CHAPTER 1

INTRODUCTION

1.1 Problem Statement and Rationale

1.1.1 World Malaria Situation

Malaria is so far the world's most important tropical parasitic disease and kills more than any other communicable disease except tuberculosis. Mortality due to malaria is estimated to be in the range of 1.5 to 2.7 million deaths each year. Malaria is a today 's public health problem in more than 90 countries inhabited by about 2,400 million people. More than 90% of all malaria cases are in sub-Saharan Africa. Two-thirds of the remainder are concentrated in six countrie: India, Brazil, Sri Lanka, Vietnam, Colombia and Solomon Islands (WHO,1996)

In many developing countries, malaria is a burden for society in medical cost, and in days of labour loss. Human malaria is a disease caused by Plasmodium. There are 4 species of parasite that infect man: *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale* and *Plasmodium malariae*. The common and important infections are those caused by *Plasmodium falciparum* and *Plasmodium vivax*. Malaria disease is transmitted by the bite of infected female Anopheles mosquitoes. Occasionally transmission occurs by blood transfution or congenitally from infected mother to fetus. The disease is characterized by fever and flu-like symtoms, including chills, headache, and malaise. These symptoms may occur at intervals. Malaria may be associated with anaemia and jaundice and *Plasmodium.falciparum* infection can cause kidney failure, coma, and death. However, death due to malaria is preventable.

The geographical areas affected by malaria has shrunk considerably over the past 50 years, but control is becoming more difficult. The principles of malaria prevention are:

- To prevent mosquitoes from feeding on human
- To reduce the breeding of mosquitoes by eliminating collection of water or by altering the environment
- To destroy the larvae of mosquitoes
- To destroy adult mosquitoes
- To eliminate the malaria parasite in the human host

But now we get some difficulties in preventing malaria disease: For example, we face spreading multi-drug resistance. The rapid spread of drug resistant parasites to chloroquine and other antimalarials is making malaria treatment more complicated. There is increased migration of susceptible human populations, and very little

progress has been made in control of the other stages of the vectors although there has been much talk about the need to improve environmental management for the control of vector breeding. In additon, the vectors have become resistant to insecticides. In many developing countries, large-scale spraying campaigns are increasingly seen as draining national health budgets, too dependent upon the vagaries of international aid supply, lacking in community involvement, and unsustainable.

These characteristics place higher priority on personal and community action to protect against mosquito bites, the methods have been aimed at reducing the longevity and/or density of adult mosquitoes, reducing human-mosquito contact and rendering malaria drug prophylaxis as less useful tool.

Ideally, an untreated net should provide a complete physical barrier to mosquitoes. Mosquito nets made of silk were first used by the Chinese, and they were bought to Japan more than a thousand years ago. Mosquito nets made from hemp became popular in Japan in the 17^{th} century. In practice, even intact tucked-in nets offer only partial protection, mosquitoes quickly find any body part touching the net or inadvertently left uncovered, good protection generally requires a very high standard of care in maintenance as well as in use. During the last few years several field trials have demonstrated that the protection effect of mosquito nets can be greatly enhanced by treating them with a repellent or insecticide, making the nets a chemical as well as a physical barrier and killing mosquitoes after they contact with the nets.

Antimalaria bednets, treated with DDT, were first used during World War II by the Russian, German and US armies. In the late 1970s, synthetic pyrethroids were developed to mimic nature insecticide compound found in chrysanthemums, but it remains effective for longer periods of time. Pyrethroids are widely used as household insecticides.

Unlike DDT, pyrethroid such as Permethrin does not accumulate in the food chain and is rapidly broken down in both sunlight and the soil. Permethrin was registered with the US EPA and first marketed in 1977. Permethrin is safe, colourless, odorless, stable, but it is not recommended for skin application. There is no human study on the potential of Permethrin to cause cancer. Permethrin is not expected to accumulate in the body (Oregon State University,1996). Therefore, the World Health Organization was interested in mosquito nets in the early 1980s and approved the use of pyrethroids in general and of Permethrin in particular for treatment of bednets. So now, most countries are switching to Permethin treated mosquito nets as their program's main form of vector control. Pyrethroids work by quickly paralyzing the nervous systems of insect. Permethrin kills insects when it contacts them and it also has repellent effect.

