HOW FOOD PRODUCTION AFFECTS THE ENVIRONMENT

NOTES FOR DISCUSSION LEADERS
SPEAKING BEFORE GENERAL AUDIENCES

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FEBRUARY, 1971

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University of Illinois at Urbana-Champaign

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Revised May, 1971

WHAT IS POLLUTION?

R.D. Walker

THERE IS A TENDENCY to regard anything added to the environment that causes an environmental change as a contaminant. A contaminant is a pollutant only if it adversely affects something that man values and is present in large enough quantities to do so.

The classification of a substance as a contaminant or pollutant may change with time. To formally classify a substance as a pollutant, its effects must be perceived. But man's perception constantly changes as he gains new knowledge.

Air Pollution

Few topics generate more debate and arguments than air pollution in our highly populated and industrialized areas. In such places, air pollution is probably the most critical pollution problem society faces.

Public concern over polluted air is not new. Members of the nobility of ancient Rome complained because the soot smudged their woolen togas. During the reign of King Edward II of England, a man was put to death for burning sulfurous "sea" coal instead of honest British oak. London was fouled with coal smoke because of its industrial economy around 1600. Foreigners traveling to London were astonished to see filthy smoke from thousands of domestic fires and workshops.

Most people are aware of the major air-pollution disasters of our time, such as London's "black fog" in 1952, when the city was brought to a standstill and 4,000 people died in four days. Much less publicity has been given to the effects of air pollution on plants. However, air-pollution injury is often evident on plants before it affects humans or animals.

Losses caused by air pollution of food and fiber crops, ornamental plants, turfgrasses, and trees in the United States are estimated at more than $500 million annually. The injury to crops and ornamental plants is increasing in Illinois and the U.S., as well as in many of the industrial and densely populated areas of the world.

The damage to crop plants from air pollutants in California is estimated at $125 million annually, and about 16,000 square miles are affected. The Atlantic seaboard from Boston to Richmond, is rivaling California in pollution damage to vegetation.

Plant injury is common near large cities, smelters, refineries, electric powerplants, and airports, and along highways and streets where traffic is heavy. Other causes of plant injury are incinerators and refuse dumps, pulp and paper mills, as well as coal- , gas- , and petroleum-burning furnaces. Plant injury occurs near industries that produce brick, pottery, cement, aluminum, copper, nickel, iron or steel, zinc, acids, ceramics, glass, phosphate fertilizers, paints and stains, soaps and detergents, rubber, and various chemicals.

The effects of pollution on plants include: mottled foliage, "burning" at the tips or edges of the leaves, growth suppression, early leaf-drop, delayed maturity, abortion or early drop of blossoms; also, a reduced yeild and lower quality.

What determines the extent of the damage and the regions where air pollution is a problem? The primary factors are: (1) kind and concentration of the pollutant, (2) distance from the source, (3) length of exposure, and (4) meteorological conditions. Other important factors are city size and location, land topography and air drainage, soil moisture and nutrient supply, maturity of plant tissues, time of year, and species and varieties of plants grown. Extreme temperatures as well as too much or too little soil moisture also alter a plant's response to an air pollutant.

The damage caused by air pollution is usually most severe during warm, clear, still, humid weather. Toxicants accumulate near the earth when warm air aloft traps cooler air near the ground--a phenomenon called "temperature inversion."

The responses of plants to air pollutants are helpful in:

1. Establishing the early presence of air-borne contaminants.

2. Determining the distribution of the pollutants.

3. Estimating the concentration of pollutants.

4. Providing a passive system for collecting pollutants for chemical analysis later.

5. Obtaining direct identification of different air pollutants on the basis of the plant species and variety injured.

The more-important pollutants--sulfur dioxide, fluorides, chlorides, ozone, peroxyacetyl nitrate (PAN), and ethylene--each have distinguishable effects on plants. Concentrations are likely to produce injury. Listings are available of certain very sensitive plants, as well as of the somewhat-resistant ones.[1/]

Other air pollutants include various fumes, odors, dusts, and aerosols; organic and inorganic acids; ammonia; carbon monoxide; hydrogen sulfide; aldehydes; oxides of nitrogen; tars; manufactured, illuminating gas; and the vapors or spray drift from hormone-type weed sprays.

Agriculture's contribution to the total air-pollution problem is relatively small and localized in nature. But the effects of air pollution on agriculture can be serious. Considerable research has been conducted on the air pollutants that cause plant damage, the concentrations and time periods involved in damage, the selection of resistant varieties or species, and the management practices that minimize the air-pollution effects. Some evidence indicates that large areas of vegetation, especially forests, may have a cleansing effect on air.

