a major public health problem in Nigeria [1,2]. It is the main cause of morbidity and mortality in Sub-Sahara Africa because the environment favours the multiplication and sustenance of the parasite causing the disease. In the African region, Nigeria is known for high prevalence of malaria, bearing up to 25 percent of the disease burden in Africa [3]. The country contributes significantly to the one million lives lost per year in the region, which mostly consists of children and pregnant women [4]. Malaria also exerts a huge social and economic burden on families, communities and the country at large with an estimated annual loss of about 132 billion Naira in payments for treatment and prevention as well as hours not worked [4,5]. Households spend huge share of their scarce resources on malaria prevention and treatment as well as on effort to control mosquitoes [6]. Also, some household members spend their productive time caring for those under malaria attack. This explains why the adverse economic effect of malaria is discussed from two indicators: direct costs and indirect costs [7].

The direct costs consist of expenditures of households and governments on the treatment and prevention of malaria with associated impact on households' income, wealth, labour productivity and labour market participation of both the sick and the caregivers. It is estimated that as much as 13 percent of total small farming households expenditure in Nigeria is being used in treating malaria, while many are simply too poor to pay for adequate prevention and treatment of the disease [8]. The indirect economic costs of malaria comprise the effects of malaria caused by mortality, morbidity and debility on individual, household and national labour supply, productivity and output. Malaria patient's loss of effective work time (number of working days) can be attributed to malaria-related morbidity (complete incapacity) and debility or partial disability [6]. Rural farm households not only lose valuable working hours in treating the sickness but also lose income that would have been generated at this period. The loss to households may however be greater with the current trend in malaria resistance to traditional first-line drugs. Such loss according to Ogunniyi et al. [7] has serious implication for poor household.

According to a study in Kogi State, Nigeria, good health is a prerequisite for a productive and economically viable life [9]. Poor health condition could portend great hardships on farming households, including monetary expenditures, loss of labour, loss of days and sometimes death. The health status of family labour affects their ability to work, and thus underpins the welfare of the household [10]. According to Titus et al. [11] poor health affects agricultural production. A report by WHO [12] cited impact of poor health on the agricultural workforce as one of the major causes of chronic malnourishment (food insecurity) in Sub-Saharan Africa. The report further posited that in Africa, malaria is adjudged to be the disease with the most widespread impacts on growth and development among farming population. The implication of this is that quality time is either lost as a result of incapacitation from malaria or caring for family members affected. This has implication for on-farm labour supply and agricultural productivity.

An area of divergence among empirical studies as observed from the literature is the difference in methodology employed in measuring the effect of malaria on welfare and productivity of farm families. Closely related to this, is the assumptions the studies make concerning the nature of the data. More recently a few studies have employed model capable of addressing such challenges in the data; [13] and [14]. In spite of the high prevalence of malaria among farming communities in the study area and its perceived impact on their productivity, very little research has been recorded on the subject matter. The implication is that there is a very lean

reference material for studies of this nature to draw motivation from. This is the thrust of this present study. Succinctly, the study describe the socioeconomic characteristics of farm households in the State, determine factors that influence malaria incidence rate, estimate the costs effect of malaria, and determine the influence of malaria incidence on farmers' productivity.

2. METHODOLOGY

2.1 Description of Study Area

The study area is Kogi State, Nigeria, located in the central region of Nigeria. The State lies between latitudes 6°30' N and 8°48' N and longitude 5°23' E and 7°48' E. Kogi State has a land area of about 30,354.74 square kilometers and 2 million hectares of cultivable land but only about 0.5 Million hectares are under cultivation [15]. The State is bounded with the Federal Capital Territory (FCT) to the North, Nasarawa State to the North East, Benue State to the East, Enugu State to the South East, Anambra State to the South, Edo State to the South West, Ondo and Ekiti States to the West, Kwara State to the North West and Niger State to the North. The state has a significant farming population as over 70% of the people are engaged in farming activities. The climate and soil conditions favour crops and livestock production.

