Harry M Elwell

# PROCEEDINGS

## Fourteenth Annual Meeting of the Southern Weed Conference

January 18, 19, 20, 1961
St. Petersburg, Florida

# PREFACE

These Proceedings of the Fourteenth Annual Meeting of the Southern Weed Conference held January 18, 19, and 20, 1961, in St. Petersburg, Florida, include formal papers, the report of the Research Committee, minutes of the business meeting and lists of registrants and sustaining members.

Additional copies of these Proceedings are available at $5.00 per copy from the Conference Secretary-Treasurer: R. E. Frans, Department of Agronomy, University of Arkansas, Fayetteville, Ark.

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## PRESIDENTIAL ADDRESS

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I would like to take as my topic the general theme of the Conference - "The Challenge of Weed Control - Past, Present and Future". I wish to consider with you the challenges to the effort and accomplishment of the Conference and the challenges to the major objectives of the Conference.

From the standpoint of challenges to the effort and accomplishment of the Conference, I would set up three categories: (1) challenges in research; (2) challenges in education; and (3) challenges in extension. Challenges to the major objectives of the Conference would be challenges in cooperation and coordination among us as individual members of groups in the Conference. The Southern Weed Conference was designed to bring together persons from industry, state and federal technicians, extension and regulatory personnel and land owners and land management personnel for a common understanding and approach to weed control problems. The challenges to coordinated effort may be given across the board to all members and in the three group efforts: research, education and extension.

### Research

Our Conference, now in its 14th year, dates back in origin to the end of World War II with its resultant explosive development of hormone-type herbicides and other chemicals for weed control. The mushrooming agricultural chemical industry attests to the imaginative and organizational minds of the chemist and the plant scientist. Our present integrated research programs by industry and experiment station personnel are reflected in the present organization and composition of our regional weed conferences and the national Weed Society of America.

To us as individual members of the Conference there are innumerable challenges in research in the form of unanswered questions and problems. These questions deal with the basic principles of herbicidal action and weed control, the conditions influencing the responses of plants to herbicides, the interrelations of climate, soils and plants in guiding principles in weed control operations. The continued search for new and better herbicides and for improvement in application methods and techniques will long occupy our research efforts on a competitive basis, and, I hope, on a cooperative basis.

In our coordinated efforts as a Conference, the challenges in research are many. The development of active and fruitful cooperation among industry technicians and state and federal experiment station workers on the same research problems has been gratifying. We can look forward to continued cooperation within these groups with more precise allocation of the component parts of the program in synthesizing, testing and developing new herbicide programs and methods of application.

One of the areas in which greater coordination is needed is in the development of application equipment. Several years ago our Conference had a subcommittee of the Research Committee dealing with equipment and cultural techniques. The subcommittee was eliminated in 1957 from lack of interest and support. I feel that the magnitude of the problems in this area warrant a concerted effort to team up agricultural engineers and plant control specialists in an interagency or group approach on the problems. Such coordinated groups may be illustrated by an interagency committee of federal agencies including the Forest Service, Soil Conservation Service, Bureau of Land Management, Bureau of Indian Affairs, and Agricultural Research Service, which has functioned in the design of range reseeding and brush clearing equipment designed for specific purposes. A similar group has functioned in developing entomological equipment. A united effort among several of our industry and public agency groups on problems such as the design of equipment for application of invert emulsions would be of great advantage.

Another need for a coordinated approach is in the program of synthesis and testing of new herbicides. From my vantage point as a worker in the area of woody plant control, I would strongly urge the inclusion of an adequate number of woody as well as herbaceous species in preliminary screening evaluations of newly synthesized herbicides to insure that promising chemicals are not overlooked. The place in development of new herbicides at which newly synthesized chemicals are released to experiment station technicians for field testing on a wide variety of plant species varies among the several companies engaged in this effort. The competitive and independent action of industrial companies in synthesizing herbicides is in keeping with the principles of American democracy and has led to rapid advances in this field. However, I feel that areas of common interest between industry and the public agencies such as the unification of screening techniques in the development of herbicide programs may well be clarified in Conferences such as ours.

## Education

Challenges in education to us as members of the Conference are numerous and evident on self-examination. Again we may say that the Southern Weed Conference was established to provide for education in its capacity as a means of communication of information among members. The presentation of papers and the development of a research committee report admirably serves this purpose in keeping members informed of current research. The continued increase in membership and attendance at our Conference attests to the new and diversified fields in which the area of chemicals and plant control has an impact or application. An example of this broadening interest in our Southern Weed Conference in chemical control of plants is shown in the recent emphasis in the problems of undesirable hardwood control in forest management by the foresters and land owners of the Southern region. Last year some 24 papers on woody plant control were presented at the Biloxi meeting. This year three sections of our program are devoted to plant control problems in forest areas, range and pasture lands, and in right-of-way maintenance. Foresters and range technicians of the Southern Section of the American Society of Range Management held a field meeting at Fort Myers, Florida immediately preceding our program to allow for joint participation in our Conference. We extend a cordial welcome to the members of this group in attendance at our Conference.

Our responsibility as a Conference in education should go beyond the level of self-improvement and should operate on a regional and national level in the promotion of education in weed control. It should be a challenge to us to face our responsibility to provide leadership in clear thinking and education in problems in weed control in our respective states and throughout the nation and the world. The recent scare literature which has arisen on the questioned use of pesticides and agricultural chemicals clearly shows the need for closer liaison of regional groups such as our Conference and our legislative representatives and to the general public. We need to be able to adequately present research information and facts concerning the use of herbicides and other chemicals to our legislative and regulatory agencies for their guidance, and to the general public to insure the safe use of these valuable assets in agriculture and industry.

