Studies on the Reliance of DDT, HCH and Malathion in Vector Control Programme

Studies were carried out in field to assess the efficacy of DDT and HCH in vector control in early eighties. These studies were actually conducted amidst the conflicting reports on the usage of DDT for vector control in indoor residual sprays owing to the reports of wide-spread resistance in major vectors to DDT and HCH.

In the year 1981, a study was conducted in villages of District Faridabad (Haryana) which were under regular spray of HCH (Sharma *et al* 1982). The main vector species in this region was *An. culicifacies* and was reported 89% resistant to DDT. Comparative entomological and epidemiological evaluation was made in villages sprayed with DDT @1 and 2 g/m^2 with unsprayed villages as control. The first round of DDT was sprayed in June and the second in August. Entomological evaluation indicated no difference in the impact of two doses of DDT spray (Fig. 18) while parasitological evaluation also did not indicate any relative advantage in the two areas of DDT spray but the slide positivity rate decreased to half in subsequent months (Fig. 19). This study indicated that the usual dose of DDT spray @ 1 g/m^2 with good coverage resulted in desired epidemiological impact.

With this background a more elaborate study was carried out in 1984 in the villages of Loni primary health centre, in District Ghaziabad (Sharma *et al* 1986). The villages were under regular spray of HCH @ 0.2 g/m^2. Spraying was carried out in 4-dose regimen in four zones. Three zones were sprayed under the supervision of NIMR) staff—HCH @ 0.2 g/m^2 (normal recommended dose) and 0.5 g/m^2 (enhanced dose) and DDT @ 1 g/m^2 (normal recommended dose) while the fourth zone was sprayed @ 0.2 g/m^2 with HCH under the supervision of state health personnel and this zone served as control for the above three zones. Three rounds of HCH were sprayed in the months of May–June, June–August and August–October respectively while DDT was sprayed in the months of May–July and August–September. Enhanced dose of HCH @ 0.5 g/m^2 was contemplated to kill the heterozygotes and some of the homozygous resistant genotypes. *An. culicifacies*, the major vector of malaria

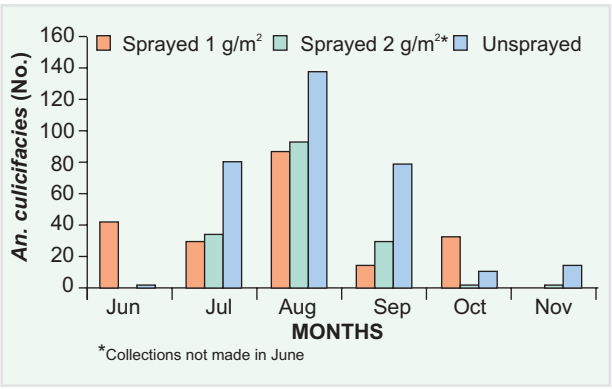

Fig. 18: Observed number of *An. culicifacies* in total catch in different months in DDT sprayed and unsprayed villages in District Faridabad, Haryana

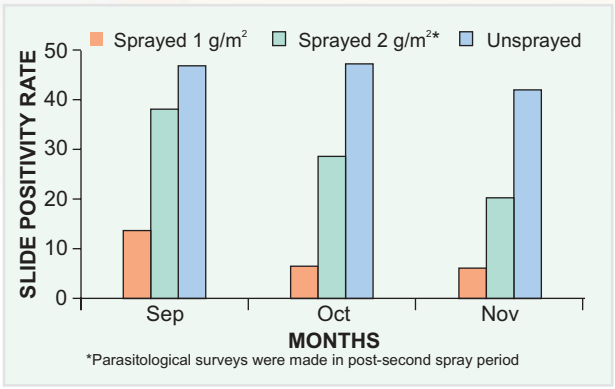

Fig.19: Parasitological data during the intervention periods in villages with 2 dose regimens of DDT and unsprayed villages in District Faridabad, Haryana