2.2 Study Population and Sampling Procedure

The population of this is made of all farmers in Kogi State, Nigeria. The state is made up of four agricultural zones (A, B, C and D zones) as delineated by the Kogi Agricultural Development Project. The sample size for this study was drawn from these four agricultural zones which comprises of the twenty-one Local Government Areas (LGAs) in the State. A three staged random sampling technique was used to select sample for the study. First, two (2) LGAs were randomly selected using a simple random sampling technique of balloting from each of the four agricultural zones to obtain eight (8) LGAs. Second, two farming communities were randomly selected from each of the LGAs to obtain a total of 16 farming communities. Third, 15 farm households were randomly selected from each community. In all, a total of 240 respondents were sampled for the study.

2.3 Data Collection and Analytical Technique

Primary data obtained through questionnaire administration were analysed using descriptive statistics, Tobit regression model and Ordinary Least Square (OLS) regression model. SPSS version 20 and STATA software were used to code and analyse the data.

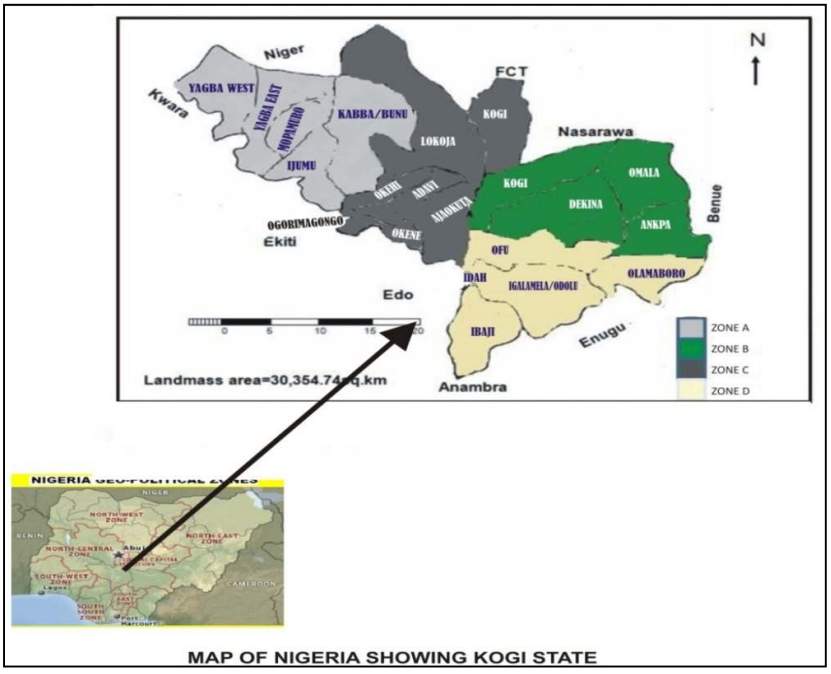

Fig. 1. Map of Nigeria showing Kogi State

2.4 Model Specification

2.4.1 Tobit model

Tobit model was used to determine factors that influence malaria incidence rate among farm households in the state. The standard Tobit model, [16] was originally developed to accommodate censoring in the dependent variable and was designed to overcome the bias associated with assuming a linear functional form in the presence of such censoring. In this study the determinants of malaria spread the latent variable is only observed if it is greater than or equal to zero though the latent variable is allowed to take on negative values even though they cannot be observed. The standard Tobit model can be written as [16]:

$$Y_i^* = X_i'\beta + \mu_i \quad \mu_i \sim N(0,\sigma^2) \quad i=1.....,n$$
$$Y_i = Y_i^* \text{ if } Y_i^* > 0$$
$$Y_i = 0 \text{ if otherwise}$$

Y_i = Incidence of malaria in the last farming season.

Y_i, are observed proportion of the *i*th household with malaria and Y_i^* is an unobserved continuous latent variable assumed to determine the value of Y_i.

X_i = explanatory variables corresponding to the *i*th household, and they include:

X_1 = Household size (numbers)
X_2 = age of the household head (years)
X_3 = sex (male = 1 and 0 otherwise)
X_4 = level of education of the household head (years)
X_5 = Distance to health centre (km)
X_6 = Distance to river (km)
X_7 = Self medication
X_8 = Frequency of visit by health workers
X_9 = Preferred treatment method (traditional = 1 and hospital = 0)

2.4.2 OLS regression analysis

The Ordinary Least Square (OLS) was used to determine the effect of malaria incidence on farmers' productivity. The model is explicitly specified as:

$$Y=f(X_s)$$
$$Y=f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, e_i)$$
$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7 + \beta_8X_8 + \beta_9X_9+ e_i$$

