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# A ROLE FOR PESTICIDES

## PART I

## PESTICIDES AND PEOPLE

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### ABSTRACT

Comment is made on the information sources used by the public to determine facts on pollution problems. The responsibility of scientists to relay this information is noted. The use and classes of pesticides along with their toxicity measurement is reviewed in simple terms. Two specific cases, one of an insecticide and the other of a herbicide, are examined in the light of current criticism. Some misconceptions are examined. The use of herbicides by Ontario Hydro is described in detail along with the present methods of application. The training of herbicide applicators within the utility is given from a legal standpoint as well as related to internal training. A view is given of some of the new trends which will assume greater importance in the future on those areas where vegetation management is currently practiced.


### INTRODUCTION

Most people, in their day to day thought processes, develop concepts on a multitude of subjects. Probably the most notable are politics and sport.

Lately, a third general area has appeared especially in the media where it has become familiarly known as "environmental concern". Many attribute the awareness of this third area, specifically that of pollution, to an aquatic biologist with whom I am sure most of you are familiar: Miss Rachel Carson.

As I mention her name, each person here will have started either consciously or subconsciously, to develop and examine his or her concepts relating to the environment. Each conclusion will depend upon specific individual interest, training, and exposure to information. It is, however, this last area on which most will depend, and draw on, for their data with which to form ideas.

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## A PROBLEM OF COMMUNICATION

It is sad, yet unfortunately true that much of the information presented or interpreted as fact on pollution issues is either not fact, is misquoted, overembellished, or translated in lay terms such that it loses much of its validity.

In the report of the Special Senate Committee on the mass media, it was found that 34% of all individuals obtain their facts from television, while 47% obtain their facts from newspapers. For the same report, a survey was made of the percentage of individuals who felt that the media in general could effect their way of thinking and consequently their way of life. Eighty-nine per cent, that is 9 in every 10 individuals sampled, felt that this was the case. As we can see then, the various forms of media are powerful opinion formers. That which they present is believed by a large segment of the population to be fact although it may not be. Yet, once a negative general impression has been created in the minds of people, rational repudiation of their opinions and concepts is then extremely difficult.

Much has been written about pesticides and their harmful, and possibly harmful, effects. The subject is frequently over simplified - as if pesticides were either intrisically "good" or "bad", and so should be accepted without question or banned altogether. In fact few problems are less amenable to generalization, for the pesticide problem concerns the effects of a wide range of chemicals on a great variety of complex natural systems. Much of the heat engendered by discussions on pesticides is due to the deep differences in approach by protagonists who wrongly assume that the premises for their arguments are shared by all, for example: whereas all would affirm that food production is essential, and most agree that the conservation of wildlife is desirable, few people agree on the relative value of food production as against wildlife conservation. The complexity of this problem then is further compounded by the inability of most scientists to interpret their technical data in laymen's terms. The situation therefore is one where we have a great deal of complex scientific information interwoven with moral considerations that must be communicated simply and accurately to those people, laymen and professional alike, who are aware and concerned about our environment. As we have seen, the media plays the major role in communicating this information to the general public. The onus then in providing the information succinctly must rest in part with the scientist, the researcher, the producer and the user of all of the products of man's inventiveness including pesticides, to both those who wish to learn and those who have a responsibility to learn.

## A TOOL FOR IMPROVED STANDARDS OF LIVING

Man is a highly intelligent species, who has been able to use his superior intelligence to overcome most of the difficulties of his environment. From learning to overcome many of his worst problems of disease, climate and other hazardous factors, his numbers have steadily increased. At the same time, his intelligence drives him to want things to change and improve, and he desires improved future standards for himself in most things - health, comfort, personal possessions, security, food. This inventive capacity leads him to make use of almost all the naturally occurring materials around him for some purpose. This new knowledge is now coming into dramatic effect; in the past generation, chemotherapeutic advances in both medicine and agriculture have brought changes which would have been unthinkable at the beginning of this century. But these advances in medicine are prolonging life, and removing some of the natural curbs on human population increase. The world population will rise from 3 billion now to 7 billion by the end of this century, with all that this means in terms of food requirements, both in quantity and in quality, in demand for power, and of course pressure for expansion of manufacturing processes.