1/ One such item, which also contains descriptions and illustrations of the effects, is *Report on Plant Diseases No. 1005 (Revised)*, Cooperative Extension Service and Department of Plant Pathology, University of Illinois at Urbana-Champaign, January, 1971. This 8-page report also includes information about overall, national damage and a list of selected, supplemental readings.

Inorganic Pollutants

Sulfur Dioxide. Injury can be severe thirty miles or more from the source, which is often an electric power plant, copper or iron smelter, oil refinery, chemical factory, or some other industry that burns soft coal, coke, or high-sulfur oil as a fuel.

Sensitive plants are injured by exposures of 0.5 PPM (parts per million) for 4 hours, or 0.25 PPM for 24 hours.

Some of the extremely sensitive plants include alfalfa, apples, table and sugar beets, birch trees, broccoli, carrots, crabapples, Douglas fir trees, lettuce, mustard, ponderosa and white pines, raspberries, roses, soybeans, spinach, tomatoes, and wheat.

One of the classic examples of sulfur-dioxide damage is seen in the Copper Basin in the Ducktown-Copperhill area of Tennessee. More than a century ago, this basin in the southern Appalachian Mountains was covered with hardwoods and pines. Mining was started in the area about 1850. Openhearth, wood-burning furnaces were installed later at the mine locations, and these furnaces were used extensively between 1890 and 1895.

Soon after 1900, sulfur-dioxide fumes combined with timber overcutting to fire the furnaces, and wild fires killed most of the vegetation in the basin. Even today, some 7,000 acres to the leeward side of the smelters are devoid of vegetation. Erosion has been intense. Most all of the soil and subsoil is gone. Another 17,000 acres surrounding the nude area are devoid of trees, producing only broomsedge and some kudzu. White pines thirty miles from the smelters were injured.1/

Fluorides. Compounds containing fluorine are produced by glass, aluminum, pottery, brick, and ceramic industries, as well as by refineries, metal smelters, and phosphate fertilizer plants.

Accumulated leaf-fluoride concentrations of 20 to 150 PPM often result in injury to sensitive plants. Some of the most-sensitive plants are: apples, barley, blueberries, buckwheat, corn, grape, maple, peach, most pines, sorghum, strawberry, tulip.

Ozone. This is probably the most-important of the toxic air pollutants to plants in the United States. It is brought down from the stratosphere by vertical winds, produced during electrical storms. Ozone is produced when sunlight reacts with the products formed by the combustion of coal or petroleum fuels, especially the exhaust gases from internal-combustion engines. When sensitive plants are exposed to ozone for four to six hours at levels of 0.02 to 0.04 PPM or more, injury patterns soon appear.

Some of the most-sensitive plants are: alfalfa; green and white ash; barley; table and sugar beets; brussels sprouts; carrots; red clover; corn; grapes; sugar maples; white oaks; onions; peas; peanuts; ponderosa, scotch, and white pines; rye; spinach; sycamores; tobacco; tomatoes; and wheat.

1/ *Wastes in Relation to Agriculture and Forestry*, USDA Miscellaneous Publication 1060, March, 1968. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; price, 60 cents.

Peroxyacetyl Nitrate (PAN). The most-important plant toxic, next to Ozone, is PAN. It is formed by oxides of nitrogen reacting with unsaturated hydrocarbons that come from auto exhaust gases and other products of combustion in the presence of light. Typical damage to susceptible plants occurs with PAN at levels of 0.01 to 0.05 PPM for an hour or more. The very sensitive plants are alfalfa, beets, Douglas firs, lettuce, lilacs, oats, certain orchids, potatoes, spinach, tobacco, and tomatoes.

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ANIMAL WASTE

R.D. Walker

THE AGRICULTURAL REVOLUTION has caused major changes in livestock handling. In the past, animal herds were relatively small, and manure was returned to the land. Nutrients were utilized by growing crops and organic matter was incorporated into the soil. This system is still popular where land is available and is not located too near neighboring residents.

The change to larger farm units and intensive livestock production has altered the balance between the production of crops and livestock and the use of manure as fertilizer. With increased concentrations of livestock and the availability of low-cost fertilizer, spreading manure is questionable from a profit standpoint.

Suburban housing developments and the switch to confinement feeding units are in conflict in some places, because manure-handling methods may adversely affect air, water, and soil quality, and may also offend neighbors. Some experts estimate that 50 percent of the livestock waste is produced by large-scale confinement units. A feedlot handling 500 cattle accumulates 13 tons of solid and 5 tons of liquid waste daily.

A 1961 Michigan study indicated that beef feedlot operators spent $3.43 per head marketed and dairymen, $9.29 per head per year for waste removal and spreading. A manager of a million-bird egg laying operation in Mississippi estimates his annual waste-handling costs at 10 cents a bird. What is to be done with this manure?

