Malaria prevalence and impact on farm household labour use and productivity in the irrigated rice production system of Omor community, Nigeria

E.C.EBOH[1] & J.C. OKEIBUNOR[2*]
[1]Department of Agricultural Economics, University of Nigeria, Nsukka, Nigeria
[2]Department of Sociology/Anthropology, University of Nigeria, Nsukka, Enugu State, Nigeria

Abstract: The growing concern about the impact of malaria in local communities is yet to translate into increased empirical research particularly its impact on household labour use and productivity. Not much is yet known about the mechanisms of farmers in government facilitated farming communities in coping with the debilitating effects of malaria on their productivity. The present paper examines the prevalence and impact of malaria on household labour use and productivity in the irrigated rice production system of Omor community in Nigeria. The effects of malaria on labour supply (work time) and labour/work efficiency are significant, both on the basis of computed estimates and recall data from household members. Household members who rely on wage labour, whereby malaria-caused morbidity or debility may mean instant loss of cash earnings/income, experience the most adverse consequences of malaria. Households, where a member experiences malaria illness providing critical labour (particularly specialized labour task), also are more prone to adverse malaria effects on their production activities. Substitution for the sick person's labour input mitigated the labour reduction implications of malaria illness for farm production; so also was the role of reallocation of tasks within the household. Larger households and those with greater cash resources showed greater flexibility in coping with a member's loss of effective work time by drawing largely on the labour of other household members.

Key words: malaria, agriculture, rice production, labour use, Nigeria

Introduction

Malaria constitutes a major public health problem in Africa, south of the Sahara, extending even into previously malaria-free mountainous areas (WHO, 1987; Brinkmann & Brinkmann, 1991). Observable trends in Africa indicate that the malaria burden on public health is greater today than it was 10-20 years ago (WHO, 1990). Population migration, growing resistance to anti-malarial drugs, limited resources for malaria treatment and control as well as irrigation and other development activities that create mosquito-breeding sites contributed to this increase and are likely to continue in the short-run (Shepard *et al.*, 1991).

Malaria inflicts tremendous adverse effects on the physical, social and economic well being of households; and retards overall development in the economy (Janssens & Werry, 1987; Taylor & Muller, 1978). As the foremost cause of illness in rural areas, malaria undermines agricultural productivity and income generation efforts, especially because the peak period of transmission (the rainy season) often coincides with the peak period of agricultural activity and labour operations (Ukoli, 1990). The combined effects of malaria related mortality, morbidity and debility on household labour force and on community members as a whole, manifest in reduced quantity and quality of labour inputs, reduced economic output and resource under-utilization (Shepard *et al.*, 1991).

Malaria is a health problem with adverse economic and developmental consequences. Its adverse economic consequences are often discussed under two broad categories: direct costs and indirect costs (Shepard *et al.*, 1991; Ettling & Shepard, 1991; Lennox, 1991; Picard & Mills, 1992; Mills, 1994). Direct costs comprise the expenditures of households and governments on the treatment and prevention of malaria. By 1997, estimates for all sub-Saharan Africa showed that a case of malaria incurred US$1.83 in direct costs. For Africa as a whole, the annual economic burden of malaria was $0.8 billion as of 1987 and was expected to rise to $1.7 billion in 1995 – representing a 0.6% share of GDP previously, and a 1.0% share for 1995 (WHO, 1988; Shepard *et al.*, 1991).

Indirect economic costs of malaria comprise the effects of malaria-caused 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 (Nur & Mahran, 1988; Leighton & Foster, 1993; Nur, 1993). For the whole sub-Saharan Africa, the indirect cost of malaria has been estimated to be US$8.01 in 1987, with average cost (direct plus indirect) of malaria projected to rise to $16.40 by 1995, due to increasing case severity and chloroquine resistance (Shepard *et al.*, 1991). In 2003 the Global Funds earmarked US$ 256 million for malaria control activities in 25 African

*Correspondence to: Dr. Joseph C. Okeibunor; email:jokeibunor@yahoo.com

countries (WHO/UNICEF, 2003). In a study of the economic consequences of malaria for households in Nepal, Mills (1994) found that malaria episodes inflicted deleterious effects on household productive time of both adults and children as well as on household cash availability. Similar evidence exists on malaria effect in terms of loss of work capacity (Gazin *et al.*, 1988) and also in terms of lowered agricultural productivity (Audibert, 1986). In 1987, malaria costed Africa about 12 days of output; if as estimated, *per capita* output falls to $0.77; then one case of malaria will bring a burden equivalent to 21 days of output (Shepard *et al.*, 1991).

