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The Environment and Agriculture

THE ENVIRONMENTAL HAZARDS OF PESTICIDES USED IN CEYLON'S AGRICULTURE

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Rachel Carson's 'Silent Spring' and Lewis Herber's 'Our Synthetic Environment' focussed the importance of preventing the deterioration of the environment in the public mind. These well-documented semi-popular books showed how the indiscriminate use or the careless disposal of products and byproducts of modern technology were providing hazards to human health and to the survival of many species. Carson alleged that man had caused the 'contamination of air, earth, rivers and seas with dangerous and even lethal materials...changing the very nature of the world'. Chief among these contaminants were the pesticides which 'have the power to kill every insect, to still the song of birds and the leaping of fish in the stream'. Descriptions such as these are so vivid that the public could well be under the misconception that all pesticides, which form only one aspect of the pollution problem (see Table 1) are capable of polluting the entire environment beyond reclamation.

TABLE 1 — *Organic pesticides in the environment some residues contaminating our environment*

Boron (certain fuels, washing aids)
Detergents (nonbiodegradable)
Fluorides (naturally occurring and from industry)
Household and farm wastes
Industrial wastes (immense quantity and variety)
Lead (from gasoline, plumbing, solder in tin cans)
Peroxyacetyl nitrites (in smog)
Pesticides
Polynucleares (ante exhaust, burning, asphalt, some food grade waxes, petroleum oil sprays and many other sources)
Strontium—89 and 90
Sulphur dioxide, sulphur trioxide (from industry and smog)
Tin (from cans, concrete, glass, aluminium and plastic wrapping materials)
Ythrum—90

There is good cause for concern. Pesticides are synthesized and evaluated for their lethal effect on one or more living organisms ; they are used directly in the environment in agriculture, forestry and in public health. Evidence of DDT contaminating land and water, fish, animals and plants in areas remote from the points of application is increasing. These facts indicate that pesticides can contribute to environmental pollution. Abbott and Thompson depict how pesticides could become widely dispersed in the earth in Fig 1. However, the application of pesticides *per se* does not necessarily lead to environmental contamination. Pollution of the environment would arise only if the pesticides should persist and accumulate in soil and in water and become magnified through food chains threatening various

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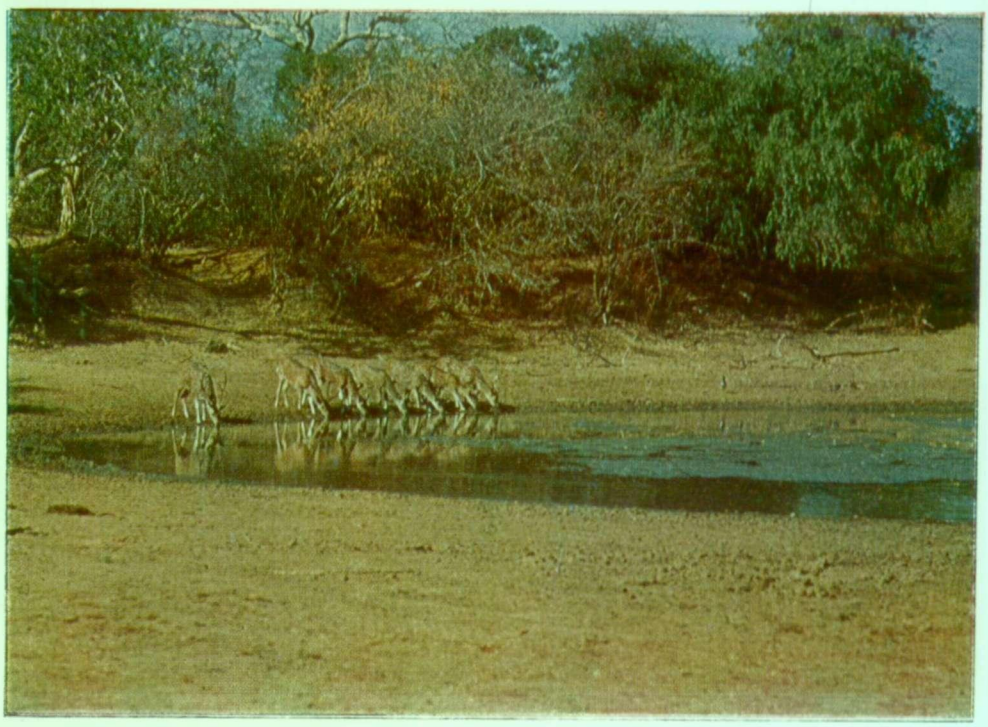

