The Health Impacts of Pesticide Use: The Need for a National Response

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Introduction

Uncontrolled pests pose significant risks to humans, animals and crops, and sometimes, pesticides are the only viable alternative. For example, DDT (Dichloro Diphenyl Tri chloroethane), being toxic to a wide range of insect pests, has been successfully used in the control of malaria and yellow fever, diseases that resulted in millions of deaths in the past. Not surprisingly, Dr Paul Mueller received the Nobel Prize in Physiology / Medicine for his discovery of DDT. On the other hand, the discovery of organophosphates (OPs) in 1945 by Dr Shrader in Germany led to the production of it as a chemical warfare agent by the Hitler Government. After the war, the use of this warfare agent in agriculture became popular and remains so to date.

The pesticides that provide benefits essential to our way of life cannot be denied. The uses of pesticides in the control of vector-borne diseases, such as, malaria and Japanese encephalitis, for the protection of livestock and crops, to increase crop yield and quality and in the protection of property, are well-known.

However, the use and abuse of pesticides, particularly, in agriculture, and to a lesser extent, in disease control, has brought about many other problems. Over the years, resistance to these pesticides has developed requiring the chemical/ pesticide industries to produce stronger and more powerful pesticides. The commercially-driven pesticide industry has been quick to respond to the need for more toxic products. This has now led to pesticides destroying not only its target species, but also non-target species including man, and the ecosystem.

The purpose of this paper is to highlight the need for a multidisciplinary national response to manage the threat of pesticides on human health. The paper is presented in four cohesive sections, first on the health impacts of pesticide use with particular focus on low-dose exposure, then on an overview of the regulatory mechanism, thereafter, on identified deficiencies in relation to meeting the health challenges, and lastly, some suggestions for dealing with the problems at hand.

Health Impacts

High-dose poisoning

In Sri Lanka, the impact of high-dose pesticide poisoning has been significant in terms of mortality, morbidity and the economics of health and well-being. In the early 1990s, Sri Lanka had one of the highest suicide rates in the world. Between 1950 and 1995, rates increased 8-fold to a peak of 47 per 100, 000 in 1995 (Gunnell et al., 2007). Self-poisoning was the greatest contributor to this figure. In the 10 years after 1995, Sri Lanka's suicide rates declined by 50%, with the decline in the number of self-poisoning cases. Restrictions on the import and sales of WHO (World Health Organisation) Class I toxicity pesticides in 1995 and Endosulfan in 1998, coincided with reductions in suicide. Other initiatives that may have influenced the decline in suicide rates in Sri Lanka were the appointment of the Registrar of Pesticides, establishment of national poisons information centre in 1988, creation of the Presidential task force on suicide and de-criminalisation of suicide in Sri Lanka in 1998.

Low-dose poisoning

There is mounting scientific evidence on the adverse health impacts of exposure to low doses of pesticides. Evidence is reported from both the developed countries in which pesticide use is regulated and monitored and from the developing nations in which pesticide use and abuse is greater. Low-dose exposure is the exposure that occurs at levels lower than that which causes acute clinical manifestations. Low-dose exposure occurs during pesticide spraying, due to the pollution of the environment caused by household use and pesticide spray drift, and due to pesticide residues in food. Some impacts on low-dose poisoning are presented below.

Impacts on adults

The reported effects of low-dose exposure to pesticides in adults include neurological, respiratory, reproductive, immunotoxic, and genotoxic effects and cancer.

Neurobehavioural effects following both occupational and environmental exposure to

pesticides are documented. Mental and emotional symptoms, mood changes, depression, altered neurobehavioural performance, altered cognitive and psychomotor function and minor psychiatric morbidity are documented to be associated with low-dose pesticide exposure (Blainey et al., 2008; Sanborn et al., 2007). Symptoms, such as, dizziness, muscle weakness, feeling of fear, tremor, staggering gait, painful tingling sensation, irritability and impairments in nerve function, were found to be associated with low-dose pesticide exposure in studies conducted in the Uda Walawe irrigation system in Sri Lanka (Smit et al., 2003; Peiris-John et al., 2002). Respiratory problems too have been documented in the population studied in Uda Walawe (Peiris-John et al., 2005).