These potential economic impacts of malaria illness can be mediated by the household responses to reduce losses in work output (Mills, 1994). There is evidence that the risk of malaria may affect systems of production and decisions about crops (Conly, 1975); such as resource shift from labour-critical cash crops like tobacco to less labour-critical but also less valuable crops like cassava. Resource allocation adjustments which farmers can make in response to minimize the economic effects of malaria drawing on the time of other household members or outside labour to compensate for the reduction in labour supply caused by a malaria episode, treatment choices and expenditure re-allocations.

In Nigeria, despite the growing awareness of the economic consequences of malaria, empirical research into the household level evidence is inadequate. Most literature on the socio-economic aspects of malaria impact is mere hypothetical propositions and scanty generalizations about malaria and in relation to economic development (Ukoli, 1990), agricultural development (Ormerod, 1978; Pant & Grantz, 1979) and general human welfare. Yet the micro level evidence is needed to demonstrate the economic losses associated with malaria illness among farmers; and to convince policy makers to devise properly targeted intervention strategies for mitigating malaria burden to household members and the economy as a whole. Understanding malaria prevalence and impact on farm labour use and productivity is particularly important for the area under study, given the often hypothesized direct relationship between irrigated farming and malaria incidence and economic impact.

This paper derives from a study, which investigated malaria prevalence in relation to the socio-demographic characteristics and economic activities of farming households, and malaria impact on labour availability/supply, labour productivity or work efficiency and resource allocation among rural households in an irrigated rice farming community.

Materials and Methods

Study area

The study was conducted in Omor community in Oyi local government area of Anambra State, Nigeria. Omor community is one of the catchment areas of the Lower Anambra Irrigation Project completed in 1987. Omor is essentially an agricultural community, with a predominantly farming population that is considerably motivated by the availability of irrigation water under the Lower Anambra Irrigation Project auspices. Omor community was chosen purposively to be the location of this research, based on the theoretical and empirical premise that malaria prevalence and burden tend to increase with the establishment/expansion of irrigation activities.

Sampling procedure and study sample

The study was based on a sample of 50 farm-households scattered throughout the five villages (Akanator, Obumeri, Uga, Iboji and Ikenga) that make up Omor community. Two administrative wards were randomly selected from each of these villages. The selected wards were alphabetically arranged and the dwelling unit in them listed from the first dwelling unit in the first ward to the last dwelling unit in the last ward. This gave a total of 112 dwelling units with a sampling interval of two dwelling units. From the selected or included dwelling units, a purposive sample of 50 households was drawn.

The sampling criteria included the presence of currently married couple, with the husband and wife fully resident in the community as well as the presence of a working-age household member (whether biological child or relative) aged ≥18 years. To allow for equal representation of the sexes in the sampling of household members (exclusive of husband and wife), further stratification by sex was carried out. So, the final sample included, for each household, the couple and one male/female member of ≥ 18 years. This gave a total of three individuals per household and sum-total of 150 from the fifty households. Community informed consent was obtained form the community leaders after going through the study protocol. The confidentiality of information was duly guaranteed.

Data collection

Two separate data collection instruments were used concurrently. On the one hand, there was a questionnaire designed to obtain information on the knowledge, attitudes and practices (KAP) regarding malaria prevalence, transmission, prevention and treatment. Other information sought through this interview schedule included environmental characteristics of living houses of individuals/households; types/degree of economic activities engaged in; socio economic characteristics of respondents (age, educational level and religious group and perception about the role of malaria in the health status of household members). On the other hand, the study used an interview schedule to obtain information on the consequences of malaria illness on the labour availability from working-age individuals, on resource allocation and on labour productivity on farms.

The interview strategy employed was the one-shot visit method under which the respondents were asked to give information, mostly through recall, on whether they suffered malaria illness during the land preparation/ planting season, the weeding/harvesting season and the dry season cropping. Some of the specific information sought through the malaria impact questionnaire included number and duration of malaria episode(s) suffered during each of the three reference periods/season; morbidity and/or debility (that is complete incapacity or partial incapacity caused by malaria, as an indication of the malaria severity (severity was classified as severe or mild according to whether the illness had forced the patient to stay at home and not work; loss of effective work time (labour input) incurred during the malaria episode, and estimated value of the lost effective work time; production and financial losses caused by malaria illness; household/individual responses to malaria for the purpose of reducing and/or disguising the actual impact of illness – that is, in terms of adjusting resource allocation patterns and the use of new type of resources (human and material).