1.1.2 Malaria Situation in Vietnam

Vietnam lies in the South East Asia region with an area of 331,114 square km and half of its territory is covered with forest. The country has a coast line of 3,260

km. The climate is tropical and subtropical. The average annual temperature is 21°C to 27°C. The average rainfall is about 1,680ml in Hanoi and 2,180ml in Ho Chi Minh city. Rainy season occurs from April to October in the Northern part and from June to December in the Southern part. Relative humidity is always more than 70%. Such a physical environment has created ideal conditions for mosquito development as well as for malaria parasite's completion of life cycle in the mosquito host. In 1996 population in Vietnam is about 75,300,000 people belonging to 56 ethenic groups. Among them, the Kinh is majority people accounting for 85%. The other 15% distribute in the mountainous and forest areas from the North to the South. Nearly half of the population live in malaria endemic areas, 20% living in urban areas and the remain in the rural areas

Health Budget

Health budget usually takes up a modest part of national total expenditure. Budget for malaria control activities, as a result is limited (see Table 1.1)

Table 1.1 : Malaria Expenditure From 1992 – 1995 Period in Vietnam

Year / Malaria expenditure	1992		1993		1994		1995	
	VND	%	VND	%	VND	%	VND	%
National Total expenditure	23,665		39,063		48,890		63,080	
Health budget	1020	4.3*	1289	3.3*	1686	3.5*	1952	3.1*
Malaria budget	35.6	3.5**	51	3.9**	60	3.5**	70	3.6**

Source: Health Statistics Yearbook in Ministry of Health of Vietnam, 1995

Note :* in relation to National total expenditure

** in relation to Health Budget

Historical of preventing malaria

The malaria eradication program started in 1958 in the North and in 1975 in the South part of Vietnam. The goal of malaria eradication program is to eliminate malaria disease, but through many years conducting this program, malaria has still been a major health problem in Vietnam. The leaders of Malaria Eradication Program recognized that they could reach their objectives. So from 1986, the Malaria Eradication program has changed its strategies and converted to the National Malaria Control Program in 1991 with the following objectives:

- To reduce mortality
- To reduce morbidity
- To reduce epidemic outbreaks

The National Malaria Control Program (NMCP) is ranked the second of the 7 state priority health programs. In 1991, malaria became a serious problem with 1,091,201 malaria cases and 4,646 deaths and the parasite rate was 7.55%. Since 1992, the NMCP has been paid more attention by the Government, Ministry of Health and various level authorities in financial provision. More funds have been given to the program to ensure the need of the antimalaria drugs, extention of Permethrin treated bednets application, improvement of the quality of insecticide residual spray, strengthening of the health education, mobilization of the participation of the community and various branches in malaria control activities.

With appropriate objectives and more attention by the Govertment and others, the malaria situation in Vietnam has improved considerably since 1996. The objectives of National Malaria Control Program during the period from 1996 to 1998 are:

- To reduce mortality
- To reduce morbidity
- To prevent epidemic outbreaks

Malaria Situation

Vietnam is situated in a highly malaria endemic area of the world. More than 32 millions people are exposed to the risk of malaria in the whole country. The malaria situation in 1991-1995 are summarized in Table 1.2.

Table 1.2 Malaria Statistic in 1991-1995 Period

Year	1991	1992	1993	1994	1995
Pop at risk of malaria	31,530,420	31,848,910	32,170,620	32,495,570	34,042,468
Pop. Protected by Insecticides	4,305,786	5,560,562	7,829,045	10,457,880	11,059,862
Malaria cases	1,091,201	1,294,426	1,111,960	857,999	666,153
No of death	4,646	2,658	1,061	604	348
SPR (%)	7.55	7.94	6.20	5.29	4.04
No of outbreak	144	115	19	8	3

Source : Institute of Malariology, Parasitology and Entomology, Ha Noi, 1995

Malaria parasites and vectors

In Vietnam *Plasmodium falciparum* is responsible for 60 – 70% of malaria cases, *Plasmodium vivax* for 30-40%, *Plasmodium malariae for* 1%. The parasite structure is varied between the areas and the season. Along the coast, *Plasmodium vivax* is predominant while in the forest and highland areas *Plasmodium falciparum* prevail. (The rate of parasite and the distribution of malaria parasites in 1995 are presented in the maps in Appendix 1).