For most of this modern era, people have been aware only of the apparent material benefits resulting from man's capability. Now, however, we have become conscious of the fact that environmental control, if not properly exercised, can also produce massive environmental problems.

Pesticides then, are one of the many tools man uses to protect himself, to increase his productive power and mobility or to increase his comfort and convenience.

In agriculture and forestry these chemical weapons intended for controlling pest organisms are in many cases very sharp-edged so that they must be used with care to avoid getting the wrong effect, either by lack of adequate knowledge, or by carelessness, or through sheer human laziness. However, almost every one of man's inventions has a capacity for doing harm, and we humans are often the experimental guinea pigs for our own ingenious ideas. The really bad ideas get rejected very quickly, but still our daily lives are lived in a jungle of developments which, misused, can do us harm.

Moreover, there is almost always an attendant hazard to anything introduced by man into the environment just as there is from the natural phenomena which surround us: viruses, poisonous plants, putrefactive organisms, flood and storm, extremes of climate, and the force of gravity in particular. It is interesting that our ingeniousness has not yet been able to remove completely or prevent conventional hazards, and how we learn to accept them to a large extent, and to live with them. It seems, however, that it is more difficult for humans to accept chemical problems than physical or mechanical ones, although the broad risk and end result are just the same.

## REGULATION OF PESTICIDES

The problem tackled by a chemical pesticide is simple to state, difficult to accomplish. The objective of the exercise is to control or destroy the living pest species with safety to other species, including man. More simply - selective pest poisoning, in the interests of human food, health, comfort, or safety. The method varies with the difficulties of the situation, and with the properties of the chemicals so far available for the job. It involves either a selective dosage rate, or selective placement, or selective timing, or selective biochemical action of the chemical on the pest: often it is a combination of all these things, in order to give the highest possible total of selectivity. Even so, if significant mistakes occur in dosage rate, application, timing, selection or handling of the chemical, then selectivity may sharply decrease. Unpleasant side-effects can then occur, on target or non-target organisms, on other species in or later entering the treated areas, on the user himself, or even on his fellow men.

We have vested the responsibility for the regulation of these toxic materials in Federal and Provincial Departments and their attendant regulating Acts. The Pest Control Products Act embodies the federal regulations. These apply to pesticides developed in Canada and to pesticides developed in other countries and used here.

Before a pesticide can be offered for sale in Canada, the manufacturer must show to the complete satisfaction of the Food and Drug Directorate that, when used according to directions, and in the context of good practices, the pesticide will not constitute a hazard to man or animals. On the basis of the information and the demonstrated efficacy of the compound, the Canadian Department of Agriculture will decide whether the pesticide is acceptable for its intended use.

In agriculture and forestry, chemicals used to manipulate the environment fall into three main groups; those intended for insect control, insecticides; those intended for fungus control, fungicides and those for plant control, herbicides, all commonly grouped together under the heading "pesticides". Pesticides then, are clearly very special chemicals in several ways; one important characteristic is that, before ever they are marketed, a great deal is known about their toxicity and toxicology, primarily on test animals: they are certainly not unknown quantities, as is oftentimes suggested by some critics. Additionally, there is always a precise analytical method available for their detection and measurement, although at times the method may be very specialized. Nevertheless, it must be admitted and accepted that even the most arduous toxicological test program with animals may turn out not to be entirely applicable to man; this has always been a serious problem, and will remain so in the foreseeable future. These tests set out to measure, as exactly as is possible with experimental animals, the properties of a chemical which may cause poisoning in man or animals. The tests cover the effects of single dosages, multiple dosages, and daily dosage for the majority of an animal's life span. They investigate toxicity by swallowing, skin absorption, and where appropriate, by breathing the vapour mist or dust of the pesticide. As it is never known for any chemical whether man will respond like rat, or mouse, guinea pig, rabbit, dog, or monkey, tests are carried out on many of such species, to study the range of response. External normality may be associated with significant cellular changes, so long term tests end up with detailed examination of tissues of internal organs. The most important and useful tests are repeated with the intended commercial formulations, which may behave in a different fashion from the active chemical alone, due to the presence of emulsifiers, solvents, fillers, stabilizers, or the other active chemicals added in the mixed products found increasingly necessary in spray control programs for various organisms. Fortunately, it does seem from the thousands of synthetic chemicals by now studied toxicologically as industrial, agricultural or medicinal agents, that the possibility of animal tests being fallacious is extremely small. The precautionary safety factors favoured by government adjudicators on pesticide manufacturers' test results have to date removed almost all known risks from new chemical introductions - as long as they are used for the purposes and by the methods which basic and applied research has demonstrated them to be safe.

