The widespread use of pesticides

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That a paper bearing the above title appears in a symposium entitled 'Drugs and disease' might suggest that these agricultural 'drugs', designed to control or eradicate infestations, infections and vector-borne diseases of plants, can cause illness in people. That some of the preparations used to kill insects, fungi and weeds may also poison people there is no doubt. However, data from the Chief Safety Inspector, Ministry of Agriculture (table I) puts the hazards faced by our food producers in proper perspective. Data on the scale of agricultural operations in Great Britain together with a full description of all the toxic hazards encountered on farms are given by Edson (1969). Fatalities from tractor accidents in any single year far surpass the total fatalities from pesticide poisoning in 25 years. The fact that we have this information on accidents due to pesticides stems from legislation and a voluntary notification scheme for the introduction and use of pesticides that followed less than a dozen fatalities among agricultural workers applying dinitroorthocresol (DNOC) as a selective herbicide in cereal crops during the summers 1947-50 (see Bidstrup and Payne, 1951).

Accident		1970	1971	1972	1973
Tractors	Deaths	39	37	30	26
	Injuries	378	395	362	283
Fall	Deaths	15	14	13	17
	Injuries	1368	1277	1326	1227
Pesticides	Deaths	0	0	0	0
	Injuries	23	15	18	16

Table I *Accidents on farms in the UK*¹

¹Figures kindly supplied by the Chief Safety Inspector MAFF

It is perhaps salutary to remember in the context of this symposium that many more overweight patients were killed or blinded by DNOC prescribed by doctors as a slimming agent in the decade before World War II. The legislation that followed the introduction of DNOC as a herbicide was designed to protect the agricultural worker from acute poisoning by laying down certain safety measures such as the provision of hygiene facilities when cer-

tain pesticides were to be used. The voluntary Pesticides Safety Precaution Scheme (PSPS) that followed ensured that industry notified the Ministry of every compound which it wishes to use and also the manner in which it was proposed to apply them. Chemical, biological and toxicological data relating to each pesticide, including residues in the crops, are provided and scrutinized by a committee of the Ministry which has a majority of independent members. This committee decides whether the compound has a mammalian toxicity such as would indicate the desirability of including it in the 'regulations'. Such 'regulated' chemicals present problems to farmers and these responsibilities could be avoided if less dangerous alternatives could be used to achieve the same end. It was largely as a result of these restraints that cheap, effective but dangerous insecticides like parathion have not been used in Great Britain for 20 years. Safer formulations, such as granules, of even more intrinsically toxic insecticides have long been safely used.

The scheme to control the introduction of new agricultural 'drugs' was in operation many years before there was any comparable control over the introduction of drugs, even though DNOC had killed patients 25 years before thalidomide deformed embryos. For pesticides, the system has remained voluntary though proposals to make it statutory have been put forward from time to time both by industry and from official quarters. That the system operates effectively is largely due to the responsible attitude of the medical advisers to the pesticide industry and all the testing procedures designed to obtain satisfactory evidence of safety have been thrashed out in discussions between official and industrial toxicologists. At any rate in practice it can be seen that those who are most seriously exposed to pesticides do not seem to incur any unacceptable toxic hazard. A summary of the incidents reported in 1972 and 1973 is given in table II.

With so much current preoccupation about the possibility that a pesticide may act selectively and solely as a mutagen or carcinogen, it is well to remember the hazards to eyes and skin from simple organic acids now widely used in silage preparation.

¹Dr J. M. Barnes died on 24 September 1975.

<i>Illness</i>	<i>1972</i>	<i>1973</i>
Skin and eye irritation including dermatitis	14	11
Eye injury from splashes of concentrate	8	8
Mild symptoms from organophosphorus compounds	3	2
Marked symptoms from organophosphorus compounds	2	—
Chest irritation from dust or smoke	3	—
Complaints unrelated to known toxic effects	8	6
Totals	38	27

Table II *Nature of illnesses reported among agricultural workers exposed to pesticides*

The general population encounters some pesticides as garden or household products and the promotion of these is also included in the Ministry's Pesticide Safety Precaution Scheme. Residues of pesticides in food can sometimes be detected and of these the persistent organochlorine compounds DDT and dieldrin have caught most attention because they can also be found in our fat and blood. There is a great deal of published data on DDT levels in human fat and some figures for DDT plus DDE, its first metabolite, are given in table III. They show wide ranges from different countries and even in different parts of the same country.