Reproductive problems, such as, poor semen quality and sub-fertility (Peiris-John and Wickremasinghe, 2008; Sanborn et al., 2007; Hanke and Jurewicz, 2004), and disruption of hormonal function leading to impaired fertility and ovarian cycle irregularities (Bretveld et al., 2006) resulting from pesticide exposure are reported.

The immunotoxic and genotoxic effects and the cancers that are more prevalent following pesticide exposure are reported in studies conducted in countries in which pesticide use is more regulated and monitored as compared to ours. The situation is likely to be worse in Sri Lanka, although, presently, largely unknown.

Hypersensitivity reactions, suppression or stimulation of the immune system and cancers of the immune cell lines are some immunotoxic effects reported (Blainey et al., 2008). These effects may manifest as altered susceptibility to infections and other diseases, including cancers. Evidence of an increase in genotoxicity, as shown by an increase in chromosome aberrations following low-dose pesticide exposure, is also documented (Sanborn et al., 2007). Chromosomal aberrations predict the occurrence of cancer. Moreover, chromosomal damage induced by pesticides is found to be cumulative when people are continuously exposed to complex agrochemical mixtures (Bolognesi, 2003). Farmers in our country are constantly exposed cocktails of pesticides which they believe will improve crop yield and quality.

Studies also consistently report positive associations between pesticide exposure and increased risk of cancers, such as, non-Hodgkin's lymphoma, leukaemia, multiple myeloma, brain tumours, colon and renal cancers (Blainey et al., 2008; Sanborn et al., 2004). Apart from these, pancreatic cancer in males and prostatic cancer are found to be more prevalent in populations exposed to low doses of pesticides. In the females, higher prevalence rates of breast, cervical, uterine, vaginal and ovarian cancers are reported following low-dose exposure to pesticides.

Impacts on pregnant mothers and children

Unborn babies can be exposed to pesticides through exposure of the pregnant mother which may occur at any time during the pregnancy.

In a study conducted among pregnant mothers and their babies in New York, chlorpyrifos and diazinon, both moderately hazardous OP pesticides, were detected in all mothers and in 64% of the babies (Whyatt et al., 2002). Mothers were exposed by environmental spray drift, resulting in exposure of their unborn babies. Ironically, although DDT has not been used for over 30 years in the United States (US), it was detected in 15% of women tested between the ages of 18-40 years. In a similar study conducted in Embilipitiya, Sri Lanka, evidence of exposure of mothers by environmental spray drift was found to result in exposure of the foetus during the third trimester (Samarawickrema et al., 2008). Evidence of DNA (Deoxyribonucleic Acid) damage caused by exposure of the unborn baby to pesticides was detected in this study. DNA damage is known to increase the risk of cardiovascular disease and cancer, particularly, when protective mechanisms in the body fail.

Reviews of studies confirm an increase in spontaneous abortions, intrauterine growth retardation and still births following low-dose pesticide exposure of the pregnant mothers (Peiris-John and Wickremasinghe, 2008; Blainey et al., 2008; Sanborn et al., 2007, Hanke and Jurewicz, 2004). The pesticides implicated are pyrethroids, chlopyrifos, DDT, etc. Congenital malformation, such as, cleft palate and hair lip, genital and urinary tract malformations are also more prevalent in pesticide-exposed groups as confirmed in a review paper (Sanborn et al., 2004).

Older children are exposed to pesticides because of the environment they live in, particularly, if they live on or close to agricultural fields, because of the hand-to-mouth behaviour pattern of young children and by the food they eat. The reviews on exposure in childhood document evidence for neuro-developmental deficits caused by pesticide exposure that takes place prior to birth, via breast milk and by environmental exposure. The effects include deficits in perception and judgment known as cognition, and

psychomotor function which is the motor effect of the mental process (Eskenazi et al., 2007). Developmental disorders, such as, autism spectrum disorder and Asperger's syndrome, are reported following exposure to OPs. Studies on this aspect have not been conducted in Sri Lanka.

Alarmingly, review papers consistently report positive associations between pesticide exposure and increased risk of childhood cancers, of particular note on brain tumours, childhood leukaemia, non-Hodgkin's lymphoma and renal tumours. Exposure is documented to be by parental occupational exposure and by pest-control services used at home.

