

## Public health

## Pesticide poisoning in the developing world—a minimum pesticides list

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**In parts of the developing world, pesticide poisoning causes more deaths than infectious diseases. Use of pesticides is poorly regulated and often dangerous; their easy availability also makes them a popular method of self-harm. In 1985, the UN Food and Agriculture Organisation (FAO) produced a voluntary code of conduct for the pesticide industry in an attempt to limit the harmful effects of pesticides. Unfortunately, a lack of adequate government resources in the developing world makes this code ineffective, and thousands of deaths continue today. WHO has recommended that access to highly toxic pesticides be restricted—where this has been done, suicide rates have fallen. Since an Essential Drugs List was established in 1977, use of a few essential drugs has rationalised drug use in many regions. An analogous Minimum Pesticides List would identify a restricted number of less dangerous pesticides to do specific tasks within an integrated pest management system. Use of safer pesticides should result in fewer deaths, just as the change from barbiturates to benzodiazepines has reduced the number of deaths from pharmaceutical self-poisoning.**

Hundreds of active ingredients and tens of thousands of formulations are used to control agricultural pests and disease-carrying vectors.<sup>1</sup> 1.5 million tonnes of pesticides are manufactured every year, producing a business worth US\$30 billion.<sup>2</sup> The widespread adoption of pesticides during the 1950s was associated with increased crop yields, opening up of new agricultural land, and reductions in incidence of vector-borne diseases. However, increasing pest resistance has resulted in lower yields and a resurgence of vector-borne diseases such as malaria. At the same time, the many health and environmental costs of intensive pesticide use have become starkly apparent.

Most pesticides are toxic to human beings; WHO has classified their toxic effects from class Ia (extremely

hazardous) to class III (slightly hazardous) and then “active ingredients unlikely to present acute hazard”.<sup>3</sup> Most class-I technical grade pesticides are banned or strictly controlled in the regulated industrialised world, but not in developing countries, where class-I pesticides are freely available in places that do not have the resources for their safe use.<sup>4</sup>

### Deliberate self-poisoning with pesticides

Most pesticide deaths recorded in hospital surveys are the result of self-poisoning.<sup>5</sup> The Global Burden of Disease study<sup>6</sup> estimated that 798 000 people died from deliberate self-harm in 1990, over 75% of whom were from developing countries.<sup>6</sup> More recent WHO estimates show that over 500 000 people died from self-harm in Southeast Asia and the western Pacific during 2000 alone.<sup>7</sup> Suicide is the commonest cause of death in young Chinese women and Sri Lankan men and women.<sup>6-8</sup>

Pesticides are the most important method of self-poisoning in many rural regions and are associated with a high death rate.<sup>5</sup> In an extrapolation from very limited data, WHO estimates that three million pesticide poisoning cases occur worldwide every year, with 220 000 deaths, most of which are intentional.<sup>9</sup> The problem is particularly severe in Sri Lanka<sup>10,11</sup> (panel), where pesticide poisoning is the

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### Pesticide poisoning in Sri Lanka

Self-harm and pesticide poisoning are such great problems in Sri Lanka that the President set up a special commission in the mid 1990s to advise on ways to reduce the country's high rate of suicide. In 1995, self-harm was the main cause of death nationally in the 15–24 and 25–49 year age-groups.<sup>8</sup> Pesticide poisoning was the sixth commonest cause of hospital death in Sri Lanka, with 1571 deaths and 15 730 cases.<sup>8</sup> However, in six rural districts (population 2.7 million), pesticide poisoning was the main cause of hospital death. Infectious diseases were in the top ten causes of death in only four of these districts and in no district was it higher than third. Government action after the Commission's report has centred on decriminalisation of suicide, community education and youth empowerment, restriction of access to toxic pesticides, and improved medical management by setting up specialised treatment centres and encouraging research.<sup>11</sup>

commonest cause of hospital death in many rural districts.<sup>8</sup>

### Occupational and accidental pesticide poisoning

However, concentration on self-poisoning risks ignoring the illness and death that result from occupational and accidental exposure.<sup>12,13</sup> Occupational illness is common because it is impractical and expensive to use safety equipment in the humid tropics.<sup>4,13</sup> Safety instructions on containers are often written in unfamiliar languages, many farmers are illiterate, and the instructions themselves are difficult to follow: after coming into contact with pesticides, it is difficult to “wash off at once” when there is no water available. The irrelevance of workers’ health to employers in the tropics—where sick employees can be fired and new workers recruited—will continue to hinder safe practice.