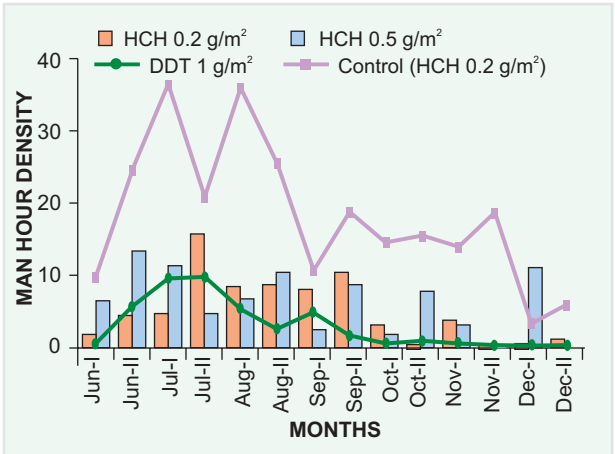

Fig.20: Man hour density of *An. culicifacies* in villages with different dose regimens of HCH and DDT in villages of PHC Loni, District Ghaziabad

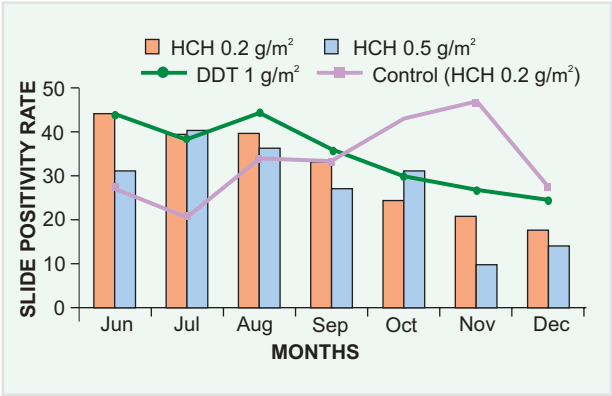

Fig. 21: Slide positivity rates in different months during the intervention in villages with spray under different dose regimens of HCH as compared to DDT

in this region was >60% resistant to DDT and >90% resistant to dieldrin. Entomological evaluation revealed no significant difference in the impact of two doses of HCH (Fig. 20). Usual dose of DDT @ 1 g/m^2 with good coverage indicated desirable impact even on the parasitological indices (Fig. 21).

In continuation of these studies, another study was carried out during 1985–86 to assess the comparative advantage of DDT spraying in cattlesheds alone and human dwellings and cattlesheds with two doses of DDT spray @ 1 and 2 g/m^2 and HCH @ 0.2 g/m^2 (Ansari *et al* 1988). The study was aimed at studying the impact of this different regimens of sprays on the main malaria vector in the area, *An. culicifacies* which is primarily zoophagic. Entomological and epidemiological studies revealed no comparative advantage of increased DDT dose (2 g/m^2) as was observed in earlier studies and spraying. These studies have again brought out that improved coverage of human dwellings with the usual dose of 1 g/m^2 could provide the desired impact on parasitological indices (Fig. 22).

Due to continuous usage of DDT, HCH and other insecticides in vector control programme, *An. culicifacies* has developed resistance to all the insecticides used in public health. Presently from the available database, this species has become resistant to DDT in 286 districts, DDT and HCH in 233 districts, DDT, HCH and malathion in 71 districts and synthetic pyrethroids in two districts. It may be mentioned here that this species is responsible for ~60–70% of new cases of malaria each year.

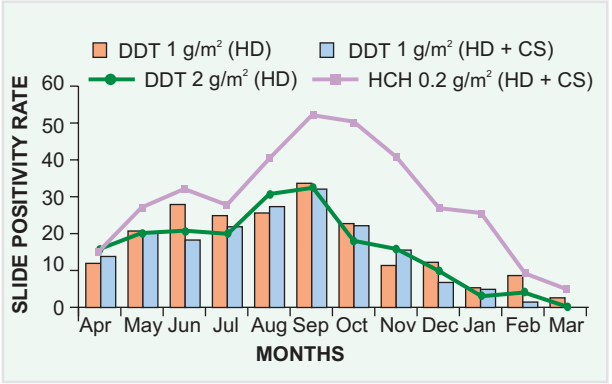

Fig. 22: Slide positivity rates in villages with different dose regimens and spray pattern of DDT anf HCH