It is our additional responsibility as individual representatives of this field of endeavor and perhaps in part as a Conference or group to point the way to the development of satisfactory training of college students in the nature and use of agricultural chemicals. I am glad to announce that a panel discussion on this general topic will be held in the Wednesday session on Extension, Teaching and Public Health. We need not only to consider the general subject matter to be included in a course for all agricultural students but, in addition, the development of curriculum standards in training weed control technicians and specialists in research and industry. Our field is still a youthful one in this respect, but such a coordinated approach between industry and our agricultural colleges would help to meet the challenge of the future in the increasing demand for men trained in agricultural chemicals and their use. Last year our Conference adopted a plan prepared by the Student Interest Committee for a series of awards to students to stimulate interest in weed control. Financial support of this plan has been requested from you as individual members of the Conference to develop funds for contest awards to students to encourage interest in this field of study through attendance at the meetings of the Southern Weed Conference. We hope to bring you more information on this effort at a later period in the meetings.

Extension

Putting research into practice through education - or extension - has long been a major challenge to agriculture. To us as individuals comes this challenge to put our information into practice. Guidance to the producer of agricultural or timber crops in effective weed control programs is a rewarding and satisfying effort.

The extension program in weed and brush control requires a coordinated effort. In the land-grant college system, the research information developed by the experiment station technician is assimilated by the closely cooperating extension specialist and passed on to the county agricultural agent or farm advisor who in turn passes it on to the farmer or land owner who will put the program into practice.

Unfortunately, our state extension programs in weed and brush control as handled by the state agricultural extension services are not developed to the same extent that our research programs have been in many cases and the number of extension weed control specialists is still pitifully small for the job to be done. This gap between the research worker and the farmer or landowner may be partially filled in some regions by industry representatives, agricultural supply dealers and others. Another direct line from the research worker to the farmer goes through a chain of industry representatives - technical service and development personnel, salesmen for chemical companies, dealers and distributors of agricultural supplies and ultimately to the consumer.

Our Conference again should serve as a common meeting ground for the entire array of service workers from the researcher to the land owner who uses the control practice or herbicide as recommended by research. We need closer liaison between industry and agricultural extension workers and between our regulatory agencies and the research and extension workers. Only through liaison such as is feasible at Conferences like this can we achieve coordination among sales representatives, county agents, SCS technicians, ASC representatives, and other public agency personnel concerned in the education and promotion of recommended programs.

Sectional programs on Extension work have been included in the last several Conferences, but a decidedly greater effort is needed in this important field of public relations and communications. I would strongly urge each of you to consider your own assignment as an extension worker in maintaining an informed public on the current developments in our field.

An important area of extension activity in which our Conference can play an important role is in maintaining a close relationship between the regulatory services and the technical worker on the one hand and with the general public on the other. It is equally as important for the public to be informed of current status of regulatory matters pertaining to pesticides and plant control as on the most current recommendations for weed control. Our Conference can help greatly in providing a forum for discussion of the communication problems involved.

In summary, may I say that human experience has often shown that a cooperative effort such as our Conference may yield results far greater than the sums of the individual efforts applied toward a common goal. It is our challenge for the future to strengthen this common bond among us and to support the total program - research - education and extension - through cooperation and coordination!

# CROP-WEED ECOLOGY IN RELATION TO WEED CONTROL RESEARCH

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The use of the principles of plant ecology in planning weed control is not a new idea. Many effective weed control practices exploit known differences in the ecological characteristics of crops and the competing weed species. Crop-weed ecology is basic to any comprehensive weed research program. In contemplating the role of plant ecology in weed control, I am grateful to your program committee for the excellent theme of this meeting.

When we consider the challenges of weeds that have been met by the development of sound control practices, we find the results of ecological research have played a major part in the solution of these problems and have uncovered new lines of approach to weed control. Such techniques as seed bed preparation, rates of planting, cultivation, smother crops and the use of selective herbicides are designed and adapted to the end of maintaining crop plants in a superior competitive position over weeds. The success of these operations depends on knowledge of plant ecology.

This is not to infer that all weed control research should be concerned with plant ecology specifically, nor do I suggest that only plant ecologists are competent to plan and conduct research in weed control. In presenting this brief, however, I would point out plant ecology does encompass many phases of plant science and has been described as essentially a synthetic science. As such it provides a common meeting ground for the various disciplines of plant science and serves admirably well as a staging area from which to mount the attack on weeds.

Ecology has been defined more precisely, as "the study of the reciprocal relations between organisms and their environment". A literal translation of the term "plant ecology" might be "the study of plant organisms at home". A major difficulty in weed control is, weeds are very often more at home than the crop. Weeds are plants that possess ecological adaptations which enable them to grow, survive and flourish in the same habitat as the crop, in spite of a sequence of agronomic practices designed to favor crop establishment and growth. In general an annual weed, as contrasted to an annual crop plant, is a species with dormant seeds which germinate only under a narrow range of environmental conditions. Conversely, the rapid and predictable germination of non dormant crop seeds is an adaptation of major importance in the successful establishment and subsequent growth of crop plants.

Our ignorance of the biological interactions of the crop we wish to grow and the weeds we wish to destroy is a major contributing factor to the weed problem. Accurate information about the biological capabilities, or more simply about the growth characteristics and habitat requirements of crops and weeds, is essential to ultimate success in growing the one and eliminating the other. Such research must be concerned with the habitat requirements and responses of the plants individually and with the patterns of competition which develop in weed infested crops. Time does not permit a complete presentation of all the ramifications of this thesis, but I shall include the important points needed to develop my case for plant ecology.

I have chosen a simple example to demonstrate the central role of plant ecology in weed research and illustrate how the talents and interests of other specialists in plant science may best be utilized. A field of corn uniformly infested with yellow foxtail (Setaria lutescens) and located in central Iowa provides a suitable sample experiment in crop-weed ecology. I will conveniently omit the problems and considerations which attend the establishment of this experimental plant community.

In conducting this research project, two closely related aspects of crop-weed ecology must be investigated. The first is concerned with the relationships of the corn and of foxtail to their environment and is known to purists in plant ecology by the descriptive term autecology of each of the two plants. The second aspect is called synecology and includes the reactions of the plants on each other through the factors of their environment. I shall discuss these two divisions separately, although in practice we consider them simultaneously.