### Medical management

Medical management is difficult with the few resources available—case-fatality rates for pesticide poisoning in Sri Lanka can exceed 50%<sup>14</sup> and case-fatality rates with aluminium phosphide or paraquat reach 70% in southern Asia.<sup>15,16</sup> There are too many patients, too few doctors, too few drugs and ventilators, and too little good evidence about how to treat patients with overwhelming poisoning after ingestion of these highly toxic compounds.

### Induction of pest resistance and alternative pest-control methods

Another difficulty with uncontrolled use of pesticides is induction of pest resistance. Results of studies<sup>4</sup> have shown that intense use of pesticides to kill resistant pests induces more resistance until further increases in pesticide use actually reduce agricultural yield. This effect has resulted in the complete loss of crops from certain regions—eg, cotton in Nicaragua and Indonesia.<sup>17,18</sup> In both countries, agricultural yield recovered only after introduction of an integrated system of pest management.

Integrated pest management encourages use of fewer pesticide applications and more environmentally friendly methods of pest control. The most toxic pesticides and those with greatest local resistance are identified; their use is then restricted and a regimen of decreased applications is implemented to protect natural enemies of the pests. This strategy results in reduced pesticide use, increased productivity and profitability, and fewer deaths from poisoning.

The pesticide industry states that it now fully supports a policy of restricted use of pesticides within an integrated programme of pest management.<sup>19</sup> However, its view of such management differs from that of some workers in that it perceives a clear need for pesticides in most situations.<sup>20</sup> Furthermore, its practice of paying salespeople on a commission basis, with increased sales being rewarded with increased earnings, is unlikely



Figure 1: Causes and effects of pesticide poisoning

Pesticide spraying without protective clothing in rural (A) and urban (B) regions. Discarded pesticide bottles in a garden (C) and in a rice paddy (D)—neither bottle in the paddy gave details of the pesticide they once contained. (E, F) patients poisoned with organophosphate filling three of four beds in the intensive treatment unit in Anuradhapura, Sri Lanka. (G) A line of self-poisoning patients in a male ward in Kurunegala, Sri Lanka—four had taken unknown organophosphates from unlabelled bottles, one had taken the chlorophenoxy compound MCPA, and two had taken yellow oleander seeds (*Thevetia peruviana*). (H) A patient poisoned with organophosphates with the bottle he had drunk from. (I) the label says ‘Poison. Do not re-use’ in Sinhala, Tamil, and English. No specific information on the pesticide contents is given. Panels A, C, and D were taken by L Smit near Embilipitiya, Sri Lanka, in 2000. All other photographs were taken by M Eddleston during visits to Anuradhapura, Kurunegala, and Colombo, Sri Lanka, during August 2001.

to encourage reduced use of pesticides. If integrated pest management is ever to be more widely used, the industry will need to reconsider this incentive for pesticide use.

### The international code of conduct on the distribution and use of pesticides

In the early 1980s, a debate developed about the effects of uncontrolled pesticide use on health in the developing world. The major response was the production of the International Code of Conduct on the Distribution and Use of Pesticides in 1985 by the UN Food and Agricultural Organisation (FAO). This code attempted to rationalise use of pesticides and reduce the number of deaths.<sup>21</sup> Its aim was to establish:

“...voluntary standards of conduct for public and private entities engaged in . . . the distribution and use of pesticides, particularly where there is . . . inadequate national law to regulate pesticides” (Article 1.1)

In particular, the code wished to ensure that the benefits derived from use of pesticides be achieved without substantial adverse effects on people or environment (Article 1.2).

Manufacturers were requested to supply only pesticides of adequate quality, packaged and labelled as appropriate for each specific market, and to retain an interest in the product as far as the ultimate consumer. In particular, the code stated that

“pesticides whose handling and application require the use of uncomfortable and expensive protective clothing . . . should be avoided, especially in the case of small scale users in tropical climates” (Article 3.5).

If the code were followed, this article would effectively prohibit distribution of class-I pesticides in the tropics, since the required safety equipment is expensive, cumbersome, and almost never worn (figure 1). National governments were asked to

“allocate high priority and adequate resources to the task of effectively managing the availability, distribution and use of pesticides in their countries” (Article 3.7).

Governments were noted to have overall responsibility for regulating pesticides (Article 3.1). However, governments in the developing world do not have the resources to do this job, as acknowledged by the FAO’s director in his introduction:

“In the absence of effective pesticide registration processes and governmental infrastructure for controlling the availability of pesticides, some countries importing pesticides must rely on the pesticide industry to promote the safe and proper distribution and use of pesticides. In these circumstances, foreign manufacturers, exporters and importers . . . must accept a share of the responsibility for safety and efficiency in distribution and use”.