To check the validity of the information given on the malaria status of the respondents, evidence of malaria experiences was demanded. The evidence was in the form of prescriptions/treatment. Furthermore, the researchers visited the facility from where treatment was obtained to crosscheck the records and confirm that the respondent actually experienced malaria episodes as indicated. In addition to these sets of data, in-depth interviews were held with health workers and farm extension officers on the nature of malaria in the study community. Case reporting and treatment records of medical officers were also examined.

Information about the state of health infrastructure and the availability of health services in Omor community were obtained through a combination of methods including physical observation of health facilities, interviews with both medical personnel and household members and secondary information from the State's Ministry of Health/Hospital Management Board. In the same manner, data on the role of malaria in the community's health situation were obtained from the clinics in the community and interviews with the medical directors of the clinics.

Data analysis

Information obtained through the KAP questionnaire was analysed using simple descriptive statistics. Data analysis regarding the malaria impact on household/individual labour supply, work time and output was based on counterfactual technique. That is, obtaining data from households and individuals about the number of days spent in farming during a week in the absence of malaria, obtaining estimates of the number of days of complete incapacity (morbidity) per case and the number of days of partial incapacity (debility). These data were used to compute the amount of work time lost to malaria illness, the output or labour task forfeited and the wage earnings lost, assuming the individuals were to be involved in agricultural wage labour. In other words, the economic costs of malaria to the household or individual, were therefore estimated by applying a calculated output per day for adults to the estimated productive time loss of both adult and child cases (Shepard *et al.*, 1991), and by imputing the value of time, determined seasonally based on the concept of marginal cost of labour, i.e. the opportunity cost of time (Sauerborn *et al.*, 1991).

Regarding malaria consequences on resource allocation and individual coping strategies to mitigate the adverse economic losses caused by the disease, the data were analyzed to capture the extent to which farmers shifted resources to easier activities or tasks either during a malaria episode or at the beginning of the farming year in anticipation of malaria occurrence. Other potential indicators of coping with malaria which were subject of data analysis, included adjustments in farmland area cultivated, switching to specific less labour-intensive crops/farming operations, adjustments in farm location (for example, concentrating greater resource and efforts on nearer or homestead farms), compensatory actions such as use of hired labour, and/or drawing on labour of other household members.

Results

It was found that Omor community had on the whole, very poor health infrastructure and thus low availability of health services. The health infrastructure consisted of two privately owned clinics, patent medicine stores/ operators and a number of traditional herbalists (unorthodox medicine practitioners). The community had no public health facility and there was no comprehensive programme of malaria prevention, treatment and control. The nearest government health centre was located some distance away from Omor community; such that Omor households could hardly estimate trekking time to it. Consequently, the inhabitants of this irrigated farming community were constrained to seek health care from the profit-oriented private clinics and quack patent medicine operators who often pose to be competent in providing medication to patients. Worse still, only households, who could afford the treatment charges and bills, were attending the private clinics. As a result, majority of individuals needing medical care could not reach the health services available. They largely resorted to local herbalists who administer mixtures on them.

Regarding the importance of malaria as a health burden in the community, it was generally observed that malaria was the most important illness among household members. A medical director who owned one of the private health clinics in the community affirmed this view, while adding that schistosomiasis posed another health burden. According to him, the environment was

Table 1: A sample of clinic records with total number of patients and proportion of malaria cases

Date	No. of patients	No. of malaria cases	% malaria cases
01.04.1996	31	10	32
03.04.1996	26	26	100
07.06.1996	16	8	50
03.07.1996	21	18	86
03.08.1996	19	10	53
17.10.1996	19	18	58

ridden with dirty and muddy collections of water in open ponds, especially during the rainy season. An agricultural extension officer who had close association with farming households through his extension visits to households, also agreed with this view, but added that the year-round presence of mosquito was attributable to the irrigated farming activities. According to the agricultural extension officer, "*the mosquitoes are found during the rainy season as well as during the months of the dry season when irrigation water is pumped onto farmlands, especially since the irrigated canals are open*"

Data obtained from the health clinics in the area indicated that reported malaria cases were at the peak in the onset of dry season farming (February-April) when water is pumped through the canal. In order to determine the importance of malaria illness among reported cases of illness in the area, the percentage of total reported illness accounted for by malaria was elicited from the clinic records available in the health clinics (Table 1).

