CASE STUDY | To Ban or Not to Ban DDT? Its History and Future

The Early History of DDT

Before the advent of DDT, the only insecticides available were toxic ones such as arsenic-based compounds, and those extracted from plants, which quickly lost their effectiveness when exposed to the elements. Thus DDT seemed at first to be the ideal insecticide: it was not very toxic to humans but fatal to insects, and its persistence seemed to represent a further advantage.

DDT was first synthesized in 1874, but its insecticidal properties were not discovered until 1939, by Paul Muller, a Swiss scientist working on the development of agricultural chemicals for *Geigy*. Although both sides in World War II were informed of its potential, only the Allies used it. DDT was hailed as miraculous in 1945 by Sir Winston Churchill because of its use and effectiveness in the war effort. The Allies sprayed DDT extensively in areas with hot climates to kill insects and thereby protect their troops and civilians from bites from mosquitoes that carry malaria and yellow fever, from body lice that can transmit typhus, and from plague-carrying fleas. For example, an incipient outbreak of typhus carried by lice in Naples, Italy, was thwarted by spraying huge numbers of civilians and troops alike with DDT. Outbreaks of typhus elsewhere in Europe, including the concentration camps at Dachau and Bergen-Belsen, were dealt with in the same way by the Allied troops as they advanced. In this way, the horrendous experience of World War I, when more than 5 million deaths had been caused by typhus, was largely avoided. Aerial spraying with DDT to combat biting insects was also carried out by the Allies in the Pacific before their troops invaded the islands.

Once World War II ended, DDT was used so extensively in preventing disease—malaria caused by mosquitoes and typhus carried by lice—that an estimated 25 million lives were saved! Indeed, in 1948 Paul Muller was awarded the Nobel Prize in Medicine and Physiology in recognition of the many civilian lives that DDT had saved.

Post-war, DDT was also used extensively to control insect pests attacking agricultural crops. Initially it was used on fruit trees (codling moth control), and on vegetable crops, and subsequently in the growing of cotton (pink boll

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worm control) and in forestry. Unfortunately, DDT was widely overused in the 1950s and 1960s in agriculture, which consumed 70–80% of its production, and in forestry. Eventually, some insect populations became resistant to DDT and its effectiveness decreased. This phenomenon led some farmers to apply greater and greater amounts of the insecticide, particularly on cotton fields. Peak usage in the United States occurred in 1959 (over 35,000 tonnes), and declined gradually over the 1960s to one-third of the peak by 1970. In the early 1970s, most of the remaining agricultural use of DDT was on cotton crops. Overall, more than 600 hundred million kilograms of DDT were used in the United States alone, and more than 1 billion kilograms worldwide.

DDT and Malaria

In the United States, Canada, and Europe, malaria had been largely eliminated by the early twentieth century by public health measures, but DDT played a role in its final eradication in mid-century. However, malaria was still endemic in many hotter, developing countries. For that reason, the World Health Organization in 1955 initiated a program to eliminate the disease worldwide, relying heavily on DDT. Although the program initially was very successful in many parts of the world, eventually insect resistance to the insecticide emerged. For example, from 1934 to 1955, Sri Lanka (formerly called Ceylon) averaged 75,000 cases and 4,000 deaths annually from malaria. Following an extensive campaign based upon DDT, the number of cases had fallen to only 17 in 1963. The antimalarial campaign was then halted, but by 1968, the disease re-emerged with a vengeance, and half a million cases of malaria per year were being reported. In the interval, DDT was still being used on crops, and as a result, many of the local mosquitoes had acquired resistance. So, when spraying with DDT against malaria was begun again, it was much less effective than before. Malathion was then used effectively for several decades to again reduce the incidence of malaria in Sri Lanka, but recently some mosquitoes have become resistant to it as well, so pyrethroids are now being used instead.

The Sri Lankan case illustrates a general tension in DDT use that has arisen in several developing countries. Although now illegal by the U.N. convention, massive spraying of cropland by DDT was used in agriculture to combat insects that destroy valuable harvests. In addition to adding to the global reservoir of DDT circulating in the air, however, such widespread use promotes the development of resistance by the mosquitoes to DDT in the local area. Consequently, the (legal) use of much smaller amounts of the insecticide to combat malaria is rendered largely ineffective, because the mosquitoes are resistant to it. Although in 1969 the WHO abandoned the goal of completely eradicating malaria, they have continued efforts to control and treat the disease.

The use of DDT never proved particularly successful in tropical areas where mosquitoes are present in all seasons. The WHO program did not come into force in sub-Saharan Africa, and consequently malaria continued there unabated. Unfortunately, resistance of some forms of malaria has developed to antimalarial drugs, the most prominent of which is chloroquine. The *plasmodium falciparum* parasite, which now accounts for 80% of infections

and which is more prevalent in sub-Saharan Africa than elsewhere, produces a type of malaria that is the most dangerous in terms of complications and mortality, causing 90% of the mortalities from this disease. It is resistant to chloroquine and most other drugs in Africa, India, and southeast Asia.