Accumulated manure may give-off odors; it may provide a spawning ground for vermin; when dry, it becomes a source of dust; in rainstorms, it produces runoff that may rob the water in a stream or river of its oxygen, thus killing fish and other marine life. Manure may also be the source of pollutants found in streams.

Confinement Livestock Operations

Despite these disadvantages, raising livestock in confinement offers many advantages over other methods. Many animals can be raised with a small investment in land. In addition, the feeding and individual care of livestock requires much less labor.

Livestock producers and researchers are looking for waste-treatment and disposal methods that reduce labor requirements and nuisance conditions, and improve sanitation at a minimum cost. Present producers are limited by the lack of available technical information, and by totally inadequate guidelines for handling manure in order to meet state pollution-control criteria.

Pollution Laws and the Livestock Farmer

New state and federal antipollution laws are forcing livestock operators to reexamine their manure-handling systems. Yesterday's practices may not be acceptable today.

Our pollution laws apply to the farmer as well as to industries, cities, and all other segments of society. Simply stated, our laws will not permit materials that will pollute the water to go into our streams or seep into the groundwater. Any effluent or runoff from livestock-manure treatment systems must meet the same standards as those for a city sewage-disposal plant. The farmers' only practical solution is to use some system to recycle the untreated or partially treated waste back into the soil.

Livestock Wastes

Some people may suggest using treatment plants like those used to handle domestic waste. This is not practical because of the nature of domestic waste compared to livestock waste. Every day's domestic waste--body waste, bath water, wash water, and the like--is diluted in approximately 100 gallons of water and delivered to the sewage plant in a pipe.

The domestic sewage plant is not designed to handle the concentrated waste produced by livestock. If we were to dilute the waste accumulated from one pig from weaning to market, our dilution water would cost approximately $7. The operation of the sewage plant would cost another $4, assuming an adequate water supply and the economics of a five-million-gallon-per-day plant.

The management of today's confinement feeding systems forces farmers to store manure in some form until it can be safely applied to the soil. One method is to use liquid manure-handling systems, so pumps can be used to reduce labor. This produces strong odors, especially during the spreading operation. Another approach is to use oxidation ditches or aerated lagoons. In these, air is forced into the waste in order to control odors. The electric power cost for an oxidation ditch is approximately 90 cents per hog. Overflow and solids from an oxidation must also go back to the soil.

Most Illinois feedlots are in the hands of farmer-businessmen who are conservation-minded and who have always made their living from the land. They are also community-minded people who do not want to spoil the environment in their neighborhood. After all, they are a part of that neighborhood. The farmer does not like the thought of polluting his own water or living with malodors any more than anyone else. Volume producers are trying their level best to prevent the things that we fear the most.

Many figures have been given about pollution from livestock. It is often stated that one beef or dairy animal produces as much waste as sixteen persons. It is true that one adult dairy cow or large beef steer produces as much body waste, measured as BOD (biochemical oxygen demand), as sixteen persons. However, human body waste is usually piped directly to a sewage plant for treatment and then discharged directly into a stream. We must also keep in mind that bath water, laundry water, and garbage is flushed along with the human waste. Livestock waste is flushed from the feedlot only when there is an inch or more of rain, and even then only a small portion of the animal waste leaves the lot. Presently, most of livestock waste is eventually hauled to the field where it is incorporated into the soil.

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PLANT NUTRIENTS

R.D. Walker

TECHNOLOGICAL ADVANCES in food production have enabled Illinois farmers to produce a greater and greater amount of food on their land. For example, the average Illinois corn yield was below 60 bushels in the early 1940's, but rose to almost 100 bushels per acre by the late 1960's.

The application of fertilizers to supplement the plant nutrients available from the soil has played a major role in increasing yields. Nitrogen, phosphorus, and potassium are the primary elements in the fertilizers applied in Illinois.

Ecologists are concerned about phosphates and nitrates in water because of their influence on excessive algae growth. In small quantities, algae is beneficial. It adds oxygen to the water and provides fish food. But the excessive algae "blooms" that frequently develop in nutrient-rich waters may cause an off-taste and an unpleasant odor, followed by the death of fish when the oxygen supply in the water is exhausted by decaying plant residues.

Health officials are interested in the nitrogen content because a high concentration of nitrates in drinking water can be toxic to babies under one year of age. The result is Methemoglobinema (the condition that causes blue babies).

Nitrates

Nitrates found in ground water may be produced by seepage from septic tanks and feedlots; field fertilizers, under some conditions; natural accumulations in the soil; or industrial sources. The nitrates found in streams may be from the above sources or from sewage-treatment-plant effluents.