Under the heading of autecology are included these major considerations: seed dormancy and germination requirements of the foxtail, life history and phasic development of corn and foxtail plants, disease reactions of the crop and weed, responses of corn and foxtail to variations and differences in soil fertility, soil moisture, shading and several climatic factors, and to rates of planting and other agronomic variables. The potential roles of several specialized disciplines of plant science are discerned readily, if not as easily fulfilled.

Among these are found plant physiologists and biochemists investigating the enzyme systems of seeds, using the techniques of tissue cultures to grow isolated embryos of seeds and determining the roles of naturally occurring and synthetic germination inhibitors and growth regulators; cytologists using the electron microscope to study the fine detail of cellular structure in dormant and non dormant embryos of foxtail seed; pathologists assessing the nature and extent of rot infection on the roots of corn and foxtail; students of plant anatomy determining the developmental sequences in the embryo and seed coat of the weed seed; and agronomists, climatologists, taxonomists and others, each working in their respective area of interest and competence.

A plant community of corn and foxtail represents probably the ultimate in simplicity and just barely qualifies for the term synecology.

Nevertheless, what happens in this simple plant community during the growing season, is a most exciting episode in plant science. The sequence of good agronomic practices has set the stage for a contest between the two rivals in the community. This contest is plant competition.

Plant competition is a natural force whereby the corn and foxtail plants tend to attain maximum growth and yield, each at the expense of the other. It begins when the demands of the plants for moisture, nutrients and light exceed the available supply. Competition may develop not only between corn and foxtail, but also between individual plants of each of the species. The ultimate outcome of this struggle may be described in one of three ways: (1) the crop and weeds grow and mature in a state of mutual suppression, with variable crop yield reductions; (2) the weeds suppress crop growth to the point where little if any crop return is realized; (3) the crop suppresses the weeds, and the resultant crop yield reductions may be significant but do not in any way constitute a crop failure. Each of these three conditions is found in crop production. The first, that of mutual suppression, is found commonly in cereal crops particularly where no selective herbicide is available to control weeds. The second is the ultimate in crop neglect and poor stewardship of the land; we have all seen it and it needs no further discussion; the third condition is a logical consequence in row crop cultures, that not only permit but virtually demand effective cultural weed control methods. Our example of a simple plant community of corn and foxtail typifies the third condition described above. I shall use research results obtained from studies with such plant communities to develop a discussion of some major aspects of competition between crops and weeds. In such ecological experiments, the factors of seasonal rainfall and growing conditions are variables which change with years and locations. Rainfall effects may be modified on a small scale by the use of supplemental irrigation and plastic ground covers. In large part however, these variations in seasonal conditions must be expected and anticipated in the design and execution of experimental procedures. Major agronomic variables, which may be controlled or modified, include corn plant populations, weed populations, available soil nutrients, crop varieties and the duration of competition between crops and weeds.

Of these variables, corn plant populations and size of competing foxtail infestations are of major importance, since the relative numbers and growth of each determine the intensity and final outcome of competition. If the foxtail infestation is comparatively light, competition may become merely a sharing of the supply of available factors with little or no corn yield reduction. Heavy infestations are often essential to certain types of ecological research, but are totally unrealistic in experiments designed to assess the losses due to weed competition under production conditions. The experimental infestations must be adjusted to suit the needs of the research project. In experiments to assess average losses due to weeds, we have used infestations which approximated closely those found commonly in commercial fields in the area. For experiments involving moisture, nutrients and other variables, the need to intensify competition has required substantially higher levels of infestation. Essentially the same considerations apply to the choice of experimental corn plant populations.

Shading is a one way effect with corn and foxtail. Foxtail did not shade corn, but the shading effects of corn on foxtail determined in part the size and competing potential of the foxtail infestations. The effect of shading was reflected generally by increased weed growth under low corn plant populations. Dwarf corn may eliminate much of this differential shading and thus prove a useful research tool, provided the yields of dwarf lines approximate those of taller, conventional lines.

The factors of soil moisture and available soil nutrients, particularly nitrogen, were studies extensively. Their effects on corn-foxtail competition are related closely and play a major role in the outcome of competition. Competition between corn and foxtail for nitrogen and water did not follow the same sequence or reach the same degree of severity in all experiments. But, under all conditions encountered, nitrogen fertilizer applications greatly minimized the competitive effects of foxtail on corn, and particularly where soil moisture was limiting. Supplemental irrigation water offset the competitive effects of foxtail when nitrogen levels were adequate or high, but not when nitrogen was in short supply.

Seasonal distribution of rainfall in Iowa follows a typical pattern of adequate soil moisture from spring until early July, a dry period in late July and August, and fall rains in late August and September. Competition for moisture was confined generally to the dry periods in summer. Foxtail infestations which grew with the corn until early July and were then removed prior to the onset of dry weather did not reduce corn yields except under conditions of very low nitrogen. The extent of competition between corn and foxtail during the dry periods was determined, however, by the growth of foxtail and corn prior to the onset of drought. Thus available nitrogen and moisture in the spring determined the severity of competition for moisture later in the summer. In this connection, nitrogen had relatively little effect on the growth of foxtail compared with its effect on the growth and vigor of the corn plants.

The patterns of foxtail growth and resulting corn yield reductions indicated the final outcome of corn-foxtail competition was conditioned not only by individual factors of soil nitrogen, soil moisture, corn plant populations and degree of foxtail infestation, but also by the interactions of all four. The effects of nitrogen fertilizer in minimizing foxtail competition varied within corn plant populations; corn plant populations in turn determined to a considerable degree the growth and hence the competing potential of the foxtail. Similarly the effects of a given level of foxtail infestation were modified differentially by nitrogen supply, depending on corn plant populations. Observed corn yields suggested further that competition among corn plants themselves as well as that from foxtail, determined the extent of corn yield reductions, particularly at high population levels. In general, for each season and habitat encountered, maximum yield reductions were observed in that corn plant population which produced maximum yields under weed-free conditions. These results suggest a dual role for nitrogen. Nitrogen was a factor in competition not only as it limited plant growth at lower levels but also to the extent that the ready availability of nitrogen early in the season resulted in corn plants which competed effectively with foxtail during the dry periods of July and August.

