Contents Lists Available at sddubidsjplm.com

Journal of Planning and Land Management

Journal homepage: https://www.sddubidsjplm.com

Implications of malaria incidence on farmers' productivity in rural Ghana: Empirical analyses from Tanina Community, Upper West Region

*[1]Francis Issahaku Malongza Bukari, [1]Kenneth Peprah, [1]Nicholas N-Kang Yembilah, [1]Raphael Afedzi & [1]John Bosco Baguri Sumani

[1]*Faculty of Integrated Development Studies, SD Dombo University of Business and Integrated Development Studies, Wa, Ghana.*

ARTICLE INFO

Received: 2020-09-25
Revised: 2021-05-15
Accepted: 2021-06-10

Keywords:
Malaria, Farm labour, Productivity, Livelihood, Tanina, Ghana

ABSTRACT

Despite numerous publications on the incidence of malaria, very few have addressed its effects on farm labour productivity. This study examined the implications of malaria on farm labour productivity in Tanina, a rural community in the Upper West Region of Ghana. A mixed research design was used, involving 90 respondents, and using a questionnaire. Key informant interviews and focus group discussions were also conducted with relevant participants. The results of the study indicated that malaria prevalence rate during the farming season was 97% among respondents, resulted in 82% of them absenting themselves from farm work, 59% could not effectively access investment capital, with 68% agreeing that malaria reduced their farm output. This was reported to cause low income and inadequate food supply among rural farmers. It is recommended that preventive allopathic healthcare services are instituted. These could be through training of local volunteers to assist in distributing preventive healthcare necessities such as bed nets, indoor spraying of insecticides, and education of rural residents.

1. Introduction

Health is an essential aspect of human capital, partly determining the productivity of workers (Strauss & Thomas, 1999). Malaria is one of the diseases that negatively affect health and productivity in developing countries. In 2016, there were 216 million malaria cases reported in 91 countries, with five million new cases above the 2015 malaria cases of 211 million. Out of the 2016 cases, malaria infection caused the death of 445,000 people (World Health Organisation [WHO], 2018). It is acquired when one is bitten by the anopheles mosquito, infected by any one of the four kinds of the plasmodium parasite (p. parasite). These include *P. vivax*, *P. ovale*, *P. malariae*, and *P. falciparum* (del Prado et al. 2014). Malaria could be classified into uncomplicated and severe types. The severe type of malaria is caused by *P. falciparum,* with a parasitaemia (quantitative presence of disease parasites) that is greater than 5%. The other plasmodium parasites hardly manifest parasitaemia (about 2%), because *P. vivax* and *P. oval* infect younger erythrocytes (red blood cells) which aid the transportation of oxygen to other parts of the body from the lungs and promoting physiological functions of body cells while *P. malariae* infects older erythrocytes (Vinay, Abul, Nelson & Richard, 2007, World Health Organisation [WHO], 2010).

Severe malaria is of major concern because its symptoms such as fever, headache, abdominal pain, diarrhoea, and muscle pain have debilitating effects on labour productivity, and causes hospitalization, deaths, and heavy financial expenditure (Ssempiira, Kissa, Nambuusi, Mukooyo et al., 2018). According to del Prado et al. (2014), 2010 alone experienced 660,000 deaths due to malaria, and African children are the most affected. In 2016, African countries contributed 194 million (90%) cases and 407,000 (91%) deaths of the global figures (WHO, 2018). In 2016, total global expenditure on malaria treatment and control amounted to US$2.7 billion (WHO, 2018). In Ghana, the first quarter of 2016 recorded about 2.2 million suspected cases of malaria (Ghana Health Service [GHS], 2016) while Asiamah, Dzadze and Gyasi (2013), in their case study found that malaria causes 90.2% of farmers with the disease to refrain from farm work. The few that worked with malaria had reduced vigour. However, their study targeted a whole Municipality, such that the specific cases of rural communities did not stand out clearly.

This study explores the effects of malaria on farmers' productivity, with a focus on cereal and leguminous crop farmers in Tanina, a rural community located in the Wa West District at latitude 9° 52'60" N and longitude 2°28'0" W, in the Upper West Region of Ghana. It has a population of 2,323, dominated by 57% females. The dominant age group is 0-14year old, constituting 47%, followed by the economically active age group 15-64, which makes up 38%. The aged or 65+ year olds constitute the remaining 15% according to the Tanina Community Health Centre (2018). This population structure holds greater proportions of malaria high-risk groups, such as infants, children under five, pregnant women and the younger segment of the economically active age group that are mobile or migrant in nature and so lack preventive and diagnostic services (World Health Organisation, 2017).

Like many other rural communities of Ghana, Tanina is predominantly agrarian, and the tendency of the rainy season to increase the incidence of malaria as water collects in ponds and other drainage systems is high. So, this poses a major threat to the health of farmers in the cropping season, between March and October each year. Adu-Prah and Tetteh (2015) found that annual malaria incidence in Ghana has increased, and that temperature and humidity (climate variability) play significant roles in the rise of the numbers.

Theoretically, sickness presenteeism explains how sickness affects one's performance at work while sick (Garrow, 2016; Johns, 2009), and the production function also explains how land, labour, and capital influence output (Echevarria, 1998). Despite the focus of these theoretical explanations of production from different perspectives, they share labour in common. So, the questions that emanate for this study are: What is the malaria prevalence level among the sample population? Does malaria affect farmers' attendance to farm? What is the effect of malaria on the labour offered by farmers? How does malaria affect other factors of production such as capital and land area cultivated? How does malaria affect outputs of farmers? Other factors such as soil fertility, level of technology and nature of rainfall must be contended with. However, these could broaden the scope of this study with countless variables to deal with, but each of which could constitute research topics on their own.

Answers to the research questions necessitated further inquiry into the livelihoods of farming households exposed to the incidence of malaria. Based on the conceptual and theoretical orientations of this study, the following null research hypotheses were also tested:

$H0_1$: There is no significant difference between malaria infection among farmers and effectiveness of their labour on the farm.

