Insecticide treated mosquito nets for malaria control in India-experience from a tribal area on operational feasibility and uptake

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The study assessed the operational feasibility and acceptability of insecticide-treated mosquito nets (ITNs) in one Primary Health Centre (PHC) in a falciparum malaria endemic district in the state of Orissa, India, where 74% of the people are tribes and DDT indoor residual spraying had been withdrawn and ITNs introduced by the National Vector Borne Disease Control Programme. To a population of 63,920, 24,442 ITNs were distributed free of charge through 101 treatment centers during July-August 2002. Interview of 1,130, 1,012 and 126 respondents showed that the net use rates were 80%, 74% and 55% in the cold, rainy and summer seasons, respectively. Since using ITNs, 74.5-76.6% of the respondents observed reduction of mosquito bites and 7.2-32.1% reduction of malaria incidence; 37% expressed willingness to buy ITNs if the cost was lower and they were affordable. Up to ten months post-treatment, almost 100% mortality of vector mosquitoes was recorded on unwashed and washed nets (once or twice). Health workers re-treated the nets at the treatment centers eight months after distribution on a cost-recovery basis. The coverage reported by the PHC was only 4.2%, mainly because of unwillingness of the people to pay for re-treatment and to go to the treatment centers from their villages. When the re-treatment was continued at the villages involving personnel from several departments, the coverage improved to about 90%. Interview of 126 respondents showed that among those who got their nets re-treated, 81.4% paid cash for the re-treatment and the remainder were reluctant to pay. Majority of those who paid said that they did so due to the fear that if they did not do so they would lose benefits from other government welfare schemes. The 2nd re-treatment was therefore carried out free of charge nine months after the 1st re-treatment and thus achieved coverage of 70.4%. The study showed community acceptance to use ITNs as they perceived the benefit. Distribution and re-treatment of nets was thus possible through the PHC system, if done free of charge and when personnel from different departments, especially those at village level, were involved.

Key words: ITNs - acceptability - usage - re-treatment - cost-recovery - Orissa - India

Malaria is an important cause of illness and death in many parts of the world, including India. There has been a renewed emphasis on preventive measures at community and individual levels. Insecticide-treated nets (ITNs) are the most prominent malaria preventive measure for large-scale deployment in highly endemic areas (Schellenberg et al. 2002, Lengeler 2004). Most research about the efficacy of bed net impregnation has been done in Africa and Asia (Kroeger et al. 1997). The study by Choi et al. (1995) showed a reduction of the malaria incidence rate by 50%. Also, the overall mortality and mortality attributed to malaria in children aged 1-4 years were reduced by 63% and 70% respectively in areas in Gambia where insecticide treated nets were used (Alonso et al. 1991). The controlled trials carried out so far thus showed a reduction not only of malaria related morbidity but also of child mortality (Lengeler 2004). The positive results obtained in various trials prompted the government to introduce ITNs in to the malaria control programme in India on a pilot scale in 100 highly endemic districts under the Enhanced Malaria Control Programme. This is the first time ITNs have been incorporated into the malaria control programme to replace insecticide indoor residual spraying in India at Primary Health Centre (PHC)/district level. Expansion of this method to larger malaria endemic areas would depend on the experience gained in this programme. In diverse social and epidemiological settings, efficacy of the ITNs alone may not be the crucial determinant for the effective implementation of this community-based intervention measure (Binka & Adongo 1997). Social and operational aspects of ITNs are equally important for large-scale implementation and for further expansion of the programme. Information about logistics and operational implications of ITNs programme is still scarce (Gyapong et al. 1996, Curtis et al. 2003) and the need for operational research has been stressed (Lengeler et al. 1996, Lengeler & Snow 1996). In this context, there is a need for assessment of the operational feasibility and acceptability of ITNs by the local people. We report here the results of a study undertaken in Koraput district, state of Orissa, India.

SUBJECTS, MATERIALS AND METHODS

Study area - Koraput district (17°50'-20°30'N, 81°27'-84°10'E) is situated in the Southern part of the state of Orissa, India, and has a population of 1,100,938 inhabitants (2001 census). The literacy rate was 47.6% in males and 24.8% in females. The district is a home for several

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tribes whose major occupation is agriculture and collection of forest products. About 84% of the rural families live below the poverty line. The district has 14 PHCs, each with a few sub-centres (sub-unit of a PHC). The district has been highly endemic for malaria (Rajagopalan et al. 1990), transmitted primarily by *Anopheles fluviatilis* (Parida et al. 1991). The Annual Parasite Incidence ranged from 14.3 (1997) to 15.8 (2001), indicating a stable situation. Deaths due to malaria have been recorded every year and during 1997-2001 the number ranged from 12 in the summer to 44 in the cold season. More than 95% of the total cases were due to *Plasmodium falciparum* (Jambulingam et al. 1991). All PHCs in the district used DDT indoor residual spraying till 2001. Koraput is one of the 100 highly endemic districts included under the Enhanced Malaria Control Programme.