In spite of multiple insecticide-resistance in *An. culicifacies*, DDT is continued to be used in indoor residual spray in rural areas to control especially *An. culicifacies*. DDT is still a cost-effective insecticide. Recently, DDT has been designated as an exempted insecticide from the persistent organic pollutant chemicals in Stockholm Convention which suggested that this insecticide could be continued for use till a cost-effective sustainable alternative strategy is found.

Meanwhile, The Mandate Committee of the Government of India for the use of DDT formed under the Chairmanship of the Secretary, Health & Family Welfare, decided to evaluate the efficacy of DDT and malathion in malaria and kala-azar control programmes. Accordingly, Indian Council of Medical Research was requested to conduct a multicentric study in different parts of the country and the Director, NIMR, Delhi, coordinated the project. The NIMR, Delhi and the Vector Control Research Centre, Pondicherry carried out the studies on malaria control and the Rajendra Memorial Research Institute of Medical Sciences, Patna, on kala-azar control. Multicentric studies were undertaken in 10 districts of eight states (Fig. 23). Both entomological and epidemiological evaluations were done. Studies were carried out during pre- and post-spraying periods of the respective rounds of spray. Evaluation was done in areas under the influence of the three major vectors of malaria, namely *An. culicifacies, An. fluviatilis* and *An.minimus*; and Kala-azar vector—*Phlebotomus argentipes.*

This multicentric study revealed that *An. culicifacies* was resistant to DDT in three districts, namely Chhindwara (Madhya Pradesh), Mandya (Karnataka) and Bareilly (Uttar Pradesh). In general, indoor spraying of DDT has indicated that DDT was ineffective in reducing the vector densities to a desired level. The excito-repellent effect lasted for the initial 2–3 weeks. Though the studies were done on limited scale, the data available on susceptibility status of *An. culicifacies* showed that DDT is not the insecticide of choice of spray in areas with *An. culicifacies* prevalence—rural plains and peri-urban areas of India. However, the use of DDT can be continued in areas under the influence of *An. fluviatilis* and *An. minimus*.

Malathion was evaluated in two districts, namely Hardwar (Uttarakhand) and Kheda (Gujarat) and was found effective in reducing *An. culicifacies* population. In other districts in Gujarat variable level of malathion susceptibility was observed. This suggested a further need to assess the susceptibility to malathion and its use as per the need.

