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Intensive Agriculture and its Impact on Vector-borne Diseases

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Introduction of high yielding varieties of crops, increased use of pesticides and fertilizers, increase in irrigation and the cropped area, and improved post-harvest technology were some of the important components of intensive agriculture in India which resulted in the increase in food production. But then there have also been increased incidences of a few vector borne diseases, mainly due to Increase in irrigation, misuse of insecticides, paddy cultivation and movement of labour and their unhygienic living conditions may have also contributed towards this increase.

Introduction

During the last two decades intensive and improved agricultural practices resulted in the increase of India's food production from 74 million tonnes in 1966 to 156 million tonnes in 1984. During the same period there was steady increase in the incidence of vector borne diseases and the most notable example was that of malaria. For example before launching of the National Malaria Control Programme (NMCP) in 1953, it was estimated that there were atleast 75 million cases of malaria and 800,000 deaths annually. Sinton described the malaria situation as "The problem of existence in very many parts of India is the problem of malaria. There is no aspect of life in this country which is not affected either directly or indirectly by this disease. It constitutes one of the most important causes of economic misfortune, engendering poverty, diminishing the quantity and quality of the food supply, lowering the physical and intellectual standards of the nation, and hampering increased prosperity and economic progress in every way". As a result of the nationwide spraying of DDT and other residual insecticides under the NMCP and later National Malaria Eradication Programme (NMEP), there was dramatic reduction in morbidity and mortality due to malaria. By 1965, the disease was nearly eradicated and there were only about 100,000 cases of malaria. Deaths due to malaria were completely eliminated. This followed a period of resurgence which showed a parallelism with the food production. There was therefore a possibility of the relationship of intensive agriculture to the vector borne diseases. Some of these aspects would be discussed in this paper.

Relationship to Agriculturre

Increase in agricultural production was the result of the introduction of high yielding varieties (HYV) of crops, increased use of

a variety of plant protection chemicals, high consumption of fertilizers, increase in gross area under crops, and improved post-harvest technology etc. Some of these factors may have contributed to the increasing incidence of vector borne diseases. A careful study of the various components of green revolution, for the period of malaria resurgence, was recently made by Sharma and Mehrotra (1985). Study revealed that during the years of resurgence, the area under high-yielding varieties was negligible, if at all. Malaria resurgence occurred even in areas where intensive agriculture was not practiced or in areas where there was no increase in acerage under agriculture. The foremost reason of resurgence was the presence of foci of infection throughout the country, shortages of DDT and poor surveillance and vigilance.

Of the vectors of diseases *A. culicifacies* and *Culex vishnui* group mosquitoes come in direct contact with agricultural practices. *A. culici/facies* breeds profousely in irrigation channels, seepage water, ponds, puddles and water collections in agricultural fields, while rice fields support breeding of *A. culicifacies* and *Culex vishnui* among a variety of mosquitoes.

Russell and Rao (1940) made extensive observations on *Anopheles* breeding in rice fields in Pattukkottai area of Tamil Nadu. The larval density was higher in newly transplanted fields and fell progressively as the plants become taller. Generally the breeding of *A. culicifacies* stops when the rice plants become 30 cm tall. They also observed that 10 out of 12 species occurring in the area were found in the rice fields and concluded that distribution and density of the species in rice fields depended on the stage of rice growth rather than the season of the year. Recently Bang and Pant (1983) cited Mulla and Main on rite fiecd breeding who listed a total of 40 mosquito species from 29 publications; 3 *Aedes* spp; 19 *Anopheles* spp; 13 *Culex* spp; 2 *Mansonia* spp. and 3 *Psorophora* spp; Senior White (1946) compiled the species distribution of anophelines in the rice fields from Bengal, Orissa and Bihar, and as many as 15 species were collected. Rice fields therefore contribute significantly to the mosquito populations. Rice-growing areas have higher incidence of malaria and these areas also become prone to Japanese encephalitis. In the past, JE epidemics were confined to the rice growing regions of the country.

Gill (1930) working on irrigation malaria in Punjab and Russell et al (1938) in Pattukkottai had shown that there was intimate association of the breeding of *A. culicifacies* with irrigation, and that irrigation increases the incidence of malaria. Malaria in Pattukkottai was seen after the irrigation system was opened in 1934. Russell (1938) concluded that "it was not the irrigation *per se* but defective and untidy irrigation, which by misplacing to the advantage of certain anopheline mosquitoes, generates malaria" and that waste water was the important source of malaria. Studies made by Rao (1945) and Rao and Nassiruddin (1945) showed that average enlarged spleen rate increased from 15.3% to 50–90% with the opening of Visvesvaraya canal in Mandya district (Karnataka). There was a 20-fold increase in deaths due to fever and within 3 years of the introduction of irrigation the region became hyperendemic to malaria.