Where:

Y = Value of output (Naira)
β_0 = Intercept (Naira)
β = Marginal effect of X_S on Y
X_1 = total days of incapacitation (number of days)
X_2 = total income lost due to malaria (Naira)
X_3 = distance to treatment area (km)
X_4 = treatment cost (Naira)
X_5 = prevention cost (Naira)
X_6 = time loss to care given (days)
e_i = Error term

Three functional forms of the equation above were analyzed and the one with best fit selected as the lead equation. The lead equation was selected based on the R^2, number of significant variables, F-value and the value of the estimated coefficient. These functional forms are:

The linear functional form:

$$Y= \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6 + e_i$$

The Semi-log functional form:

$$Y=\beta_0+ln\beta_1X_1+ln\beta_2X_2+ln\beta_3X_3+ln\beta_4X_4+ln\beta_5X_5+ln\beta_6X_6 + e_i$$

The Double-log functional form:

$$lnY=\beta_0+ln\beta_1X_1+ln\beta_2X_2+ln\beta_3X_3+ln\beta_4X_4+ln\beta_5X_5+ln\beta_6X_6+ e_i$$

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics of Farm Households

The socioeconomic characteristics of farm households are presented in Table 1.

From the result, most (72.5%) of the household heads were males, which could be attributed to the tedious nature of the various activities in agricultural production. The mean age of 43 years age could be seen as a productive age and is requisite for manual labour necessary for agricultural production. Age could further have influence on malaria incidence and agricultural productivity. Most (76.3%) of the respondents were married. Marriage could be seen as the basis for labour availability necessary for farming activities. The mean household size was 6 members. Farm households often depend on the pull of their family labour to carry out farm

Table 1. Distribution of respondents according to socioeconomic characteristics

Socioeconomic characteristics	Frequency	Percentage	Mean	Std. deviation (SD)
Gender				
Male	174	72.5		
Female	66	27.5		
Age (years)				
20 – 35	46	19.2		
36 – 55	113	47.1		
56 – 75	70	29.2		
76 – 95	11	4.5	43 years	12.9
Marital status				
Single	24	10.0		
Married	183	76.3		
Divorced	07	2.9		
Widowed	21	8.8		
Widower	05	2.1		
Household size (Number of Persons)				
1 – 5	79	32.9		
6 – 10	103	42.9		
11 – 15	39	16.3		
> 15	19	7.9	6 members	3.9
Education status (Years)				
No formal education (0 years)	75	31.3		
Primary education (1 – 6 years)	44	18.3		
Secondary education (7 – 12 years)	78	32.5		
Tertiary education (13 – 18 years)	43	17.9		
Farming experience (years)				
1 – 10	80	33.3		
11 – 20	78	32.5		
21 – 30	42	17.5		
31 – 40	26	10.8		
41 – 50	14	5.8	9 years	6.7
Farm size (hectares)				
0.1 – 2	191	79.6		
2.1 – 4	45	18.8		
>4	04	1.6	2.1 hectares	0.8
	n = 240			

n= 240: Field survey, 2016

operations. In addition, household members can contribute in taking care of sick members since labour is often allocated for the collective goal of profit maximization. The result further shows that reasonable number of the respondent were educated and this may help in their approach towards malaria treatment and prevention, implying that with their education, they can access health care facilities. The average year of farming of 9 years among the respondents implies that farmers in the area had relatively enough experience for a profitable farming venture. The mean farm size of 2.1 hectares however is an indication that all the farmers operated on a small scale. This finding further underscore the fact that crop production in rural areas and Nigeria is still at the subsistence level. Most farmers are into farming venture as source of livelihood and not necessarily for commercialization.

3.2 Factors that Influence Malaria Incidence Rate among Farming Households

Estimates of the Tobit regression analysis on factors that influence malaria incidence rate among farming households is presented in Table 2.

From the result, farm size, age, education, and distance to health facility significantly influenced the incidence rate of malaria among farming households in the area. These variables were significant at 5% level of measurement.

The coefficient (0.123) of farm size was positive and significant at 1%. This relationship implies that a unit increase in the hectares of farm land will increase the incidence rate of malaria among farming households. This finding could be associated to the fact that farming household members with large hectares of farm land would be exposed to malaria as a result of frequent farming activities. Finding of this study agrees with Mboera [17] when they reported that agricultural activities increases exposure of individuals to mosquito bites which could lead to malaria transmission.

