DDT IN RETROSPECT

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Summary

The benefits from the use of DDT, the hazards associated with its use, and the reasons for the restrictions recently imposed in various countries are summarized. The main reason for curtailing the use of DDT is public concern regarding its widespread distribution throughout the environment and the consequential long term effects of exposure of non-target organisms, particularly man, fish and birds to low levels of DDT and its metabolites DDD and DDE. There is evidence that such exposure may have serious effects on fish and birds but as yet there is no proof that there are health hazards to man. The fear of hazards as yet unproven has influenced public opinion and possibly also expert commissions which reported to their governments.

INTRODUCTION

ALTHOUGH DDT has been so beneficial several countries have recently taken action to restrict severely its use. It is therefore appropriate to review the case for and against DDT.

Unless the text indicates otherwise the statements in this article are taken from the reports of the recent expert committees in Great Britain and in the United States (Anon., 1969a; Anon., 1969b) and two earlier reviews of the use of persistent organochlorine insecticides (Anon., 1966; Whitten, 1967).

DISCOVERY AND PRODUCTION OF DDT

Although DDT was discovered in 1874, its insecticidal value was not established until 1939 when it was tested to control a beetle which threatened the Swiss potato crop. Its value for the control of many insects was soon proved. Commercial production in the United States commenced in 1942 and it was used successfully for the control of typhus and malaria during the remaining years of the war.

Production in the United States reached a peak of nearly 179 million pounds in 1963 but dropped to 103 million pounds in 1967. More than 60% of this was exported for malaria control and another 20% exported for other purposes.

PUBLIC HEALTH USES

Millions of lives have been saved by the use of DDT to control insects which spread disease. More than 1½ thousand million people are living in previously known malaria areas.

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The use of DDT has reduced the number of cases of malaria in India from an estimated 75 million in 1952 to about 100,000 in 1964. The annual tonnage of DDT used for this purpose rose to a peak of 21,000 tons in 1961. It was estimated that 2,400 tons will be needed in 1970. A similar story can be told about the Soviet Union where cases of malaria fell from 35 million in 1946 to 13,000 in 1956.

PLANT PROTECTION USES

The reviews quoted all stress the value of DDT in the production of food.

Its main use in New Zealand has been for the control of grass grub (*Costelytra zealandica*) and porina caterpillar (*Wiseana* spp.) which are the insects of most economic importance. J. M. Kelsey showed that applications of mixtures of DDT and superphosphate to pasture provided an effective and convenient method of controlling these pests, and these mixtures were used extensively during the 1950s. Improved farming techniques have resulted in spectacular increases in dry-land production since 1950. In areas such as Canterbury these increases would not have been possible if it were not for the extent to which DDT has controlled grass grub and porina caterpillar.

However, restrictions were imposed on the use of DDT following the detection of organochlorine residues in meat in 1961 and legislation has progressively limited its use during the last few years.

HAZARDS TO FISH AND BIRDS

The widespread distribution of persistent organochlorine insecticides throughout the environment has resulted in hazards to fish and wildlife. Residues of DDT have been detected in air, rainwater and in the water of many lakes, rivers and oceans. DDT is spread in food containing DDT residues and by birds and fish. Residues have been detected in fish and other organisms large distances from any place where DDT has been applied. For example, residues have been found in penguins and seals in the Antarctic (Brewerton, 1969).

Even extremely low levels of DDT in water are a hazard since the residues may be concentrated and stored in the bodies of minute aquatic organisms. This concentrating effect is frequently enhanced as one species feeds on another and passes the pesticide residue from one link to another in the food chain. In a typical case, after mosquito-infested marshes were sprayed, traces of DDT in the water were concentrated to 0.04 ppm in plankton. This was built up to 0.5 ppm in the fat of plankton-eating fish. These small fish were in turn devoured by larger fish and the concentration of DDT increased to 2.0 ppm. The bodies of birds which ate the fish contained 25 ppm (Anon., 1969c).

Oysters have remarkable capacity for biological concentration of pesticides and have been noted to accumulate DDT to 70,000 times the concentration in the surrounding water. DDT has inhibited reproduction of trout. The fry were killed at the time of the final absorption of the yolk sac when they were ready to feed. At 3 ppm DDT in the eggs, few fry survived and at 5 ppm the mortality was 100%.

DDT and its metabolites DDD and DDE have severely impaired the reproductivity of birds. Egg breakage and decrease in egg-shell weight have been correlated with exposure to pesticides but in some species only. DDT has been blamed for the decrease in numbers of several species of birds some of which are said to be on the verge of extinction.

EFFECTS ON EXPERIMENTAL ANIMALS

Reports in 1966 from Hungary revealed the occurrence of an unusually high incidence of leukaemia and some other tumours in the third and succeeding generations of mice when fed DDT in amounts which produced in their fat a concentration of DDT similar to that in the fat of the population of Hungary. Because of the importance of DDT in controlling malaria and other insect borne diseases, WHO consulted the International Cancer Laboratory which arranged for three different laboratories to check the findings of the Hungarian experiment.

In 1969, results were reported of investigations in the United States from which it was concluded that DDT administered at high rates to mice from birth increased the incidence of cancer.