Table 2: Distribution of respondents by their socio-demographic characteristics

Socio-demographic characteristics		Frequency	Percentage
Sex	Male	98	65.3
	Female	52	34.7
Age	Less than 20	1	0.7
	20-29	49	32.7
	30-39	37	24.6
	40-49	1	12.7
	50-59	23	15.3
	60+	21	14.0
Level of Education			
	No formal education	64	42.7
	First school leaving certificate	64	42.7
	School certificate	22	14.7
Religion			
	Catholic	42	28.0
	Protestant	48	32.0
	African traditional religion	60	40.0
Marital status			
	Single	70	46.7
	Married	74	49.3
	Divorced	1	0.7
	Widowed	5	3.3
Occupational group			
	Civil servant	2	1.3
	Artisan business	1	1.3
	Student	2	1.3
	Job seeker	22	14.7
	Petty trader	22	14.7
	Farmer	100	66.7

Most of the respondents were between 20-29 years old, followed by those in age group 30-39 years, with 32.7 and 24.6%, respectively (Table 2). The respondents' level of education was generally low. More than three quarters (85.4%) of the respondents had only primary education or less with half (42.7%) of this proportion having no formal education at all. Majority of the respondents were farmers (66.7%). The next segment with high proportion of the respondents was students (14.7%), followed by petty-traders (14.0%).

Virtually all of the respondents indicated that they could correctly identify the malaria insect vector-the mosquito, known locally as "*anwu nta*" (small fly). Respondents (94.7%) blamed the high incidence of malaria vectors on the irrigation activities especially the open irrigation water canals, farmlands, bushes, and irrigation sites (Table 2). According to one of the respondents to an in-depth interview:" *mosquitoes are ever present in this community irrespective of seasons. In the rainy season, the pools and open collections of water provide breeding sites for the mosquitoes. The dry season is not better either, because instead of the dryness you still find water collections which are man-made"*

In another interview, a respondent argued that "*in the dry season, water is pumped into the irrigation site through these canals which, as you can see, are uncovered. The water remains in them just as it would in the rainy season. I say it is worse because these mosquitoes, which would have remained in the bushes, will now rush to and stay in the canals and breed here. Worse still, the canals are just around the houses*"

While only 6% mentioned the prevalence of the mosquitoes in the dry seasons, 92.7% mentioned that mosquitoes were prevalent in the dry season only when water is being pumped into the irrigated farmlands through the open canals. For 93.3% of the respondents, mosquitoes were present there all year round. Interestingly, some of the people believed that

Table 3: Distribution of respondents as regards to their knowledge on malaria transmission, treatment and prevention

	Responses	Percentage
Location of mosquito bites		
Everywhere	83	55.3
Around the houses	140	93.3
Along the canals	142	94.7
In the bushes	140	93.3
At irrigation site	142	94.7
At farmland	140	93.3
Seasons of mosquito bites		
In the rainy season	145	96.7
In the dry season	9	6.0
Dry season when water is pumped at the irrigation project	139	92.7
All round the year	140	93.3
Belief on transmission of malaria		
Transmitted from an infected person	53	35.3
Not transmissible	17	11.3
Uncertain	80	53.3
Mode of transmission		
By mosquito	18	33.3
No idea	32	60.0
No response	3	6.7
Treatment		
Herbs	17	11.3
Local mixture (*'iba mixture'*)	106	70.7
Antimalarial drugs	3	2.0
Injectables	2	1.3
No treatment	22	14.7
Belief on prevention		
Malaria can be prevented	57	38.0
Malaria cannot be prevented	93	62.0
Method of prevention		
Clean environment	21	36.0
Use of insecticides	2	3.2
No response	34	61.3

malaria can be transmitted from an infected person to another (35.3%). However, 11.3% said malaria is not transmissible while more than half (53.3%) of the respondents were uncertain on this question. Of those who said that malaria is transmissible, only 33.3% indicated that this is done through the transfer of parasites by mosquitoes. Sixty percent said they do not know how this happens wile 6.7% gave no response.