$H0_2$ There is no significant difference between malaria infection among farmers and financial capital acquisition for farm investment.

$H0_3$: There is no significant difference between malaria infection among farmers and land area cultivated.

$H0_4$: There is no significant difference between malaria infection among farmers and the output level of farmers.

2. Conceptual foundations of the study

Conceptually, sickness presenteeism refers to the situation in which people who complain of ill health and are expected to be seeking treatment, still turn up to work (Aronsson & Gustafsson, 2005). Thus, sickness presenteeism has the potential to reduce productivity and production, but reasons such as being in the company of comrades and household members could motivate sick people to be present at work (Garrow, 2016). Contextually, we conceptualised sickness presenteeism in terms of attendance to farm and working while sick and output due to sickness while working.

The above conceptualisation of sickness presenteeism could be expressed as a function of the form:

$$S = f(A, O) \qquad \text{(eq.1)}$$

Where S= frequency of sickness presenteeism due to malaria; A = frequency of malaria affecting labour efficiency while at farm, and O = frequency of output due to malaria.

Echevarria (1998) contextualises that production is determined by three factors, namely land, labour, and capital. So, we limit ourselves to Echevarria's three factors because we are interested in individual household farm labour productivity. Theoretically, Echevarria's position gives rise to a production function of the form:

$$P = f(L, W, K) \qquad \text{(eq.2)}$$

Where P = production; L = land; W = labour; and K = capital.

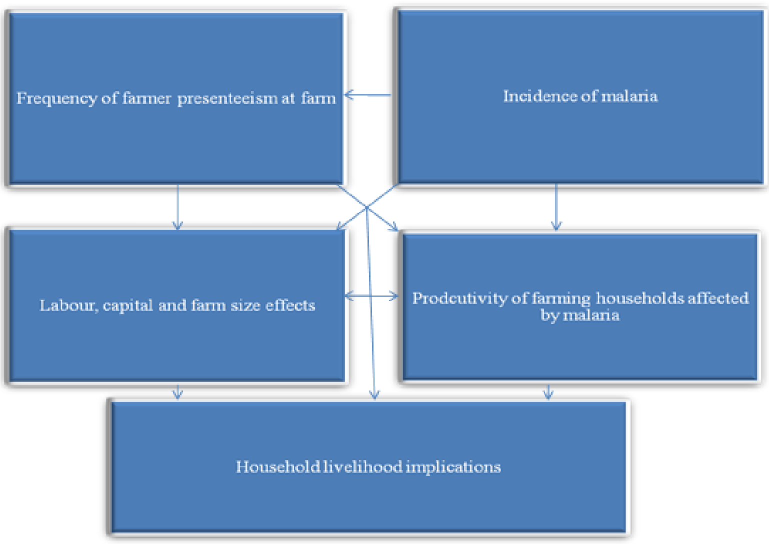

Figure 1: Conceptual framework of malaria and farm labour productivity
Source: Authors' own construct, 2018

Figure 1 illustrates a framework of the relationship between malaria and the variables in eq.1 and eq.2, which also guided the bases of inquiry in the design of instruments of data collection and data analysis in our methodological framework. However, there is no indication of livelihood implications in the functions of sickness presenteeism and production.

Figure 1 shows that the incidence of malaria could impact on farmers' presenteeism to work, factors of production such as labour, land and financial capital, the productivity of farmers and their livelihoods. This is in line with the exposition of Asenso-Okyere, Asante, Tarekegn and Andam (2009), that globally, malaria affects human health, productivity, and general well-being. However, Asenso-Okyere et al. (2009) were more interested in how farming activities promote the breeding of mosquitoes that infect human beings with the malaria parasites. Because of its symptoms such as fever, headache and weakness, malaria debilitates farmers so that they are absent or abstain from work completely (Breman, 2001; Garrow, 2016). This view is partially related to the sickness presenteeism dictum, which explains that sick people who go to work would not be effective (Johns, 2009), while debilitation and the ultimate effect of absenteeism due to malaria takes away the labour supply component of the factors of production (Echevarria,1998).

Russell (2004) also asserts that sickness limits choices of the affected people and affect providers' willingness to grant them access to tangible assets such as physical and financial capital. Impliedly, a malaria infected farmer could be restricted in terms of his ability to adequately acquire or cultivate a farm size of his choice. Low productivity also reduces savings and hence capital formation for further production (Gries & Dung, 2014). Some studies also link household livelihoods and malaria. For instance, Dunn, Le Mare and Makungu (2011), examined this linkage, but their concern was on how household livelihood activities rather negatively impacted on the prevention of malaria using treated bed nets. More et al. (2008), however, found that malaria increases household expenditure on treatment and reduces ability to participate in livelihood activities such as crop cultivation and animal rearing. The framework in Figure 1 suggests a two-way relationship between access to the factors of production and household productivity. It further illustrates that malaria affects both aspects, which could ultimately affect livelihoods of farming households. Examples are food security, income, health and educational needs of children, clothing, shelter, and other wealth creation activities.

3. Materials and methods

A mixed research design was used, involving qualitative and quantitative approaches. The total population of the study area (Tanina) was 2,323. Out of this, the target population was 874, involving people belonging to the economically active age group of 15-64 years. A sample size of 90 was drawn from 874 using a formula (see Yamane, 1967):

$$n = \frac{N}{(1 + N(e)^2)}$$

Where: n= Sample size, N= Total population (the sample frame of 874 was used), e= Margin of error (0.1 or 10% was used), and 1= constant, and the result was 89.73, rounded off to 90 for n (sample size [n]).

A transect walk was conducted to identify the built-up residential area and 150 houses easily identifiable by features such as house numbers or names were counted. These were coded and the fish-bowl method of simple random sampling used to select 90 houses for the sample size. The sample units were cereal and leguminous crop farmers who were 18 years or older. One qualified respondent was chosen by accidental sampling upon entering each selected house. Permission was sought and structured interview guides with largely close-ended questions administered by face-to-face interview. In this way, respondents who could not read and write the English language participated comfortably in the study.