There are 59 Anopheles species, sub species in Vietnam. The following have been found as the main vectors: *Anopheles minimus* and *Anopheles dirus* in the forested and mountainous areas and *Anopheles sundaicus* in the coastal areas. (Characteristics of main vectors are presented in Appendix 5)

1.1.3 Problems in Preventing Malaria in Vietnam

Technical Problems

Plasmodium faciparum is predominant: 60-70 % of total positive cases. Drug resistant *Plasmodium falciparum* is wide-spread, chloroquine 70-80%, amodiaquine 25%, Fansidar 70%. *Plasmodium falciparum* has started appearing resistant to quinine and mefloquine (5-20% respectively)

The main vectors of malaria are complicated. Due to environmental ecological changes, their behaviour has been changed.

- *Anopheles minimus* is widely distributed in the mountainous and forest areas from the North to the South. Some studies showed the species has a phenomenon of exophily
- *Anopheles dirus* has phenomenon of exophagy, endophagy and completely exophilic (Definition of this phenomennon is presented in Appendix 5)
- *Anopheles subpictus* is resistant to DDT
- *Anopheles sundaicus* is highly tolerant to DDT

Organizational and Socio- Economic Problems

- Big movement of population occurs with resultant changes in the environment new development areas, exploitation of natural resources, and ethnic minority group still keeping their nomadic habits thereby having limited means of protection from malaria.

- Poverty and lack of knowledge of population living in high risk areas, this leads to high contact between humans and mosquitoes

Shortage of resources

- The Government budget only meets 60% of the total requirement of the National Malaria Control Program (NMCP)
- The insecticides, especially for house spraying are only enough to cover 50% of the population at risk and antimalaria drugs meet 70% of needs

1.1.4 Vector Control Programs by NMCP

Environmental Management

Larvivorous fishes

House Residual Spraying

Residual spraying of insecticides is only concentrated in the hyperendemic areas with high risk of outbreak where inhabitants have no habit of sleeping under bednets. The main chemical used for house spray is ICON, but it is costly. DDT imported in the past from Russia is no longer available and some Anopheles species become resistant to DDT meanwhile Deltamethrin, Sumithion, Vectron are less effective.