On the effective modes of treatment perceived by the respondents an open-ended question was asked for them to fill in those methods they consider effective (Table 3). A large proportion of the respondents used unorthodox methods and believed these to be more effective. These methods included the use of traditional herbs (11.3%) and locally made solutions commonly referred to as '*Iba mixture*' (70.7%). Two percent of the respondents used antimalarial tablets and 1.3% thought injectables were more effective. Only thirty-eight percent of the respondents believed that malaria can be prevented. Out of these, 36.0% believed this could be achieved through clean and healthy environment and 3.2% believed this could be achieved through the use of insecticides. Of the respondents interviewed, 61.3% gave no response on the ways of preventing malaria. It was indicated that the community sometimes embarks on bush clearing to ward off mosquitoes.

Irrigated rice farming activities inadvertently exposed Omor households to the bites of the malaria vector. Seventy-six percent of the respondents mentioned that they are engaged in farming most times. Sometimes, however, 37.3% were engaged in fishing, 26.0% in lumbering and 66.0% also in addition were engaged in trading sometimes (Figure 1). However, the local economy was largely dependent on irrigated rice production by participants in the Lower Anambra Irrigation Project. The dry season rice production takes place between February and June: while the rainy season rice production takes place between July and November. During the dry months, rice production is made possible by the supply of irrigation water from the Lower Anambra Irrigation Project. During the rainy season, farmers cultivate, in addition to rice, other crops including cassava, maize, yam, and pigeon pea in order to meet household staple food needs.

Household members are often engaged in wage labour on farms with deficit labour, particularly during the peak labour demand periods. The main labour tasks/operations in the rice production economy included tillage, transplanting, broadcasting (direct seeding), clearing, fertilizer application, insecticide application, weeding, bird scaring, harvesting, threshing and packing. The number of days spent on farm work in a week ranged from 4-6 with an average of 5.7. The number of hours spent on the farm in a farm-day ranged from 8-12 hours, with an average of 9.8 hours. The particular farm labour operation done during a given 6-day farm week and/or during a 9.8-hour work period per day depended on the stage of the farming cycle and the farm management decisions and labour utilization patterns of the household members. So, on the average, a household member spent a total of 56.0 hours on the farm per week. Data on the number of persons that could accomplish a particular labour task in a day on a 0.5 hectare plot, that is the number of days a single person can accomplish that particular labour task showed that a single person can accomplish tillage on 0.5ha plot in a total of 8 days; transplanting on 0.5ha plot in a total of 8 days; weeding on 0.5ha plot in a total of 8 days also harvesting on a 0.5 ha plot in a total of 8 days (Table 4).

Table 4: Labour utilization patterns and wage rate in the rice production economy of Omor

Labour task/operation	Number of persons that can accomplish task in a day on a 0.5ha plot	Wage rate for labour task/operation (US$)	Total value of labour (US$)
Tillage	8	2.5/day/chain	19.8/plot
Transplanting	8	2.5	19.8/plot
Broadcasting (direct seed sowing)	1	4.3/day/chain	4.3
Clearing	8	2.5/day/chain	19.8/plot
Weeding	8	1.9/day/chain	14.9/plot
Bird scaring	1	37.1/year/plot	37.1/plot
Harvesting	8	2.5/day/chain	19.8/plot
Threshing	Thresher, operator + 7 servicemen8	37.1/day	37.1
Packing	8	0.7/day/chain	5.9/plot

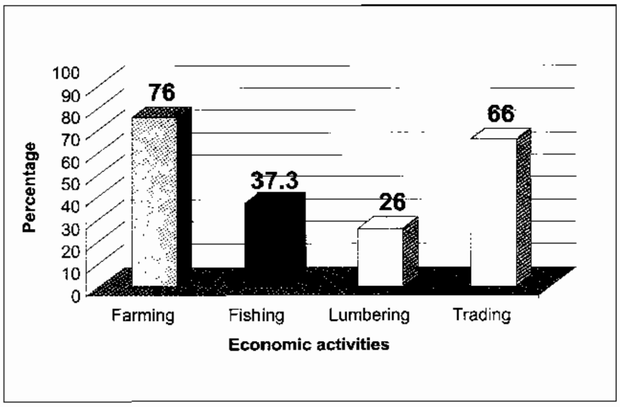

Figure 1: Distribution of respondents by the economic activities that occupy them

There was a remarkable labour stereotyping along gender lines. The labour tasks were divided between men and women according to the pattern determined by traditional culture and perception of gender abilities and responsibilities. Men clearly dominated the labour tasks including digging, land preparation, clearing of bunds, chemical spraying, threshing and bird scaring. On the other hand, labour tasks such as transplanting; women dominated weeding, harvesting and winnowing. Even though there was marked gender division of labour in the rice production economy, it did not mean gender exclusion from any particular activity, since in most cases, both men and women participated jointly in doing labour operations on the farm. It was therefore a matter of which gender does a greater share of the particular farm labour operation, rather than a single gender doing a particular farm work, exclusively.