The data from the household respondents were coded and entered using the Statistical Package for Social Scientists (SPSS), and analysed using descriptive and inferential statistics. Descriptive statistics involved the use of frequency distribution and cross-tabulation, while inferential statistics involved the use of Chi-Square Test to address the hypotheses.

3.1 Model specification

We preferred to use 2 x 2 Chi-Square tables for eq.1 and eq.2. The Chi-Square formulae for computing the relationships between sickness presenteeism and farm labour productivity based on the dependent variables A and O uses the frequencies of the responses. We were interested in whether a farmer's attendance to farm while sick of malaria (S, with frequencies S_1 for 'No' and S_2 for 'Yes'), affects a farmer's labour while at farm with malaria (A, with frequencies A_1 and A_2 for 'No' and 'Yes' respectively), and a farmer's output under the influence of the incidence of malaria (O, with frequencies O_1 and O_2 for 'No' and 'Yes' respectively). Because of the use of 2 x 2 Chi-Square ($\chi 2$) tables, the Yate's Continuity Correction was introduced into the Chi-Square equations to off-set possible overstatement, by subtracting 0.5 of the number of units studied 'N' (i.e., 0.5N) from delta (Δ). Thus, we express the relationship between S and the frequencies of each of the dependent variables as below:

When $S = f(A)$,

$$\Rightarrow \chi^2 = \frac{N(|S_1A_2 - S_2A_1| - 0.5N)^2}{(S_1 + A_1)(S_2 + A_2)(S_1 + S_2)(A_1 + A_2)} = \frac{N(|\Delta^2| - 0.5N)}{N_1 N_2 N_s N_A}$$

where $\Delta = S_1A_2 - S_2A_1$; $N = S_1 + S_2 + A_1 + A_2$; $N_1 = S_1 + A_1$, $N_2 = S_2 + A_2$, $N_S = S_1 + S_2$, and

$N_A = A_1 + A_2$.

When $S = f(O)$,

$$\Rightarrow \chi^2 = \frac{N(|S_1O_2 - S_2O_1| - 0.5N)^2}{(S_1 + O_1)(S_2 + O_2)(S_1 + S_2)(O_1 + O_2)} = \frac{N(|\Delta^2| - 0.5N)}{N_1N_2N_sN_O}$$

Where $\Delta = S_1O_2 - S_2O_1$, $N = S_1 + S_2 + O_1 + O_2$, $N_1 = S_1 + O_1$, $N_2 = S_2 + O_2$, $N_S = S_1 + S_2$, and

$N_A = O_1 + O_2$.

Unlike the Yamane (1967) formula where N represents total population, in the Chi-Square formula, based on Spiegel and Stephens (2008), N rather represents the sample size. For eq.2, i.e., $P = f(L, W, K)$, P is the dependent variable and L, W and K are the independent variables. Testing the relationship between P and each of the independent variables are typical of the production function and would have no link to malaria infection. The latter is rather an independent variable influencing the performance of the factors of production in this study. Since eq.1 caters for frequency of output due to malaria (O) which replaces P, and frequency of farmer's attendance to work, as well as the effects of malaria on the actual work performance of the farmer, which also replaces W, we rather test for the relationship between attendance to farm while sick of malaria (S) with the frequencies of the remaining variables L (with frequencies L_1 and L_2 for 'No' and 'Yes' respectively) and K (with frequencies K_1 and K_2 for 'No' and 'Yes' respectively). From the above, we re-write the function as follows:

$S = f(L, K)$ (eq.3)

When $S = f(L)$,

$$\Rightarrow \chi^2 = \frac{N(|S_1L_2 - S_2L_1| - 0.5N)^2}{(S_1 + L_1)(S_2 + L_2)(S_1 + S_2)(L_1 + L_2)} = \frac{N(|\Delta^2| - 0.5N)}{N_1N_2N_sN_L}$$

Where $\Delta = S_1L_2 - S_2L_1$, $N = S_1 + S_2 + L_1 + L_2$, $N_1 = S_1 + L_1$, $N_2 = S_2 + L_2$, $N_S = S_1 + S_2$, and

$N_L = L_1 + L_2$.

When $S = f(k)$,

$$\Rightarrow \chi^2 = \frac{N(|S_1K_2 - S_2K_1| - 0.5N)^2}{(S_1 + K_1)(S_2 + K_2)(S_1 + S_2)(K_1 + K_2)} = \frac{N(|\Delta^2| - 0.5N)}{N_1N_2N_sN_K}$$

Where $\Delta = S_1K_2 - S_2K_1$, $N = S_1 + S_2 + {}_1 + K_2$, $N_1 = S_1 + K_1$, $N_2 = S_2 + K_2$, $N_S = S_1 + S_2$, and
$N_K = K_1 + K_2$

The functions and equations above enabled the testing of the research hypotheses. SPSS commands were used to complete the Chi-Square tests, and alpha levels were statistically significant at 0.05 or less. The results were then tabulated. A key informant interview was held with a medical assistant at the Tanina Community Health Centre. Also, one focus group discussion was organised for farmers. Questions were based on the thematic issues derived from the research questions and like those of the structured interview guide for individual farmers at the household level. Questions on the focus group discussion guide and the questionnaire were open-ended, to obtain adequate information to cross-triangulate the quantitative data concurrently. Qualitative data were presented by narrations and direct quotations, while quantitative data were presented by frequency distribution tables and charts using household survey data entered SPSS.