Contrary to the impressions left by some news stories, a relationship between the application of nitrogen fertilizer and the occurrence of high levels of nitrates in ground or surface water has not been established. However, few agriculturalists will deny that the contribution will become greater if the present trend of applying increasing amounts of nitrogen fertilizer continues.

The Illinois Water Survey has monitored several major and minor streams in Illinois irregularly for more than twenty years. The amount of nitrates has increased in some streams. The source appears to be from agricultural land, because there is no sizable urban population in these areas. We need more-specific research to identify the quantity of each source of nitrate found in these streams before we can develop practices that will reduce or eliminate the potential problem.

Restricting the use of nitrogen fertilizer is one way, often suggested, of lowering the nitrate concentration in ground and surface water. This simplistic solution raises threats of pollution from other sources, as pointed out in the following example developed by Dr. S.R. Aldrich of the Department of Agronomy, University of Illinois at Urbana-Champaign.1/

1/ Dr. Aldrich is currently on leave, serving as a member of the Illinois Pollution Control Board.

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An additional 2 million acres of corn would probably be required to achieve the present level of corn production if Illinois farmers were forced to reduce their nitrogen fertilizer application by 50 pounds per acre. Relying on legumes and manure for all of the nitrogen now being applied as nitrogen fertilizer would require an estimated 10 million acres of additional cropland--4 million acres for corn (because of the reduced yield), 2 million acres of small grain for seeding legumes, and 4 million acres of legume crops.

Many of the additional cropland acres would come from very sloping to steep soils that are highly erosive. Such use could result in millions of tons of silt displacing water in our lakes and streams. The loss of surface soil would reduce the productive capability of soils, and this would require the application of more nutrients in order to maintain a given level of crop production. To be economical, livestock would be needed to utilize the forage crops increasing the already sizable livestock waste-disposal problem.

These examples show that simplistic solutions to environmental control frequently only shift the type or location of the problem--from nitrate to sediment pollution, for example.

This is the fundamental question: "What priority will society place on learning and doing more about agriculture's contribution to environmental problems?" Restrictions on agriculture will increase consumer costs because of less-efficient production. The increased costs strike hard at low-income people.

Agriculture may be able to make adjustments that will reduce the nitrate level in water. One example is nitrifying inhibitors. These slow the conversion of ammonium into nitrate, thus lessening the quantity of nitrate available at a given time. However, these inhibitors may reduce efficiency, cost more money, or both. Nitrogen fertilizer could be applied closer to the time plants require it. The amount of nitrogen fertilizer applied should not be more than the estimated, optimum rate for each situation. Production practices that increase the response of corn to nitrogen can be encouraged, thus increasing the efficiency of the nitrogen fertilizer which is applied.

In the United States, the choices about fertilizer use are governed largely by the individual farmer--using crop yields, soil fertility maintenance, and economic returns as guidelines. Fortunately, these factors exercise constraints that prevent wasteful fertilizer practices, such as excess fertilizer runoff or the contamination of ground water. The farmer, too, is concerned about the potential health hazard of farm chemicals. He and his family are often vulnerable to these hazards.

Phosphorus

Phosphorus is usually considered as the nutrient that determines whether surface water will develop algae blooms. However, some recent evidence indicates that carbon dioxide is the limiting factor, not phosphorus.

There is evidence that much of the phosphorus in surface waters comes from sewage-treatment plants, and that the phosphorus in fertilizers is only a secondary source. Phosphorus applied to the soil is bound tightly to soil particles. It enters surface waters from land mainly as the result of soil erosion and feedlot runoff.

The detergents found in sewage effluents are one of the major sources of soluble phosphorus in many of our surface waters. Approximately one pound per person per year goes into our streams from detergents--about a third of the total phosphorus in our surface waters. This picture could change rapidly if a suitable substitute can be found for the phosphorus in detergents.

FOOD FOR THE FUTURE

R.D. Walker

ALTHOUGH MOST PEOPLE DO NOT REALIZE IT, we have gone through a successful agricultural revolution in the United States since World War II. Fertilizers have contributed greatly to this.

The amount of cropland needed for our crops is determined by the productivity of our land. Land ranges from the ideal acre--the best Illinois land--to marginal and completely useless land. We can increase production by improving drainage on existing land, supplying irrigation water, or by clearing wooded areas. But, the addition of enough fertilizer to double the productivity of an acre that is deficient in fertility is just as effective as adding another acre to the land base.