Information on malaria prevalence was based on self-reported data from members of the farming households who have at least a malaria episode during the 1996 farming cycle confirmed from the treatment points. About 80% of the respondents reported having experienced at least a malaria episode during the 1996 farming cycle. The average number of malaria episode per individual was found to be 2 (that is, among individuals who experienced malaria episode at least once during the farming cycle). About 52% of the total number of malaria episodes were experienced during the land preparation/planting season (or June–August period) while the remaining percentage of malaria episodes occurred during the weeding/harvesting season (September-October period). Data showed that about 90% of the farmer respondents/household members were involved in the dry season irrigated rice cultivation, which usually begins in February/March. It was reported that about 70% of household members involved in dry season irrigated rice cultivation had experienced at least a malaria episode during the on-going season.

About 46% of farmers who suffered malaria episode during the land preparation/planting season had it for 3–4 days, the same as 52% of farmers who suffered malaria episode during the weeding/harvesting season and 65% of farmers who suffered malaria episode during the dry season irrigated rice cultivation period.

Information was sought on the extent to which the malaria episode caused complete incapacity (disability) or partial incapacity (debility) to work on the farm. About 72% of farmers who experienced malaria episode during the land preparation/planting season said they were completely incapacitated by the illness, and so, did not attend farm throughout the duration of the malaria. The remaining 28% of farmers reported that they attended farm at least once during the malaria illness (or they were not completely incapacitated on all the days of malaria). Similarly, about 77% of farmers who experienced malaria episode during the weeding/harvesting season were completely disabled by the malaria episode while 23% of them said they were partially disabled at least for a day. Also, 74% of farmers who experienced malaria episode during the on-going dry season irrigated farming said they were completely disabled throughout the malaria episode while 26% reported having partial disability.

Farmers had, on the average, 2 malaria episodes during the entire farming cycle; and a single malaria episode lasted 3 – 4 days on the average. Farmers who experienced complete disability due to malaria illness lost, on the average, 6–8 days of farm labour input. Based on counterfactual evidence (that is, what a person could have accomplished in 6–8 days), malaria episodes caused farmers to forfeit, on the average: complete tillage of 0.4–0.5ha plot or complete weeding of 0.4 –0.5 ha plot or harvesting of 0.4-0.5 ha plot. Further investigation of partial disability caused by malaria illness showed that farmers who were partially disabled by malaria during land preparation/planting season attended farm for an average of 2.5 days out of the total days of the illness. Similarly, farmers who were partially disabled by malaria during the weeding/harvesting season were found to have attended farm for an average of 3 days out of the total duration of the illness. The days of partial disability were found to be 2.7 days, on the average.

Farmers who reported partial disability during some days of malaria and who therefore attended farm were asked to indicate the extent to which the malaria illness affected labour efficiency (that is, whether they accomplished the same amount of work as possible in the absence of malaria). About 88% of the farmers reported that even though they attended farm, they accomplished less than a quarter of the normal daily work output, while 12% reported that they accomplished one quarter or half of what they would have accomplished in the absence of malaria. So, given that an average adult normally accomplishes: tillage of 0.063ha per day or transplanting on 0.06 ha per day, a farmer or adult who accomplishes only one quarter of the normal daily output would have tilled 0.016ha per day or weeded on 0.016ha per day. The one-quarter proportion of work output also meant that the farmer could only do broadcasting on 0.12ha per day. In the same vein, farmers who accomplished half of their normal daily work during days of partial disability due to malaria illness did tillage of 0.032ha per day or weeding on 0.032ha per day or transplanted on 0.032ha per day. It also meant that the farmer did broadcasting on 0.25ha per day or applied fertilizer on 0.25ha per day.