The difficulties of separating the components of competition for nitrogen and water is a major problem. The substitution of nodulating and non nodulating isogenic lines of soybeans for foxtail, the use of dwarf corn to eliminate the effects of differential shading, varying nitrogen availability with soil applications of ground corn cobs and fertilizer, and the careful application of irrigation water and plastic ground covers are promising approaches. Preliminary experiment have revealed some new problems, but I am confident a combination of these techniques will prove successful.

In the experiments I have been describing foxtail infestations yielded approximately a ton of dry matter at maturity. Such infestations are quite unrealistic for studies designed to assess the losses due to weeds under conventional production conditions. During the past ten years I have included the comparison of weed-free corn and conventionally cultivated corn in most of the herbicide evaluation tests. The residual foxtail infestations which survived three good cultivations approximated closely those found in many farmers' fields. During the past ten seasons the average yield of these surviving infestations has been 600 to 700 pounds per acre. The resulting corn yield reductions have averaged 7 or 8 bushels per acre, or approximately 10 per cent.

Experiments with ordinary nodulating soybeans and annual weeds have revealed some interesting differences in the patterns of competition as contrasted with those observed in corn. The effects of nitrogen fertilizer were very slight and were evidenced only by slightly better weed growth and somewhat higher bean yield losses where beans and weeds followed heavily fertilized corn in the rotation. The shading effects of soybeans on weeds was quite pronounced with soybean plant stands of 9 or more per foot of row. Competition for moisture during the dry periods of summer was a major factor in determining the outcome of soybean weed competition. Bean yield reductions were greatest in seasons which had a wet spring and a dry summer. When plastic ground covers were used to create dry conditions over the entire season, growth of soybeans and foxtail was reduced and yields lowered, but the losses due to weed competition were negligible. A complicating factor in soybean-weed competition studies was the occurrence of early fall rains which resulted in an increase in soybean seed size and yield, thus masking some of the effects of earlier weed competition.

With weed infestations similar to those found in production fields in the area, losses due to weeds in soybeans averaged 3-4 bushels per acre or 10 to 15 percent, for the ten year period 1950 to 1959.

These, then, are some of the things which happened when weeds and crops grew together in the field. Crop yield reductions were not always spectacular, and crop failures never occurred even on land which had grown corn for almost ten years without any fertilizer. We have noted the tangled interrelationships of factors such as plant stand, nitrogen supply, moisture availability and shading. I have indicated some of the techniques which may simplify the experimental approaches to the problem.

But a good program of weed control research must encompass more than the germination of weed seeds, the physiology and botany of weeds, and the nature and extent of plant competition. Herbicide technology has assumed and ever increasing role in weed control. What then are the potential roles of plant ecology in this herbicide technology? Certainly the ecological successions which follow herbicide applications in brush and rangeland areas would provide a fruitful area of investigation. But we are working in a corn field at present and while we occasionally look up from a row of corn to see what the rest of the world is doing, let us confine the discussion to the example chosen earlier.

Plant ecology is not concerned directly with the formulation of herbicides, with their early testing or with studies of their toxicity, except as these facets are related to and concerned with changes in the habitat of crops and weeds in question. But after an herbicide has been synthesized, screened and tested, it must be evaluated under production conditions and must pass rigid tests of user acceptance. Herbicide acceptance will grow as their use provides more effective and economical control of weeds as compared with alternative methods of control.

The real and potential economic returns derived from controlling weeds in crop production may be divided into three components, characterized as follows. First, there is the normal crop yield expected from average to good agronomic practice and reasonable plant pest control. Secondly, there is the added increment of crop yield that results from superior weed control efforts and which may involve extra cultivations, the use of herbicides, or both. The third component is less concerned with absolute yield increases, and may be defined as the economic return derived from the use of weed control practices which save cultivation time or minimize weather hazards to effective cultivation. The potential role of herbicides in these latter two connections looms large. The role of crop-weed ecology in determining the economic advantages of herbicides over alternative control methods looms equally large.

We are dealing now with weed infestations which survive normal cultivation, which vary greatly from year to year, and which pose a variable but real threat to crop production. The crop yield reductions they produce are sizeable and represent a considerable loss to the agricultural economy. In general however, they are not so great that we can ignore the element of cost in making recommendations for weed control. This consideration assumes that herbicides will find their best role as supplements and limited substitutes for cultivation. Many of us feel this is an entirely too limited outlook or prospect for herbicides. In the corn belt states and elsewhere, there is a keen interest in minimum tillage practices. Many agronomists are willing at least to discuss the prospect of a plowless agriculture for corn. Such developments are probable, if not inevitable. The ecological problems of such production systems will demand a share of attention fully as great as that accorded the problems occasioned by the accompanying herbicide technologies.

In assigning to crop-weed ecology this central role in weed control research, I must also make reference to the role of the individual plant ecologist. In developing this theme, I have assigned both major and supporting roles to many specialists in the various disciplines of plant science. I have not, however, sharply delineated the duties of the plant ecologist. There are valid reasons for this omission. Perhaps as an agronomist, turned plant physiologist, I should hesitate to tell professional plant ecologists what they should do. But the step from agronomy to plant physiology perhaps exposed me to plant ecology long enough for me to qualify, not as an ecologist, but as an informed observer.

Earlier, I characterized plant ecology as essentially a synthetic science. In this sense then, plant ecology combines and correlates the particular facts and principles of several branches of plant science into an inclusive body of knowledge which clarifies the interrelations of plants and their environments. Individuals with broad knowledge of plant science and great proficiency in the process of synthetic thinking are rare. Such men will be our leaders in the continuing quest for the Holy Grail of a weed-free agriculture. I do not hold that these leaders will all be plant ecologists, nor that plant ecology can solve all the secrets of plants. I do submit the thesis that as long as weeds grow in the same field as crops, research in plant ecology will be an integral and vital part of weed control. Gentlemen, I rest my case.