Kala-azar vector—*Phlebotomus argentipes*

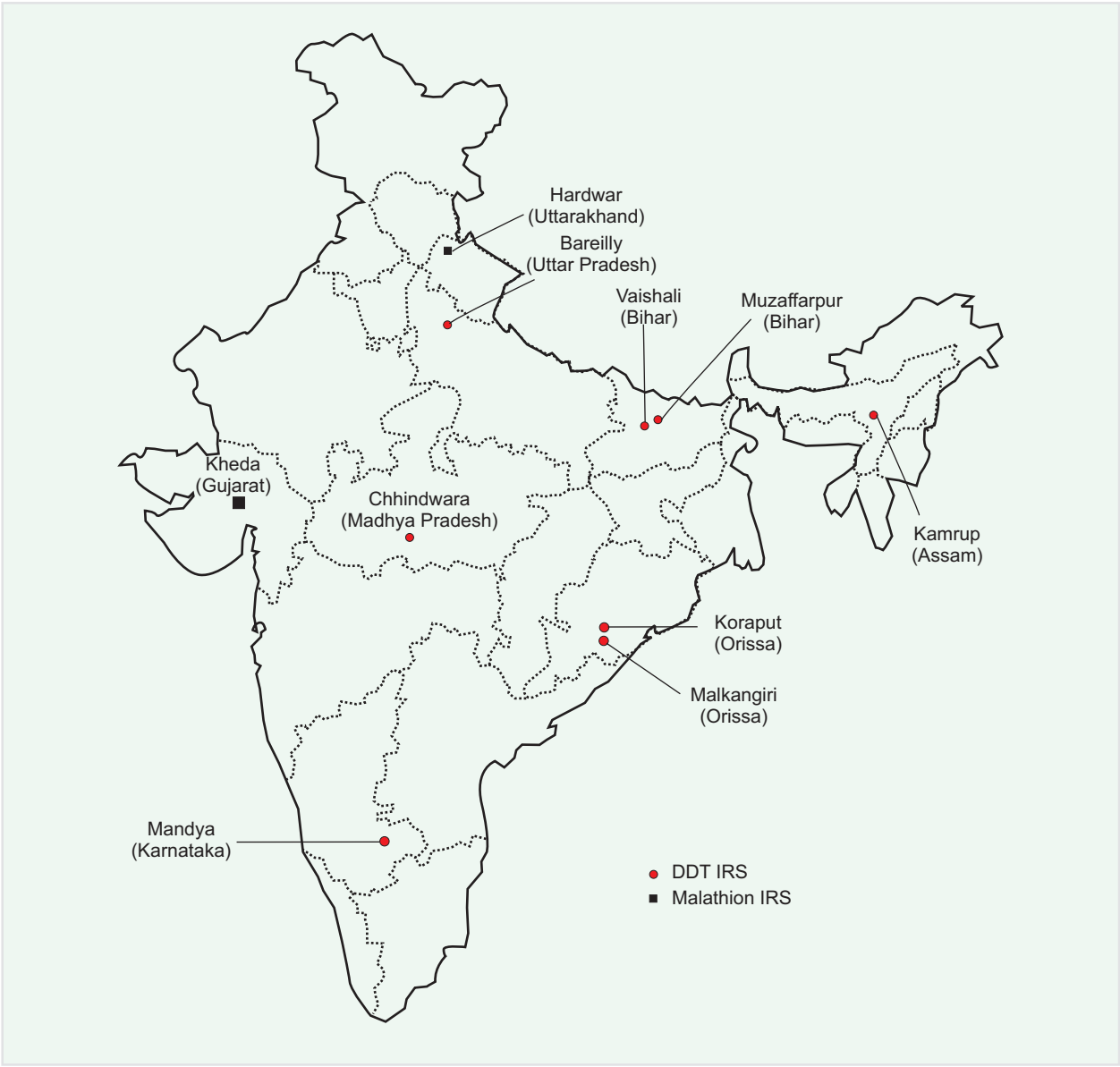

Fig. 23: Map showing districts selected for evaluation of DDT and malathion indoor residual sprays

showed variable resistance to DDT in Vaishali (Bihar) and a few other districts. This calls for regular monitoring of resistance in this vector, as DDT is going to be used extensively in the kala-azar control programme. Also more studies have to be conducted to see the efficacy of DDT in these areas.

Present Status of DDT Use in India

The Stockholm Convention on persistent organic pollutants (POPs) in 2001 identified DDT as one of the 12 POPs. But DDT ban had certain restrictions applicable to countries that have notfied to the secretariat for its continued use and India is one of it. The restriction permits indoor residual sprays (IRS) of DDT in malaria control as per the WHO specifications for its production and following safety precautions for its safe use and disposal. Phasing out of DDT is delayed till an effective, affordable and safe alternative is available. In India, the use of DDT in agriculture was banned in 1989 with a mandate to use a maximum of 10,000 tons of DDT per annum for the control of malaria and kala-azar and this policy is strictly adhered to till date.

There are reports that *An. culicifacies*, a major malaria vector is highly resistant to DDT since 1960s, now shows increased susceptibility in Gujarat and other parts of the country where DDT was withdrawn since 1969. Meanwhile, WHO has issued a clean bill to use DDT supported by scientific and programmatic evidences (http://www.who.int/mediacentre/news/releases/2006/pr50/en/print.html)

❑