Both, the absence from farm work (complete incapacity/disability) and lowered labour efficiency (partial incapacity/disability) during malaria illness translated into loss of wage earnings or forfeiture of work output/value by the farmers. Considering that the average wage rate in the community was US$2.5-4.4 per day of complete disability depending on the labour operation/ task and on the period of the farming cycle. Also, based on counterfactual computation, farmers lost between US$0.25-0.44 per hour of complete disability. Under a situation of partial disability, farmers who did only a quarter of the normal daily work output lost between US$1.85-3.25 per day or US$0.19-0.33 per hour.

It was found that farmers employed at least one or a combination of the following resource allocation adjustments: (i) Reallocation of labour tasks to non-ill family members or use of hired labour to compensate for loss of work hours due to malaria; (ii) switch to easier labour tasks/crop choices during days of partial disability when the farmers attended farm work; (iii) switch from using labour on outlying farm-fields to homestead farm-fields that are more accessible from the living homes.

Re-allocation of tasks within the household was the most important coping strategy adopted to compensate for the lost work hours due to malaria illness suffered by a household member. About 60% of respondents who experienced malaria episode reported that the work hours lost were compensated for by other household members who had to do more than normal work either during the days the sick member was incapacitated or during other convenient periods. There seemed not to be difficulties in making up for the labour deficit resulting from malaria. However, it was found that in cases where the sick household members has specialized labour role, there was difficulty in obtaining other household members to stand in for the sick person, thereby leading to a lower rate of labour re-allocation of tasks in such situations. The same difficulty existed where the sick household member is currently involved in activities, such as wage labour, even though there was sufficient flexibility within most households (particularly larger households) to cope with a relatively brief loss of labour supply due to malaria, the same could not be said for relatively smaller households. About 10% of the respondents reported that they have used hired labour at least once to compensate for reduction in labour supply caused by malaria illness. Farmers therefore diverted cash resources already allocated for other uses to pay hired labour, as a way of mitigating the deleterious impact of malaria illness on farm labour efficiency and work output, particularly in critical labour operation periods such as planting, weeding and harvesting.

Household members who attended farm during the days of partial disability caused by malaria illness were investigated to ascertain whether the kind of labour operation they did was the same as they would have done in the absence of the malaria. Seventy-one percent of the respondents said they switched to less energy sapping and/or relatively easier labour tasks rather than the weeding operation they were supposed (or had wished) to do. It was found that partially disabled persons who attended farm avoided heavy labour tasks such as tillage, weeding and harvesting. Moreover, farmers who attended farm during days of partial disability concentrated the relatively low work effort on homestead farm-fields that were more accessible from the living houses; there were deliberate avoidance of outlying farm-fields which required trekking time to reach. Farmers who had neither household member to draw on nor cash to pay hired labour to compensate for work hours lost during malaria episode reported that they put in extra work hours after they recovered fully from the malaria illness. They worked relatively longer day, thus sacrificing leisure. Some farmers said exchange labour arrangements contributed to alleviating the labour losses due to malaria.

Discussion

This study has used farm household survey information to show the consequences of malaria on labour supply, labour efficiency and resource allocation. The effects of malaria on labour supply (work time) and labour/work efficiency appeared to be significant, both on the basis of computed estimates and recall data from household members. Malaria-caused complete disability (this is, morbidity) seemed to account for a greater proportion of the total effective work time loss, compared to malaria-caused partial disability (or debility). Household members who rely on wage labour, whereby malaria-caused morbidity or debility may mean instant loss of cash earnings/income, probably experience the most adverse consequences of malaria. Households, in which malaria illness is experienced by a member providing critical labour (particularly specialized labour task), also are more prone to adverse malaria effects on their production activities. Substitution (whether immediate or subsequent of unpaid household members or paid outside labour for the sick person's labour input mitigated the labour reduction implications of malaria illness for farm production; so also was the role of reallocation of tasks within the household. Households appeared to be able to cope with the labour supply problems caused by malaria; larger households showed greater flexibility in coping with a member's loss of effective work time by drawing largely on the labour of other household members. Also farmers with greater cash resources or credit access were more disposed to coping well with the loss of effective work time, since they could pay hired labour to compensate for lost work time.

Since malaria's influence on a person's work time may depend on the absence or adequacy of treatment (that is, the effect of malaria on the marginal disutility of work), it is useful for health policy officials to consider a comprehensive and active malaria treatment and control programme. There is need for speedy case detection and treatment; and reducing the time lag between the onset of fever and treatment will help not only to reduce incapacity but also to avert debility arising from malaria.

