Summary

1. Pesticides have made a big headway in this country since the beginning was made in 1950. This is evident from the growth of pesticide industry, increase in production, and also the consumption of pesticides during past three decades. Now over hundred chemical pesticides of varying toxicity are registered for manufacture and/or use in the country.

2. The pesticide consumption on the basis of gram per hectare of crop area has increased from 149 gm/hectare in (1963) to 570 gm/hectare in 1978-79. However, it still is on the lower side as compared to that in the other countries like U.S.A., West Germany and Japan. Thus there is enough scope and strong possibility in the future of increasing consumption of pesticides in our country.

3. All pesticides are toxic chemicals and potentially hazardous to men. Some of these chemicals are persistent in nature and contaminate our environment.

3.1. Direct hazards due to pesticides are work related. The people who are exposed to high concentrations of these
chemicals for prolonged periods are more liable to suffer from toxic manifestations. Therefore, occupationally exposed workers constitute the 'High-risk group' of population.

3.2. Indirect hazards are mainly by the incidental entry of the pesticides into the body, mainly through food chain and other environmental sources. Persistent type of chlorinated insecticides like DDT are usually responsible for such hazards. The concentration or residues of these chemicals in a population is a reliable index of the extent and severity of pesticide pollution in a community. The risks are in the form of chronic toxicity from cumulative action.

4. Health hazards in pesticide applicators, i.e. short and long term effects of BHC (Hexachlorocyclohexane) in malaria spraymen.

In National Malaria Eradication Programme, so far DDT was used as a choice insecticide. In view of mosquitoes developing resistance, it is being substituted and supplemented by BHC. Therefore, medical surveillance of malaria spraymen using BHC was undertaken to evaluate both immediate and long term effects of this chemical. Health monitoring was done in 200 spraymen exposed to BHC for three or more consecutive seasons to study long term effects.
In order to evaluate immediate toxic effects, 32 spraymen were investigated before and after one season (16 weeks) exposure to BHC.

4.1. Long term effects of BHC.

4.1.1. In 5% spraymen signs and symptoms of toxicity were observed; Of particular significance being the deviated neurological responses in 2.5% spraymen as compared to controls.

4.1.2. There were significant changes in blood biochemistry e.g. SGPT and Alkaline phosphatase enzymes and serum proteins (A:G Ratio) in the spraymen. However, the values for all these parameters were well within the normal range, suggestive of an adaptive change rather than any pathology or derangement in organ functions.

4.1.3. The three fold increase in the serum residues for total BHC in spraymen undertaking no protective measures, indicate sufficient exposure and potential risk of delayed toxic manifestations.

4.1.4. The analyses of data on the basis of smoking and dietary habits and alcoholic intake make it clear that these factors do not appreciably influence the toxicity of BHC.
4.2. Short-term effects of BHC.

4.2.1. The immediate toxic manifestation was in the form of skin irritation in 10% subjects.

4.2.2. The biochemical tests showed a significant rise in blood sugar in post-exposure values, suggestive of gluconeogenesis and an increase in A:G ratio without any change in total proteins probably due to immuno-depression.

4.2.3. Post-exposure serum BHC concentrations were significantly high in spraymen. This indicates that the subjects without any previous exposure are more prone to accumulate this insecticide.

5. Health hazards in pesticide formulators.

Among the high risk workers the formulators deserve special attention, since they are handling the technical grade material which is relatively very toxic. Moreover, in majority of cases there is simultaneous or intermittent exposure to more than one chemical whereby interactions may occur, influencing the toxicity of one another.

5.1. Exposure to combination of pesticides.

Medical surveillance of 160 male workers of pesticide
formulation units and their comparison to equal number of matched controls reveal as follows.

5.1.1. It is difficult to quantify exposure in these subjects, since these units usually belong to small scale industrial sector who employ casual workers and have no definite work schedule. Moreover, the hygienic conditions and safety practices are inadequate as majority of them are not under the purview of Factories Act.