As is evident from the aforesaid, pesticides, though beneficial to our world, are significantly harmful to its people and the ecosystem; a subject by itself and an aspect not dealt with in this paper.

An Overview of the Pesticide Regulatory Process

In many aspects, the pesticide regulatory process is similar in the world over. When pesticide companies want a product marketed, they submit an application that, among other details, contains sections on toxicological and environmental impact information. These may be submitted to the ministries of health (as is the case in Brazil) or agriculture (as occurs in Sri Lanka). These ministries will then conduct a risk/benefit analysis based on the evidence provided by the company and on animal toxicological and ecological studies conducted by them. After due consideration is given to all facts before them, they will either permit registration of the product or will restrict its use. If registered, a re-evaluation of the product is conducted from 3 -15 years after registration, depending on the country. If restricted, once the company appeals or if litigation is brought about, exposure data on the population may be considered. Exposure data on the population is sometimes considered during the re-evaluation process as well. At these times, data from the poison information centres and monitoring data is used. This is in a nutshell of an overview of the regulatory process. Countries differ in their approach, depending on their requirements and on the facilities that are available.

In 1983, the Government of Sri Lanka enacted the Control of Pesticides Act which stipulates regulations in relation to pesticide import, formulation and use. The overall objective of the regulation is to assure health safety, minimise environmental pollution and assure product quality. Regulations and standards of the pesticides used in Sri Lanka are set by the Registrar of Pesticides. Persistent chemicals, such as, chlorinated hydrocarbons, are prohibited. The WHO Class Ia and Ib pesticides which are the extremely and highly hazardous, are not in use. Agriculture is the biggest user of pesticides in the country. Pesticides are also used for public health purposes. These are imported when recommended by the anti-malaria campaign and cannot be used for any other purpose.

Toxicological studies are not conducted in Sri Lanka due to resource constraints. Instead, the results of ecological and toxicological studies conducted in similar countries in the region are taken into consideration.

Drawbacks in Dealing with the Challenges to Health
Scientific evidence

In the regulatory process, a pesticide may be registered for use without any consideration given to exposure findings in the population. In general, only occasionally is the scientific evidence from population studies examined in the regulatory process. There are reasons for this. There are indeed limitations in the epidemiological evidence that is presented. A major limitation being the inability to confirm cause and effect relationships, because of the; a) absence of good biological markers of exposure, and b) inability to conduct toxicological experiments on human subjects. Good biomarkers provide definitive proof of a single pesticide as the cause of an effect. Hundreds of types of pesticides are used by farmers, and it is not possible to measure blood levels of all these pesticides, because the costs involved are prohibitive. Study subjects also cannot be deliberately exposed to potentially harmful toxins. Therefore, regulators face challenges when using epidemiological evidence in the regulatory process. The pesticide industry is a multibillion dollar industry – the threat of litigations is ever present.

Toxicological studies in animals, on the other hand, provide clear evidence of such effects, and are uncomplicated by confounders, such as, mixed exposures and environmental and lifestyle factors. Therefore, they are widely used in the pesticide regulatory process. However, there are many deficiencies when excessive reliance is placed on animal toxicological experiments. Animal toxicological studies cannot be used to identify causality of all human afflictions. For instance, conditions, such as, autism spectrum disorder or even poor cognition, cannot be shown in a rat or monkey model. Therefore, the likely occurrences of these conditions and many other similar

conditions are not even considered at present in the pesticide regulatory process. Moreover, experimental studies do not capture the 'real' world we live in. The synergistic effects of other potential exposures that increase the risk of adverse health effects are simply not considered. Factors, such as, the different combinations of pesticides and solvents used, the environmental conditions, the protective measures used, the lifestyle and individual genetic make up, are simply ignored.

The evidence generated by well-constructed clinical and epidemiologic observational studies is the highest level of evidence we can ethically obtain in relation to low-dose pesticide exposure in man. Mechanisms of using this scientific evidence in the regulatory process must be identified.

Monitoring mechanisms

The legislation enacted in 1980 by the Government of Sri Lanka is not supported by an appropriate surveillance system, and every adult is empowered to inspect and sample pesticides. Naturally, there is skepticism as to how this arrangement actually works, if it does at all. Monitoring and Evaluation activities are almost non-existent. Measures need to be enforced to overcome this situation.