Wild life contain DDT in their fat. Do we wish to threaten them with extinction?

life giving cycles. Pesticides like all chemicals have physical, chemical and biological properties. Their fate in any system is governed by the interaction of these properties with external factors such as temperature, light, humidity and enzymatic activity of micro and macro-organisms. Their rate of degradation or breakdown would depend on their ability to vaporize, oxidize, hydrolyse or metabolize under the conditions they are subjected to. The differences that exist in their properties and reaction rates are what influence their importance as pollutants. From the pollution angle, therefore, pesticides can be arbitrarily divided into two groups—innocuous pesticides and dangerous ones depending on whether they are rapidly destroyed by chemical and biological processes or whether they persist in the environment because of their stability to degradation, translocation into plant tissues, solubility and storability in fat and other lipid substances, movement in water and air currents and magnification of residues through food chain relationships.

FIG 1. *Widespread distribution of pesticides residues*

Type of Pesticide	Uses	Residues occur in
Organochlorine	Domestic uses-fly sprays *etc.*	Food Stuffs
	Infestation control in food stores	Mean, milk, butter vegetables, fruit
	Animal treatments	Wildlife... insects worms, birds, predators
Herbicides	Seed dressings	Waters fish and water birds
Fungicides		

What are these potentially dangerous pesticides that threaten our future? They refer in the main to the organochlorine group of insecticides. Until recently the bulk of the pesticides used were of this type. Their low costs and broad spectrum of activity made them very popular for use against pests of cultivated crops. In public health eradication programmes for the control of Malaria, yellow fever, sleeping sickness *etc,* too many of these compounds have been used on the land, in water resources and in houses by a number of international agencies as well as by national bodies. But the accumulation of data on their residual nature in the soil, on food produce and their concentration in fat deposits of animals, birds and even man have reduced the popularity of these products.

A survey of milk, butter, beef fat and mutton fat in imports into the United Kingdom in 1966 indicated that DDT, dieldrin and BHC isomers were the chief contaminants. Analysis of human fat from several countries (Brown 1967) revealed DDT, dieldrin and BHC isomers as the main pesticidal contaminants. Harrigan's Studies (1969) indicated that in livestock and poultry, deposits of DDT and dieldrin occur in the flesh of a large proportion of the animals examined. Heptachlor, BHC, Lindane (Gamma BHC), and endrin also accumulate but at much lower levels.

During recent years one or more of the organochlorine insecticides have been found in fish and wild life species. In the UK, investigations by the Government Chemist (1966) reveal that in the majority of the species examined, the levels are a few parts per million or less. Table 2 summarizes the data from eggs of predatory birds. The majority of the species harbour DDT and its metabolite pp DDE but the presence of dieldrin was found in a number of cases especially among predatory marine feeders. Findings of studies now underway in the United States indicate that dieldrin levels of 4 ppm or more in the daily food intake could significantly effect survival and reproduction of certain birds species.

TABLE 2 — *Pesticide chemicals in general use*

Classification	*Approximate number in use*
Insecticides	40
Miticides	5
Nematicides	5
Rodenticides	3
Fungicides	28
Herbicides	30
Miscellaneous	10

The presently-available data shows that certain pesticides used in large scale Agricultural projects and eradication programmes are accumulating in the environment not only at the point of application in the soil and on target organisms but are also distributed far afield in non-pest species.

In Ceylon there is no legislation to enforce the safe use of pesticides. We have no organizations monitoring the presence of pesticide residues in food produce; there is no data on the actual persistence, fate and movement of most of the pesticides. The organochlorine group, can contribute to environmental pollutional and we may find some of the practices of pesticide use in the past are no longer acceptable. In our struggle towards self sufficiency in many of our food commodities and for the improvement of our health standards, pesticides have proved to be a necessary tool. Our goal must be safe effective pest control. We can justify their use only if a better alternative methods of control cannot be found.