In recent years blood levels have also been determined where the concentrations are three orders less than that in fat, but probably are proportional to the fat levels. However, it is worth bearing in mind that for every molecule of DDT in the blood of a person not occupationally exposed in the UK, there are 30 atoms of lead. These are formulators of DDT with an exposure of 20 years or more who have fat levels 100 fold greater than the general population. They have not yet shown any ill effects from this exposure (Laws, Curley, and Birros, 1967). Special

biochemical studies do show that they can metabolize phenylbutazone and cortisol more rapidly than a matched set of controls though their capacity in this respect does not fall outside the range in the general population (Poland, Smith, Kuntzman, Jacobson, and Conney, 1970).

Since these organochlorine pesticides can damage the liver acutely in very large doses and, in the case of mice, chronically when fed continuously, it is useful to note two special studies of liver function tests in the formulators referred to above (Laws, Maddrey, Curley, and Burse, 1973) and in farm workers with a higher tissue level than that in a comparable population (Warnick and Carter, 1972). No evidence of any deficit in liver function could be discerned.

Since this is a symposium on drugs it is perhaps appropriate to draw attention to the observations of Davies, Edmundson, Carter, and Barquet (1969) that patients receiving anticonvulsant drugs, phenytoin and phenobarbitone, have much lower levels of DDT and DDE in their fat and their blood than patients in the same institution not receiving these drugs. This observation is consistent with the finding that these drugs stimulate the liver microsomes, as indeed does DDT, but of course the dose is much greater. Many drugs stimulate the activity of the so-called drug-metabolizing enzymes and it seems irrational to worry about the possible effects of minute doses of pesticides such as DDT, the daily intake of which is a few microgrammes, by a patient receiving 1000 times as much of a common drug.

The pesticide that has attracted most attention in the medical press is the herbicide paraquat. The use of this compound is on a vast scale and it has brought about a technological revolution. In doing

<i>Country</i>	<i>Years</i>	<i>DDT + DDE (µg/g)</i>	<i>Reference</i>
U.K.	1963-64	3.1	Abbott, Collins, and Goulding (1972)
	1965-67	2.78	Abbott, Collins, and Goulding (1972)
	1969-71	2.32	Abbott, Collins, and Goulding (1972)
Denmark	1965	3.1	Abbott, Collins, and Goulding (1972)
Holland	1967-68	3.02	Abbott, Collins, and Goulding (1972)
W. Germany	1970	3.3	Abbott, Collins, and Goulding (1972)
Hungary	1969	12.2	Abbott, Collins, and Goulding (1972)
Poland	1968	23.5	Bronisz, Ochynski, and Latkowski (1972)
Israel	1965-66	18.1	Abbott, Collins, and Goulding (1972)
Pakistan	1970-71	25.0	Mughal and Rahman (1973)
Japan	1970	2.4	Curley <i>et al</i> (1973)
Australia	1965-66	8.8	Abbott, Collins, and Goulding (1972)
U.S.A.	1961-62	12.6	Quinby <i>et al</i> (1965)
Florida	1967	9.4	Abbott, Collins, and Goulding (1972)
Hawaii	1967-68	6.0	Abbott, Collins, and Goulding (1972)
Idaho	1970	9.1	Wyllie, Gabica, and Benson (1970)
Utah	1967-71	7.3	Warnick (1972)
Texas	1969-72	23.2	Burns (1974)

Table III *Levels of DDT + DDE found in body fat of members of the general population not occupationally exposed*

this it has not caused a single fatality or serious illness from occupational exposure. Splashes in the eye can be unpleasant and some workers have lost finger nails or toe nails temporarily after splashes of concentrate when neither gloves nor shoes were worn. Apart from suicides, all the fatalities from paraquat have followed its illicit removal from bulk containers into beverage bottles and its subsequent consumption in error by both adults and children. It is interesting perhaps to reflect that if so much care had not been taken to protect people from this toxic liquid concentrate then no such fatalities would have occurred. If paraquat concentrates had been available to the retail buyer in properly labelled bottles who would then want to put it in a Coca Cola bottle? There are no simple cut-and-dried, fool-proof, fail-safe procedures to protect people from the results of irresponsible behaviour.