If health officials and policy makers are to increase the effectiveness of efforts to control the effects of malaria on the micro-economy of households, local variations in both the malaria morbidity/debility and in the associated costs to households should be taken into account. Also, it is pertinent to consider gender differences in the behavioural response to malaria illness and gender differences in the duration of complete disability and/or partial disability.

Even though this study has demonstrated the value for health policy of household-based evidence of malaria effects on labour supply and efficiency; and the value of looking at how households respond to, and cope with malaria illness, the analysis of economic impact of malaria should ideally be multivariate and long-term. This study, nonetheless represent the demonstration of the need to focus more sharply on averting the deleterious impact of malaria on farm production activities.

Acknowledgements

This paper derives from a larger study on malaria prevalence and impact on farm labour supply, use, productivity and resource allocation under the irrigated rice production systems of Omor Community, Nigeria. The World Bank/UNDP/WHO Special Programme of Training on Tropical Disease Research Small Grants programme in Institut de Formation et Demographique (IFORD) Cameroon, provided funds for the study.

References

Audibert, M. (1986) Agricultural non-wage productive and health status: a case study in a tropical environment. *Journal of Development Studies,* **24**, 275-291.

Brinkmann, U. & Brinkmann, A. (1991) Malaria and health in Africa: the present situation and epidemiological trends. *Tropical Medicine & Parasitology,* **42,** 204-213.

Conly, G.N. (1975) *The Impact of Malaria on Economic Development: A Case Study.* Scientific Publication No. 297. Pan American Health Organization, Washington DC.

Ettling, M.B. & Shepard, D.S. (1991) Economic cost of malaria in Rwanda. *Tropical Medicine & Parasitology* **42,** 214-218.

Gazin, P., Robert, V., Cot, M. & Carnevale, P. (1988) *Plasmodium falciparum* incidence and patency in a high seasonal transmission area of Burkina Faso. *Transactions of the Royal Society of Tropical Medicine & Hygiene* **82,** 50-55.

Janssens, P.G. & Werry, M. (1987) Malaria in Africa south of the Sahara. *Annals of Tropical Medicine and Parasitology* **81**, 5.

Leighton, C. & Foster, R. (1993) *Economic Impacts of Malaria in Kenya and Nigeria,* HFS Major Applied Research Paper No. 6, Maryland.

Lennox, R.W. (1991) Malaria in Africa: the need for economic analysis. *Tropical Medicine & Parasitology* **42,** 198-203.

Mills, A. (1994) The economic consequences of malaria for households: a case study in Nepal. *Health Policy* **29,** 209-227.

Nur, E.T.M. (1993) The impact of malaria on labour use and efficiency in the Sudan. *Social Science & Medicine* **37**, 1115-1119.

Nur, E.T.M. & Mahran, H.A. (1988) The effect of health on agricultural labour supply: a theoretical and empirical investigation. *Health Policy* **29,** 209-229.

Ormerod, W.E. (1978) Comments and discussions in agricultural aspects. In Taylor, A.E.R. and Mullor, R., eds., *The Relevance of Parasitology to Human Welfare Today,* **6,** 12.

Pant, C.P. & Grantz, N.G. (1979) Malaria and agricultural development. *Outlook in Agriculture* **10**, 3.

Picard, F. & Mills, A. (1992) The effect of malaria on work time: analysis of data from two Nepal districts. *Journal of Tropical Medicine and Hygiene* **95**, 382-389.

Sauerborn, R., Shepard, D.S., Ettling, M.B., Brinkmann, U., Nougtera, A. & Diesfeld, H.J. (1991) Estimating the direct and indirect economic costs of malaria in a rural district of Burkina Faso. *Tropical Medicine & Parasitology* **42,** 219-223.

Shepard, D.S., Ettling, M.B., Brinkmann, U. & Sauerborn, R. (1991) The economic cost of malaria in Africa. *Tropical Medicine & Parasitology* **42,** 214-218.

Ukoli, F.M.A. (1990) *Introduction to Parasitology in Tropical Africa.* Textflow Ltd., Ibadan.

WHO (1987)World malaria situation. *World Health Statistics Quarterly* 40.

WHO (1988) Synopsis of the world malaria situation. *World Health Statistics Quarterly* 43, 1.

WHO (1990) Synopsis of the world malaria situation. *Weekly Epidemiological Records* 22 and 25.

WHO/UNICEF (2003) *The African Malaria Report 2003.* WHO/UNICEF, WHO/CDS/MAL/2003.1093, 60.