Bans on DDT

The American public became aware of the environmental problems associated with DDT upon the publication in 1962 of Rachel Carson's book, *Silent Spring*. In it, she discussed the decline of the American robin in certain regions of the United States, due to its consumption of earthworms laden with DDT used in massive amounts to combat Dutch elm disease. Carson's book stimulated widespread public concern about the insecticide.

The U.S. Department of Agriculture cancelled most uses of DDT in 1969 and 1970. Following months of hearings, the U.S. Environmental Protection Agency cancelled all remaining uses except for vector-borne disease and body-lice control, effective in early 1973; all remaining uses were cancelled in 1989. Canada followed a similar timeline. DDT was banned in Norway and Sweden in 1970, in most other developed countries in the 1970s, and in the United Kingdom in 1984.

Although many of the general public believe DDT was banned because of its harmful effect on human health—Rachel Carson having stated in her book that it caused human cancer—there was and still is very little evidence to support that claim. The science supporting the bans is based mainly on its effects on wildlife, such as bald eagles, as discussed in Chapter 12 of the text.

According to the U.N.'s recent *Stockholm Convention on Persistent Organic Pollutants* treaty discussed in the text, countries can request to continue using DDT against malaria until effective *and* affordable alternatives become available, and more than two dozen countries—mainly in sub-Saharan Africa—have done so. Although some environmental groups have pressured the U.N. to include a total ban on DDT, others have been strongly opposed to a complete ban, given that it so effective in small amounts against malaria, a disease which kills 1 million children annually in Africa and whose incidence is increasing. (Children under five years of age are much more susceptible to mortality from malaria than are teenagers and adults. However, poverty, malnutrition, diarrhea, and respiratory disease still are responsible for most infant mortality in sub-Saharan Africa.) The solid residue on surfaces such as indoor walls after spraying with the insecticide provides months of protection against mosquitoes. Groups opposing a ban argued that the health hazards of DDT to humans are miniscule compared to the great benefits it can provide. Switching to alternatives would probably be beyond the financial means of many poor countries, and would require more frequent applications since other insecticides are not as persistent, and alternatives are usually more acutely toxic. As a consequence, several African countries have lifted their bans on DDT use and have reintroduced it for malaria control—for example, South Africa, where mosquito resistance to pyrethroids developed—and others are debating the issue. Indeed, in 2006, the U.S. Agency for International Development, a major donor agency, reversed its previous policy and

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endorsed the indoor spraying of DDT for malaria control, and the World Health Organization followed this lead the same year.

The global amounts of DDT that would be employed for indoor spraying to prevent disease would be tiny compared to the quantities used in the past for agricultural purposes, and which to some extent are still present in air, water, and soil around the world. However, people living in the sprayed homes and adjoining areas would be exposed to significant levels of the chemical. There is some social resistance to effective indoor spraying, because DDT produces stains on walls, which residents then clean or replaster, thereby removing or covering the insecticide. Experience in the past has shown that DDT spraying is most effective in reducing malaria in highland areas, and regions where mosquitoes and disease occurrence is occasional or seasonal rather than endemic.

Groups supporting a total, immediate ban have argued in the past that some countries such as Mexico have eliminated malaria without the use of DDT, and that the mosquitoes responsible for carrying most of the disease are already resistant to DDT in parts of the world such as India. Another argument against allowing spraying of DDT against disease is that it can interfere with pregnancy, and might affect the health of newborns, as discussed below. In addition, studies indicate that more than 80% of the DDT sprayed indoors eventually evaporates and escapes outdoors, where it adds to the pool of the insecticide circulating globally in the atmosphere. Groups proposing a total ban on DDT point out that bednets soaked in more eco-friendly insecticides and environmentally friendly pest control measures together are effective in mosquito control.

Recent research on the effects to humans of high-level exposure to DDT, as occurs when houses are sprayed with it for malaria control, has centered its effects to newborns and to women of child-bearing age. In particular, there is a correlation of blood DDT levels with early loss of pregnancy. Also, exposure of the mother to high DDE levels in the first trimester of pregnancy may produce children having some psychomotor development problems in their first year of life. Although some studies indicated that exposure to DDT and DDE gave rise to premature delivery and small birth weight, a recent analysis of births during the 1960s in the United States to women who had high levels of DDE does not support this conclusion. High levels of DDE present in breast milk have also been associated with a reduced period of lactation, which could potentially increase the rate of infant mortality in developing countries.

Discussion Points

1. Why do you think DDT is such an emotional topic?

2. Develop three-minute debate-style speeches (a) in support of a total ban on DDT, and (b) in opposition to banning DDT for use in disease control.

3. The agricultural sector in some developing countries opposes the use of DDT for malaria control because they fear DDT residues will increase on food that they produce. Do you think high DDT levels on produce would affect their international sales?