Other forms of data on expenditure reflecting the use of capital for inputs such as fertilizer, labour (weeding) and ploughing were also ascertained, and averages computed for the various ranges of farm sizes of respondents in a separate table. However, the qualitative categorical values that represented this set of data by the Chi-Square test was more suitable because robust cost items such as expenditure on inputs experience price changes with inflationary effects, making comparison difficult. Secondly respondents kept no farm records, and so had difficulty recalling actual amounts spent beyond the immediate past farming season from the season of interview. Thus, as the title implies, effects of malaria on productivity were measured in terms of average outputs in bags and weight, that is in kilograms (kg), or frequency of activity such as number of days or number of times of attendance to farm with or without malaria, which are not affected by inflation. This approach was motivated by similar methods used by Ajani and Ashagidigbi (2008, p. 262). See also Madaki (2017, p. 3527). It is also acknowledged that the periods given by respondents that they experienced malaria ranged between 2012 and 2018, but all the 90 respondents were giving different dates, making it necessary to group them generally under 'with malaria' and 'without malaria', and the emphases were ranges of output levels for various crops in kilograms and number of days. Ethically, permission was sought from traditional leaders in the community and the authorities of the Tanina Community Health Centre before data collection began on 16th June 2018 and ended on 4th August 2018. The choice of the commencement period of July was because it was the period of peak farming activities other than harvesting and storage. Hence it allowed the researchers to ascertain malaria prevalence rates among the respondents within the ploughing, planting, and weeding periods, which could then be compared to other years with or without malaria. The focus was on cereal and leguminous crops which are produced and harvested within the rainy season, such as maize, millet, rice, cow peas and groundnuts.

Accuracy was ensured by avoiding errors related to the questions and responses. Questions were set based on the themes related to the research questions and were pretested to detect and correct identified limitations. Appropriate techniques were also used in the administration of the data collection instruments according to the categories of the respondents. Interviews were used for illiterate respondents to facilitate interpretation and explanation of questions to the understanding of the household respondents. Questionnaires for educated respondents were self-administered, after the researchers ensured that the questions were within their areas of jurisdiction.

4. Results and discussions

This section addresses the thematic issues related to the research questions and hypotheses after establishing that the sample population of farmers was exposed to the incidence of malaria.

4. 1 Causes of malaria infection

We began by ascertaining the incidence of malaria as initially dictated by the conceptual framework in Figure 1, which also addresses the first research question on malaria infection. Interview results of the key informant from the Tanina Community Health Centre indicated that plasmodium parasites transmitted through the bite of the anopheles mosquito is the main cause of malaria. Malnutrition, poor sanitation, and lack of preventive services such as access to and use of treated bed nets through health personnel were also reported as factors that influence the incidence of malaria among the economically active age groups such as farmers. Table 1 shows that the proportion of respondents who said they had malaria at the time of the interview was 46%, while 54% had no malaria. However, because this study was interested in farmers who ever had malaria to assess its effects on productivity chronologically, respondents were also asked whether they ever had malaria.

Table 1: Prevalence of malaria

In situ malaria infection among respondents	Respondents who suspected they had malaria before or within 2018	Malaria prevalence among respondents	Means of verification
41 (46%) had malaria at the time of the study	90 (100%) out of 90	97% of the suspected cases were confirmed	89% were diagnosed by physical examination for symptoms at the health centre.
49 (54%) had no malaria at the time of the study			8% were by laboratory tests
			3% did not report to the health centre

Source: Field survey, 2018.

Table 1 further shows that all the 90 farmers sampled for the study said they ever had malaria before or within July 2018, during which the study was conducted. Among these, 89% said they were diagnosed physically while 8% said they had laboratory tests, which all confirmed that they had malaria parasites. Three percent of the farmers who suspected malaria did not visit any health facility but successfully treated themselves. This last group of respondents said they used vended malaria drugs after experiencing symptoms based on previous diagnostic histories and prescriptions at the health centre.

There was no information at the Tanina Community Health Centre on the types of mosquitos that cause malaria. However, a study by Sarpong et al. (2015) which included the Wa West District where Tanina is located yielded the results in Table 2. It shows that *Plasmodium falciparum* (*P. falciparum*) which is the major cause of severe type of malaria dominated the number of cases studied by almost 96%.

Table 2: Prevalence of malaria by plasmodium species

Type of plasmodium species	Prevalence level
Plasmodium falciparum	95.9%,
Plasmodium malariae	2.3%,
Plasmodium ovale	0.2%
Mixed infections with *P. falciparum* and *P. Malariae*	1.6%

Source: Sarpong et al. (2015)

The prevalence of malaria due to *P. falciparum* generated more interests in exploring the effects of malaria on farm labour productivity, since it is the major cause of severe malaria (WHO, 2010).

4.2 Effects of malaria on farm labour

Farmer presenteeism is the next issue of interest in the conceptual framework and relates to the aspect of farm labour as implied in the second research question. As much as 82% of the farmers interviewed answered 'no' to the question of presenteeism on the farm when sick of malaria. Another 66% agreed that malaria affected the labour they offered on the farm, in relation to the third research question. Interview with the medical assistant at the Tanina Community Health Centre indicated that malaria has some symptoms that could debilitate patients. He said that:

> *"Not everyone infected by malaria might be able to work. Some patients do test positive for malaria but have no signs of complications and so they are able to work. However, patients who experience severe headache, muscle pains, loss of appetite and vomiting hang their tools if they are farmers, or request for casual leave if they are formal sector workers. These are manifestations of severe malaria".*

Accordingly, responses from farmers sampled from households also confirmed how severe malaria affected their attendance to farm as seen in Tables 3 and 4. Table 3, for instance, shows that the highest number of days respondents indicated they absented themselves from farm when not sick of malaria was 11-15, and the most frequent was 6-10 days.

Table 3: Days of absenteeism from farm per month without malaria

Days of Absenteeism	Frequency	Percentage%
1-5 days	32	35.6
6-10 days	46	51.1
11-15 days	12	13.3
16-20 days	0	0.0
21-25 days	0	0.0
26-30 days	0	0.0
Total	90	100.0

Source: Field survey (2018)

Table 4 also shows that some respondents absented themselves from farm up to a whole month when sick of malaria (26-30 days), with a second highest frequency of about 24%, after 21-25 days had the highest frequency of about 52%. It was also interesting to note that 1-5 days of absenteeism per month, which ranked second highest with a frequency of about 36% in Table 3, when not sick of malaria had no scores for the period of malaria infection in Table 4.

Table 4: Days of absenteeism from farm per month with malaria

Days of Absenteeism	Frequency	Percentage%
1-5 days	0	0.0
6-10 days	4	4.4
11-15 days	4	4.4
16-20 days	13	14.4
21-25 days	47	52.3
26-30 days	22	24.4
Total	90	100.0

Source: Field survey, 2018.