# WEED CONTROL IN TIMBERLANDS

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The control of undesirable plants in southern timberlands is big business. Last fall I made a survey of weed control practices by 48 industrial foresters in the South. The survey indicated that 8 million dollars were spent on weed control last year by southern timber industries. An additional million dollars were probably spent by non-industrial forest landowners, including governmental agencies and individuals. Expenditures for herbicides amounted to approximately $1,300,000.

In this paper I shall attempt to point out why we have a weed control problem in southern timberlands, what control techniques are now being used, and what some of the problems and research needs appear to be. Details of ways of controlling weed trees are beyond the scope of this paper.

There are 193 million acres of commercial forest land in the South. Nearly every acre is in need of some form of weed-tree control. The weeds are mainly deciduous woody plants. Herbs are of minor importance as competition for forest trees. Hardwood control and weed-tree control are terms which are practically synonymous.

The hardwood control problem is acute in the South because of the following factors:

1. Pine is the preferred species in most of our southern forests. It is in great demand for pulpwood, lumber, poles, and piling. Pine is worth 3 or 4 times as much per cord or board foot as associated hardwoods. Pine grows faster and is straighter and sounder than hardwoods on pine-growing sites. These sites total about 102 million acres in the South.

2. Hardwoods form the ecological climax in most of the southern pine region. Hardwoods thrive under a pine overstory, but pines grow poorly or not at all under a hardwood overstory.

3. Young hardwoods sprout vigorously. Fire and cutting keep hardwoods down, but hardwoods sprout back from the lower stem and root collar.

4. High-grading in southern timberlands in the early part of this century left the less desirable species and cull trees to grow.

5. Cull trees are common in pure hardwood stands. The cause of cull is primarily butt rot, which is due to fungi which have gained entrance to the wood through fire wounds.

6. Weed control costs are generally high compared to per-acre incomes from sales of timber stumpage.

It is easy to over-simplify the weed-tree problem. It is not true that "hardwoods are bad" and "pines are good." The situation is complicated. On bottomland hardwood sites, foresters are attempting to favor good hardwood trees. Some of these trees will sell for much more than will pines of comparable size. And some, for example cottonwood, grow faster than pine. However, on most of the upland sites in the South, hardwoods are slow-growing, short-boled, and defective. Here, foresters try to grow successive crops of pines. If hardwoods are not controlled, they will take over the site after the pine is harvested.

Weed control in southern timberlands is now being done mainly by company foresters. Industries own only 17 per cent of the South's timberland, but management is more intense on these holdings than on most farm and small private ownerships. And the trend in pine management is toward what might be called "field-crop silviculture." In this type of management, weed control is standard practice.

At present, control measures are largely performed on pine-growing lands. Hardwood forestry lags far behind pine forestry. The trend, however, is toward increasing weed-tree control in both pine and hardwood stands.

Hardwood control on an extensive scale began in the South only about ten years ago. Foresters began to use controlled burning and girdling as silvicultural techniques for hardwood reduction. They then turned to using ammate in frills and cups on tree stems. A little later they began using 2,4,5-T. Recently they have been using bulldozers, brush choppers, and other heavy equipment for large-scale site preparation prior to planting pine, particularly in the southeastern states.

A variety of hardwood control techniques is now being used commercially by southern foresters. My recent survey shows that the most common technique is injection of the base of individual trees with 2,4,5-T. Controlled burning is second in acreage treated. Other methods in common use are (1) girdling or frilling with axe or powered girdler, with or without 2,4,5-T, (2) aerial spraying with 2,4,5-T, (3) foliar application of 2,4,5-T from tractor-mounted sprayers and blowers, (4) bulldozing, and (5) mechanical brush chopping. On some acres, several methods or a combination of methods are used for hardwood control. Factors affecting the choice of hardwood control method are: condition of stand, management goal, soil fertility, density and size of understory, species present, location, topography, weather, adjoining properties, state regulations governing herbicides, and last but not least, cost of treatment. There is no single "ideal" prescription for hardwood control.

Many problems confront foresters trying to control weed trees. Some of these are:

1. High cost. Foresters hesitate to spend more than about $10 per acre for hardwood control. Weed-tree control is a delayed-return investment. Benefits in dollars are not received as a rule for at least ten years. It takes a released stand of pine seedlings at least that long to attain merchantable size.

2. Many weed species. On a single company ownership the number of weed species to be controlled is generally about 30. These species vary greatly in response to herbicides. Some hardwoods are easily killed, others are moderately resistant, and a few species are very resistant. Fortunately, the southern pines are highly resistant to foliage sprays of 2,4,5-T.

3. Sprouting of weed hardwoods. Controlled burning is the cheapest hardwood control measure. However, abundant sprouting always follows, and burns have to be repeated or combined with chemical sprays to get effective control. Sprouting frequently follows herbicide use if the job is not done correctly.

4. Seasonal limitations. Foliage application of herbicides is effective only during the period of active growth, a relatively short length of time during the year.

5. Rough topography. In mountainous areas, existing mechanical equipment is not rugged enough for ground use, and costs of hardwood control are high.

6. Weather conditions. These limit hardwood control, especially aerial spraying, mist blowing, and controlled burning.

7. Ignorance of herbicides. Foresters are not well trained in chemistry. Herbicide use has been something new, to be learned after graduation from college. Salesmen from reliable chemical companies are continually educating foresters in proper chemical usage. However, it is difficult for a salesman not trained in forestry to advise foresters on herbicide use, because he may fail to understand the forester's timber-growing objectives.

8. Possible soil impoverishment. Some foresters fear that growing pure pine where the natural forest is a pine-hardwood mixture

will cause soil deterioration. In general, hardwood leaves contain more nutrients than do pine needles. However, it is not economically feasible to eliminate all hardwoods permanently from a pine-hardwood stand. Soil impoverishment appears unlikely to be a serious problem in hardwood control.

9. Public relations. Wildlife enthusiasts frequently oppose hardwood removal, since hardwoods provide food for game animals. The forest landowner is vulnerable to a disgruntled squirrel hunter with a pocket full of matches. The following hand-lettered sign was found deep in the woods by a company forester soon after he started a girdling program:

> "You've got the money, we've got the time;
> You girdle the hardwoods, and we'll burn the pine."