Research and development initiatives

Research in the field, at present, has been conducted in an ad-hoc manner with minimal inter-sectoral collaboration. It is neither promoted by the Government nor is it facilitated in any way – this is at the risk of the long-term impact on the health and intellect of our population as a whole and its economic consequences.

Education and training

At present, training of the farmers and applicators is not conducted at a national level, and training that is conducted is done in an ad-hoc manner. It is highly likely that many end users are not approached. There is no mechanism of registration of trained users enabling only them the use of the more toxic pesticides. Continuous education services, such as, pesticide extension services, are not in place to counter the dependence on information from the aggressive commercial marketing interests, although, it has been suggested previously.

Suggestions for a National Response

There is sufficient scientific evidence that confirms the increase in prevalence and risk of a wide range of diseases among populations exposed to low doses of pesticides. We cannot continue to ignore these findings, simply because, it does not provide 'credible' data to be used in the regulatory process as perceived by some. It is timely that policymakers and regulators address this situation, otherwise, pesticides are continuously registered for sale and use at the enormous cost of the health and well-being of our population. We must remember that many of these diseases are slow to manifest, and therefore, the social and economic burden is still to be made apparent. Although, more affluent countries face the same challenges, we cannot wait for them to find solutions to what is also in some ways exclusively our problem. It must be remembered that many pesticides that are banned for use in the developed countries are, nevertheless, exported to our country as technical material for local formulation and use.

It is indeed timely that we re-evaluate and reconstruct our national policy on pesticides to deal with the situation. I propose a three-pronged strategy in working towards formulating a new policy which I have outlined briefly. Experts in multiple specialties relevant to the problem at hand-the scientists, regulators, legislators, economists, toxicologists, physicians, sociologists, biologists, environmentalists and the policy makers, need to work together. The conceptual framework presented below (Figure 1) is just that – a concept on which to build on, a base for discussion, development and change. As indicated in the proposed framework, we need to focus on; a) strengthening the regulatory process, b) promoting research and development in the field of pesticides, and on c) promoting education and training of all stakeholders in general and the applicators in particular.

Regulatory process

Mechanisms to promote the rational and disciplined use of pesticides must be initiated. Perhaps, even by restricting its availability – a measure that has shown beneficial impacts in our country previously.

We must find means to use information from human studies more effectively in the regulatory process. Regulators need to be urged to take serious note of the scientific evidence and understand the limitations in 'proving' causality in human studies. Regulators need to find ways of utilising this evidence for greater well-being of exposed populations. Policy changes are required to mitigate any litigation that may ensue.

The health care profession should take the initiative to monitor the impact of low-dose exposure on the health of our people. We need to set up a mechanism to monitor the impacts of pesticides in the population and use them to explore the crucial public health issues of pesticide use, akin to the field of

pharmaco-epidemiology. Not long ago, the expansion of the pharmaceutical industry led to the development of pharmaco-epidemiology for the study of the use and effects of drugs in the population.

Monitoring of water sources, air quality and food residues need to be done in a regular and organised manner. We need to develop cost effective methods of testing and establish a network of field-level laboratories for this. Findings must be coupled to regulation pertaining to restriction of use, if exposure is found to be at levels higher than that which is permitted, as is the case in the developed world.

Most importantly, we need to establish a database of the information obtained from monitoring the use and effects of pesticides in the population and levels in the environment. This will then facilitate the regulatory process, providing much needed information pertaining to the situation in the country.

Research and development

Research in developing cost effective protective clothing / gear that is suitable to our climate and environment has to be initiated. It is inadequate to instruct farmers to cover their bodies when applying pesticides, because they use cotton clothing to do so, promoting greater skin absorption when soaked with pesticides.

Research on safer alternative technologies for pest control and on identifying biomarkers for monitoring must be promoted. Research in these key areas must be identified as national priorities and resources need to be made available for this.

Education and training

It is recommended that the current education and training programs be evaluated and further strengthened, and that the end users be trained through a national initiative. The training may even be tied to subsidies that are provided to the farmers. Only registered applicators should be permitted to use the more toxic pesticides. Continuous education services must be made available to counter the dependence on information from aggressive commercial marketing interests as highlighted previously.