It is noteworthy to mention that gross area under irrigation was 29.05 million heactares in 1960, 37.10 million hectares in 1968, 40 million hectares in 1973, 52 million hectares in 1977 and the area steadily increased to 60 million hectares in 1980. Obviously, this increase of 100% in irrigation made large areas prone to malaria. Commenting on the irrigation, Sharma and Mehrotra (1982a) observed that "Irrigation increased the average humidity of the

atmosphere and made the regions more conducive for mosquitoes' survival. This had the most profound affect on the basic reproduction rate. Thus, there was a resurgence of malaria in the country, at one time freed from the disease". More recently Sharma and Uprety (1982) compared the prevalence of malaria in villages with tube well irrigation and canal irrigation, and found that canal irrigated areas were more prone to malaria. It may also be noted that large areas of the country (such as Punjab) which in the past were prone to malaria epidemics in years of high precipitation have become endemic as a result of irrigation (Sharma & Mehrotra 1982a).

The construction of dams and a network of canals in the country utilized labour force which was drawn from many regions of the country where focus of malaria prevailed. Many among labour were the gametocyte-carriers. The unhygienic living conditions in labour camps resulted in the multiplication of mosquitoes, and it was commonplace to find limited outbreaks of malaria near the projects area, thus disseminating the disease to newer areas. Similarly movement of labour for agriculture, particularly during the harvest season has resulted in the dissemination of filaria to non-endemic areas. A classical example is that of U P terai. This region was free from filaria. Due to intensive agriculture, a large number of developments occurred in terai. There was growth of towns and villages without a simultaneous increase in sewerage and sanitation. As a result, large number of breeding sites were created for the breeding of filaria vector *Culex quinquefasciatus*. During the harvest season, labour in terai comes from eastern U P districts which are endemic for filaria. Some of this labour is invariably microfilaria-carrier. The vectors were already present in high densities in terai, and the presence of microfilaria carriers resulted in the transmission of the disease, thus making the areas endemic for filaria (MRC Annual Report 1979). Similarly, there is a regular back and forth movement of labour from Bihar, West Bengal, Orissa, etc., to north-eastern states for either construction or agriculture. Parts of north-eastern states are well known for high proportion of *P. falciparum* infection, and some of these areas are known for drug resistance in *P. falciparum* which first appeared in 1973. The movement of labour resulted in the dissemination of *P. falciparum* strains to the neighbouring states (Ray 1984). Therefore there are examples when agriculture has indirectly contributed to the spread ofvector-borne diseases, particularly malaria, and to a lesser extent filaria.

Generally, DDT is sprayed on fibre crops like jute and to some extent cotton, and therefore its recommended use from the public health point of view is safe. But misuse of insecticides may cause problems. In certain areas, although authentic data is not available, the misuse of insecticides, particularly DDT may have also contributed towards the rapid build-up of resistance in the field. Although the problem of pilfering DDT meant for use in public health and diverted for spraying the crops has not been quantified or studied in depth, but if the spraying of DDT on crops finds its way to places where mosquito breeding occurs, it may accelerate the build up of resistant populations, and make malaria control more difficult and problematical (Sharma 1985). There are no specific examples that may be cited to support the widespread emergence of insecticide resistance in *A. culcifacies* as a result of the use or misuse of insecticides in agriculture, as was propsed by Chapin and Wasserstrom (1981). With this background Sharma and Mehrotra (1982a,b; 1983) concluded that the high degree of resistance in *A. culcifacies*, which has become a serious impediment in the successful malaria control, was the result of the massive quantities of insecticides used over a long

period of time in public health. The malaria vectors were forced to rest on treated surfaces and selection for the resistant genes started to accumulate in the field populations gradually. The misuse of insecticides, may have also contributed to this growing problem in certain areas by way of diluted spray i.e., the exposure of mosquitoes to sub-critical disages, which is known to accelerate the onset of resistance.

Conclusions

Main reasons for the resurgence of malaria were the technical and administrative problems and financial constraints. A review of the components of intensive agriculture and its impact on vector borne diseases revealed that increase in canal irrigation, rice cultivation, unplanned growth of urban and rural centres without adequate water disposal systems, movement of labour, etc., also resulted in the spurt of vector borne diseases in certain areas of the country. A well managed water system can prevent/ reduce the incidence of malaria, filaria and Japanese encephalitis. There was no perceptible relationship of agriculture to the occurrence of other vector-borne diseases like dengue or Kala Azar, and intensive agriculture *per se* was not the major reason for the widespread resurgence of malaria in India.

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