About the same number of acres was harvested in the U.S. in 1960 as in 1910. But crop yields were two-thirds higher in 1960, saving us the necessity of finding 250 million additional cropland acres. That 250 million acres, incidentally, is about equal to the entire land area of the European Common Market--farms, cities, and villages.[1/]

Presently, we are able to feed our population of 200 million and meet the export needs with some reserve. We should also ask: "Will we be able to feed the projected population of 300 million by the year 2000 without using large amounts of fertilizer?" What standard of living can we expect for these people?

1/ *Natural Resources for U.S. Growth*, Hans H. Lansberg, The Johns Hopkins Press, Baltimore, Maryland. 1964.

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QUESTIONS AND ANSWERS ON INSECTICIDES

H.B. Petty

1. *ARE ALL INSECTICIDES HIGHLY POISONOUS?*

No. Some are and some are not. Most of the insecticides recommended by the University of Illinois to homeowners range from twice as toxic as aspirin to a fourth to an eighth as toxic. However, in agriculture, farmers do handle insecticides that may be far more toxic, and they must take proper precautions in order to protect their own health.

2. *DO HOMEOWNERS USE ANY OF THE PERSISTENT CHLORINATED HYDROCARBONS?*

Yes. The most-common one is chlordane. It is used as a soil treatment for termites and as a foundation spray to prevent ants, crickets, certain roaches, and other outdoor pests from entering the home. If it were not for its persistence (ability to last), chlordane would be of no value in controlling these insect pests.

We view the foundation spray as a safety measure because it decreases the need for insecticide, especially baits, used in the home. More than 60 percent of the accidental ingestions of pesticides by children under 12 involve baits.

3. *DO WE KNOW THE END-PRODUCTS OF ALL THE INSECTICIDES USED BY THE HOMEOWNER?*

For some, we do. For others, we do not. A common one, malathion, breaks down within a few days into alcohol, phosphoric acid, and water. This is particularly true if it is ingested by a warm-blooded animal. The same is true for DDVP, the active ingredient in the "no pest" strip now in common use.

On the other hand, methoxychlor (a chlorinated hydrocarbon) does not store in the fat of warm-blooded animals as readily as DDT. It also breaks down readily.

Carbaryl (Sevin) and diazinon do not remain effective for more than a few days. Thus, they must be breaking down. Studies on all of these things are continuing.

4. *DO ILLINOIS FARMERS STILL USE PERSISTENT CHLORINATED HYDROCARBONS?*

Yes. As an example, toxaphene is one of the safest pesticides for use near bee hives to control crop pests. However, it is highly toxic to fish. Toxaphene is a chlorinated hydrocarbon, but it is not stored in the fat of warm-blooded animals. It is broken down and excreted.

Sevin, a carbamate, is toxic to bees but not to fish. Therefore, if grasshoppers are devouring a farmer's crops and he has hives of bees nearby, he uses toxaphene. If no bees are involved but there is a pond nearby, he uses Sevin. If both are involved, he will probably use an organophosphate such as diazinon, naled (Dibrom), or malathion late in the afternoon. This avoids killing the bees. If done carefully to avoid drift into a pond, very little if any fish kill will occur. These are not chlorinated hydrocarbons and are not stored in fatty tissue.

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Although no longer recommended by the University of Illinois, aldrin and heptachlor are still used as soil insecticides in cornfields. However, their use decreased by 50 percent during the past three years. DDT has not been used to any extent in agriculture since 1964, when it was used on sweet corn to control European corn borers and corn earworms. Its greatest use was in the late 1940's and early 1950's in Illinois.

5. *DO WE STILL NEED DDT IN ILLINOIS?*

No, little has been used since 1964 in commercial agriculture in Illinois. Its use has largely been for control of insect pests of ornamentals and nuisance insects.

6. *IS DDT ALL BAD?*

DDT will probably go down as one of the wonders of the 20th century. But it has had bad features as well as good features and we need to view all points as a guide to future use of insecticides.

7. *DOES DDT CAUSE CANCER?*

We have been trying to determine this for twenty years. In one laboratory, it seemed to cause leukemia in mice. But the mice that did not receive DDT also developed leukemia. It has since been shown that moldy feed was the cause, not DDT. Generally, the medical profession believes DDT is not harmful to human health.

8. *WILL DDT DECREASE THE OXYGEN SUPPLY OF THE WORLD?*

No. Limited and fragmentary tests in a laboratory have indicated that DDT in large amounts in water might cause a decrease in oxygen excretion by the phytoplankton in the ocean. The findings of this limited study were blown out of proportion, unfortunately, and some misunderstanding has resulted. Only three species of phytoplankton were involved. The rates of DDDT required were many times greater than the solubility of DDT in water. Further studies showed that the oxygen content of the air is almost identical to what it was in 1910.