In assessing the extent to which any pesticide might pervade the environment, the first consideration of course is to determine the extent to which it has been used. In Ceylon the approximate number of pesticides in general use is not more than 125 (Table 2). These pesticides are marketed as more than 500 different formulations. Insecticides account for about half the number, yet, except for pesticides used for Malaria control in any given year, only a small percentage of the land under food and fibre crops receive pesticides. Of the total 15.9 million acres land area of Ceylon half is forested (8.1 million acres). Table 3 gives the areas under the various crops in Ceylon. The land under Rubber and Coconut, 1.7 million acres, do not receive much pesticide except sulphur and sodium arsenite, (weed killer in rubber estates). The use of pesticides is mainly confined to areas under tea and cash crops such as tobacco, chillies, lentils and cruciferous and cucurbitvege tables. In paddy cultivation pesticide use is mainly confined to high potential areas such as the special projects and colonization schemes covering about 0.2 million acres, where crop management is carried out at a high level. The balance 1.1 million acres under paddy is in small holdings cultivated at subsistence levels. Less than 7% of the land, therefore, receives appreciable quantities of agricultural pesticides.

TABLE 3 — *Distribution of area under crops*

Asweddumized paddy lands*	1.138 million acres
Temporary crops	.168
Grassland	.032
Plantation crops	2.323
Other crops	.354

* 1.3 *million acres at present*

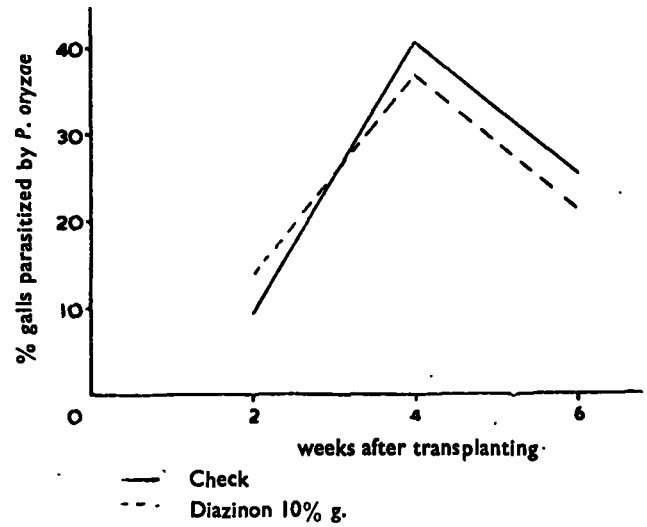

FIG. 2—*The effect of granular application on* Platygaster oryzae (*Dambadeniya* 1968)

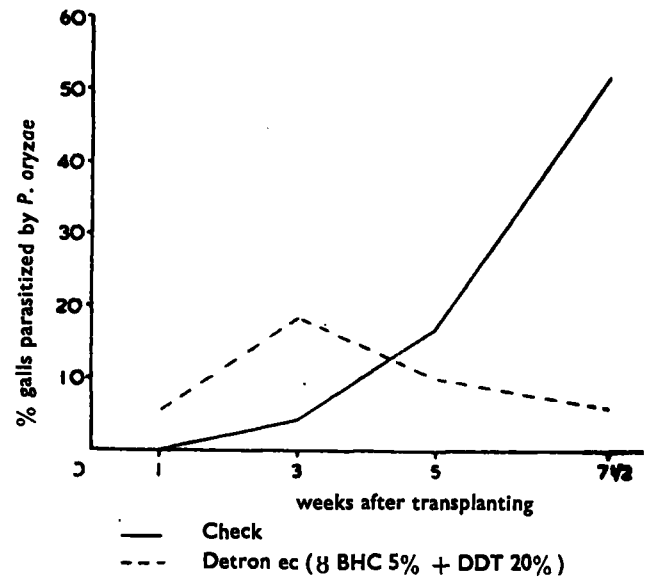

FIG. 3—*Effect of insecticidal spray on* Polygaster oryzae (*Ibbagamuwa* 1968)