The most important data from these tests has up to now been the establishment of the relative toxicity of compounds. What is toxicity? In this modern work we use many units of measurement. Most are based on relativity. That is to say, we take a base line and measure in relation to it. And this is the case when we use the term toxic in a technical sense.

Very simply, toxicity is expressed in terms related to the method of entry of a pesticide into an organism under test. The result is then given as a whole number for a term called "LD50". That is to say the single dose which, when administered kills 50 per cent of the particular animal in the test. The dosage is then expressed in milligrams of chemical per kilogram of animal body weight.

Therefore, only a tiny amount of a toxic chemical is required to produce a lethal effect, while the converse would be true for a relatively safe chemical for example, table salt. Thus the higher the LD50 number, the safer the substance.

The degree of comparative hazard for all types of pesticide may be shown as follows:

| LD50 VALUE | HAZARD RATING |
|---|---|
| 1. Above 500 | Very low hazard |
| 2. 101-500 | Low hazard |
| 3. 21-100 | Moderate hazard |
| 4. 11- 20 | Highly hazardous |
| 5. 10 or less | Extremely hazardous |

Almost inevitably, there have been a number of fatal human accidents or suicides caused by pesticides. Not surprisingly, the latter have rarely involved high toxicity materials, but usually gross intake of large amounts of freely available low toxicity amateur garden products, while the former is often the result of improper storage. Thus, even in this enlightened, literate and disciplined country, we have had our pesticide problems from a purely toxicological standpoint.

## NEW CONSIDERATIONS

In the past, we have relied heavily on our ability to distinguish the relative acute and chronic toxicity of compounds. These compounds may have, however, a wide range of adverse biological effects. More specific manifestations of chronic toxicity include carcinogenicity, teratogenicity and mutagenicity. These little known terms have been given some prominence in the media although their specific meaning is rarely explained. When the term carcinogenic is applied to any chemical, industrial or pesticidal, it indicates that the compound will induce the formation of cancer in living organisms. Most compounds do not have this ability, a few may cause this effect at low levels while some will at high concentrations. The other two terms can be readily confused. They are, however, quite separate. Teratogenicity refers to the ability of a compound to produce serious malformations or marked deviations from the normal pattern in the developing young of animal species. These changes occur during "organogenesis" or development of the young in the mother. On subsequent birth and examination, some young will exhibit these malformations. Examples are skeletal abnormalities, cleft palates, and cystic kidneys. These manifestations of teratogenic effect are specific to one particular set of offspring if exposure of the mother to the terata forming substance is limited to that particular pregnancy. Offspring which are affected do not transmit their defects to subsequent offspring.

Mutagenicity on the other hand, is where there is a marked change in the character of individuals and subsequent hereditary transmission to future offspring. Exposure to various types of radiation is the most common method of obtaining mutation in experimental situations; few chemical substances have this ability.

Let us examine two specific instances of pesticides which can under certain laboratory conditions, exhibit one or other of these effects. The two examples are the insecticide Dichloro-diphenyl-trichlorethane (DDT) and a herbicide 2, 4, 5-Trichlorophenoxy acetic acid (2, 4, 5-T). It should be remembered that these structures are quite different and their end use is also quite different. Our examination shall not be in depth but is intended to provide factual and informative data rarely available to the public but which is of substance when we understand that no pesticide question has an answer which is either black or white.

