CHAPTER 5

DISCUSSION

WHO Supply Service has estimated costs, in 1991, of malaria control in an endemic area inhabited by a population of 1 million, based on one round of spraying. Requirement for one round of residual spraying with DDT 75% water-dispersible powder are 147 tonnes DDT. If the price per unit was US$ 3,150 per tone, then the cost of insecticide per person equals to US$ 0.46 (Onori and others, 1993). By the same time, in South-east Sulawesi, the total houses sprayed are 63,452 with estimated DDT used being 30.497 tonnes and population protected were 317,260. Unfortunately, the cost of DDT are not available because all of insecticides, vehicle, spraycans, fontans and microscopes are supplied from the headquaters (Jakarta). But, if the same cost to be used, the estimated cost of insecticide per person equals to US$ 0.30 which it is lower than the WHO estimation.

If the exchange rate of the Indonesian rupiah to the US dollar in 1991 was 1,938 rupiahs per US$ 1, the estimated cost for one house spraying by DDT in Table 4.4 was US$ 0.39 and the cost per person was US$ 0.08. When the cost of insecticide is included, the estimated total cost of residual house spraying for one house becomes US$ 1.89 and per person US$ 0.38. This cost excludes the cost of vehicles, spraycans and salaries. The cost of other insecticides cannot be compared because of lack of data. However, the costs of Ficam^R are US$ 0.78 per house and US$ 0.16 per person, and for Icon^R are US$ 0.58 per house and US$ 0.12 per person, excluding the costs of insecticides, vehicles, spraycans and salaries.

Although DDT is one of the cheapest insecticide and has long time residual effect (± 6 months), however, since 1992 it has shifted by other insecticides that is Ficam^R and Icon^R. The reasons are some species of malaria vectors in Indonesia have been resistant to DDT, and it has extenality effect to the environment, which could increased the costs for application and environment. While Ficam^R and Icon^R, despite they are more expensive and relatively shorter of residual effect (± 3 months) but the vectors are still susceptible and with minimum or no externality effect. But, Icon^R is more cheaper than Ficam^R, therefore, since 1994 has been selected as insecticide to be used for IRS in the Malaria Control Programme.

VCM in South-east Sulawesi by indoor residual spraying has been commenced in 1973. The effect of IRS has reduced PR from 40.03% (1972) to 6.14% (1977). Since 1978, the effect of IRS became inconsistent. Based on the assumption in Chapter 3, when PR increased and the proportion of indoor resting density of vectors decreased, there was a change of resting behavior of vectors to avoid contact with insecticide. Unfortunately, there was no entomological study at the beginning of IRS application. The late studies from1976-1986 as the baseline information with inadequate follow-up, show that *An. subpictus* and *An. barbirostris* have a significant correlation between the decrease of indoor resting density proportion and the increasing of outdoor man-bite density proportion ($p < 0.01$), while *An. flavirostris* only has moderate correlation ($p < 0.10$). *An. barbirostris* also shows that the parity index was still higher after 4 years spraying applications, as the signed of ineffectiveness of IRS.

Those facts indicate that the vector control measures by indoor residual spraying is not efficient. The vectors may be changed their behavior from indoor resting after spraying to the extent that the vectors are irritated by short contacts with insecticide sprayed surfaces, that they do not pick up a lethal dose of the insecticide. Then, the vectors continue to bite man and transmit malaria, while the utility of insecticide in controlling transmission is thus very largely restricted. Sundararaman (1958) found that after four years of spraying, with abundant *An. sundaicus* in the act of biting man at night, very few rested on walls at night and practically none by day. The degree of exophily increased after DDT spraying and probably is associated with a slightly increased exophagy. He appointed at that new infection continued to occur in infants after one, two, or even three years of application of DDT, and mosquito infections were met with after spraying for two or three years. The failure of DDT appeared to be the result of an altered behavioristic manifestation in *An. sundaicus*.

Although there is inadequate information about resting behavior of *An. subpictus, An. barbirostris* and *An. flavirostris* in South-east Sulawesi, the fluctuation of annual PR and the information of resting behavior other vector species lead the author to assume that since 1978 malaria vectors in South-east Sulawesi have changed in resting behavior, at least the vectors avoided to contact with insecticide on the wall surfaces. Therefore, the periods of VCM application can be divided into before (1973-1977) and after (1978-1994) changed behavior of vectors.

As mentioned above, since 1978 the effect of VCM by indoor residual spraying became inconsistent. The PR of less than 2 % as the goal MCP which it attained in 1986 has taken a very long time, after 13 years of IRS applications. Theoretically, in the malaria eradication programme the PR < 2% should be attained after 3 years of IRS application, when all of requirement are satisfied.

VCM by indoor residual spraying seems to have a slight effect on the reduction of PR. But, there is no significantly different effect between IRS before and after changed resting behavior of vectors ($p < 0.05$). The same effect also occurred on the efficiency or cost-effectiveness. This result may be caused by the data used in the analysis and the effect of other factors.