The National Programme allocated 25,000 mosquito nets to the district. Since the allotment was not sufficient to cover the entire population of the district, the District Malaria Control Society (a district committee for management of malaria control programme with the Collector as its Chairman) distributed the nets, in place of DDT indoor residual spraying, to the people in Pottangi PHC that recorded a high malaria incidence. The PHC has an area of about 240 km^2 and a population of 63,920 (2001 census), in 425 villages including hamlets, which have 16,423 households under 14 Gram Panchayats (GP). There are 15 sub-centres under the PHC; each one is the headquarters for a health worker. The number of households ranged from 10 to 300 per village. The distance of villages from the PHC ranged from 1 to 35 km.

Dipping and distribution of nets - The medical officer and the paramedical staff of the PHC, village level workers, teachers and the Integrated Child Development Scheme (ICDS) personnel were trained in net treatment. The nets were treated and distributed through 101 distribution centres opened in schools, Panchayat offices, ICDS centres and village meeting places nearer to villages, each for a population of 300-1100. A total of 24,442 nets were treated using 244.5 l of Cyfluthrin 5% EC diluted to give a target dosage of 50 mg/m^2 and distributed free of charge to all households, 1-3 nets for each household, in the months of July-August 2002 when malaria transmission was at its peak. All safety precautions were followed during net impregnation. Nets were supplied taking into account the number of members in each family, their age and relationship to ensure that every one would have access to a net. About 95% of the target households received the nets in person. The nets for the absentees were handed over to the village leader for distribution later. Appropriate use of bed nets was demonstrated to the villagers and they were also informed that the ITNs were supplied to them for control of malaria.

Re-treatment of nets - The PHC health workers under the supervision of malaria inspectors carried out the first re-treatment of the nets at the treatment centres eight months after the distribution (i.e.,April-May 2003). Deltamethrin 2.5% SC was used at a dosage of 25 mg/m^2, and for each net Rs. 10/- (US$ 0.2) was charged. Since, the coverage was very poor (< 4%), a team consisting of a health worker, teacher, village link worker and Anganwadi worker (female field worker of ICDS) carried out the re-treatment during July-September 2003 in each village.

The second re-treatment was carried out in May 2004, i.e., nine months after the 1st re-treatment by the health worker with the assistance of an Anganwadi worker in each village. Advance information was sent to the villagers through village leaders visiting weekly markets. This time, re-treatment was done free of charge, as the villagers were unwilling to pay. In 55 households the members participated in treating the nets.

Measuring community acceptance - The acceptability, use rate and washing practice of the community were assessed using quantitative cross-sectional surveys. Other information collected during the 1st survey included the literacy levels, KAP, ownership and willingness to buy a net. The minimum sample size to be collected in a sub-centre of the PHC was calculated using Statcalc (Epi Info 2000) based on population size, expected acceptability of ITNs (50%), precision (10%) and confidence level (95%). In each sub-centre, 10% or a minimum of three villages was randomly selected and in each village, the number of households selected was proportionate to the size of the village. Out of a total 15 sub-centres of the PHC, only 13 were considered for the evaluation (two were excluded due to a reported societal unrest). Three cross-sectional surveys, one in each season, were carried out. The household head (male) or the mother or, in their absence, any other adult in the household who could be relied upon was interviewed using a pre-tested questionnaire. The data collectors were trained beforehand. A total of 1,130 and 1,012 households were surveyed respectively during the cold (1st survey, December 2002) and the rainy season (3rd survey, July 2003) in 41 villages (out of a total of 425). During the summer, for logistic reasons, the cross sectional survey (2nd survey), conducted in May 2003, included only 100 households in three randomly selected villages.