The code is still being revised. The current draft revision states that WHO class-I pesticides should not be used in developing countries. This revision should be implemented within the next year, but how it will affect the availability of class-I pesticides remains to be seen. Policing the code is the responsibility of national governments but the lack of resources and political will mean that there is no effective mechanism to enforce it or to publicise violations.

Other organisations, including the pesticide industry and governments, have also made intensive efforts to reduce human and environmental toxic effects caused by pesticides. However, despite these efforts, deaths continue and the problem is worsening (figure 2).<sup>22–25</sup>

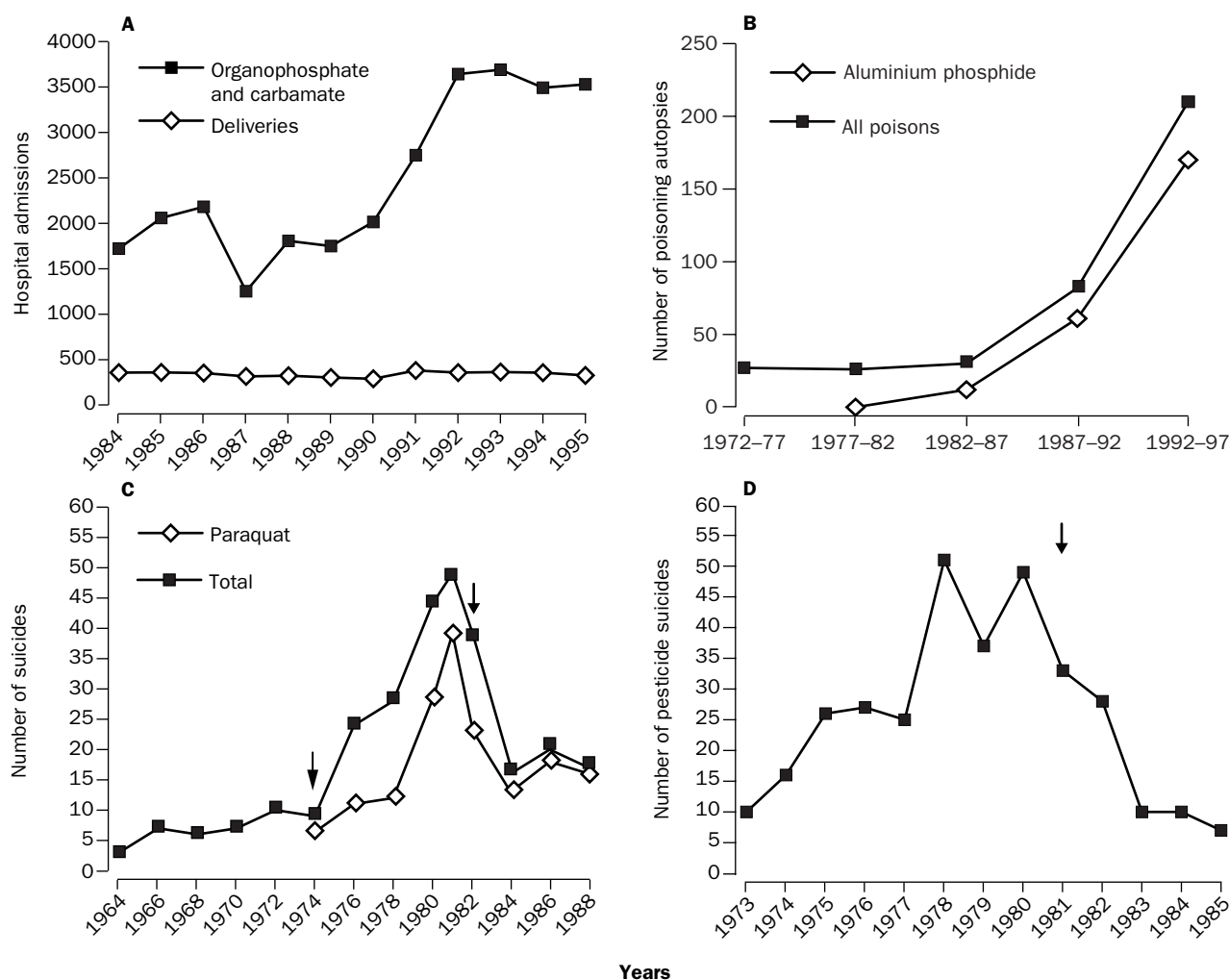


Figure 2: **Pesticide poisoning: admissions, suicides, and autopsies**

(A) number of admissions for organophosphate and carbamate poisoning (and, as a control, the number of babies delivered  $\div 100$ ) in the districts of Anuradhapura and Kurunegala, Sri Lanka, between 1984 and 1995.<sup>22</sup> (B) number of poisoning autopsies due to all poisons and to aluminium phosphide done in Chandigarh, northwest India, between 1974 and 1997.<sup>23</sup> (C) incidence of suicide in Samoa, related to arrival of paraquat in 1974 (first arrow) and control of its availability (second arrow) in 1982.<sup>24</sup> (D) changes in the number of poisoning autopsies in Amman before and after (arrow) the nationwide ban of parathion in January, 1981.<sup>25</sup>

