California Avocado Society 1971-72 Yearbook 55: 14-22

ENVIRONMENT AND ECOLOGY

Dr. Emil M. Mrak
Chancellor Emeritus, University of California, Davis

Speech presented by Dr. Emil M. Mrak to the members of the Annual Meeting at Don the Beachcomber Restaurant, Marina del Rey, California, October 23, I971.

In preparing a paper for the title assigned me I could cover many things concerned with the environment from air pollution to agriculture. I have chosen to limit myself to agriculture and even then to pesticides, thus omitting such subjects as burning, animal and other wastes, erosion, odors and even noises such as the crow of the early morning rooster, the moo of a cow or the bark of the watchful dog.

Not so many years ago people in this country were genuinely interested in the production of wholesome foods at a reasonable cost. The important concern was to produce and distribute enough food to meet the needs. This concern became very apparent when people in greater numbers moved from the farms to cities enabling farm workers to become factory workers in the cities. This came about, of course, as a result of great improvements in agricultural technology, an important part of which was the development and use of agricultural chemicals, including insecticides, fungicides, herbicides, rodenticides, nematocides, defoliating agents, and so on.

With these movements and as time went on, our society became more affluent and not only produced more and better foods at lower costs, but also other consumer goods, all of which, in one way or another contributed to the contamination of our environment. One need not stretch his imagination very much to realize that such advances required power, the burning of fossil fuels and the pouring of wastes into our water systems, the production of solid waste, and for food of course, the use of agricultural chemicals. Unfortunately agriculture has been the distinguished whipping boy m this spectrum perhaps.

We were so busy with our constructive advances that we just overlooked the destructive ones. Now we find ourselves in a situation that is dangerously near getting out of hand as a result of the pressure of emotions, misguided activists, and even the failure of some bureaucrats to exercise good and considered judgment before pushing the panic button. Furthermore, we arc rapidly becoming victims of the news media which have a tendency to dramatize, emphasize the exceptions, and publish half truths rather than the constructive and true situations.

It seems that almost everyone is now riding the environmental bandwagon, and in spite of the fact that many if not all advances contribute to environmental contamination, pesticides and agricultural chemicals continue to be the favored whipping boys.

When seals off the coast of California became ill, stories immediately appeared in the news media about the possibility of pesticide intoxications. When it was discovered later that the illness was caused by bacteria - Leptospirosis — there was little if any news mention of it. When Great Lakes salmon were found to contain DDT in excess of the established tolerance, it was presumed to be an agricultural matter. Later, however, it was found to be only in part caused by agricultural chemicals, if at all. As a matter of fact, that which was analyzed as DDT is now proving to be largely, if not entirely, polychloronated biphenyls. Industries, parks, golf courses, home gardeners, and so on were inadvertently feeding chemicals into the hikes through the water run off systems.

When the fish in the Great Lakes area were found to be contaminated with mercury, it was immediately considered to be mercury compounds used in seed treatment. Very soon, however, it was found to come from manufacturing plants located in the Great Lakes area.

Now we hear about polychloronated biphenyls contaminating the ocean, the fish that live in it, the birds that prey on them, and even chickens, turkeys and milk, which, of course, are produced on land. But where do these contaminants come from. Some have speculated that they may be related to the use of certain agricultural chemicals, but I have been unable to find evidence of the use of these compounds as pesticides today, although a few years back they were used in very small quantities as carrying agents. On the other hand, they are commonly used in the electrical industries and have been used in paints, lubricating oils, brake linings, plasticizers, and so on. Today, they appear to be ubiquitous environmental contaminants, and this is a clear indication of how little can go so far. It is a clear indication too how easy it is to overlook the subtle possibilities of environmental contamination and place the blame in the wrong place.

It so happens that there are many such aerochlors and they are very difficult to determine analytically. In fact, they are easily confused with DDT, all of which makes one wonder if some or even much of the material found in food might not have been PCB's rather than DDT.

William Klomparens, in a paper given at a Turf Grass Conference held in Michigan, quoted from the December 1970 issue of "Animal Nutrition and Health" as follows:

"A most discouraging aspect of the pesticide ecology furor is the fact that an irresponsible charge or accusation can be made on the spur of the moment, without cost, preparation, or even mental reflection, but it may take months, dozens of reputable scientists, and untold thousands of dollars to investigate it and determine the truth about it. Then, try to get a newsman interested in it. It is easier to start a fire than to put it out, and the public will always be more interested in what burned than what was .saved."