10. Lag in research. Hardwood control research has often lagged behind commercial use of a given technique. This situation results from inadequacy of forestry research in general, the natural hesitancy of research workers to publish findings before they are conclusive, the urgency of weed control problems in industrial forests, and the pressure for chemical sales.

There is a great need for increased research effort in weed-tree control. Most of the research thus far has been of the "spray it on, then watch" type. Better chemicals are needed, and better application techniques can perhaps be developed. Effects of chemicals in relation to species, soil, and other factors should be studied. However, the crying need is for basic research in tree physiology. We need to know how 2,4,5-T is transported inside the tree, what happens to the tree when it dies, and why some trees resist the chemical more than others. I believe that this basic research can best be done in the agricultural experiment stations. Additional financial support is needed for such research from both state and Federal sources.

In summary, weed-tree control in southern timberlands has become a major endeavor in the past ten years. Efforts are being made by industrial foresters to reduce hardwoods in favor of getting increased growth of associated pines. A variety of hardwood control techniques are being used. Foresters face many problems in weed control, and more research is needed, particularly basic studies in tree physiology.

# PROGRESS AND POTENTIAL IN WEED INVESTIGATIONS

W. B. Ennis, Jr.
Crops Research Division, Agricultural Research Service
U. S. Department of Agriculture

I am very glad to participate in this Fourteenth meeting of the Southern Weed Conference. I followed the development of your conference for many years as an active participant within the region and am still interested in your conference affairs. The remarkable growths in membership and in scope of the services provided by this conference mark real progress in weed control. Seventy-three persons attended the organizational meeting at Stoneville, Mississippi, in 1948, but your program this year stimulated attendance of over 355 persons representing a wide array of scientific interests in weed control research and development, extension, and other activities. Growth in membership and in activities of the Southern Weed Conference is part of an overall pattern of progress in weed control. Many staggering weed problems lie ahead, but the accomplishments of weed control scientists working and planning together through this conference can be looked upon with considerable pride.

## Professional Manpower Devoted to Weed Control Work

In connection with a recent survey in which many of you participated, the Federal and State weed personnel devoting time to different lines of weed work were listed. More than 400 scientists devote an aggregate of about 268 professional Federal and State man-years to weed control research and the integration of weed control measures into management systems, about 23 professional man-years to extension aspects of weed control, and about 4 professional man-years to regulatory aspects.

Approximately 200 research personnel devote less than one-fourth of their time to weed investigations. Almost half of the manpower devoted to extension aspects is on a part-time basis. Obviously most of the aggregate professional manpower concerned with weed control consists of personnel working part time in widely scattered locations. Such diffusion of scientific effort makes difficult the development of well-integrated and hard-hitting state and national weed control programs. I believe continuing attention must be given to maximum concentrations of research on critical weed control problems. Greater concentrations of available manpower on weed problems perhaps at fewer locations should provide more efficient coordination and leadership of weed investigations work.

Most present research is devoted to practical aspects of herbicide application aimed at solving critical control problems. However, it is encouraging that more attention is now being given to basic weed control research including the nature, behavior, and effects of herbicides and their degradation products in and on plants and plant products, in and on soils, and in irrigation, drainage, and other waters. Of the estimated 268 professional man-years devoted to different phases of weed control research, 125 are engaged in lines of work that apply to many crops and situations, whereas the remaining are directed toward developing weed control measures for specific crops or situations. Some important lines of basic research need to be initiated and more scientific manpower should be brought to bear on all weed control problems.

## Progress in Use of Chemicals and Biological Agents for Weed Control

Even though most public agency work has been conducted on a part-time basis by men in widely scattered locations, their accomplishments and those of research and development personnel of the chemical industry have paved the way to rapid adoption of many improved weed control practices. A recent survey by the Federal Extension Service, in cooperation with the Agricultural Research Service and 43 of our States, shows that over 50 million acres of agricultural land were treated for weed control in 1959 (table 1). The acreage treated with herbicides more than doubled between 1949 and 1959 (table 2). Although a large portion of the acreage was treated with 2,4-D many other herbicides are being used increasingly on a wide variety of crops. The number of herbicides produced and used in the United States in comparison with other non-insecticidal pesticides (table 3) reflects progress in development of these materials for agricultural uses. Before 1940 most herbicides were inorganic. Subsequently, use of most inorganic herbicides dropped, because they were replaced by such organic materials as DNBP, 2, 4-D, carbamates, ureas, and the s-triazines. Large tonnages of inorganics such as chlorates, borates, and arsenicals, however, are still used on noncrop areas. Synthesis and evaluation of new herbicides are currently expanding rapidly.

Progress in use of herbicides is also illustrated by estimates of United States production and consumption of herbicides. In 1956 of an estimated 84 million pounds of organic herbicides produced 68 million pounds were used in the United States. In 1959 production was almost 100 million pounds, of which 86 million pounds were used domestically. The market value of the organic herbicides produced in 1959 was estimated to be more than $74 million. In addition, about 92 million pounds of inorganic herbicides, with a value of about $6 million, are produced annually.

The essentiality of using herbicides and other improved measures for control of weeds in modern American farming cannot be questioned with scientific justification. Enough specific data have not been assembled and analyzed to show the economic benefits that result from present uses of herbicides, but undoubtedly such use markedly reduces production costs. In addition, improved quality and yield, lower labor requirement, less risk of crop failure, and other benefits are being realized through safe use of herbicides. Progress in developing improved weed control materials and methods and in their adoption by farmers is a fine tribute to cooperative public agency-industry work.