The coefficient (-0.048) of age was negatively related to the incidence rate of malaria among farming households in the area. This relationship was also significant at 1% level of measurement. The implication of this finding is that an increase in the age of farming household head will increase the incidence rate of malaria. This finding can be explained for by the fact that advancement in age may *ceteris paribus* reduce immunity against diseases, thus, increasing the incidence of malaria. Younger farmers could possess the immunity to withstand malaria incidence and as well have reduced days of incapacitation with increased output. This result agrees with Oluwatayo [18].

The number of years spent schooling negatively influenced the incidence of malaria infection among farming households. By implication, an increase in the number of years spent schooling will reduce the incidence of malaria among farming households in the area. Pointedly, farming households with higher level of education tends to have low incidence rate of malaria. This finding is most probably due to the fact that with increase in education, farmers will employ more measures to control malaria. An increase in education is likely to improve the standard of living of farmers and facilitate control of malaria, hence reduction in incidence rate.

Table 2 also indicated that the coefficient (-0.043) of distance to health facility inversely influence the incidence rate of malaria among farming households. This relation was significant at 5%. The implication of this finding is that the likelihood of increased malaria incidence is reduced with farmers who are closer to health facilities. Closeness to health facilities could ease access to treatment. Also, it could increase the level of awareness and orientation on the possible causes of malaria infection and measures to control its incidence.

3.3 Direct and Indirect Costs of Malaria Disease

The estimates of direct and indirect costs of malaria disease are presented in Table 3.

Table 2. Estimates of Tobit regression analysis on factors that influence malaria incidence rate among farming households

Variables	Coefficient	Std. Error	t	p>/t/
Farm size (hectares)	0.123	0.041	2.98	0.003***
Age (years)	-0.048	0.014	-3.44	0.001***
Sex (dummy)	-0.564	0.364	-1.55	0.122
Education (years)	-0.085	0.033	-2.56	0.011**
Distance to health facility (km)	-0.043	0.009	-4.69	0.000***
Distance to water (km)	0.0001	0.0003	0.30	0.763
Preferred treatment method (dummy)	-0.481	0.336	-1.43	0.154
No. of visit by health workers (no.)	0.193	0.129	1.49	0.137

Log likelihood = -523.309

*Source: Computed from Field Survey Data, 2016, *** and ** = sig. @ 1% and 5% respectively*

Table 3. Mean estimates of direct and indirect costs of malaria disease

Direct cost	Value (Naira)	Indirect cost	Value (Naira)	Total cost= Direct + Indirect costs (Naira)
Mosquito net	1, 527.50	Lost labour	4,919.17	6,446.67
Insecticide	3,383.13	Care giving	4,486.80	7,869.93
Sanitation	2,596.27			2,596.27
Treatment	6,706.68			6,706.68
Total	**12,686.08**		**9,405.97**	**23,619.55**
Mean household income = 84,512.67				

Source: Field Survey, 2016, USD = 306.13NGN

The result shows the mean cost expended by farming household on malaria per farming season. According to Alaba and Olumuyiwa [19], direct cost of malaria includes the out-of-pocket expenditures on treatment, and cost of transportation (round-trip) associated with receiving medical care. The treatment cost is 6,706.68 Naira, the mean amount spent on insecticide is 3,383.13 Naira, an average of 2,596.27 Naira was spent on sanitation, while 1,527.50 Naira was spent on mosquito net. It can be inferred from the result that treatment cost account for more than half (52.9%) of the average total direct cost. The total mean indirect cost was 9, 405.97 Naira with lost of labour and care giving accounting for almost equal percentage. The total cost due to malaria was computed as the sum of direct and indirect costs of malaria. These give an average of 23, 619.55 Naira. Furthermore, the mean household income per farming season was 84, 512.67 Naira. This implies that the respondents lost 27.9% of farm household income per farming season to malaria.

3.4 Influence of Malaria Incidence on Farmers' Productivity

Estimates of the Ordinary Least Square (OLS) multiple regression on the influence of malaria incidence on farmers' productivity is presented in Table 4.