There is some justification for the concern expressed in recent years over the occurrence of pesticides in the environment. The principal concern has centered around the widespread presence of residues of the cholorinated hydrocarbon insecticides, such as DDT. There is a tremendous variation, however, in the behavior of the large number of chemicals used. Among chemical classes and within classes, the properties of these pesticides can differ widely, and their potential as environmental contaminants can vary accordingly. Among the properties that are important arc the tendency of a pesticide to vaporize, its solubility in water and other solvents, and its degree of resistance to

various degradation processes.

Needs and uses for agricultural chemicals have been discussed thoroughly in the Commission's Report to the Secretary of HEW. In this report it was pointed out that the annual growth of the use of insecticides is about 15%, and that this should double between 1969 and 1975.

It is rather interesting that we speak so often of pesticides and have in mind only insecticides, whereas actually the greatest use of agricultural chemicals is in the area of herbicides. We may categorize the uses of pesticides as follows: insecticides, fungicides, nematocides, herbicides, rodenticides, defolients, mollusicides, piscicides, avicides, growth control chemicals, lampricides, and so on.

In 1969 there were 900 active pesticides, but these were used in approximately 60,000 preparations or formulations. Some of the pesticides are for very specific purposes, such as lampricides.

It is well known that the use of DDT is decreasing rapidly, and there is only one manufacturer left in the United States. This is still a very important chemical, however, for certain purposes such as the use for the control of malaria.

There is a great deal of talk about integrated control and substitute methods, such as those involving the use of sex attractants, repellents, and natural enemies. These, however, cannot replace all pesticides, at least with the present state of knowledge.

Formulation of the products is a process that may very well cause great variations in the behavior of a pesticide. Materials may be formulated as dusts, impregnated granules, solutions, emulsions, or suspensions of wettable powders. They may be mixed with dilutents such as clays. talc, water or nonaqueous solvents. The formulated pesticide may contain as little as 0.1% or as much as 95% by weight of the active material.

PESTICIDES IN THE ENVIRONMENT

Pesticides are widely distributed and occur in soil, fresh and marine waters, air, wildlife, man, the food man eats, and even his home. I should like now to discuss some of these environmental contaminations.

Soil

How do agricultural chemicals get into the soil, and how long do they remain there are factors of great concern and yet we know so little about these areas. We do know, however, that chemicals are most apt to reach the soil after spraying or by direct application to the soil.

The most common metallic chemical contaminants occurring in soil are arsenic and lead which to a considerable extent date back to days when orchards, particularly apple and pear orchards, were sprayed with lead arsenate and chemicals of this type. In general the soil in orchards that have been sprayed with lead arsenate for years are heavily contaminated to a depth of about two feet. Strange as it may seem, the metal contaminants seem to move out slowly, if at all, and do not seem to reach underground water levels. On the other hand, they can be taken up by the trees and plants that grow

on the soil. Furthermore, in certain areas this is a very serious matter for when new plantings are made and it is necessary to replace the contaminated soil in the immediate area of the new planting with uncontaminated soil, otherwise the new plant may not grow.

The most common organic pesticide residues in soils are the chlorinated hydrocarbon insecticides, but others also occur, especially organophosphorus and carbamates. The latter, however, generally decompose quite rapidly and disappear between crop seasons. On the other hand, organophosphorus compounds and particularly parathion, can persist for several years under certain conditions and particularly in relatively dry soil. This certainly indicates the importance of moisture and the significant role that rainfall play in the removal of pesticides from certain areas. This becomes apparent when one considers that there is about 70 million acre feet of total rainfall in California each year and of this 50 million reaches the ocean.

Most herbicides, decompose rapidly in soils, chiefly through the action of microorganisms, and this seems to take place even after very heavy applications.

There are a number of factors that affect accumulation of pesticides in the soil. The pesticide may characteristically have a long life and resist destruction in the soil. Soil type also has a great influence on the length of life of the pesticides. Those heavy in organic materials, and particularly muck soils, tend to hold on to the pesticide contaminants for a long period of time. In sandy and clay soils, on the other hand, pesticides tend to disappear more rapidly.