Let us deal with DDT first as it has been the subject of extensive examination - much of it contradictory - in the media. DDT was first synthesized in 1874, however, it was not until 1939 that the Swiss chemist Dr. P. Muller discovered the insecticidal properties of the compound. In 1948, Dr. Muller was to be awarded the Swedish Nobel Prize for his research which provided an insecticide which can be used to protect man against a number of important arthropod-borne diseases; malaria, onchocerciasis, typhus, encephalitis, yellow fever, tick fever, bubonic plague, cholera and dengue fever are all notable examples. Moreover it is, in comparison with other insecticides, highly toxic to a wide variety of pests other than disease carriers which are also injurious to both man and agriculture. It is relatively low in acute toxicity to non-target organisms including humans. Yet in 1969 the country which conferred that high honour on Dr. Muller was the first to severely restrict all uses of the pesticide. This apparent incongruity relates to the fact that the chemical activity of DDT may persist in the environment for a number of years after it has been applied. Moreover, it accumulates to varying levels in the fatty tissues of animals. There is information to suggest that it is interfering with the reproduction of certain species of raptional birds and may be a contributor, among other factors, to the decline of some of these species. There are reports of carcinogenicity resulting from the administration of large doses of DDT to test animals.

Now let us examine the other side of the coin in the same order. We shall use malaria as our disease example. The World Health Organization in a very recent report notes that some 329 million people in the world are being protected through malaria control or total eradication programs. The organization has emphasized that even temporary lack of DDT for malaria control can seriously jeopardize the gains achieved at great cost. Ceylon is a case in point. Malaria was almost eradicated there, the number of deaths being reduced from 12,587 to zero. But Ceylon, following premature cessation of spraying, is again facing an epidemic of malaria, with a total of 2.5 million cases reported for 1968 and 1969.

Although alternatives are steadily becoming available for the control of most arthropods, DDT is till urgently required for mosquitoes and tsetse fly control. Not only is it the most effective compound it is considerably cheaper, an important consideration in the developing countries where the need is greatest. Present DDT malaria programs are estimated to cost $60 million while two possible chemical alternatives would cost $184 million or 300% and $510 million or 850% greater respectively. The continued use then of DDT in malaria programs by the World Health Organization is based on three conclusions:

1. Indoor spraying of DDT in routine antimalaria operations does not involve a significant risk to man or to wildlife. The withdrawal of DDT from the malaria programs of the world would be fraught with great danger and is unjustifiable in the light of present knowledge.

2. The outdoor use of DDT should be avoided as far as possible.

3. Further research is needed on substitute insecticides and methods, especially for blackfly and tsetse fly control.

The most notable deleterious side effect of the massive use of DDT in agriculture and biting insect control is the apparent bio-magnification through parts of the food chain by the pesticide and a subsequent effect of the hatching failure of a number of predatory birds. This inability of the eggs to hatch has been correlated with the content of DDE a principal metabolite of DDT which appears to reduce the thickness of egg shells thus rendering them susceptible to damage during incubation. However we should not lose sight of the fact that the American Bureau of Sport Fisheries and Wildlife classifies 60 types of birds as "endangered species". The Bureau also lists causes for the precarious situation of these types of birds. Of the 60 species, only four are said to be possibly threatened by pesticides. The four species are the osprey, the bald eagle, the peregrine falcon and the California condor.

As we have noted previously, there have been reports of carcinogenicity resulting from the administration of large doses of DDT in test animals. However, the relevance of such findings to cancer in man has not been established, and the American Medical Association has stated recently that the claim that DDT has a carcinogenic effect upon humans constitutes an unproved speculation.

# PART II

# PESTICIDES AND ONTARIO HYDRO

## INTRODUCTION

The second half of this presentation I will devote to Ontario Hydro specifically. However, without the foundation that we covered in the opening remarks, it would not be easy to develop a rational concept of our work in the Forestry Department, nor to understand the background on which we base many of our decisions.

In the first section of our discussion, we noted three main groupings of pesticides - insecticides, fungicides and herbicides. The former two are in the most part, very toxic substances intended for organisms equipped with very effective survival devices. However, with few exceptions, Ontario Hydro is not concerned with using these compounds but rather with substances used to suppress weed and brush growth. The substances toxic to plant life which are used for this purpose are called herbicides. Most herbicides in present day use in Ontario are synthetic organic compounds and it is around these compounds that the science of chemical weed control has been largely built. To understand why an electrical utility should be involved - in fact, deeply involved in many facets of this science requires that we return in history to the latter half of the decade between 1920 and 1930.

