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Pesticides and the Protection of the Environment and Health in the Tropics (**)

Although pesticides are known to be harmful to man as well as the environment, they still continue to be used on a large scale. For the short term they will still be essential, particularly in the tropics to combat pests which cause considerable damage to agriculture.

This reality will have to be taken into account when designing new strategies for crop protection. However, it should not make us slacken our efforts in the field of research and experiments to reduce the amount of pesticides now used, by introducing alternative systems.

Such systems could consist of integrated pest control, the selection or use of plant genetic engineering to develop species resistant to insects, etc. To cope with the problems caused by the use of pesticides in the tropics, specific criteria should be adopted to ensure the protection of human beings, animals and the environment.

Pesticides have the purpose of protecting crops from the damage caused by insects and other harmful agents. This can be achieved by destroying the harmful insects, controlling them or repelling them from the plant. New techniques are required for applying pesticides to crops so as to reduce the large quantities currently needed on account of the induced resistance of arthropodes.

Slow releasing techniques sometimes call for large amounts of pesticides. In recent months the locust plagues have shown how necessary these chemicals are to prevent a complete destruction of harvests.

The protection of human beings and animals as well as the environment has to be considered in terms of the risk-benefit involved, in other words not only

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scientific implications but also ethical implications which moreover cannot be unrealistic.

We should recall the words of Prof. Baba, who once replied to those who were against the use of pesticides in India: "I prefer to have within twenty years 100 cases more of cancer in India than millions of deaths from hunger next year".

At any rate we believe that one should not overestimate the real benefits of pesticides or minimize the risks for man and the ecosystem.

I think it can be said that progress in recent years has made it possible to secure an improved management of pesticides in agriculture, measures to enhance health protection of workers and peoples and prevent the contamination of the food chain and the environment.

Table I contains a list of the most widely used pesticides and their mode of action.

Certain pesticides like DDT, chlordane and leptachlor have been banned from use in agriculture in northern hemisphere countries while the import of these potentially dangerous chemicals is not always prohibited by legislation in southern hemisphere countries. UNEP and FAO have made major efforts in this respect to prevent contamination of the environment by these dangerous substances.

The efficacy of a drug in man (or animals) can be assessed by the formula:

$$E = \frac{D_T}{D_E}$$

i.e., through the ratio between the toxic and the active dose.

E should always be lower than the unit for the drug to be acceptable. For pesticides, Todhunter has proposed an Efficacy Index (EI) resulting from the formula:

$$EI = \frac{D_A}{D_T}$$

where D_A represents the minimum dose of pesticides producing an adverse effect on humans, mammals, and non-target species, and D_T the minimum dose required to protect the plant. In this case too it is necessary to keep the index as low as possible to avoid undue toxicity.

This formula is a good guideline, but the D_A index is difficult to establish, especially in the case of non-target organisms.

In the tropics, D_A and D_T would have to take into account the climatic component, i.e., the photochemical influence, temperature and relative humidity.

More commonly used pesticides have a broad spectrum of activity and hence have a major impact on the environment; specific pesticides are rare and expensive and therefore are not easily marketed or used.

From data in literature and long-standing field experience we know that

TABLE 1 - Pesticides, fungicides and herbicides and their effects. (*)

Chemical class	Mode of action	Humans and mammals		Effects on Environment
		Acute	Long term	
Phosphate esters Carbamates	AChEsterase Inhibitors	Death	(1)	(1)
Chlorinated hydrocarbons (Chloradanes, Hexahydro hexachlorobenzene, etc.)	Interference with nerve functions	Allergies	Accumulation in fat membranes	Contamination of soil water food chain
DDT and analogues	Interference with axonal transmission		Accumulation in fat membranes Tumors (?)	
Rotenoids Hydrocyanic acid (Cyanides)	Inhibitors of respiratory metabolism	Death	—	—
Fluoracetate	Inhibitors of tricarboxylic acid cycle	Toxic	—	—
Triazines Ureas	Inhibitors of photosynthesis	Toxic	—	Contaminates soil and water
Paraquat	Inhibitor of photosynthesis (2)	Toxic	—	Contaminates soil and water

(*) See also Corbett in references.
(1) The product is degraded in a few days by atmospheric agents and humidity.
(2) Inhibitor of the Hill reaction.

pesticides are directly or indirectly toxic and that special care has to be taken in the temperate zones to avoid side effects. The situation in hot tropical climates is less clear and quite different, because of the virulence of pests, climatic factors and the need for massive quantities of pesticides, which contaminate the environment.

The increasing use of pesticides required to combat resistant pests and control arthropods and fungi in the tropics exposes farmers and the population to their toxic effects (sometimes long-term) through residues and/or the food chain.

Moreover, the dramatic situation in some tropical regions makes it necessary — despite the protest of environmentalists — to use certain pesticides prohibited or of restricted use in temperate zone countries, such as DDT, chlorinated hydrocarbons (Gamahexane) and chlorinated cyclopentadiene.

At times the quantity of pesticides used to control insects that are vectors of human or animal diseases adds to those used in agriculture, thus increasing their environmental effect.