Soil moisture has a great influence on the rate of vaporization of the chemical from the soil and, too, on the growth of microorganisms that may be active in deteriorative processes. Microorganisms do attack a large number of them and do not seem to be harmed by pesticides except in the case of soil fumigants.

Deterioration is more apt to take place rapidly when temperatures are relatively high rather than when they are very low. Cover crops tend to retard the disappearance of pesticides from soils, whereas cultivation tends to increase it. Wind, too, can be a factor in reducing persistence and this, of course, depends, to a large extent, on the method of application.

Crops vary in the amount of pesticides they absorb from the soil. Some absorb pesticides more than others, and this is particularly true of carrots, but even in the case of carrots, there is considerable variation with variety. Some crops, such as potatoes, on the other hand, absorb very little. Then again, cucumbers tend to translocate materials such as benzine hexachloride into the plant and the fruits to such an extent that it may have an adverse effect on taste when they are pickled.

It is apparent that the fate of pesticides in soil depends on many factors and it is a very complicated matter. If all these factors are to be taken into consideration when applying pesticides, the farmer is indeed confronted with a difficult situation and must know the characteristics of the soil, pesticide and crop to which it is applied.

The only answer, of course, is the use of the best judgment possible which involves use of the most desirable chemical, restricted dosages and applications, and above all integrated control where possible.

Water:

If pesticides occur in the soil, some of the residues are apt to find their way into rivers, lakes and eventually the ocean. This is true even if the material is insoluble. DDT, for example, is common in surface water, and dieldrin in river basins. Endrin has been found in the Mississippi drainage system where it caused some serious problems. Surface water has also been found to contain the herbicide 2-4-D. As a matter of fact, surface waters commonly do contain Chlorinated Hydrocarbons, and particularly DDT and dieldrin. There has been great concern about the use of dieldrin and aldrin to control the corn root worm because of the possibilities of run off water carrying the chemical into streams and waterways. On the other hand it has been pointed out that if used properly and some distance from streams, these chemicals would not contaminate streams and waterways. If this is true, then here again careful and restricted use seems to be the answer.

There is no evidence to indicate that the extremely small amounts found in water have an adverse effect on human health. The serious part of the presence of this material in water occurs through the process of biomagnificaticn, which involves absorption, perhaps first by plankton which is eaten by small fish, which in turn are eaten by larger fish, and so on until the material involves birds and other wild life. During this process, of course, there is biomagnification of the residues and this can be harmful.

Air:

Perhaps the most complicated and least understood is the contamination of air with pesticides. Data pertaining to aerial contamination is very limited for we just do not have the equipment or methodology for monitoring pesticides in the air.

Pesticides certainly become airborne, and especially if one considers that droplets of 25 to 100 microns float and can be carried for long distances. Fumigants which go into the air as vapor also may be carried long distances and persist for a very long period of time.

Wind blowing up dust on which the pesticide may be deposited is responsible for the far flung distribution of the dust adhering chemicals. Unfortunately even though we know that such situations take place, we do not have the needed quantitative data to enable us to attain a satisfactory understanding of what is really taking place.

We also lack information relating to the respiratory effects of pesticides on humans and animals. There is, however, some data, to indicate that if one monitors the human organism and follows the isobars from the northern part of our country to the Gulf of Mexico, there is a tendency to find increasing amounts of DDT in the body fat from North to South correlating with the isobars. Speculations have been made as to why this occurs, but we do not have a satisfactory answer.

However, there has been some speculation as to the relationship of the type of environment, and especially the air in the home, to the concentration of DDT in the body. Accordingly, a very interesting experiment was conducted in the South with two cats taken from the same litter and placed in two different homes. One home was a well built, modern house with air conditioning, and so en. The other was old, run down and located in a poor section of the city, no air conditioning, and a situation where windows

and doors were left open to obtain some cooling. It was necessary to use aerosol sprays (perhaps DDT) in the old home in order to control mosquitoes and insect invasions. Dust, of course, had access to this house. The two cats were fed exactly the same food, but otherwise lived in two distinctly different environments. After six months, blood samples were taken from the two animals and it was found that the cat living in the poorer home had ten times as much DDT in its blood than the one living in the modern home.