5.1.2. The severity of problem can be judged by the finding that as many as 73% of formulators manifest toxicity symptoms and/or signs.

5.1.3. The blood ChE-activity was significantly low both in plasma and RBCs in formulators. The relationship of specific toxic manifestations and blood ChE-activity has shown that formulators with behavioural or psychological symptoms showed relatively less depression of ChE-activity (25%) as compared to those with other types of symptoms (35%). This suggests that behavioural changes may signify or indicate early manifestation of exposure to organophosphorus insecticides and should not be overlooked or ignored in screening of the formulators.
5.1.4. The E.C.G. abnormalities were observed in about 20% of the formulators as compared to 4% in control subjects. The main abnormalities were in heart rate (18% subjects), conduction defects (11% cases) and tall 'R' waves (6% cases). The changes detected in E.C.G. were not related to depression in blood ChE-activity. These need close watch for any delayed cardiac manifestations in pesticide exposed population groups. The other possibility that those with cardiac ailments may be more vulnerable, also need detailed scrutiny.

5.2. Exposure to a single highly toxic pesticide.

Phorate is one of the most toxic O.P. insecticide in use. Its manufacture and formulation is usually under proper supervision in organized sector. The units are under the purview of Factories Act. Thus, adequate safety measures are possible. The results of health monitoring in 40 workers, before and during two weeks of exposure and 10 days post-exposure period revealed following salient features.

5.2.1. In phorate formulation units, inspite of using protective clothings, face masks, boots, gloves, goggles,
etc. about 60% workers suffered from symptoms and signs of toxicity like nausea, vomiting, abdominal cramps, neurological symptoms, etc.

5.2.2. Blood ChE-activity showed a significant and gradual depression during exposure and quick recovery in post-exposure period. Plasma ChE-activity was depressed by 55% at the end of first week of exposure and 71% by the second week of exposure. However, it recovered to the extent of 80% within 10 days of post-exposure period. There was no change in Red Cells ChE-activity during the exposure period.

5.2.3. In 40% subjects the E.C.G. records during exposure and in post-exposure period showed bradycardia.

5.2.4. The results of medical examination and laboratory tests have shown that the introduction of a highly toxic pesticide like phorate in our country should be done with great caution and be resorted to only under strict medical supervision of workers at periodic intervals.

6. Present status of body burden of insecticide DDT in the community.

In order to ascertain the magnitude of problem from use of pesticides in our community biological monitoring
of DDT residues in the fat of 313 autopsy samples collected from different regions in the country have been analysed.

6.1. The results of DDT residues have shown a wide frequency distribution with majority of observations within 9 ppm limit. The arithmetic mean being 11.04 ppm.

6.2. The sex-wise averages do not show significant differences, although mean value for males is slightly higher than in females.

6.3. The geographical distribution i.e. residues in different urban centres show wide variations, the minimum mean value being 6.15 ppm in Bombay samples and maximum mean being 21.81 ppm from Ahmedabad samples.

6.4. The average DDT concentrations (11.04 ppm) as compared to previous reports show a declining trend. It may be due to more restrictions and stringent controls in the use of DDT after the introduction of Insecticide Act 1968.

6.5. The relatively high residues in our people, inspite of lesser consumption of pesticides as compared to
countries, like USA, Japan, West Germany, etc. indicate injudicious use of these persistent type of chemical pesticides. There is need to be more selective and vigilant to minimise overall risks of contamination.