9. *HAS DDT AFFECTED BIRD POPULATIONS?*

Yes, in some species. During the 1950's, some thought that robins would soon become extinct when the discovery was made here in Illinois that earthworms absorb and store huge amounts of DDT. Since robins eat worms, robin fatalities did occur. However, fifteen years later robins are probably as plentiful, if not more so, than in the mid-1950's.

On the other hand, the food-chain effect is known for some birds of prey and certain fish-eating birds. A small organism is eaten by a larger one, and that one in turn by a still larger one--such a chain may have as few as one link (robin and earthworms) or as many as ten or more. In each case, insecticide storage may be magnified several times. Pelicans, osprey, falcons, and other birds can be affected. But this occurs only in certain bird species.

Also, a few species of fish-eating birds are now laying thin-shelled eggs. DDE, an analog of DDT, may be the cause. Unfortunately, other factors may also be involved--such as the PCB's (polychlorinated byphenyls, a contaminant from the plastics industries). All of this confuses the issue.

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10. *HOW ABOUT DDT AND FISH?*

DDT and its breakdown products concentrate in the fat of fish. The amount varies between species (diet) and between individuals within a particular species. When the female lays eggs, she uses up the fat. The DDT is deposited in the eggs. When the newly hatched fish uses up the yolk, the DDT can be fatal.

11. *HAVE ANY BIRD OR FISH SPECIES BECOME EXTINCT BECAUSE OF DDT?*

No. No such development is known. Many other factors, such as habitat or cover or food, may be far more important. Wildlife will prosper if they have adequate protective cover, nesting grounds, and food.

12. *CAN DDT BE FOUND IN HUMAN FAT?*

Yes. However, the amount is about a third of what it was in the U.S. fifteen years ago. DDT is not stored forever, as some would imply. It breaks down and is excreted. The average person in India has 20 to 30 PPM (parts per million) of DDT in their fat. In the U.S., we now have 5 PPM or less. This difference reflects malaria control efforts in India--a choice Indians must make.

13. *HAS DDT BEEN PROVEN TO HARM HUMANS IN NORMAL PRODUCTION AND USE?*

No. Production-plant workers have been studied carefully, and have showed no signs of injury. In one instance, the incidence of a certain type of cancer was noticeably lower than in the general population. This has led some to believe that DDT might be used as a cancer treatment.

14. *HAS DDT SAVED HUMAN LIVES?*

Yes. Malaria has all but been eliminated from some areas of the world by mosquito control. DDT is an insecticide that can be handled safely by people in the underdeveloped countries. Its weakness is its persistence and the way it is stored in the fat of animals. The World Health Organization credits DDT with saving millions of lives and preventing hundreds of millions of illnesses from malaria. The use of DDT reduced the death rate from malaria in India from 750 thousand to 15 hundred per year. In Ceylon malaria was almost eliminated until use of DDT for mosquito control was discontinued; malaria is now present in epidemic proportions again.

15. *WHAT ABOUT THE USE OF PERSISTENT CHLORINATED HYDROCARBONS?*

In Illinois, this is rapidly decreasing--except as mentioned earlier. Within another few years, little if any is likely to be used--except for termite control.

16. *HAS PUBLICITY ABOUT PESTICIDES TENDED TO OVERSHADOW OTHER, MORE IMPORTANT FORMS OF ENVIRONMENTAL CONTAMINATION?*

The trend has been this way. Because of laws governing their manufacture and use, pesticides have been under rigid surveillance for many years. Steps to avoid incorrect use were taken in the late 1940's and early 1950's. DDT was banned for use in dairy barns and on cattle in 1949. DDT and other persistent insecticides were banned from use on crops to be fed to dairy animals during the 1950's. These are only a few examples.

Actually, although much is being said now, corrective steps have been taken and we are continuing to examine current practices. We have learned a lot about insecticides. Preventive measures related to environmental contamination by pesticides have been greatly improved, while other forms of contamination and pollution are just now being discovered. However, it will probably never be possible to apply an insecticide without leaving a residue of some type and without killing some insect other than the target species.

17. *WHY CONTROL INSECTS?*

To provide better health, ample food, and greater comfort.

18. *WILL WE CONTINUE TO USE INSECTICIDES?*

Yes. There is no other general alternative, now or in the foreseeable future, if we are to provide better health, ample food, and greater comfort. However, the newer insecticides will be safer, biodegradable, and much-less persistent. They may even be more specific. It is unlikely, though, that an insecticide to control Mexican bean beetles would not kill lady beetles. After all, they do belong to the same family of beetles.

19. *ARE OTHER METHODS OF INSECT CONTROL BEING DEVELOPED?*

Yes, but slowly. Such control methods as sterility, disease development, and parasites and predators are developed one insect at a time. Much effort is being devoted to these methods.