## HISTORY

In 1928 Ontario Hydro was operating through not only municipalities, but about 3,800 miles of lines in 122 rural power districts serving more than 31,000 customers. Contrary to the assertions of those who could not foresee the growth of the power system, expansion and better service became pressing needs - and with expansion came problems. Interruptions caused by trees were frequent; a frequency which neither the customers would tolerate nor the Commission reduce without a concerted effort. So, in 1930 a Forestry Department was organized with a field staff of 22 men. A policy of thorough line clearing was implemented, which included in addition to securing good clearance for the conductors, the removal of deadwood overhanging lines, shaping the trees and finally the cutting of all underbrush and the removal of hazardous weed trees. This work was confined, however, to transmission and rural distribution lines along the Kings Highway.

Seventeen years were to elapse before drastic change was to take place in this sequence. However, drastic change had faced the world in six terrible years of war. During these years a heavy backlog of work had accumulated and when the servicemen returned from active duty to their prewar jobs, the staff was still too small to catch up with it. To complicate this situation there was soon a dramatic upswing in population followed by rapid industrial expansion. This resulted in increased line mileage which went hand in hand with more trees and more brush to control. Thus, the problem became further compounded. Up until now the method of dealing with brush on rights-of-way had been those familiar hand tools, the axe and the saw - a laborious and expensive method indeed as we shall note further on. Under such conditions an increase in staff was inevitable. Such was the demand for power Ontario Hydro found that it could no longer operate efficiently from one location in Toronto. Thus complete decentralization of administration was brought about through reorganization of Ontario Hydro into Regions and Areas in 1947. Yet the Forestry Department was to find that this was a mixed blessing for it was now responsible for clearing all rural distribution as well as transmission lines; right-of-way vegetation control became then, another major item in an already sizeable workload. The department now had 114 tradesmen divided amongst the operating areas which were small wholly contained units in each of nine major regions of the Province.

Advances in agriculture research were, however, to come to the aid of the beleaguered men whose early battle with woody brush had been conducted so strenuously with those primitive hand tools. Early plant physiologists had laid the foundation for the study of plant hormones not only as they could effect plant growth rates, but for their use as selective weed control substances. In 1945 scientists were to discover the potential of the synthetic auxins, 2, 4,-D and 2, 4, 5,-T as selective herbicides. These compounds were to play a large part in our management of rights-of-way over the next two decades. Not only did they make it possible to catch up to the hydra like problem of controlling woody brush but they offered a method now calculated as six times less costly than the axe and the saw.

## PRESENT PATTERNS OF USE

From the beginnings described in the initial part of this section and spray programs of some 100 acres in 1949 we have developed a large integrated yet diversified management program for our rights-of-way and associated property. The population of Ontario has grown from a few hundred thousand to our present day 7,000,000. To serve the electrical needs of these people Ontario Hydro maintains 20,000 miles of transmission lines and some 50,000 miles of distribution lines. Associated with this system are some 200,000 acres of rights-of-way where brush control programs must be practiced to maintain a dependable supply of electrical energy. The full scope of this undertaking can be shown by examining our annual work programs. Approximately 40,000 acres of brush are treated by our Forestry crews each year while in addition, over 5,000 acres of turf are mown and sprayed for weed control. Moreover, 750,000 of the estimated 3,000,000 trees in close proximity to our conductors are either pruned or removed in the course of one season. Further, soil sterilization is conducted on the stoned areas in close proximity to our transformer stations.

Such an undertaking cannot be attempted without considerable resources of both men and equipment. The intrepid twenty-two originals would not recognize the present work force now numbering close to five hundred, ranging from professional foresters in a resource capacity at our head office to the journeyman in the field with a $25,000 trim lift or $18,000 articulated sprayer.

The power saws, chipping machines, aerial ladders, aerial bucket devices, articulated tractors, hydraulic tools and helicopters, all a product of our advancing technology, would seem as foreign to them as would the household appliances which greedily consume the electricity that we work so hard to supply.

To accommodate the constant changes in the technology of work equipment and thus work methods, Hydro has always endorsed the philosophy of training staff - this with the understanding that it is the only way to make best use of the human abilities which are essential for the development of a good tradesman.