Conclusions

The pesticides have played a critical role in Agriculture and Public Health Programmes. The consumption of these toxic chemicals on the basis of past trend and as projected by the pesticide industry and users departments is bound to increase in the years ahead. Since the use of pesticides is a must in order to provide food and ensure health for our 670 millions people, all out efforts are to be made to minimise health risks from these toxicants, as it is not possible to eliminate them altogether. This can be accomplished only through scientific approach i.e. research under existing conditions in the country.
The observations of medical surveillance studies undertaken in high risk group of pesticide exposed people i.e. malaria spraymen and formulators have clearly shown that the present pattern of pesticide use does involve certain degree of health risks to persons directly exposed to them during their occupation as is evident by clinical observations, biochemical tests and residues analysis of these chemicals. Certainly, the monitoring of pesticide residues in the people from different geographical regions of the country have shown the situation is not so alarming as is usually made out to be through non-scientific forums. But definitely it cannot be overlooked or ignored due to the possibility of delayed long term effects from the exposure to these chemicals, since the levels of DDT residues in the fat of our people are still relatively high as compared to those from advanced countries.

On the basis of country-wide monitoring of DDT residues in the fat, it is apparent that the contamination due to persistent chlorinated insecticides, i.e. DDT has already reached to a stage which can pose a potential risk to the health of people, particularly if allowed to be continued unchecked. With the enactment of Insecticide
Act 1968, which is in operation since 1971-72, there is definite evidence of improvement in the situation, in the form of declining levels of DDT residues in fat of our people, which were first reported to be as high as 30 ppm, (Dale et al, 1965) the levels observed in the present study are around 11 ppm. Thus with strict enforcement of control measures and being selective in the use of persistent insecticides, we can overcome the situation. The high degree of environmental contamination, as reflected in body burden of pesticides under this study seems to be due to injudicious use of these chemicals, in the past and even at present as can be borne by the fact that average consumption of pesticides in our country is still very less as compared to that in developed countries like USA and Japan.

Since the overall adverse effects of these chemicals on man will depend upon his genetic pre-disposition, health and nutritional status, dietary habits and also the environmental factors e.g. heat, rainfall, soil microbes, etc. which determine the fate of the pesticides in the environment, there is no choice except to evaluate the health risks of pesticides under local conditions. No animal experiments can overcome this need. The results of
health monitoring of malaria spraymen using BHC and formulators exposed to combination of pesticides have made it amply clear.

The use of even BHC, so commonly used in agriculture, in National Malaria Eradication Programme as such do carry some risks, as is evident by clinical findings i.e. neurological abnormalities in few cases and high residues of the insecticide in the blood of spraymen. These risks can be minimised to certain extent if applicators (spraymen) are persuaded to use protective clothings and follow simple hygienic practices. On the basis of biochemical changes and organ function tests the most important fact emerges, that at present the situation is not alarming, but there is a need for periodical monitoring of occupationally exposed people for any delayed toxic manifestations.

The observations in formulators exposed to cocktail of pesticides have demonstrated that this group of workers carry higher risks as is evident by medical examination, E.C.G. records and biochemical tests. Thus there is an immediate need to enforce regulatory practices in these small scale units which do not come under purview of Factories Act 1948, atleast they need more close supervision and scrutiny under Insecticides Act (1968).
The results of monitoring of health in workers exposed to a highly toxic insecticide 'phorate' have shown that in spite of practising usual safety practices, such chemicals have adverse impact on the health of exposed workers. Therefore, to overcome risks there is need to be more choosy in selecting pesticides for manufacture and use in the country. In other words in our country, since the enforcement of regulatory measures is difficult due to lack of man power and uneducated work force, highly toxic pesticides be registered only if these are indispensable and no safer substitutes are available.

In screening or monitoring of these exposed workers, special attention be given to behavioural changes, which indicate early exposure to O.P. insecticides. On the basis of E.C.G. abnormalities it is quite probable that people with cardiac lesions may be more vulnerable to pesticide exposure.

Conclusively the introduction of pesticides in a developing country like ours should be a scientific enterprise based on technical information and results of field trials under local conditions with a view to ensure safety.
The present study serves to catalyze scientific opinion that there should not be a rush of these chemicals for short term gains at the cost of long term losses, and also on the need of progressive actions to combat pesticide pollution in order to prevent rapid deterioration of environmental quality of our land to keep it safe for us and our progeny.