20. *SHOULD WE TRY TO KILL EACH AND EVERY INSECT WE SEE?*

No. There are many beneficial insects, ones that eat pest insects. Also, there are pollinating insects--ones of no importance--and insect pests. Even insect pests have to reach a certain population level to be so destructive that the use of an insecticide for crop protection is warranted. It takes 6 armyworms per linear foot of drill row, or 9 to 12 worms per square foot, to warrant use of toxaphene, carbaryl, or malathion.

21. *HOW ABOUT NATURAL ENEMIES?*

Entomologists observe insect parasites and predators and advise people when to treat and when not to do so, in order to make maximum use of natural controls.

22. *WHAT ABOUT THE FUTURE?*

We will continue to use insecticides for our own good--for food production and health protection--but we will use them more wisely: when needed. New insecticides will break down more readily than those of yesterday. Today's pesticides are noticeably improved in being less persistent than some once were; thus environmental problems created by pesticide use are decreasing rapidly.

In the future, however, the homeowner must take care to use the correct insecticide at the appropriate time. There probably have been more cases of misuse involving insecticides by homeowners than by farmers. A misuse by one farmer, however, is usually greater than one misuse by a homeowner.

Let us remember that when the Illinois Interagency Pesticide Committee withdrew the use of DDT (except by permit), inspectors did not find any DDT in agricultural outlets. But it was commonly found in insecticide supplies for the homeowner, even though we had recommended DDT rarely to the homeowner for several years.

23. *WHAT CAN THE INDIVIDUAL DO?*

Use pesticides only when they are needed: do not "overdose" just to be sure. Be sure you are using the right pesticide. Read the label and follow all precautions. Remember pesticides can be dangerous when used carelessly.

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APPENDIX

PPM--PARTS PER MILLION

One part per million would be like 1 minute in almost 2 years, 1 inch in 16 miles, 1 ounce of salt in 62,500 pounds of sugar, or 1 ounce of sand in 31 tons of concrete.

Table 1. Composition of Clean, Dry Air Near Sea Level

Component (Percent by volume)	Content (PPM)	Component (Percent by volume)	Content (PPM)
Nitrogen. 78.09	780,900	Hydrogen. . . .00005	.05
Oxygen. 20.94	209,400	Methane 00015	1.5
Argon 93	9,300	Nitrogen dioxide . . .0000001	.001
Carbon dioxide 0318	318	Ozone 000002	.02
Neon. 0018	18	Sulfur dioxide . . .00000002	.0002
Helium. 00052	5.2	Carbon monoxide. . .00001	.1
Krypton 0001	1	Ammonia 000001	.01
Xenon 000008	.08		
Nitrous oxide . . .000025	.25		

Note: The concentrations of some of these gases may differ with time and place, and the data for some are open to question. Single values for concentrations instead of ranges of concentrations are given above, to indicate the order of magnitude, not specific and universally accepted concentrations.

Source: *Cleaning Our Environment--The Chemical Basis for Action*, report by the Subcommittee on Environmental Improvement, Committee on Chemistry and the Public, American Chemical Society, Washington, D.C., 1969, p. 24.

Table 2. National Air-Pollutant Emissions, 1965

Source	Totals	Pct. of totals	Carbon monoxide	Sulfur oxides	Hydro-carbons	Nitrogen oxides	Particles
			(millions of tons per year)				
Automobiles.	86	60	66	1	12	6	1
Industry	23	17	2	9	4	2	6
Electric power plants	20	14	1	12	1	3	3
Space heating. . . .	8	6	2	3	1	1	1
Refuse disposal. . .	5	3	1	1	1	1	1
	142		72	26	19	13	12

Source: *Clearing the Air, A Layman's Guide to Atmospheric Purity*, Wallace West, Committee on Public Affairs, American Petroleum Institute, 1965.

Table 3. Federal Standards for Hydrocarbon and Carbon Monoxide Emissions from Cars and Light Trucks

Exhaust	Emissions from a typical, uncontrolled car	Allowable emissions, model year 1968	Allowable emissions, model year 1970
Hydrocarbons.	900 PPM	275 PPM (3.2 grams per vehicle mile)	180 PPM (2.2 grams per vehicle mile)
Carbon monoxide	3.5 percent	1.5 percent (33 grams per vehicle mile)	1 percent (23 grams per vehicle mile)
Crankcase blowby. . . .	20 to 25 percent of the total hydrocarbons emitted	Zero	Zero
Evaporation from fuel tank and carburetor hydrocarbons	15 percent of the total hydrocarbons emitted	No standard	6 grams per test (equivalent to 90-percent control). Takes effect in 1971.