Farmers' productivity in this study was proxied by the value of farm output in Naira (₦). An R^2 value of 0.624 implies that 62% of the change in the dependent variable (farmers' productivity) was explained by the independent variables. The remaining 38% is attributed to error term. Significant F-value shows that the independent variables jointly explained the dependent variable. The result further indicated that except for income lost due to malaria, all the included variables were significant at 5%.

The coefficient of time and days lost due to malaria incidence were negatively signed and significant at 1% each. The inverse relationship implies that a one day or one hour increase in the days or time lost due to malaria will reduce the productivity of farming households by ₦16.64k and ₦44.60 respectively. Ibitoye [20] attributed this decrease to the number of days farmers and member of the households were not available for farming activities as a result of malaria incidence. Shaibu et al. [21] and Onuche et al. [22] in their separate studies reported an inverse relationship between days lost to ill-health and the naira value of farm output.

The coefficient (-1116.1) of distance to health facility was negative and significant at 5%. This implies that an increase in the distance to health facility will decrease the productivity of farming households. This finding could be attributed to the amount spent in transporting ill member(s) to the health facility. It could also transcend in the cost of transporting caregivers. This finding agrees with the report of Awoyemi [23] who outlined distance from health centres as an important variable.

The coefficient of amount spent on treatment was also negative and significant at 5%. The inverse relationship implies that a naira increase in the treatment of malaria will decrease the productivity of farming households by ₦0.63k. Malaria treatment cost involves both direct and indirect costs. Indicatively, as farmers spend more money in buying drugs and going to health centers to treat malaria, it reduces their productivity. Ibitoye *et al.* [20] reported similar finding and attributed it to high prevalence of malaria virtually in most rural farming households. This finding further agree with Ajani and Ashagidigbi [24], who reported same result in similar study carried out in Oyo state, Nigeria.

Table 4. Estimates of the semi-Log OLS multiple regression

Parameters	β	Std. Error	t-value
days lost due to malaria	-16.646	4.590	-3.63***
income lost due to malaria	-1.362	.761	1.79
dist to health facility	-1116.1	513.431	2.17**
amnt spent on trtmnt	.633	.270	2.34**
cost of prevention	1.846	.935	1.98**
time lost due to mal	-44.599	7.260	6.14***
R^2	0.624		
F-value	11.891***		

*Source: SPSS Output from Field Survey Data, 2016 *** and ** = significant @ 1% and 5% respectively*

The coefficient of prevention cost (1.846) was positively signed and significant at 5%. It can thus be inferred that, for every naira spent on malaria prevention, farmers' productivity increase by ₦1.85k. This finding is not surprising as it is a common maxim that "prevention is better than cure". Prevention cost include cost of buying mosquito nets, mosquito coil cost, cost of sanitation, and other measures that could prevent malaria incidence. Prevention cost could also have an effect on the number of days lost. As farmers prevent malaria incidence, days lost due to malaria decreases, thereby increasing their farming activities with its multiplier effect on productivity.

4. LIMITATION OF THE STUDY

This study employed data obtained from a cross-sectional survey at one point of the farming season and not a cohort survey capable of determining malaria incidence throughout the wet and dry seasons.

5. CONCLUSION AND RECOMMENDATIONS

It can be concluded from findings of this study that age, education and distance to health facility reduced the incidence rate of malaria among farming households. Most importantly, farm income significantly reduced due to days and time lost to malaria infection among farming households.

Based on the findings, the following recommendations are made:

1. There should be interventions by Government and relevant stakeholders in form of mobilizing resources, formulating and implementing policies and programmes that will promote awareness and measures that ensure effective prevention and control of the pandemic disease.
2. Medication that can reduce the days of incapacitation should be intensified and made available to farmers at affordable prices in order to improve the quality of life and productivity of farmers
3. Closeness to health facility decreased malaria incidence rate and increased agricultural productivity. Therefore, there should be establishment of primary health centers in most rural areas. This will increase the proximity and accessibility of farming households to public health facilities.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The study was a non-invasive one and was not likely to cause any physical harm. To deal with ethical issues associated with this study, permission was sought from concerned community heads Sand respondents associated with the study. The purpose of the study was comprehensively explained to them and they were given the opportunity to decide whether they will like to partake in the study. Data collected were also held in strict confidence.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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