Regarding absenteeism from farm without malaria, a focus group discussion respondent remarked:

> *Fridays are holidays for [Muslims] in this community because it is the day of 'Juma' prayers for Muslims, and most of us in this community are Muslims. So, if a person has no malaria and remains healthy, he or she sets aside four or five Fridays in a month for prayers. We also attend funerals, wedding, and naming ceremonies and some too can travel for other reasons.*

During the interview with the key informant of the Tanina Community Health Centre, he stated that:

> *Absenteeism from work could be prolonged if the malaria parasites remain in the patient. Most patients are not able to renew their National Health Insurance cards and that prevents them from being able to visit the health centre for treatment because they cannot afford the cost without health insurance. A majority resort to the use of herbs, which in most cases do not help. So, you find people spending two weeks or a whole month with severe malaria symptoms, and some, especially children under five years old even die.*

Table 5 shows respondents' experiences of how malaria causes absenteeism and inability to work. It indicates that apart from the inability of the farmers themselves to work, they either spent time seeking treatment for themselves or for other family members sick of malaria.

Table 5: Effects of malaria on farm labour

Effects	Frequency	Percent
Cannot work due to bodily weakness	47	52
Absence from work for health seeking	28	31
Absence from work due to seeking treatment for other family members sick of malaria	15	17
Total	90	100.0

Source: Field survey, 2018.

The findings in Table 4 further support the fact that *P. falciparum* is largely responsible for
Malaria in the community since infection causes absenteeism from farm work as a sign of severe malaria. This is contrary to the sickness presenteeism dictum espoused by Johns (2009). In the latter case, *P. ovale* and *P. malariae* could have been implicated, since they cause uncomplicated malaria and so patients are capable of being present at work and could work, even though they might be inefficient (see Johns, 2009). These conditions made it necessary to examine how malaria affects other factors of production as indicated by the next component of the conceptual framework, related to land and capital.

4.3 Effects of malaria on capital and land area cultivated

Subject to eq.3, which links sickness due to malaria (S), to farmers' land (L) and capital (K) and relate to the fourth research question on other factors of production, this section discusses the necessary findings. It was found that 59% of the respondents agreed that malaria affected their abilities to access financial capital for farming. Figure 2 illustrates the relationship between malaria and capital acquisition by affected farmers. It shows how farmers ascertained the effects of malaria on capital acquisition for investment.

Expenditure on drugs for treatment and insecticides for the control of mosquitoes using income intended for savings accounted for 68% of the responses. These reduce their ability to improve household savings for investment in farming. Another 21% said they were unable to carry out other livelihood activities such as petty trading and small-scale industrial activities to mobilise investment capital for meeting the cost of ploughing by tractor, farm inputs such fertilizers, and in recent times, insecticides for the control of fall army worms, especially maize crop farmers (Refer to Table 6). Others also said that prolonged and protracted malaria due to ineffective treatment compels them to seek the assistance of money lenders for inputs and labour for farm work. However, their conditions discourage others from lending them money with respect to (w.r.t.) fear of repayment defaults. These constituted the remaining 11%.

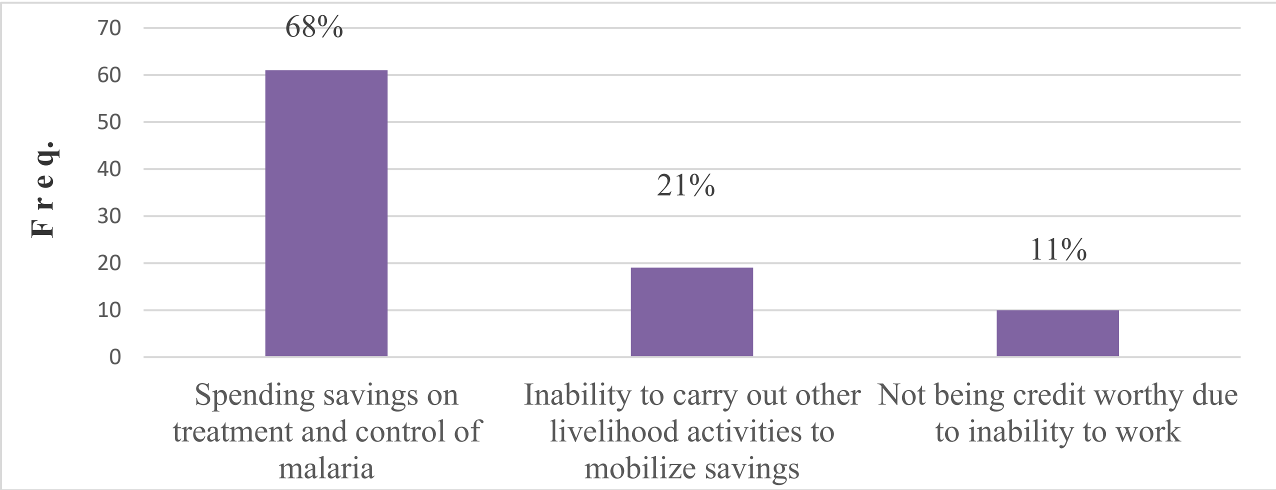

Figure 2: Effects of malaria on farmers' access to financial capital
Source: Field survey, 2018.

Also related to the production function contextually, is the aspect of the land size a farmer can cultivate in the year with, and without malaria. Figures 3 and 4 show the responses to the question of cultivated land size in the farming season of the year farmers did not have malaria and the year they fell sick of malaria respectively. The mean average farm size cultivated by all the farmers studied in the year they did not have malaria, calculated from the averages of the ranges of farm sizes in Figure 3, was 4.25 hectares. The modal farm size was in the range of 0.4-2.3 hectares with 44% responses, followed by 2.4-4.3 hectares with 41% responses.