Even though the experiment involved only two animals, it does give us a clue as to what might happen and this is worthy of further study. It would tend to indicate that airborne contamination on dust particles, and perhaps even in the pure particulate form of the chemical itself can account for some of the differences observed in man. The North-South difference also seems to indicate absorption in the body through food which had picked up residues from the air or dust, through inhalation and possibly even through the skin.

There have been relatively few well documented cases of harm to animals by airborne pesticides. On the other hand, crops can be and have been harmed by airborne herbicides, particularly of the phenoxy or 2-4-D type that may drift long distances from the point of application. This is particularly true when highly volatile materials are used. On the other hand, the distance at which harm may occur can be greatly reduced by using less volatile esters or salts, by using sprays instead of dusts, and by limiting aerial application to low altitudes and low wind conditions.

Some agricultural chemicals disappear very rapidly in the air when exposed to ultra violet light, but far too little is known about such changes, what, when, where, and how they take place.

Residues on Plants:

The residue of agricultural chemicals on or in plants is a matter that is usually not given great consideration. At the same time, it is extremely important from the standpoint of reentry of the workers into the fields, vineyards or orchards. Once again it is just coming to light that some of the chemicals may not decompose or disappear rapidly as previously thought. These judgments were made in the absence of sound information. Let's take parathion as an example. It was believed that this material breaks down quite rapidly, but I am now told that new evidence indicates that parathion is really a systemic chemical and rather than breaking down, may actually be absorbed by the plant. Furthermore, it may be picked up by roots and translocated into other parts of the plant. This, of course, is still a hazy matter. In any event, we need to know a great deal more, we should know about the fate of the chemical and, of course, what affect this may have on the worker.

Now we say it should be ten days before reentering the vineyards and longer for orchards. This timing is related to decomposition of the chemical. Now it appears that an important factor in making these determinations may be the absorption and retention of the chemical by the plants.

We must keep in mind that one of the most serious problems we have with agricultural chemicals is the safety of the worker, and this is particularly true of the organic

phosphates and materials that may be absorbed through the skin or inhaled.

I am told that there is a possibility of developing a urine test with para nitro phenol (PNB) to indicate the degree of exposure to parathion. Let's hope this comes soon.

Food Contamination:

A great deal of concern is often expressed over the safety of our foods and a great deal has been said about carcinogenesis, teratogenesis, and mutagenesis that may be induced by agricultural chemical residues in the food. Accordingly, tests are required today to determine the effect of the chemical on these processes. These tests are made by the individuals or organizations applying for tolerances and then the data is reviewed by the Environmental Protection Agency. Until recently, this has been a satisfactory procedure, but, now so many different people are involved in testing and exerting influences on final judgments as to whether or not a chemical should be permitted, restricted, or even banned, that it has become a chaotic situation. Different scientists are now using different methods in testing for cancer, teratogenesis, mutagenesis, and so on, and this has, indeed, caused confusion.

Today there is a great divergence of opinion with respect to the procedures that should be used in testing for carcinogenesis, teratogenesis, etc. Some of these differences pertain to dosage, method of application - whether it be in food or as the pure chemical, infected, implanted, placed on the skin, inhaled, and so on. Then, too, there are different views with respect to the number and types of animals to use, whether they be males or females or both, and if, females, whether or not they be pregnant, and then at what stage, and so it goes. There is also a divergence of views among statisticians and even pathologists.

The situation with respect to teratogenesis is even more confused and, as I see it, the test procedures for mutagenesis about hopeless at present.

In any event, the present situation has indeed made clear the great need for a government center where. Generally accepted protocols can be developed for safety testing and where information concerning accepted protocols for testing can be obtained. The Secretary's Pesticide Advisory Committee recommended that such a laboratory facility be developed, and I am glad to say that a few months ago, the President indicated that the Pine Bluff Biological Warfare Laboratory in Arkansas will be converted into one where such protocol development will take place. This indeed is a great step forward, and, in my opinion, should do much to allay the fears and emotions that have developed as the result of the chaos and uncertainties surrounding our food supply.