Table 1. Estimated extent and cost of chemical weed control on farms in the United States, 1959[1]

| Crop or area | Acreage treated | | | Total cost of herbicides and application[2] | | |
|---|---|---|---|---|---|---|
| | Pre-emergence | Post-emergence | Total | Pre-emergence | Post-emergence | Total |
| | | 1,000 acres | | | $1,000 | |
| Corn | 1,902.7 | 14,224.4 | 16,127.1 | 7,040.0 | 24,181.5 | 31,221.5 |
| Cotton | 890.6 | 278.5 | 1,169.1 | 2,849.9 | 1,005.4 | 3,855.3 |
| Soybeans | 518.4 | 10.0 | 528.4 | 2,177.3 | 17.5 | 2,194.8 |
| Small grains | - | 19,475.2 | 19,475.2 | - | 34,860.6 | 34,860.6 |
| Rice | - | 637.0 | 637.0 | - | 1,159.3 | 1,159.3 |
| Peanuts | 29.1 | 3.0 | 32.1 | 97.9 | 9.0 | 106.9 |
| Sugar beets | 81.6 | 42.6 | 124.2 | 427.6 | 197.2 | 624.8 |
| Sorghum | 8.0 | 2,085.0 | 2,093.0 | 48.0 | 6,463.5 | 6,511.5 |
| Hay | - | 186.4 | 186.4 | - | 1,192.9 | 1,192.9 |
| Forage seeds | - | 181.8 | 181.8 | - | 1,065.3 | 1,065.3 |
| Vegetables | 71.8 | 204.1 | 275.9 | 581.6 | 832.6 | 1,414.2 |
| Fruits and nuts | - | 5.4 | 5.4 | - | 42.6 | 42.6 |
| Strawberries | 2.0 | 3.3 | 5.3 | 35.2 | 20.4 | 55.6 |
| Ornamentals | 0.2 | 2.2 | 2.4 | 1.9 | 42.3 | 44.2 |
| Rangeland | - | 4,346.0 | 4,346.0 | - | 14,472.2 | 14,472.2 |
| Pastures | 30.1 | 2,213.4 | 2,243.5 | 30.1 | 5,754.9 | 5,785.0 |
| Lawns | 2.5 | 57.3 | 59.8 | 666.6 | 809.1 | 1,475.7 |
| Noncrop land | 27.2 | 2,932.5 | 2,959.7 | 2,596.2 | 28,064.0 | 30,660.2 |
| Total | 3,564.2 | 46,888.1 | 50,452.3 | 16,552.3 | 120,190.3 | 136,742.6 |

1/ From unpublished survey data accumulated by the Federal Extension Service; Farm Economics Research Division, and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture. Estimates for Alaska, California, Delaware, Hawaii, New Jersey, New York, Ohio, Oklahoma, and Washington not included.

2/ Calculated from average costs incurred by farmers in the reporting states.

Table 2. Estimated acreages treated for weed control in the United States[1]

| Year | Corn | Small grains | Grazing lands | All other | Total |
|---|---|---|---|---|---|
| | 1,000 acres | 1,000 acres | 1,000 acres | 1,000 acres | 1,000 acres |
| 1949 | 4,559 | 18,751 | - | - | 23,310 |
| 1952 | 8,150 | 16,792 | 2,192 | 2,629 | 29,763 |
| 1959[2] | 16,127 | 20,112 | 6,590 | 7,623[3] | 50,452 |

[1] Estimates for 1949 and 1952 from U. S. Department of Agriculture, Statistical Bulletin 156, April 1955; 1959 estimates from unpublished survey data accumulated by the Federal Extension Service; Farm Economics Research Division and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

[2] Estimates for Alaska, California, Delaware, Hawaii, New Jersey, New York, Ohio, Oklahoma, and Washington not included.

[3] Estimated 3 million acres noncrop land treated included.

The use of insects, plant pathogens, and other biological forms continues to show promise for suppressing certain introduced weeds. You are all familiar with the spectacular success in controlling Klamath weed on western rangelands with a beetle introduced from Australia. The Agricultural Research Service, in cooperation with other Federal and certain State agencies, is continuing foreign explorations for biological agents capable of suppressing growth of some important weeds such as halogeton, alligatorweed, water hyacinth, witchweed, Dalmation toadflax, Mediterranean sage, Italian thistle, and yellow starthistle. The work has progressed enough so that insects have been or soon will be released on gorse, tansy ragwort, Scotch broom, and puncture vine. Long-range weed control research programs must properly emphasize the use of biological agents to control introduced weeds, particularly on extensive rangelands and aquatic sites where chemical and mechanical methods are impractical.

Scientific research is the foundation for the revolutionary change from hand and mechanical methods of controlling weeds to the use of chemical energy and other improved control measures. We must attack aggressively the many unsolved and partially solved weed control problems. The challenging opportunities to make additional contributions in developing improved weed control materials and methods must be met by marshalling present manpower into effective teams to attack critical problems. More importantly, additional well-trained weed research scientists are required to exploit on a broad front the potentials that new chemicals and biological agents offer for developing and improving weed control methods.

Table 3. Approximate number of noninsecticidal pesticides in use in various years, 1800-1960

| Year | Fungicide: Inorganic | Fungicide: Organic | Nematocide (organic) | Growth regulator (organic) | Herbicide: Inorganic | Herbicide: Organic |
|---|---|---|---|---|---|---|
| | N U M B E R | | | | | |
| 1800 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1850 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1900 | 4 | 4 | 1 | 0 | 5 | 1 |
| 1920 | 7 | 4 | 2 | 0 | 6 | 1 |
| 1930 | 9 | 4 | 3 | 0 | 8 | 3 |
| 1940 | 9 | 29 | 3 | 4 | 8 | 6 |
| 1945 | 9 | 31 | 5 | 7 | 9 | 10 |
| 1950 | 9 | 33 | 6 | 9 | 9 | 22 |
| 1955 | 9 | 35 | 8 | 12 | 10 | 38 |
| 1960 | 9 | 36 | 12 | 16 | 10 | 57 |

## Increased Weed Control Research and Studies of Further Needs Authorized by U. S. Congress

That the U. S. Congress recognizes the importance of weeds in reducing efficiency of agricultural production and the need for research to develop safe, improved, and economical weed control measures is encouraging. The 86th Congress provided $2 million in the Agricultural Research Service appropriation for the construction of a laboratory facility at Fargo, North Dakota, to conduct fundamental studies on the metabolism of agricultural chemicals in plants, insects, and animals. A significant portion of the research at this laboratory will involve studies on herbicides. This laboratory is to be completed by September 1963. Congress also provided some support for cooperative research at Tifton, Georgia, College Station, Texas, Ithaca, New York, and Beltsville, Maryland, to develop weed control methods that do not leave harmful residues in meat, milk, or food crops. Although only a minimal program can be initiated the possible expanded cooperative work with the State agricultural experiment stations and the chemical industry should aid in finding ways of using herbicides to minimize or avoid residues and in understanding the behavior and fate of herbicides in and on plants and soils. Such information will help greatly in filling an important gap in present industrial and public agency research programs and also in reassuring the public that the health of man and animals is being protected against harmful residues.