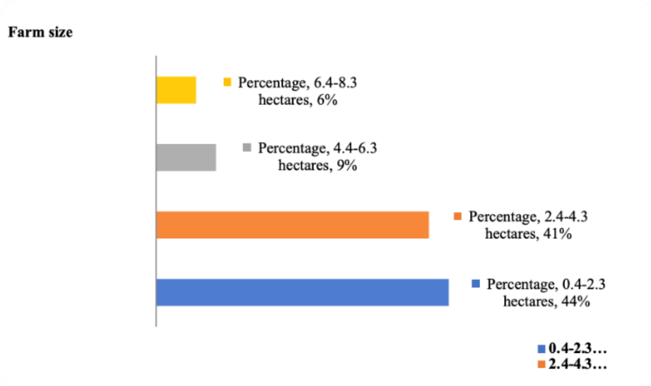

Figure 3: Farm sizes cultivated without malaria infection
Source: Field survey, 2018

Figure 4 also shows that the modal range of farm size cultivated when farmers have malaria is 0.4-1.8 hectares with 73% responses, followed by 1.9-3.3 acres with 23% responses, and the mean average farm size calculated from the ranges was 2.63 hectares. It is therefore, clear that in periods of malaria infection, farmers cultivated smaller farm sizes.

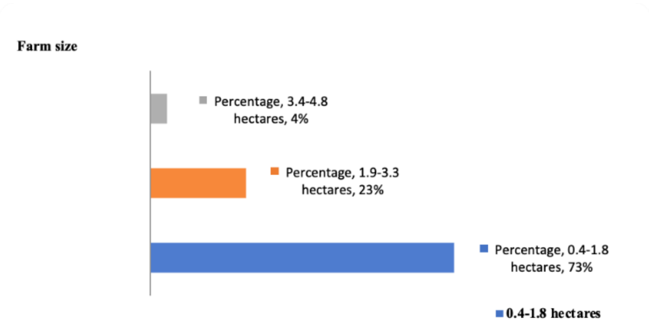

Figure 4: Farm sizes cultivated during malaria infection
Source: Field survey, 2018

During the focus group discussion with farmers, they expressed their experiences about the effects of malaria on their farm sizes. In one instance, a discussant reported that:

> *Malaria is a common sickness during the rainy season, and a farmer could get it a number of times or at some important stage of the farming activity. I am married and my wife had her first pregnancy last year and we live with my aged mother. Just at the beginning of the rainy season I started tilling my maize farm with the hoe and got sick of malaria. It took me three weeks to recover and return to the farm. I was doing the final weeding when my wife was also admitted at the hospital in Wa and I had to spend most of the time taking care of her. When she was discharged she gave birth and a week later the baby too was sick and the doctor said it had malaria. By the time I returned to the farm, only the small portion out of the 2 acres (0.8094) hectares) I weeded before my wife was admitted was the only part I could rely on. The rest of the crops on the farmland were out-competed by weeds, so I lost that to malaria.*

For the retrospective aspects of the survey questions, most farmers could not provide quantitative data on items of expenditure on the relevant factors of production beyond the previous year, 2017, for lack of record keeping. As such the study relied on data provided for 2017, and averages calculated for the various ranges of farm sizes as presented in Table 6. Furthermore, items such as cost of seeds and planting cost could not be captured becauses farmers claimed they use part of previous harvests and family labour in planting, and so majority could not make such estimates. Although Table 6 does not show the effects of malaria on changes in the cost items, the data provides objective evidences that the farmers incurred costs on the variables used in the model specification of this study. However, the linkages between malaria infection among farmers and the data in Table 6, were expressed by the Chi-Square test of significance in a later section of this paper.

of the frequency of farmers engaged in their cultivation. Mixed cropping was also found among the farmers as shown in Figure 5.

The actual outputs of each of the crops in the years without, and with malaria are provided in Table 7, which represent the average production of all the 90 farmers sampled for the study. For the periods of malaria infection, respondents were asked to mention a year in which they did, and did not experience malaria, and then state the outputs of the crops cultivated for each period. A similar approach was adopted for the land size cultivated. Years of malaria infection/ cropping seasons given by farmers ranged from 2012 to 2017, based on when they could remember with precision.

Outputs of all farmers for each crop were summed up for each of the malaria infection status periods (years without and with malaria) and divided by the number farmers who produced the crop for the respective periods.

The effects of malaria on factors used in the Chi-Square

Farm sizes	Percentage of respondents	Cost of ploughing per acre	Average cost of ploughing	Labour (weeding) per acre	Average cost of weeding	Cost of NPK fertilizer per bag	Cost of sulphate of ammonia fertilizer per bag	Total average cost of fertilizer per farm size
Less than 1 to 1 acre	73% (66)	GHc100	GHc86	GHc70	GHc65	GHc120 at market price and GHc70 at subsidized price	GHc70 at market price and GHc50 at subsidized price	GHc280
More than 1 to 2 acres	23% (21)	GHc100	GHc173	GHc70	GHc120	GHc120 at market price and GHc70 at subsidized price	GHc70 at market price and GHc50 at subsidized price	GHc540
More than 2 to 3 or more acres	4% (3)	GHc100	GHc282	GHc70	GHc198	GHc120 at market price and GHc70 at subsidized price	GHc70 at market price and GHc50 at subsidized price	GHc830

Table 6: Average expenditure on farm inputs for 2017
Source: Field survey, 2018

model and how these affect farmers' outputs as stipulated in the conceptual framework have been discussed in the next section.