It may interest you to know that there have been no deaths or even intoxications from agricultural chemical residues on foods during the past many years. If one examines the annual summary of the National Communicable Disease Center on food intoxications, he will find that most have been microbial in origin, and less than 10 percent by chemicals. Although the chemical category includes agricultural chemicals, practically all of the reported injuries were caused by chemicals other than agricultural. This does net mean, however, that the use of pesticides is free of problems for there are problems indeed, and some are serious ones. These relate largely to the farm worker and those

who would be in or near treated areas. This has become particularly serious with the shift from the more persistent chlorinated hydrocarbons to more toxic substances such as the organic phosphates. Even though these may disintegrate in relatively short periods of time, there is a danger period for re-entry and we have much to learn about this and subclinical effects.

Yet, there are some who would ban the use of all chlorinated hydrocarbons even though they are far less toxic, if at all, to the human organism.

This is a pretty severe approach and while there is a real need for more careful application, for restriction, licensing applicators, and even placing many of them on a "by prescription" use only, it would be unwise to outlaw the availability of DDT, which may be needed to handle an unforeseen emergency. Klamporens pointed out that this leads us to the all-important benefit — risk equation which is seldom faced realistically, because it is so large and so difficult to appraise. He has pointed out that the abolition of pesticides would have an economic and social impact so devastating that one can find comfort in the belief that the responsible government agencies will never allow a total banning to occur. He quoted from USDA economic report No. 194, which in its abstract says, "assuming that current levels of farm production are to be maintained, restricting the farm use of phenoxy herbicides would increase U.S. farmers' direct production costs about $290 million. In addition, about 20 million more hours of farm labor would be used."

The answer to the problem, therefore, is the more careful use of pesticides, minimizing the amounts and frequency of use, improvement of application equipment, modification of formulations, development of alternates which are short-lived, the training and licensing of applicators, and the restriction of use on crops only to when needed, or perhaps by prescription.

We must train those who are working with the chemicals to handle them carefully, and to take all precautions needed to protect themselves. We must realize that we are working with toxic materials, and we must work with them in a manner that is safe for the human organism.

Containers and Unused Materials:

One of the most difficult problems relating to the use of agricultural chemicals, or in fact many chemicals, is disposing of the excess materials and particularly used containers. One of the most frustrating problems facing state and local governments involves the development of rules, regulations and laws relating to the disposal of these waste materials.

It has been said that empty metallic containers should be shipped back to the manufacturer. This perhaps is in order, but there are problems of collection, handling and cost. But even if this were feasible, the manufacturer must remove residues from the containers, and what would he do with these? Most certainly they should not go into the sewer system. Destruction of these chemicals is not easy. A little of such residues inadvertently can be distributed far and wide and, through the process of biomagnification, accumulate in wildlife and food materials to such an extent that they can be detected and be the cause of concern. A classical example of this is PCB. Can it

be that the residues in used containers made their way into streams and then fish? This certainly appears to be a good example of the need for care in disposing of containers and also to broaden our views with respect to the chemical contamination of the environment. No longer can we point a finger only at agricultural chemicals as such, and say, this is it.

At present, the Director of Agriculture in California, acting upon instructions from the Legislature, is developing procedures for the disposal of used containers. Until a satisfactory system is worked out, it is required that they be held in a fenced in area so that they cannot be removed and used for other purposes or accidentally contaminate streams.

It has been suggested that a closed-system incinerator be developed whereby the chemical residues can be converted into harmless substances, but this is costly and takes time. Furthermore, where should the incinerators be located — in every agricultural community, or perhaps scattered throughout the country.

No doubt the problems that remain ahead will be troublesome ones, Federal and state governments, and even industry are moving fast to correct errors and oversights of the past, but this cannot be done overnight. There is so much to learn, yet in the past year a great deal of progress has been made by implementation of orderly controls, restrictions and substitutions. We are, however, still confronted with emotional stories in the news media, with legislators attempting to pass new laws of interest to conservationists — some of which may be good and some bad.

We must, therefore, exert every effort to make changes that are sound and logical in an effective manner, free of panic button pushing and, above all, with good judgment — this will not be easy — but it is a must if we are to have both — a good food supply and a good environment.

I can assure you of one final thirty; and I've left it to the last for the sake of emphasis. Now this will be accomplished without a continued and strong scientific input — or in other words — research — and this to me a full spectrum of research clear across the board.