Re-treatment coverage - The first re-treatment coverage was assessed from the PHC record as well as through a cross-sectional survey (4th survey) in December 2003, two months after the 1st re-treatment in six randomly selected sub-centers (out of 15). In each sub-centre, three villages were randomly selected and in total 126 households, who received altogether 225 nets were interviewed. To assess the 2nd re-treatment coverage, another cross sectional survey (5th survey) was carried out in August 2004 in 34 villages choosing 838 households. The survey was also utilized to confirm the coverage of the 1st re-treatment.

Determination of insecticide persistence - Bioassays were carried out using the World Health Organization cone method at bimonthly intervals on the ITNs supplied to the villagers to monitor persistent effect of the insecticide treatment. Four villages were randomly selected and bioassays were conducted on three nets collected randomly from each village every time. For comparison, tests were conducted in parallel on one untreated net obtained from the villagers. Three sets of 11-14 wild-caught fully fed female mosquitoes were exposed to the treated

nets for 3 min and the mortality was recorded after 24 h. *An. fluviatilis* was used for the bioassay from August 2002 to April 2003. Subsequently, *Anopheles culicifacies*, the secondary malaria vector, was used since *An. fluviatilis* could not be collected in sufficient numbers due to seasonal effect.

Data analysis - The quantitative data collected through cross sectional surveys were encoded in a computer using Epidata.V.2.1b and analyzed through SPSS.V.10. For open-ended questions of the questionnaire replies of equivalent meaning were pooled into different categories during analysis. Percentages were computed for different options. The data on mortality of *An. fluviatilis* and *An. culicifacies* obtained from bioassay tests were corrected to control mortality, if any, using the formula of Abbott (1925).

RESULTS

The study population comprised predominantly of tribes (74.0%). There are 23 tribes, of which Kandho, Poroja, Dora, Gadaba and Rana are the major ones. The results of the 1st survey (conducted in the cold season) of 1,130 respondents showed that majority (80.1%) of the population had no formal education and the others had either primary or high school level education (Table I). About 66.3% of the respondents stated that malaria was a serious health problem in their village, mainly because of the severity of fever. Wage loss and death due to malaria were the other major reasons (compiled from multiple answers). During the interviews, 38.8% of the respondents stated that mosquito bites were the means of infection with malaria. While 38.1% were unaware, there were also some misconceptions regarding the cause of malaria transmission (Table I). Ten percent of the respondents stated that they already possessed untreated bed nets, 9.5% said that they had only seen a mosquito net but not used one so far, and while 80.3% stated that they had not even seen a mosquito net. Majority of those who possessed mosquito nets were from the villages situated along roads having better access to communication and transport to nearby towns. Among those who possessed untreated nets, a majority (95.7%) stated that they acquired them for protection against the nuisance of mosquito bites and 19.1% stated that another motive was to prevent malaria.

TABLE I

Education level of the study population and their awareness on malaria

	Response (%)
Education (n = 1,130)	
No formal education	80.1
Primary	9.3
High school	10.4
College	0
Not available	0.2
Is malaria a serious problem in their area? (n = 1,130)	
Yes	66.3
No	11.7
Do not know	22.0
Reasons for 'Yes'[a] (n = 749)	
1. Severity of fever	88.9
2. Wage loss as physically unfit to do labour	16.4
3. Death due to malaria	15.2
4. More expenditure for treatment	4.4
5. Others (compiled from multiple answers)	10.5
Perceived causes of getting malaria[a] (n = 1130)	
Mosquito bites	38.8
Drinking dirty water	11.3
Over work/fatigue	4.1
Eating sweet or sour or cold food	2.4
Too much exposure under sun	2.3
Irregularity in taking meals	1.9
Others (working in forest, bathing in stream etc.)	9.1
Do not know	38.1

a: multiple answers were given.

Usage of nets - Overall, according to the PHC record, a household:net ratio of about 1:1.8 and net:person ratio of about 1:2.5 was achieved. During the 1st survey, almost all the respondents (1,129/1,130) showed to the interviewer the ITNs they had received from the government. Only 1.6% reported that the number of nets supplied to them was insufficient.

Nearly 95% of the respondents were the ITN users, and most of them stated that they use regularly. The reasons for irregular use were the need to sleep near to the fire during cold weather, negligence and not liking to sleep inside a net, lack of sufficient space in houses to suspend the nets etc. Of a total of 5,119 household members of the respondents, 80% slept under ITN the night before the survey. Also, 95% of the children < 5 years and 88.6% of the pregnant women used ITNs the night before the interview. Of a total of 1,889 nets supplied to the households of the respondents, 70.9% were found hanging in the rooms indicating that those nets were being used (Table II).