By using secondary data as the main method of data collection in this study, there are some limitations, i.e. completeness and validity of data. The completeness of data depends on the availability of documents, reports and records, while the validity of data depends on the accuracy and precision of data. The main problem faced in this study is the completeness of data. Many documents, reports and records were not available, and other data on costs (e.g. cost of materials from malaria headquaters, cost from Ministry of Transmigration and foreign aid) are not covered.

In the natural ecological system, the main factors involved in malaria transmission are the parasite, the vector and the human host which react with one another and also with their wider physical and biological environment (WHO, 1975). The changes of environment due to socio-economic development have reduced receptivity and in many places transmission has been interrupted completely.

There is no doubt that reducing PR in South-east Sulawesi is not only the outcome of MCP alone but also the socio-economic development environment has made important contributions. Per capita income of the people has a significant negative effect (slope = -2.169^{-4} and $p < 0.01$) and contributed 42.85 % in the reduction of PR. Banguero (1984) reported that wage income received showed significant results at the 5 % level with both, prevalence and incidence measure of malaria in Colombia. But, Brown (1986) found that in Sri Lanka and Sardinia it seems impossible to demonstrate that the anti-malaria campaigns resulted in significant economic development. Hongvivatana and others (1985) argued that family annual income in Thailand was not found to be associated significantly with any knowledge of malaria.

Other socio-economic factors which affects the outcome of MCP is literacy rate. This study shows that there is a slight effect of literacy rate in the reduction of PR but statistically no significant effect (slope = -0.631687 and $p < 0.10$). Banguero (1984) didn't show any significant association between literacy rate with malaria incidence in Colombia. On the other hand Hongvivatana found that education is associated positively and significantly with every aspect of knowledge of malaria, and the effect of education was found to be interfering with the relationship between malarious area and knowledge of malaria.

In addition, the reasons of insignificantly different effectiveness and efficiency of VCM before and after changes behavior of vector due to inadequate evidence and only a slight contribution of MCP in the reduction of PR. In the period of 1978-1994, IRS contributed 5.64 % and treatment 11.88%, while the rest were contributed by the other factors such as per capita income, and other socio-economic development. Therefore, despite the fact that indoor residual spraying only has a slight effect, the PR decreased gradually over a very long time. The fluctuation of PR may be also caused by the beginning of first spraying in all of spraying areas were not the same year. For every years, there is the new spraying areas, especially the new transmigration areas.

When the behavior of vectors has been changed, and IRS only contributes a little effect, then an alternative VCM should be identified. The following model expeted could saved the wasted costs of IRS due to changed behavior of vectors which can be applied as an alternative model of VCM in the MCP at South-east Sulawesi Province :

$$PR_t = \beta_0 + \beta_1 LVC_{bti.t} + \beta_2 Surv_t + \varepsilon_t \qquad (5.1)$$

Some modification could be made by adding source reduction (environmental management). Source reduction methods (by integration of commercial fish into rice culture) has reduced the cost of the vector control budget by an average of less than one-fourth the total cost of spraying with added benefit that farmers take up recurrent expenditures of environmental management, in West Java, Indonesia (CPIS, 1991). While biological control by larvivorous fish seems to produce no significant effect to the reduction of PR if it is put in the model, more data are needed to specify the effect of biological control by larvivorous fish.

The usage of insecticide impregnated bed-nets should be added to the model for the endemic (non-priority) areas with no historical of indoor residual spraying by insecticide. While indoor residual spraying should be applied for the new transmigration areas or the areas with an outbreak of malaria, the decision to undertake a spraying programme should be made only where it is operationally feasible and fully justified by relevant epidemiological information (WHO, 1993). In Java-Bali, indoor residual house spraying was carried out when the mass fever treatment and other vector control such as larviciding were not satisfied (MOH, 1993).

Since the beginning of the sixth of Five Year Development Plan (PELITA VI) in 1994/95, MCP in Indonesia has completely been integrated with the general health services. Health centre staff carry out ACD, PCD, surveys, drug distribution, spraying operation, impregnated bed-net and other vector control activities, and entomological studies. There is a community participation in malaria control through POSYANDU (MOH, 1993). This policy was adopted from the global malaria control strategy through the primary health care which consists of programme integration, inter-sectoral collaboration and community participation (WHO, 1993).

This policy seems to be advantageous from the view point of the source of financing for VCM. Environmental management such as cleaning breeding sites of vectors, filling in abandoned wells and borrow pits, integration of commercial fish into rice culture, simple drainage, bed-nets, etc. could be derived from community participation, while equipment for VCM (e.g. fontan), *B. thuringiensis*, and insecticide could be funded by the government, foreign aid or donation from private sector.

Paquoeo (1988) has introduced a model of sources of financing for VCM by '*vector control tax*'. The owner or person responsible for land *k* should be made to pay in proportion to the size of the vector population it harbors. The tax rate should be equal to the sum of all incremental disease and infection control cost associated with a unit increase in the size of the vector population in space *k*, plus consequent increase in the cost of vector control in neighboring areas. These measures could include a system of fines or a tax on land (and houses) that is reimbursable upon certification of compliance with local standards regarding density of vectors in a given space. An appropriate and practical application of this model provides not only a potentially good source of finance but also an efficient approach to vector control. The fines system has been successfully applied in Singapore to control *Aedes* mosquitoes in the houses of the people (author visited, 1981).