The above recommendations are made with a view to deal with the health challenges faced by us due to the extensive use of pesticides in this country. We must continue

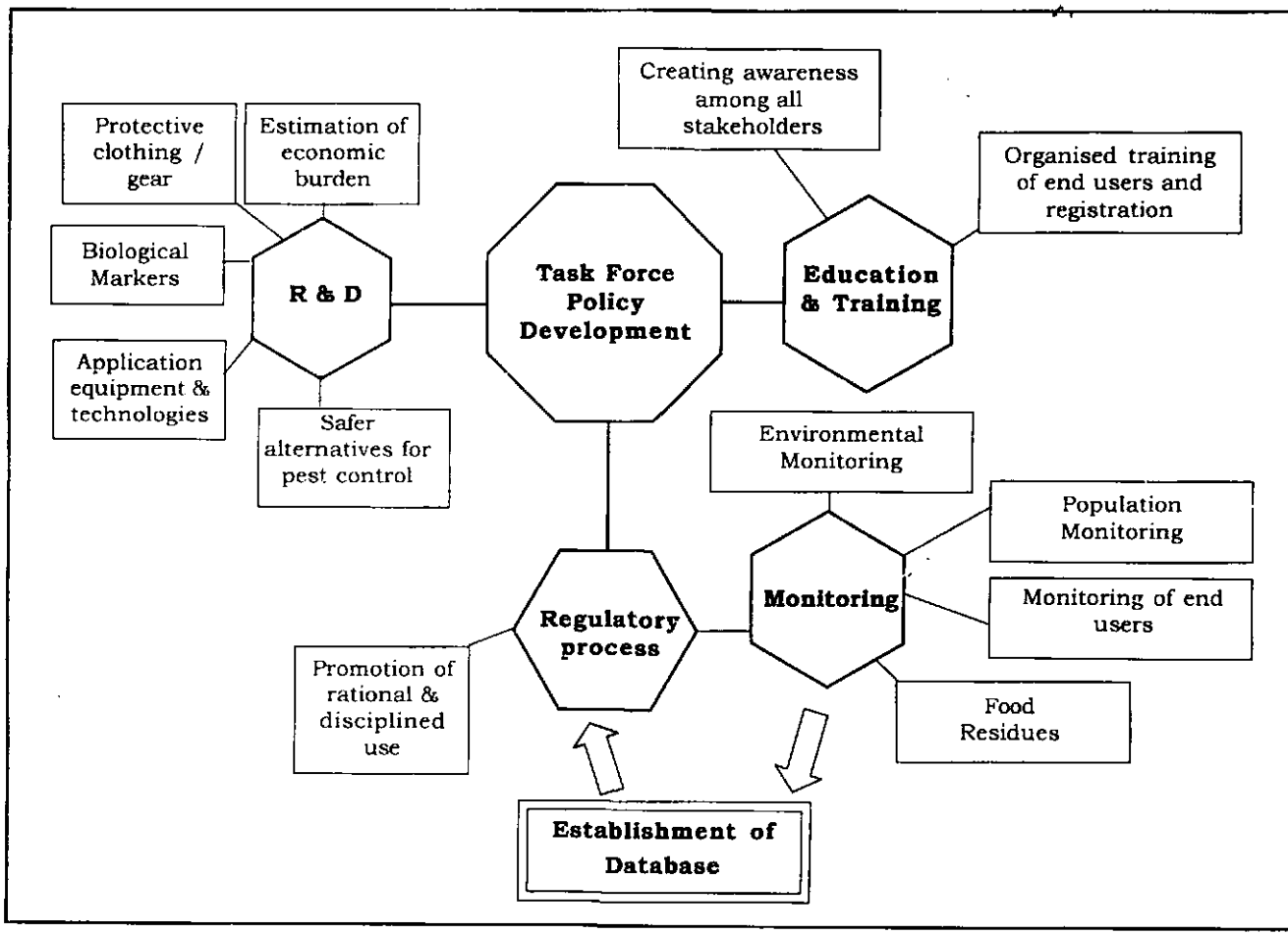

Figure 1: Conceptual framework for meeting the challenges posed by pesticides on the health of our population

to strive to clearly identify the social and environmental determinants of health of our people, so that equity in health care delivery is truly achieved.

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