Among the respondents, 15.4% stated that they had washed their nets and of them 89.7% washed their nets once (over a period of 3 months). Since using ITNs, 76.6% of the respondents observed reduction of mosquito bites, 32.1 % reported reduction of fever/malaria incidence and 19.2% reported fewer mosquitoes inside the house at night (Table III). During the survey, 37% of the respondents expressed willingness to purchase ITNs if the cost was lower and they were affordable.

The survey conducted during the rainy season among 1,012 respondents showed that 90% of them were the ITNs users and 80.5% of them stated that they use nets regularly. The main reason stated for irregular use of nets was feeling too hot under them (40.4%). Other reasons given for irregular use matched with those recorded during the 1st survey done in the cold season (Table II). Of the total household members of the respondents (n = 4,541), 74% slept under ITNs the night prior to the survey. About 96% (n = 555) of children < 5 years and 89% (n = 37) of pregnant women slept under an ITN the previous night. Of the total nets supplied to the house-

TABLE II

Insecticide-treated nets (ITN) usage in cold and rainy seasons

	Season	
	Cold	Rainy
Number of respondents interviewed	1130	1012
ITN users among the respondents	94.9%	89.9%
Respondents used ITNs regularly	88.1%	80.5%
Reasons for irregular use (%)	n = 74	n = 193
To sleep near fire due to cold[a]/due to hot inside net[b]	47.3[a]	40.4[b]
Negligence and not liking to sleep under net	2.7	14.0
Lack of sufficient space in the house to tie net	12.2	6.7
Insufficient number of net supplied	9.5	12.4
Due to dirty condition of nets	2.7	1.0
Others (visit of guests, outside trips, celebrations, alcohol consumption, not habituated to use net, reduced mosquito problem etc.)	25.7	25.4
Total family members in the households of the respondents interviewed	5,119	4,541
% slept under ITN the night before the survey	80.0	74.0
% of children < 5 slept under ITN	95.0 (n = 671)	95.7 (n = 555)
% of pregnant women slept under ITN	88.6 (n = 44)	89.2 (n = 37)
% of nets found hanging inside the houses of the respondents	70.9 (n = 1,889)	85 (n = 1,678)

TABLE III

Net washing and observation since using insecticide-treated nets (ITNs)

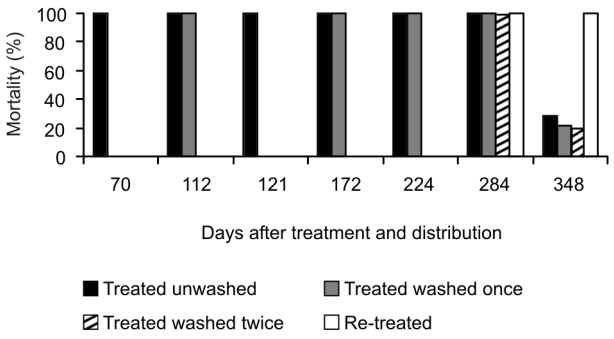
	Season	
	Cold[a]	Rainy[b]
Washing		
Respondents interviewed	1,130	1,012
Respondents washed their nets	174/1,130 (n = 174)	720/1,012 (n = 720)
% washed once	89.7	72.5
% washed twice	8.0	20.3
% washed thrice	1.1	5.3
% washed four times	0.6	1.1
% washed five times	0.6	0.8
Observation since using ITNs[c]		
Reduced mosquito bites	76.6	74.5
Reduced fever/malaria incidence	32.1	7.2
Reduced mosquitoes inside the house at night	19.2	2.9
Undisturbed (pleasant) sleep at night	18.8	5.9
Others (reduced bugs and flies, dust protection etc.	2.5	5.5
No observed effect	6.8	8.1

a: over a period of three months after net distribution; *b*: over a period of ten months after net distribution; *c*: multiple answers were given.

holds of the respondents, 85% was found hanging inside the houses (Table II) and this proportion was significantly ($\chi^2 = 99.9$, $p < 0.001$) higher compared to that observed in the cold season. About 71% of the respondents stated that they had washed their nets (over a period of 10 months after the distribution); of them 72.5% washed once, 20.3% twice and 5.3% three times. Washing four and five times were also reported (Table III). As observed in the cold season survey, since using ITNs, 74.5% of the respondents reported reduced mosquito bites and 7.2% reported reduced fever/malaria incidence, besides other observations (Table III).