The standards shown for 1968 are for engines of more than 140 cubic inches (about 2,300 cubic centimeters) displacement. Allowable emissions increase with decreasing engine size to a maximum of 410 PPM hydrocarbons and 2.3 percent carbon monoxide for less than 50 cubic inches (about 820 cubic centimeters) displacement. The standards for 1970 do not change with engine size because they are on a mass basis, grams per vehicle mile, as opposed to the 1968 standards, which are on a volume basis, parts per million and percent. Emission values in parentheses in columns for 1968 and 1970 are the volume or mass equivalent of the standard shown. Emissions are measured with nondispersive infrared analyzers.

Source: *Clearing the Air, A Layman's Guide to Atmospheric Purity*, Wallace West, Committee on Public Affairs, American Petroleum Institute, 1965.

Table 4. U.S. Automobiles

	Million
Approximate number in use, 1960	59
Projected number, 1980.	120
Projected number, 2000.	240

Source: *Natural Resources for U.S. Growth*, Hans H. Landsberg, The Johns Hopkins Press, Baltimore, Maryland, 1964.

Table 5. Oxygen-Depleting Properties of Waste, Representative Median BOD Values for 40° North Latitude

Source	BOD (PPM)
Municipal sewage, treated	4[a/]
Municipal sewage, untreated	200
Hog-manure lagoon overflow	300
Cattle-feedlot runoff	1,000
Undiluted liquid manure, cattle and hogs, as found in a storage pit under slotted floors	30,000

a/ Illinois standard, when returned to an intermittent stream.

BOD is biochemical oxygen demand.

Information furnished by Prof. Ted L. Willrich, Department of Agricultural Engineering, Iowa State University, Ames. Also see *ISU Suggestions for 1970 Crop Production--Relationship of Agriculture to Water Pollution in Iowa*, T.L. Willrich, Cooperative Extension Service, Iowa State University, Ames, EC-428-H, November, 1969.

Table 6. Plant Nutrients in Waste Waters, Representative Median Values for 40° North Latitude

Source	Nitrogen (PPM)	Phosphorus (PPM)
Municipal sewage, treated	20	9
Municipal sewage, untreated	40	10
Hog-manure lagoon overflow	300	60
Cattle-feedlot runoff	700	10

Information furnished by Prof. Ted L. Willrich, Department of Agricultural Engineering, Iowa State University, Ames. Also see *ISU Suggestions for 1970 Crop Production--Relationship of Agriculture to Water Pollution in Iowa*, T.L. Willrich, Cooperative Extension Service, Iowa State University, Ames, EC-428-H, November, 1969.

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Table 7. Estimated Nitrogen, Major Sources, Continental U.S. (Estimated annual total, all sources, 54 million tons)

Source	Percent
Released from soil organic matter	37
In livestock waste.	18.5
Fixed by soil organisms	18.5
Added by rainfall	9
Fertilizers, estimate for 1970.	13
Human waste	4

Information furnished by Prof. S.R. Aldrich, Department of Agronomy, University of Illinois at Urbana-Champaign.

Data from the Morrow Plots, University of Illinois at Urbana-Champaign, clearly show the importance of adding plant nutrients for high yields. The plots were established in 1876. The three, original plots were in continuous corn; a corn, oats rotation; and a corn, oats, clover rotation. Between 1904 and 1955, all plots were in corn in nine different years. The average yields for those nine years are shown below.

	Continuous corn since 1876	Corn, oats rotation	Corn, oats, clover rotation
		(bushels per acre)	
No fertility added	26	35	57
Manure, limestone, and phosphate added.	54	71	80

The three, original plots were divided in half in 1904, and again in 1955. The MLP treatment was added to half of each of the original plots in 1904; the LNPK treatment, in 1955. Thus, four different fertility programs are now being applied within each of the three original plots. The four averages shown below reflect these changes in treatments. M stands for manure; L, limestone; P, phosphorus or phosphate; K, potassium or potash; and N, nitrogen. Between 1955 and 1967, all plots were in corn in three different years. The average yields for those three years are given below.

	Continuous corn since 1876	Corn, oats rotation	Corn, oats, clover rotation
		(bushels per acre)	
No treatment	41.4	53	69.9
LNPK, after 1954	107.1	117.4	125.9
MLP, after 1903.	93.9	123.5	130.4
LNPK, after 1954	117.5	123.1	126.1

The Morrow Plots are now a National Landmark. For additional information about the work involving these plots, see Circular 777, *The Morrow Plots--University of Illinois*, Cooperative Extension Service, University of Illinois at Urbana-Champaign, Revised, 1960.

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