4.4 Productivity of farmers with and without malaria

This section addresses the fifth research question on how malaria impacts farmers' productivity. Sixty-eight (68%) of the respondents answered 'yes', while the remaining 32% answered 'no' to the question of whether malaria affected their outputs from the farm. To measure the effects, we ascertained the food crops produced by the farmers, especially those cultivated within the rainy season during which malaria is prevalent, and which could be quantified. Thus, cereal and leguminous crops were considered. Figure 5 presents the results. It shows that maize, groundnuts, millet and beans (cow peas) are the most important crops in terms

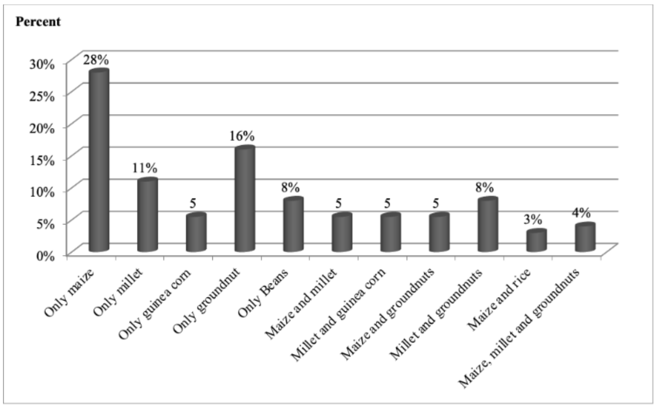

Figure 5: Major crops cultivated in the rainy season
Source: Field Survey, 2018.

Table 7: Outputs of farmers by status of malaria

Crop	Average number of bags in the years without malaria	Average number of bags in the years with malaria	Weight per bag	Average output in Kg in year without malaria	Average output in Kg in year with malaria
Maize	554 bags	444 bags	100kg	55400kg	44400kg
Millet	350 bags	225 bags	93kg	32550kg	23715kg
Guinea corn	130 bags	128 bags	105kg	13650kg	13440kg
Rice	51 bags	46 bags	100kg	5100kg	4600kg
Groundnuts (shelled)	380 bags	364 bags	82kg	31 **Crops**	29848kg
Beans (Cowpea)	54 bags	28 bags	97kg	5238kg	2716kg
			Total output	143098kg	118719kg

Source: Field survey, 2018

Table 8: Chi-Square test results on effects of malaria on productivity

Hypothesis	Function	χ2	Degree of freedom	Asymptotic significance	Remarks
$H0_1$: About malaria infection and effectiveness of the labour	S = f(A),	8.453	1	0.004	There are significant differences in responses. Null hypothesis is rejected.
$H0_2$: About malaria infection and financial capital acquisition for farm investment	S = f(k)	5.221	1	0.022	There are significant differences in responses. Null hypothesis is rejected
$H0_3$: About malaria infection and land area cultivated.	S = f(L)	5.821	1	0.016	There are significant differences in responses. Null hypothesis is rejected.
$H0_4$: About malaria infection and the output level of farmers.	S = f(O)	4.651	1	0.031	There are significant differences in responses. Null hypothesis is rejected.

Source: Field survey, 2018.
NB: χ2 (Chi-Square values are based on Yate's continuity correction due to the use of 2 x 2 tables for the functions; values are significant at the alpha level of 0.05.

The data in Table 7 show that when farmers had malaria, their productivity was lower, with a total output of 118,719 kg (1,319kg per capita for 90 farmers), compared to the periods in which they had no malaria, with a total output of 143,098kg (1,590kg per capita for 90 farmers). The findings are consistent with Strauss and Thomas' (1999) contention that health is an essential aspect of human capital which partly determines the productivity of workers. However, we acknowledge that the effects of other explanatory variables such as weather variability and soil fertility could also impact the outputs, independent of malaria. On the other hand, the study was theoretically driven and so such deviations could be attributable to theoretical limitations in terms of the scope of the study. Accordingly, by the objectivist philosophical position of this study, we present the Chi-Square test results in Table 8 to show the statistical relationship between the variables related to the production and sickness presenteeism functions and productivity of the sample units studied, for the hypotheses.

The results in Table 8 show that labour offered, land area cultivated, acquisition of financial capital and output levels of farmers were all significant. In other words, there were significant differences in the frequency of responses to the questions of whether a farmers' attendance to work while sick of malaria affected the effectiveness of their labour, cultivated land area, capital, and outputs.

4.5 Effects of malaria on household livelihoods of farmers

This section addresses the ending part of the conceptual framework in Figure 1, which also corresponds to the last research question related to livelihoods of farmers' households exposed to malaria. Figure 6 illustrates that income instability was recognized as the major negative livelihood effect of malaria on the households of affected farmers, with a response rate of 41%. This was followed by fluctuations in the availability of food (28%) and challenges of child education (27%). Other basic needs such as clothing, access to safe water, healthcare and shelter also constituted 4% of the responses.

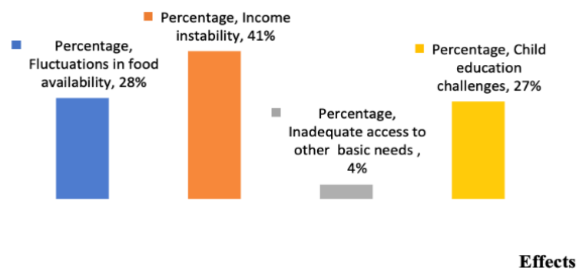

Figure 6: Effects of malaria on household livelihoods
Source: Field survey, 2018.

Focus group discussion also revealed that low productivity due to malaria in a particular cropping season reduced incomes. On the other hand, when they had no malaria, their incomes improved since they were able to increase their productivity (see also, Bukari, 2013). Consequently, farmers are unable to provide school uniforms, exercise books, and printing cost of end of term question papers for their school children in the periods of low productivity. Renewing their health insurance cards to facilitate access to healthcare at the community health center was also a problem. However, without malaria household livelihoods generally improved, due to increased productivity.

5. Conclusions and recommendations

The findings showed that *P. falciparum*, transmitted through the bite of the anopheles' mosquito is the major cause of severe malaria in Tanina. All respondents ever had malaria, but in situ malaria infection was 46%. Sickness absenteeism rather than presenteeism was a major effect of malaria on labour, since 82% of respondents could not go to farm when sick of severe malaria. Malaria also negatively impacted on effectiveness of labour on the farm, capital acquisition and land area cultivated, ultimately resulting in low output. These adversely affect household livelihoods of farmers in the forms of fluctuating income and availability of food. They also faced problems of child education and meeting other basic needs of life, such as healthcare, and shelter. There were also significant relationships between farmer presenteeism due to malaria and effectiveness of farm labour, land area cultivated, financial capital acquisition and outputs of farmers. The study has demonstrated that malaria infection could affect both farmer presenteeism and absenteeism. It also justified the substitution of sickness due to malaria for production in the production function, to rather become an independent variable that caused changes in the factors of production as multiple dependent variables. That is, it proved that malaria infection could negatively impact on all the factors of production, resulting in low output and adverse livelihood outcomes, which the robust functions of production and sickness presenteeism failed to enlist.