During summer, only 55.1% of the household members (n = 472) slept under mosquito nets the night previous to the survey and this proportion was significantly ($p < 0.01$, by χ^2 test) lower when compared to that recorded during winter and rainy seasons. Similarly, the number of hanging nets inside houses, proportion of regular net users and use rate by the children < 5 years were significantly ($p < 0.01$, by χ^2 test) lower in the summer season compared to the other two seasons. High nighttime temperature and less mosquito problem were the major reasons given by the people for the low use rate of ITNs during the summer season.

Insecticide persistence - Following the initial treatment of nets in August 2002, almost 100% mortality of *An. fluviatilis* or *An. culicifacies* was recorded for up to ten months on unwashed nets and on nets washed once or twice. At 11-12 months post-treatment, the mortality reduced to 29% on unwashed nets, 21% on nets washed once and 20% on nets washed twice (Figure).



Bioassay for persistent effect of insecticide on treated unwashed, treated washed and re-treated nets (*Anopheles fluviatilis* was used for the bioassay up to day 224 and thereafter *Anopheles culicifacies* was used).

Re-treatment - According to the PHC report, in a period of two months (April-May 2003), the health workers succeeded in re-treating only 1,023 nets, which was 4.2% of the total number of treated nets distributed. The major reasons identified for the poor coverage were the unwillingness to pay for re-treatment and unwillingness of the people to go to the treatment centers from their villages. After a campaign involving personnel from several departments at the village level around 90% of the total 24,442 treated nets supplied was re-treated, as shown by the PHC records.

Interview of 126 respondents regarding the 1st re-treatment also revealed that 89.7% had their nets re-treated. Among them, 81.4% paid cash for the re-treatment at the time, 13.3% did not pay cash but later had the payment deducted from money due to them from other government beneficiary schemes and 5.3% neither paid nor were credited from other benefits (the payment could not be recovered). The majority of those who paid for the re-treatment in cash stated they did so because of the fear that they might lose other benefits from the government if they did not pay. The reasons stated by those who did not have their nets re-treated were (i) no money (3 respondents) and (ii) absent at the time/unaware of the team's visit to their villages (10 respondents).

In the 2nd re-treatment survey, 838 persons were interviewed and 70.4% stated they had their nets re-treated. Among the 248 respondents who did not have their nets re-treated, 34.7% stated the workers did not visit their village for re-treatment, 35.5% stated they were absent at the time of the workers' visit, 26.6% gave no answer, and 3.2% were unwilling to have their nets re-treated. About 66.2% had their nets re-treated both times (1st and 2nd round) and 92% during the 1st round of re-treatment.

DISCUSSION

The present study analyzed the factors related to treatment, distribution, usage of insecticide treated mosquito nets and the feasibility of re-treatment of nets on a cost-recovery basis under the malaria control programme in a tribal community.

Net distribution - The PHC system was successful in distributing the ITNs to all villages and all households with a household:net ratio of 1:1.8. This was also evident from the fact that only 1.6% of the respondents stated that the number of nets supplied to them was inadequate. The successful completion of the net distribution was possible by meticulous planning and the multi-departmental approach. Identification of the 101 treatment centres to cover all villages in the PHC made the process of net treatment and subsequent distribution to the households much easier. The orientation training programmes conducted for the district and PHC staff was important.

Acceptance and usage of ITNs - The tribal community accepted ITNs as indicated from the 95% attendance at treatment centers to receive nets and their participation in net treatment as reported in the villages of Nicaragua, Colombia, Ecuador and Peru (Kroeger et al. 1997). The ready acceptance could be also because of free supply by the government. In a population where only a few had used or seen mosquito nets before the ITNs programme, and with only a 36.2% literacy rate, the net usage rate was encouragingly higher as people perceived the benefit of protection against mosquito bites, though their awareness of the relationship of mosquito bites to malaria was only around 40%. Thus bed nets may have higher acceptability in many communities as a defense against nuisance bites of mosquitoes than as malaria prevention (Okenu et al. 1999). The respondents who used bed nets as protection against mosquito nuisance were more likely not to use bed nets when mosquitoes were few than those who used bed nets for malaria protection (Yohannes et al. 2000). Therefore, through an appropriate IEC package, the community needs to be made aware of the benefit of ITN use in the prevention of malaria to enhance the use rate further. There was a seasonal variation in the net usage; with this being considerably higher during the cold and rainy seasons. During the summer, the results from a limited number of interviews were similar to other studies in the area (Sahu et al. 2003) and elsewhere (Binka & Adongo 1997) that, due to the heat and less mosquito nuisance, use of ITNs was lower. In summer when mosquito prevalence is low and malaria is thought to be unlikely, it would be difficult to attain high rates of net usage. It will be necessary to develop appropriate messages and communication materials that explain how it is possible that malaria can be a threat even when mosquitoes are scarce (Winch et al. 1994).