It may be suggested that this is a very complacent review of the pesticide problem. Certainly one could digress *in extenso* on hypothetical hazards but it may be more instructive to look at some reports from other places.

It is fashionable to consider toxic hazards in the context of the environment but the environment can be anything from the wide open spaces occupied by the occasional bird of prey to the bedside table on which sit the drugs which people take in an effort to adjust themselves to their environment. This same domestic environment is frequently the playground of children. In two areas of Iowa between 1965 and 1968 there were 2059 cases of poisoning of which 1989 occurred in children under 5. Of the total 95 or 5% were due to pesticides (Lisella and Long, 1970). In New Orleans between 1965 and 1967 one hospital had 1059 cases of poisoning of which 107 (10%) were due to pesticides and 77% of these were children under 5, many of whom had eaten rodenticides which they had found as prepared baits (McLeod, 1970). In North Carolina between 1970 and 1972 there were 381 cases of poisoning by pesticides reported of which 50% were children under 5 years of age. In 100 retail outlets examined there were 1200 pesticide products available for sale, many of them being 'obsolete' materials such as phosphorus or thallium for killing rats (Gehlbach, Williams, Woodall, and Freeman, 1974).

In South Carolina 1157 registered practitioners were asked how many cases of pesticide poisoning they had seen in the 12 months up to July 1969. A total of 572 cases had been seen (Keil, Sandifer, and Gadsden, 1970). When the same procedure was repeated in 1971 there were 627 reports—about 0.25 cases per 100 000 population, but most of these were in the cotton, tobacco and peach growing

areas where pesticides were used. The incidence of pesticide poisoning was the same as that for syphilis or tuberculosis (Whitlock, Keil, and Hope Sandifer, 1972).

Studies in South Florida between 1956 and 1967 revealed 121 deaths due to pesticides in a population rising during the period to a total of one million, and of these only three were occupational, all due to parathion. While the suicide and accident rates in Florida can be compared with other national statistics, it is interesting to note the authors' comment that 'other categories, such as occupational, are impossible to compare because no comparable nationwide mortality data are available' (Reich, Davis, and Davis, 1968).

The striking variation in reports from different localities is revealed by one from the Rio Grande Valley, Texas. In the period 1960-1966 there were 275 cases of acute poisoning by pesticides among agricultural workers. There was a total of 70 cases in the four years 1960-1963 but for the next three years there were 70 cases each year. This followed the introduction of the more toxic organophosphorus insecticides in place of DDT and dieldrin. Thus the safety of birds may be obtained at the price of greater hazards for people (Smith and Wiseman, 1971). However in the context of the experience elsewhere it is interesting to read that the improvement—the fall in number of cases—in 1969 was due to a greater appreciation of hazards to ground workers from aerial sprays, to efforts to keep loading facilities clean and free of spilled insecticide, and the use of blood cholinesterase determinations to monitor exposure (Smith and Wiseman, 1971). This is 20 years after the introduction of these toxic insecticides and the development of field methods for estimating blood cholinesterase activity.

It is perhaps not surprising that in the same community the DDT level in the fat of the general population was 23 ppm—the highest in the general US population (see table III). For comparison it can be recorded that in 1974 the National Poisons Reference Centre in London, serving a population of 20 to 30 million, received 250 reports of real or suspected accidental poisoning from pesticides. These figures include nine fatalities, all cases of deliberate self poisoning (R. Goulding, personal communication).

In conclusion it can be stated that pesticides can be safely used in a country with a technically highly developed and efficient agricultural industry. An early recognition of hazards had led to the evolution of an effective system of control, achieved largely by voluntary cooperation. That this satisfactory state of affairs did not just come about by chance is indicated

by the experience in another technically highly developed country.

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