It is recommended that preventive allopathic healthcare services are necessary. These could be through training of local volunteers to assist in distributing preventive healthcare necessities such as bed nets, indoor spraying of insecticides, and education of rural residents such as those in Tanina. It could also involve education of households on effective adherence to positive use behaviour that could make the preventive healthcare services effective. Poverty alleviation strategies should also be enhanced to support farmers in rural areas during periods of severe malaria epidemics, so that mechanized agriculture could be provided to prevent food insecurity. This is important because rural farmers provide the bulk of agricultural products for urban areas as well.

6. References

Adu-Prah, S., Tetteh, E. K. (2015) Spatiotemporal analysis of climate cariability impacts on malaria prevalence in Ghana. *Applied Geography Elsevier* 60, 266-273.

Ajani, O.I.Y & Ashagidigbi, W.M. (2008). Effect of malaria on rural households' farm income in Oyo State, Nigeria. *African Journal of Biomedical Research*, 11: 259 – 265.

Aronsson G. & Gustafsson, K. (2005). Sickness presenteeism: prevalence, attendance-pressure factors, and an outline of a model for research. *Journal of Occupational and Environmental Medicine*, *47* (9): 958-966.

Asenso-Okyere, K., Asante, F.A., Tarekegn, J. & Andam, K.S. (2009). *The linkages between agriculture and malaria: issues for policy, research, and capacity strengthening*. Discussion paper number 00861. Washington, D.C.: International Food Policy Research Institute.

Bukari, F.I.M. (2013). Indigenous perceptions of soil erosion, adaptations and livelihood implications: the case of maize farmers in the Zampe community of Bole in the Northern region of Ghana. *Journal of Natural Resources and Development*, (3), 114-120.

Bukari, F.I.M. (2017). *Improving water tariff payment in rural and peri-urban communities connected to urban water systems in northern Ghana*. Cape Coast, Ghana: University of Cape Coast.

del Prado, G.R.L, Garcia, C.H., Cea, L.M., Espinilla, V.F.,Moreno, M.M., Márquez, A.D., Polo, M.J. & Garcia, I.A. (2014). Malaria in developing countries. *J Infect Dev Ctries*, 8 (1):001-004.

Dunn, C.E., Le Mare, A. & Makurungu, C. (2011). Malaria risk behaviours, socio-cultural practices and rural livelihoods in Tanzania: implications for bed net usage. *Soc Sci Med*., 72 (3): 408-4017.

Echevarria, C. (1998). A three-factor agricultural production function: the case of Canada. *International Economic Journal*, 12 (3): 63-75.

Ghana Health Service (2016). *National malaria control surveillance bulletin*. Malaria 1st Bulletin, issue 5, July 14, p.1-10.

Garrow, V. (2016). *Presenteeism: a review of current thinking*. Brighton, UK: Institute of Employment Studies.

Gries, T. & Dung, H.V. (2014). Household savings and productive capital formation in rural Vietnam: insurance vs. social network. *Modern Economy*, *5*, 878-894.

Johns, G. (2009). Presenteeism in the workplace: A review and research agenda. *Journal of Organizational Behavior*, *31* (2010): 519-542.

Madaki, M. J. (2017). Effects of crop production in Yobe State, Nigeria. *International Journal of Information Research and Review*, 4 (01): 3525-3529.

More, C.M., Thang, N.D., Xa, N.X, Hung, L.X., Thuan, L.K., Van ky, P., Erhart, A., Mills, A. J. & D'Alessandro, U. (2008). The economic burden of malaria on the household in south-central Vietnam. *Malaria Journal*, **7**:166

World Health Organisation (2017). *Malaria high-risk groups*. Accessed 22/07/2018. http://www.who.int/malaria/areas/high_risk_groups/en/.

Russell, S. (2004). The economic burden of illness for households in developing countries: a review of studies focusing on malaria, tuberculosis, and human immunodeficiency virus/acquired immunodeficiency syndrome. *American Journal of Tropical Medicine and Hygiene*, 71(2): 147-155.

Sarpong, N., Owusu-Dabo, E., Kreuels, B., Fobil, J.N., Segbaya, S., Amoyaw, F., Hahn, A., Kruppa, T. & May, J. (2015). Prevalence of malaria parasitaemia in school children from two districts of Ghana earmarked for indoor residual spraying: a cross-sectional study. *Malaria Journal*, 14 (260): 1-7.

Spiegel, M. R. & Stephens, L. J. (2008). *Theory and problems of statistics* (fourth ed.). New York: McGraw-Hill.

Ssempiira, J., Kissa, J., Nambuusi, B., Mukooyo, E., Opigo, J., Makumbi, F., Kasasa, S., Vounatsou, P. (2018) Interactions between climate changes and intervention effects on malaria spatio temporal dynamics. In Uganda Parasite Epidemiology and Control. *Elsevier 3*, 1-16.

Strauss J. & D. Thomas (1998). Health, nutrition and economic development." *Journal of Economic Literature,* Vol. 36, pg.755-817.

World Health Organization (2010). *Guidelines for the treatment of malaria* (second edition). Geneva: World Health Organisation. WHO (2009) *World malaria report*. http://www.who.int/malaria/publications/world_malaria_repo rt_2012/en/index.html.Accessed 22 November 2013.

WHO (2018). *World malaria day 2018: ready to beat malaria*. www.who.int>documents>keymes... Accessed 23 October 2018.

Vinay, K., Abul, K.A., Nelson, F. & Richard N. M. (2007). *Robbins basic pathology* (8th ed.). Philadelphia: Saunders.

Yamane, T. (1967). *Statistics: an introductory analysis* (2nd edition.). New York: Harper and Row.