Until the last decade the bulk of the pesticides used were the organochlorine insecticides like DDT endrin dieldrin and also, the weed killer sodium arsenite. Their efficacy against many pest species and long residual activities have made them so popular that even after less toxic substitutes have been recommended based on experimental data, they continue to be widely used. We cannot ignore the research findings from elsewhere, DDT has a half life of 10-17 years. It has caused the extinction of several species of birds. It is capable of upsetting photosynthetic processes in plankton. Dieldrin has a half life of 2-4 years. It accumulates in the soil and fatty tissues and is more toxic than DDT. Many western countries have placed a total ban on the use of DDT and either a complete ban or a restricted use for dieldrin. In Ceylon we are not able to ban the use of DDT as it is essential for Malaria control. As a step towards limiting its use in Agriculture, the Department of Agriculture no longer recommends its use on food crops as other effective, less persistant chemicals are available.

The use of endrin recommended for paddy pest control brought about various secondary effects such as the development of resistance to various organochlorine pesticides, effects on insect parasites and predators and the build up of minor pests, that the chemical was withdrawn for use on paddy a few years ago. Despite this, endrin is still used very widely. The public must realize that when effective chemicals that have been recommended in the past are subsequently withdrawn, it is based on research findings, and indicates that continued use of such a chemical is detrimental in the long run.

The manner in which the Department of Agriculture looks after its pest problems may be regarded with doubt by certain ecologists. We on the other hand think we are tackling the problem realistically and sensibly. The recommendation of soil treatments with BHC and Diazinon granules for the control of two major pests of paddy is viewed with sceptisism, as these pesticides are known to accumulate when constantly applied to soil under upland conditions. But under the inundated conditions obtaining in paddy fields BHC and Diazinon breakdown very fast due to microbial degradation. Under these conditions the half life of BHC in soils of varying pH is found to be 15-45 days while for Diazinon it is less than 2 weeks (IRRI 1966, 1967). So persistence in the soil with subsequent contamination of waterways *etc*, does not arise. In addition, this application of a contact insecticide in a systemic manner reduces destruction of parasites and predators, as the chemical is only available to the pest species feeding within the plant and does not affect the adult stages of the natural enemies in their search for prey. A study on the effect of insecticide treatment for gall midge control on its major parasite *Platygaster oryzae* indicated the adverse influence of sprays on parasite activity when compared with granular applications. (Figs. 2 and 3).

There are several alternate methods for pest control; for many of them more basic research is required before their potential can be evaluated. The Department of Agriculture embarked on non-chemical means of pest control as early as the 1940's. To date these methods are in various stages of development.

Attempts at biological control of the coconut caterpillar, the paddy stemborer, fruit flies of gourds and fruits, cabbage caterpillars and the giant Kalutara Snail have been made through the years. The degree of control achieved in the case of the coconut caterpillar has been great enough, that it is the chief method of control now. The use of predatory snails for the control of the Kalutara Snail has met with only limited success. The failures at biological control of the other pests could in part have been due to the inability of the exotic natural enemies to establish in an alternate host between cropping seasons.

Efforts have been made at using microbial agents such as *Bacillus thuringensis*, Polyhedrosis virus and *Serratia marcesans* for the control of cabbage caterpillars, and *B. thuringensis* on the paddy leaf roller. These disease organisms are highly specific in action. The infected insect takes about 4-12 days to die, during which time the insects continue to feed so that considerable loss of the crop may occur. But as these biotic 'insecticides' require specific ranges of temperature and humidity for effective infection our attempts have not met with much success in the field.

The use of varietal resistance as a means of reducing pest damage has been a feature of the department's activity for about two decades. One of the chief drawbacks of this method of control is the time involved.The search for the resistant genes in a crop and then the incorporating of these into varieties with good agronomic characters takes as much as five to ten years in certain instances. While we continue the search for practical non-chemical methods we have, however, no other choice than to continue to use pesticides, in order to achieve targets set for food and fibre production to feed and clothe the ever-increasing populations.

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