Training has enabled us to efficiently co-ordinate men, methods and machines to achieve the best volume of high quality work at the lowest possible cost. The result is a responsive, responsible utility arborist who works safely and efficiently, a man who is respected in his community. His training will have consisted of four general courses, timed to coincide with his progression through the trade. These will normally occur in the first four years of employment and will be followed by periodic updating courses. He will have been exposed to the theory and practice of forestry, mechanical equipment, safety, and interpersonal communication. These are skills which enable him to deal with the problems that arise in the constantly changing scope of our operations.

Before examining the more important changes that are presently taking place, let us view our staple right-of-way management programs in greater depth. As previously stated the major bulk of our program is the chemical control of woody brush and noxious weeds. Three main techniques are used in our program. Foliage spraying accounts for 60 per cent of the work, while dormant spraying in sensitive crop production areas and aerial application with Commission owned helicopters account for 30 per cent and 10 per cent respectively. The choice of the best technique will depend on such factors as brush species, accessibility of the right-of-way, availability of equipment, safety and current legislation. The herbicide chosen for the job will be the one that will safely give the desired results at the lowest cost per acre per year before retreatment is required. The herbicides used in our operations are similar to those utilized by most companies involved in extensive brush management. Combinations of 2, 4-D and 2,4,5-T are used for weed and deciduous brush control. TCA is used to control conifers, and in areas where deciduous and coniferous species grow in close proximity, it is used in combination with 2,4,5-T. Tordon 101 is effective on most woody species, and is used mainly in Northern Ontario. Since it takes longer to break down in soil than the other herbicides, we do not use it in agricultural areas. Amitrol is used to eradicate poison ivy. The rates of application are based on the label recommendations approved by the Federal Department of Agriculture, the recommendations of the Ontario Herbicide Committee and the results of our own research. The concentrations used are often well under the label recommendations, and in all cases never exceed them.

All personnel involved in chemical spraying are trained in pesticide use, both by a qualified supervisor and at our Conference and Development Centre. A three-week course covers, amongst other things, the properties of the herbicides, the concentrations to use, the mixing and application, the prevention of drift and other precautionary measures. The tradesmen are each supplied with a book of specifications and instructions and are supervised by men with practical field experience, licenced by the Ontario Department of Health under the regulations of the Provincial Pesticides Act.

## CHEMISTRY AND NEW TECHNIQUES

Despite the effectiveness of our instituted programs an effort has been made to keep abreast of new developments. Complacency has no place in an efficient right-of-way management plan for there are always new chemicals, tools, equipment and philosophies which can be applied to contain nature's relentless laws of plant growth and succession. Many of the recent developments have been a natural progression of our past experiences while some are related to the current climate of environmental concern. We are in some measure trying to anticipate what modifications and innovations should be made to de facto concepts before public pressure or legislature action unwittingly or deliberately restricts the spectrum of alternatives.

Selective spraying has been introduced where feasible on existing rights-of-way. Species which pose no problems with regard to access, fire hazard or contact with conductors, and equipment will not be treated.

To overcome the problem of misplacement of aerially applied herbicides, two new developments are of particular interest. For tower lines where the maximum tower height would be no greater than 100 ft., a non thickened spray is applied with an Amchem microfoil boom. An even sheet of liquid is formed by spray droplets released from needle like orifices. Where the tower height exceeds 100 ft. it is intended to use pelletized herbicides applied with a helicopter slung centrifugal spinner. Three materials have been examined at three rates and evaluation has indicated that picloram pellets applied at 35 lb. to the acre is the optimum chemical and rate. The full right-of-way will not be treated, but rather a 15 ft. buffer strip will be left on each side to minimize the possibility of damage to trees whose roots extend into the treated area.

Biological control of brush is also under examination. To provide competition to seedlings of undesirable species, various smother crops were grown in trial plots last year. Evaluation of the experiment would indicate that a mixture of Climax Timothy and Birdsfoot Trefoil will be the best suited for future use. The reduction of erosion and the provision of ground cover for wildlife will be ancillary benefits to this development.