EFFECTS ON MAN

To reduce the hazards due to ingestion of DDT, various countries have tolerances which are the maximum levels legally permitted in food. These are based on the actual levels found in the food when the pesticide is used in accordance with good agricultural or horticultural practice. Thus, if a country has little or no use for DDT in the production of a food, it may have an extremely low tolerance for DDT in that food. The tolerance may therefore be much less than the level required to safeguard human health.

The actual daily intake of DDT residues in the food in both the United Kingdom (Anon., 1969a) and the United States (Anon., 1969d) is 6% of the acceptable daily intake of 0.01 mg/kg of body weight determined by the Joint FAO/WHO Expert Committee on Pesticide Residues. The latter figure incorporates wide safety margins.

Normally a man's total exposure to DDT is 0.04 mg/day in the food ingested. In trials, human volunteers ingested 0.61 mg/kg/day or inhaled 100 mg/day over a period of 12 months. Men with a high occupational exposure have ingested 18 mg/day and levels of up to 647 ppm DDT were recorded in the body fat compared with 8 ppm in the general population of the United States. Spraymen, working day after day, applying DDT in malaria control programmes may swallow after inhalation 7 mg of DDT each hour worked and another 1,700 mg fall on the skin. In none of these cases was there any evidence of ill-effect due to the excess exposure to DDT.

RESTRICTIONS ON USE OF DDT

GREAT BRITAIN

The Advisory Committee on Pesticides recommended that the use of DDT on grassland, in home gardens and for certain agricultural and horticultural purposes should cease as soon as can be arranged because it was considered undesirable that the human environment should contain substances capable of producing toxic effects and whose continued presence conveys no benefit to human survival and wellbeing. The banning of uses of DDT was not recommended unless satisfactory alternatives were available and one of the criteria was that the alternatives should not be unduly expensive in relation to the benefit.

EUROPEAN COUNTRIES

Many of the northern European countries are committed to a policy of phasing out agricultural and horticultural uses of DDT because of the risk to the ecological system and not because of hazards to man. However, DDT has never played a major role in crop protection in these countries.

CANADA

Restrictions have been imposed which were estimated to reduce usage by 90%. The tolerances for residues in certain foods have been reduced or are under review. The reasons for the action are the persistence of DDT, its deleterious effect on wildlife and the lack of clear-cut evidence about the long term effects on man.

UNITED STATES

The expert Commission recommended the elimination within two years of all uses of DDT and DDD except those essential to the preservation of human health. Action has been taken to implement the recommendation and tolerances in food are to be reviewed.

NEW ZEALAND

The use of DDT on farmland was stopped as from June 30, 1970. There has been concern regarding the residues in meat and milk fat from stock grazed on areas which were last treated with DDT several years previously. This is attributed to the grazing animals ingesting soil contaminated by residual DDT. In view of the policy in many countries to reduce tolerances in food, the continued use of DDT on farmland could prejudice the acceptance of New Zealand meat and dairy produce in overseas markets.

DISCUSSION AND CONCLUSIONS

Any use of DDT results in some contamination of the environment. Consequently non-target organisms such as man, fish and birds are inevitably exposed to DDT and its metabolites DDD and DDE. The main factor leading to the restrictions on the use of DDT has been public concern throughout the world regarding the long term effects of this exposure even to low levels of residues. Overseas comment has attributed this concern to newspapers arousing the public (Thompson, 1970).

There is public anxiety regarding the build-up of DDT through the food chain. This is probably the cause of the high residues of DDT in fish in the Baltic Sea and Lake Michigan. In the latter case many tons of salmon, some with 19 ppm of DDT, were rejected as unfit for human consumption. If man ate the most highly contaminated fish three times a day, day after day for 19 years he would take in no more DDT than men who have worked in a DDT factory for this period without ill-effect.

Tolerances for DDT residues in food are mostly within the range 0.05 ppm to 7 ppm. There is no record of these residues or occupational exposure to very much greater quantities of DDT causing harm to man. Nevertheless, it is general policy to reduce tolerances as much as pos-

sible. This attitude and the method of determining tolerances has been severely criticized (Barnes, 1969).

The hazards to carnivorous fish and birds could be more serious than to man who can control the levels of DDT in his food whereas fish and birds cannot. It is possible that the insidious unseen effects of DDT on the bird population as a whole is a greater hazard than the obvious immediate effects of toxic organophosphate insecticides on a limited number of birds.

Some people are concerned regarding the effect on developing countries if DDT is phased out. These countries may not be able to afford more expensive alternatives, and it may be difficult to educate illiterate workers to handle more toxic materials safely.

Evaluation of human experience with DDT has revealed little if any evidence of long-term adverse health effects from its use. On the other hand, the observations of human experience have not been sufficient to eliminate the possibility that continued exposure may induce a low level of cancer in man. Fear has been aroused. Therefore in some countries it is considered prudent to stop all unnecessary uses of DDT without waiting for the last piece of evidence. Because of the policy in these countries, in order to protect our markets, the New Zealand farmer has been deprived of an important use of DDT, which by some criteria would be still regarded as essential.

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