About 37% of the respondents expressed willingness to purchase ITNs despite the fact that 84% of the rural families in the district live below the poverty line. However, the majority of them stated they would purchase the nets only if the cost was lower and they were affordable. People's willingness to buy nets at a subsi-

dized rate of US$ 0.4-0.6/net has been demonstrated in some other tribal districts, where nets were distributed under the same programme. Therefore, it would be feasible in this area also to sell ITNs, but at a very low price. As it was practiced in Nicaragua and Colombia (Kroeger et al. 1997), netting could be bought from retailers and given to Self Help groups or Village Committees who can manufacture bed nets at a low price and sell to the villagers; earnings obtained could be returned in a revolving fund that could also be used to meet the cost of insecticide required for net re-treatment.

Re-treatment - Besides distribution coverage, re-treatment of nets every 6 or 12 months is one of the major constraints in large-scale implementation of ITNs (Gonzalez et al. 2002). In the present study, bioassay results confirmed the efficacy of Cyfluthrin treatment of nets up to ten months on nets that were reportedly washed twice. Also, the majority of the people washed their nets either once or twice over a period of ten months. The study by Maxwell et al. (1999) in Tanzania has shown that only after about five washes did the insecticidal power of the nets treated with lambdacyhalothrin or alphacypermethrin decline appreciably. Though the guidelines of the National Vector Borne Disease Control Programme suggest re-treatment every six months, re-treatment was started eight months after the distribution, which was justifiable in view of bioassay results and people's net washing practices. Initially, re-treatment coverage was poor and could not be completed before the peak transmission by the health workers. This setback was due to the fact that net treatment was a new experience to the health department personnel as they were routinely carrying out indoor residual spraying and there was no proper information given to the people on the issue of charging for re-treatment. Further, though the villagers were keen to visit the treatment centers initially to receive the nets, they did not return for re-treatment of the nets, and hence re-treatment was done in the villages or nearby villages involving staff from several departments resulting in increased coverage.

Although, re-treatment of nets with cost recovery was possible to a certain extent with a special effort, it was not sustainable, as apparently, the majority of the people made the payment owing to the fear that they may, otherwise, lose benefits from the other welfare schemes of the government. Secondly, although the extent to which the villagers accepted the deduction of the re-treatment cost from the benefits due to them from welfare schemes was not known, a few of them openly and strongly spoke against it. People found it difficult to believe that the government, which distributed nets free of charge, was charging for re-treatment. It was a mistake that the nets were first supplied free of charge and then attempted to recover the cost for re-treatment. Therefore, the department had no other option except re-treating a considerable proportion of nets during the 1st round and all the nets during the 2nd round free of charge. It is not clear whether the villagers would have paid for re-treatment if the nets had been sold to them at subsidized rates. While re-treatment of nets has been considered as a practical problem in the success of ITN programme (Lines 1996, Schellenberg et al. 1999), re-treatment of almost all nets during the 1st round constituted progress towards large-scale implementation of ITNs. However, cost-recovery for the insecticide could not be sustained. In Tanzania, a study conducted in Bagamoyo district showed that rates of re-treatment dropped significantly when payment for the insecticide was introduced (Winch et al. 1997), but 95% of the nets were brought for free re-treatment as reported by Maxwell et al. (2006).

The findings suggested a high level of social acceptability and re-treatment of ITNs under a free supply scheme and point to the need to test their acceptability further under conditions where people would pay for nets and communities would manage distribution and re-impregnation systems. The long lasting insecticide treated nets (LLNs), if introduced, would however solve the issues related to re-treatment of nets. But, reducing the cost of LLNs by subsidizing the price and making them available at villages or near by through social marketing are necessary to facilitate people's access to LLNs and promote their use by them. Further, people may buy treated bed-nets if they are made available after the harvest season when they sell their crops and have enough money to pay or the season coinciding with high mosquito nuisance. Considering the behaviour of *An. fluviatilis*, the principal malaria vector, insecticide treated bed-nets should be an effective option for malaria control in this area (Das et al. 1993, Gunasekaran et al. 1994, Sahu et al. 2003).

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