It is the view of many conservationists that electric power lines are one of the most significant despoilers of natural beauty wrought by the industrial revolution. Whether this view is right or wrong, much of the general public shares it, and the electric utilities are now under constant pressure to reduce the impact of transmission lines on the surrounding landscape. A policy has now been adopted for new rights-of-way in Southern Ontario. Where in the past the power corridor has been completely cleared, the new concept includes the use of selective cutting, screening, and other landscape techniques where appropriate to assure that the rights-of-way blend into the surrounding countryside as much as possible. Existing rights-of-way will be examined in a similar light and modifications made to road crossings wherever possible.

With the increasing trend toward utility environmental improvement and our own deep involvement in large tree moving and establishment, a number of areas relating to chemical research will have some bearing on the measure of success or otherwise that these endeavours will have. Investigations into the use of anti-transpirants to slow down moisture loss from trees both in transit and initial establishment may show some rewards. These will be indicated in a reduction of the percentage of failure and thus replacement required after new line clearing operations and station screening. This will also be true for investigation into forest tree fertilization after various species have been moved. The watering required by such trees will also be an area of importance, and successful elucidation of this particular point will have significant bearing on our planting program.

Where trees are exposed to high concentrations of air pollution or during the winter months, to air-carried salt spray, plasticized material which will reduce the damage to the tree by coating the leaves with an inert film will be used.

A field which is only now starting to be explored is a further extension of the work by the early plant physiologists. The hormone type chemicals encompass more than just the group of phenoxy herbicides. Synthetic auxins which will control the growth of plants or suppress the formation of adventitious buds are now available. A considerable amount of research has been conducted by our utility into these chemicals and a number of technical papers published. A specification for a fortified tree wound dressing is presently being formulated for tree trimming operations, while experiments are being reviewed on the foliar application to coniferous and deciduous trees which will remain on the newly cut rights-of-way. As has been noted in a previous section, some 5,000 acres of grass are mown each year, many requiring such maintenance three to six times each season. The growth regulating chemicals offer considerable potential for the reduction of maintenance costs for grass if their application can effectively reduce the number of mowings required. A tentative recommendation for the use of a retardent has resulted from an extensive examination of the available compounds.

Lastly, mention should be made of our co-operation with the University of Guelph, the Ontario Department of Agriculture's Pesticide Residue Laboratory and the Ontario Water Resources Commission. An ecology study has been initiated to study exactly what vegetative changes occur when herbicides are used to control undesirable growth. The major cause for initiating such a study was the lack of any unbiased, scientifically accurate data on such effects after both aerial and ground applications of the newer herbicides.

## THE FUTURE

It is near impossible to predict the future at least with any accuracy, and all attempts to do so in any detail appear ludicrous in a very few years. It has been observed for instance that of the children born today, 30 per cent will be employed in jobs yet to be thought of. This prospect cannot be very comforting to those whose responsibility it is to project the needs of an electric utility in the future.

Our world is in a state of constant flux. That which we acknowledge to be fact today is readily replaced by new concepts, tomorrow. This is no less true for the science of pest control than for any other advancting technology.

It is only through the use of the gas chomatograph and the mass spectrometre that can provide quantative and qualitative data on minute amounts of pesticide and the complex development of the methods for their determination that we can now observe in microscopic detail changes which are a consequence of many years of pesticide use. We will undoubtedly find that some practices and some materials are less than desirable while some are more acceptable. Without constant research, vigilance, and intelligent response, our lives will not move toward the improved standards that we examined earlier.

Within Ontario Hydro our use of pesticides is presently decreasing. Where at all possible we will continue to endeavour to move away from the purely synthetic controls to methods which provide a more natural harmony while still accomplishing the same end result. Public pressure, professional ethics, economics of employment and new scientific considerations may well influence the trend in these areas. Long range planning for the changing attitudes, for new developments of science, for more moderate consumption of resources and for more efficient use of manpower will be imperative if we are not to be faced with changing circumstances and problems that we would then be ill prepared to deal with until after they occur.

Whatever steps we take we must be aware of the needs of man and of nature. We must resolve to fulfill the needs of both to the detriment of neither. If we can accomplish this, each of use in our own way will have made a contribution now, for a future which must recognize the equality of all beings.

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