As we have already pointed out, farmers or people who use pesticides in the tropics are subject to acute toxicity if using chemicals of the ACHE type, and to chronic effects if using other products, like CH converted hydrocarbons.

A number of precautions have to be taken whenever crops are treated with pesticides in order to avoid contact with farmers or other persons, who must be properly trained in their use. Masks and other special clothing are required.

Such precautions can be taken in temperate zone countries but are highly unsuitable in tropical climates due to the excessive heat and humidity. As a result, people tend to use these dangerous chemicals without taking the necessary precautions. Even when masks are used, they are often removed during work, being considered a nuisance.

Pesticides are toxic to man. Toxicity may be acute or chronic. (See Table 1). According to W.H.O. data, there are about 500,000 cases of acute toxicity from pesticides reported every year in the world. About 10% of these cases are considered lethal. This is due to the misure of pesticides not only in agriculture but also in home use, the treatment of human parasites and even suicide, bad storage practices (leaking drums, indirect contamination of water and food, etc.). Most of these cases occur in developing countries for a number of reasons: failure to understand instructions for use, which are generally in a foreign language, illiteracy of users, inadequate training, lack of prompt medical care within easy reach, as well as climatic factors, such as heat, which make the chemicals more volatile and do not allow users to wear the required protective clothing, gloves and masks.

Furthermore, storage practices tend to be very poor in some countries, with many cases reported of leakage from rusty drums, contaminated water and food, with dangerous effects.

These poisonous substances are also used for committing suicide and other criminal practices.

Although phosphorous esters and carbamates cause high acute toxicity, they are rapidly transformed and dissolved by atmospheric agents and hence are less dangerous for the environment. Chlorinated hydrocarbons, however, constitute a potential danger for plants, the food chain and wildlife.

These pesticides and herbicides which cause low acute toxicity (see Table 1) — except when inhaled or after skin contact in large powder or liquid quantities (allergic reactions, suffocation, eczemas, etc.) — have a very long geo-biological cycle (some taking about 30 years to degrade) and their properties may enter the food chain and thus build up in the upper level of the ecological pyramid in animals and man, in lipidic structures and membranes, exerting long-term toxicity whose effects on single organs and the body as a whole are not yet fully known.

Excessive amounts of these substances taken by laboratory animals have caused tumors and impaired functional enzymatic activity.

These long-term toxic pesticides are also very dangerous for the environment. They are not easily destroyed or degraded in the soil and may cause damage to the microflora. Their effect on wildlife and some bird species has been demonstrated. Chlorinated hydrocarbons inhibit the formation of the egg's shell and cause acute toxicity (chlor-achne in particular), resulting in possible reproduction failure and cell membrane impairment in humans.

Other herbicides like triazines, difficult to degrade, may contaminate surface and ground water and thus constitute a danger to the environment and to humans. Environmental protection is even more difficult when these substances are sprayed from aircraft, on account of the large quantities used and the indiscriminate damage to both harmful and useful insects.

Although the risk/benefit ratio of pesticides, fungicides and herbicides used in the tropics is not yet at the desired level, science and technology provide no other practical realistic solution at present.

Many new possibilities have been created through insect and mold-resistant plants, the use of natural insecticides or substances which influence insect behaviour or the development of fungi, but all these solutions combined have failed to combat pests which presently destroy about 37% of crops.

Integrated pest management (I.P.M.), i.e., the contemporary use of biological control and synthetic pesticides offers many possibilities but has not yet succeeded in eliminating the threat from pests.

I will now quote from a recent paper by Atuma and Okor (1985) on this point: "For malaria and all developing countries, pesticide use is indispensable in the struggle against hunger and disease. Emphasis should therefore be given to judicious and safe use rather than the banning or restriction of pesticides. Nevertheless, in view of the adverse effects resulting from pollution of the environment by these chemicals, e.g., damage to, or mass killing of non-target organisms, there is great need to monitor pesticide usage...".

Monitoring is a very important issue and very little has been done in this respect in many countries, particularly in Africa. I think it would be highly desirable to set up a monitoring network in various countries.

Atuma and Okor go on to say: "The effectiveness of pesticides is at present determined only by product yield. There is no monitoring of the effect on users and the non-target flora and fauna, nor is there any analysis of the final product that goes to the markets. Applicators wear little or no protective clothing due to ignorance and discomfort in the hot and sometimes humid climate".

New strategies will have to be developed since it is not possible to abandon the use of pesticides but only to reduce the amount used, through improved application techniques and better management.

Finally, it is important to ensure better protection for workers in the Third World and the environment in the tropics. This can be achieved by:

1) better information and training of applicators and an overall reduction of pesticides to the bare minimum, using different techniques;

2) adopting plant species resistant to insects and disease;

3) increasing biological control through integrated management for a gradual reduction of pesticides.

4) Techniques relating to usage in the field and the protection of workers and the environment cannot be automatically transferred from temperate regions without being adjusted to the tropics, taking into account the substantial differences in the two environments.

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