## Pesticide restriction programmes to reduce self-harm

WHO has taken a different approach from the FAO, suggesting that death rates be reduced by restricting the availability of poisons commonly used for self-harm.<sup>7,26</sup> Physicians have requested that specific pesticides be banned—eg, paraquat in Trinidad and aluminium phosphide in India.<sup>27,28</sup>

Many examples worldwide have shown that restricting the availability of toxic pesticides can work, reducing total death rates from self-harm. A national ban on the organophosphate parathion reduced the total number of deaths reported to a poison centre in Rosario, Argentina, during the 1990s.<sup>29</sup> Because of an epidemic of self-poisoning with paraquat in Samoa, availability of this pesticide was restricted by the authorities in 1982, with a resulting fall in suicide rate (figure 2<sup>3</sup>). Parathion was banned in Jordan during 1981 after results of studies showed that it was responsible for more than 90% of deaths from pesticides. The total number of poisoning deaths requiring autopsy in Amman then fell by more than 80% (figure 2<sup>25</sup>).

Restriction of class-I pesticides should also reduce the number of occupational poisonings. Such a strategy might have prevented the epidemic of poisoning cases seen in Nicaragua in 1987 after adoption of the class-I pesticides carbofuran and methamidophos.<sup>30</sup> Overall, these findings suggest that restricting the availability of toxic pesticides will reduce the number of deaths from poisoning. A similar reduction in self-harm deaths has occurred in the UK and India after replacement of barbiturates with benzodiazepines as the usual sedative prescription.<sup>31,32</sup>

## An essential or minimum pesticide list

Bearing these studies in mind, might it be possible to develop a code that would restrict use of toxic pesticides and prevent deaths of people and damage to the environment?

WHO's model essential drugs list was initiated in 1977 to support rational use of drugs.<sup>33</sup> Today, the model list contains over 300 drugs that satisfy the health needs of most people for most of the time. In countries that have used the essential drugs list to develop their own essential drugs programme, it has led to better supply and use of important drugs.<sup>34</sup>

At present, the situation with pesticides has some similarities to that of drugs in the 1970s. Hundreds of active ingredients and thousands of formulations are available in an uncontrolled fashion and promoted by both manufacturer and distributor as being essential for crop production. For example, over 100 different preparations were being used by just 300 farmers around the Sri Lankan town of Embilipitya during 1999–2000 (L Smit, personal communication). Rational use with so many pesticides is difficult. Perhaps lessons learned from the essential drugs list could be applied to pesticides? Might an analogous model pesticide list be equally useful? Since many people argue that no pesticide is essential everywhere and that further development of integrated pest management will remove the need for many pesticides, the list would be a model minimum, rather than essential, pesticide list.

The model list would give governments who are under-resourced information to allow them to determine which pesticides suit their agricultural needs. Unbiased assessment and comparison of pesticides, using an explicit and transparent evidence-based approach, would be very useful for governments and small-scale farmers.

Although enforcement of legislation would still often be difficult, a greatly reduced number of pesticides should simplify this process. A model list would allow legislators to

decide which few pesticides should be used in their region and then actively register them; other pesticides would not be registered, removing a large number of obsolete and dangerous pesticides from circulation.

## Recommendation

Widespread use of pesticides in agriculture results in many short and long-term health problems. Worldwide, tens, if not hundreds, of thousands of people die every year from their effects. Future agricultural practice must aim to reduce pesticide use to a minimum. Since such action may take some years. In the meantime, pesticides causing the most human ill health and environmental disturbance should be restricted. A minimum pesticide list may go some way towards this, but only if the safest and most effective pesticides are used in combination with ways to control their use, such as prescriptions to restrict sales and increased expenditure on farmer training via the integrated pest management Facility's Integrated Pest and Plant Management-2015 project.

We therefore call on WHO and FAO to develop a model minimum pesticides list. If effective, many of the pesticide deaths that occur every year could become distant memories.

### Contributors

M Eddleston had and developed the idea of a minimum pesticides list. Early drafts of the paper were critically reviewed and extended by the other authors who have all seen and approved the final revised version.

### Conflict of interest statement

None declared.

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