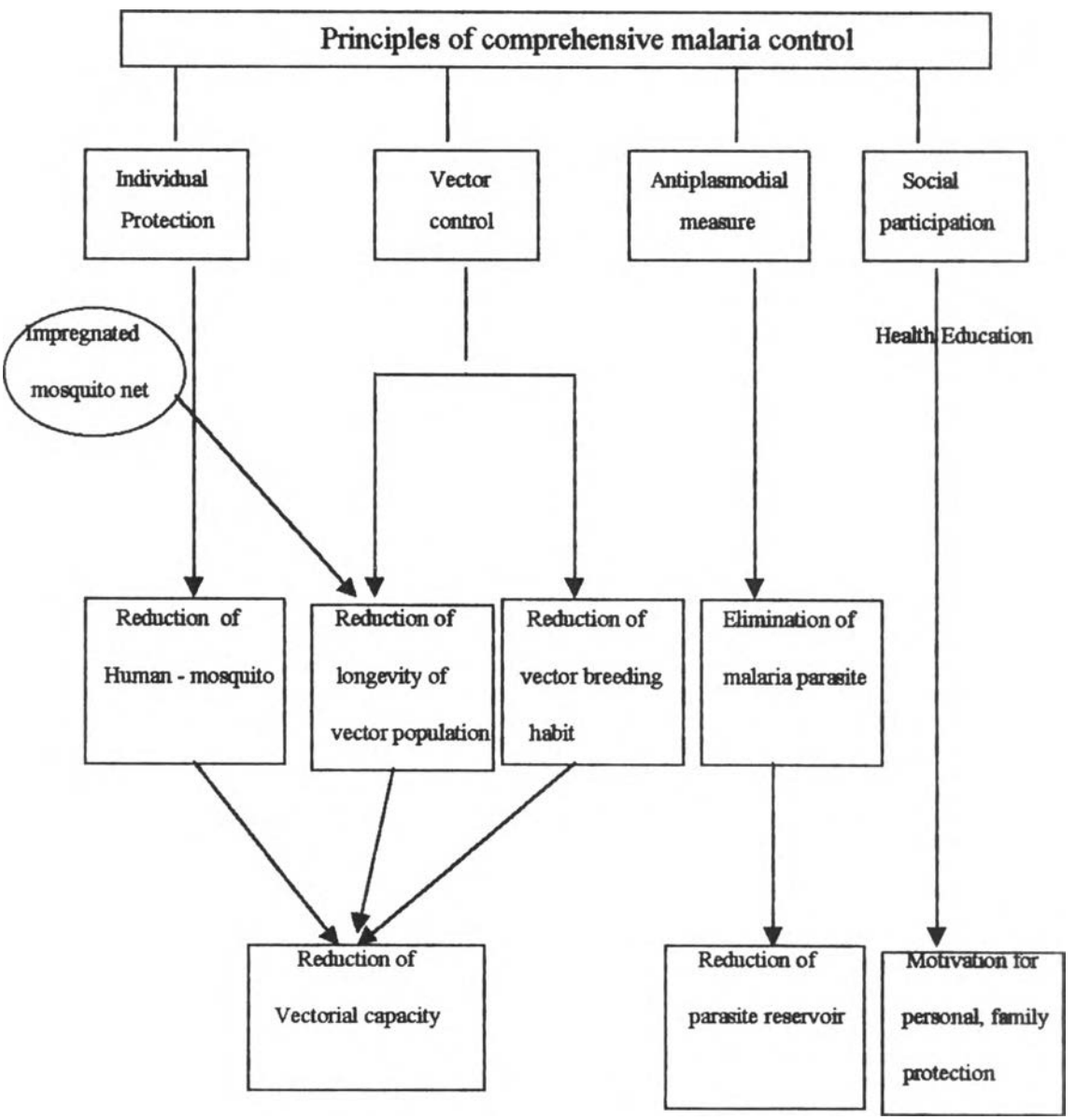
Impregnation of Bednet with Insecticides

Vietnam is in the enviable position. More than 85% of the population have and use nets regularly (Palmer,1993). Some trials in the country showed that insecticide treated bednets can significantly reduce malaria. In Vietnam, National Malaria Control Program (NMCP) tried to select a suitable measure in preventing malaria. Permethrin impregnated bednet with a dosage of 0.2 g/m2 treated twice a year was approved by NMCP. The position of permethrin treated bednets in malaria prevention and control was presented in Figure1.1

Until now, Permethrin treated bednet measure was applied in several areas in the country. This measure showed effectiveness in preventing malaria, but the rate of effectiveness changed according to different regions. With the limited budget, we should calculate cost–effectiveness and cost-benefit of this measure comparing untreated bednets in different malarious endemic regions before deciding to use permethrin treated bednets in large scale. Until now no data about the cost–effectiveness and cost-benefit of treated bednet in Vietnam are available. Therefore, in this study with the purpose of gap filling, we choose two provinces for studying:

Long An and Song Be. The former is representative for coastal region and the latter for forest region.

Figure 1.1 Position of Permethrin Impregnated Bednets Measure in Malaria Prevention and Control



1.2 Objectives

1.2.1 General Objectives

To analyse the cost-effectiveness and the cost-benefit of Permethrin impregnated bednet measure comparing untreated betnets in preventing malaria disease in two different malarious endemic regions

1.2.2 Specific Objectives

- To measure the effectiveness of Permethrin impregnated bednets and untreated bednets
- To calculate the cost of Permethrin impregnated bednets and untreated bednets
- To compare the cost-effectiveness of the two measures in two areas: coastal and forested-mountainous
- To calculate the cost-benefit of both measures in the two areas