Also, as a result of the action of the 86th Congress the Department of Agriculture will be able to initiate a research program on the control of weeds in sugarcane. This program is to be implemented at Houma, Louisiana, in the near future. In addition, the Agricultural Research Service is initiating research on the control of salt cedar and other phreatophytes in the Southwest. The U. S. Senate Committe on Appropriations directed the U. S. Department of Agriculture to study the phreatophyte problem and research needs of the Department on this problem. This Committee also directed the Department to study its needs for research aimed at the development of improved weed control materials and practices for use in cotton and other field crops, horticultural crops, and pastures and to report such needs to the Committe not later than February 1, 1961. For the past few months I have served as a member of two working groups in the Department of Agriculture charged with assisting in these two studies on research needs. The recognition by our legislators and others of the weed control problems and of the potential opportunity to reduce farm production costs through increased research to develop and improve weed control methods is encouraging. I hope that this recognition will serve as a catalyst to provide needed improvements in manpower to deal with all phases of weed control including research, extension, education, and regulatory aspects.

## Gaps in Weed Control Research Programs

Applied weed control research by many industrial, State, and Federal weed research scientists has made great progress in reducing production costs of several important crops. Many basic research problems were generated during the last decade through the applied weed control research programs and numerous basic research needs were recognized. Many weeds cannot be killed efficiently with present chemicals, and information is largely lacking as to why an herbicide will kill one kind of plant but not another.

The movement and accumulation of herbicides in plants, soils, and water including their long-term effects are not properly understood. The gross effects of herbicides are known, but more exact knowledge of the mechanisms involved in conditioning plants for efficient penetration and movement of herbicides is needed to provide a sounder basis for the development of practical and reliable procedures for chemical weed control. Fundamental knowledge of the production, germination, and longevity of weed seeds, of the vegetative reproduction and growth of weeds, and of ecological relations of weeds to desirable plants and natural enemies of weeds under different climates is largely lacking. Basic information must be obtained on problems such as enumerated to insure the continued development of improved, more economical, and safe weed control measures. Equally important are the needs of synthesis and discovery of new principles and approaches to weed control that will open new frontiers for practical developments.

The increasing development and use of herbicides have created an urgent need for more research to gain an understanding of their actions and fate in and on crop plants and soils. Ideally, enough knowledge should be available about the behavior of herbicides in and on plants and soils to permit construction of a balance sheet which accounts for a given chemical from application until its ultimate fate is known. To gain a proper understanding of the behavior and fate of herbicides should be considered one in a series of necessary studies or check points that herbicides must pass before use on food and feed crops. I do not believe there is any need for panicky concern on the part of individual workers regarding this matter. Instead, weed research scientists must calmly accept this as an additional research requirement that needs cooperative and coordinated attention. The chemical industry has accepted its responsibility for obtaining needed residue information on materials registered and sold as herbicides. I am sure the industry will continue to give major attention to residues and will work cooperatively with public agency scientists to obtain the additional information required to insure safe and efficient use of any material marketed for weed control.

As scientists and as private citizens weed control workers have an increasing responsibility to help the general public understand accurately the importance of herbicides and other pesticides in protecting crops and in insuring dependable, economical, and high-quality food and feed for our nation.

Future progress in the development and in the use of herbicides depends upon closely cooperative basic research of scientists in public agencies and in the chemical industry. In the Weed Society of America and throughout the long history of the Southern Weed Conference and the other Regional Weed Control Conferences cooperation has been outstanding. It is essential that this cooperation continue on a coordinated and effective basis. Such cooperation has served and will continue to serve as the cornerstone for successful development and use of weed control chemicals.

## Education Aspects and Program Coordination

The continuing expansion in the introduction and use of herbicides to replace or supplement present control measures has created needs to supply farmers with new technicological information to insure safe and efficient use of available herbicides and equipment for local farm situations. Research information obtained in weed control programs must be published promptly and properly disseminated to farmers. Weed control will be expedited by training and providing additional weed control specialists to work with county agents, farmers, and others interested in weed control.

The rapid progress being made in using synthetic organic chemicals for weed control has created a need for and an interest in both basic and applied research to exploit the full potential of using chemical energy instead of human and other forms of energy to control weeds. The work conducted by various private and public agencies needs increased correlation so as to insure maximum research efficiency.

The Weed Society of America has played an important role in providing for the exchange of weed control information and the mutual sparking of research ideas that aid in solving problems of national interest. The Regional Weed Control Conferences also serve an extremely valuable role in exchanging information and ideas and aiding in coordination of work and dissemination of information within regions. Some States have worked out plans for exchange of information among weed workers located in different parts of the State and in different organizational units. Even so, there is still need for regrouping and coordination of manpower at the national and local levels to obtain the greatest program efficiency. Improvements in program efficiency can best be achieved by formation of integrated units of the scientists who conduct research, extension, and teaching aspects of weed control.

## The Challenging Future

Although much progress has been made in improving weed control measures the weed control problem still represents a major challenge to optimum efficiency in farming operations because of the continuing upward spiral of labor and other production costs which contribute to reduction in producers' net incomes. Moreover, the introduction of new and powerful chemical tools and the prospect of broader utilization of biological control agents open new horizons for productive research designed to solve our nation's weed problems. The challenging opportunities for improving weed control methods must be met more aggressively. A purposeful policy is needed to encourage centers of excellence for weed control research with enough scientific manpower and facilities to attack weed problems with vigor. I believe significant progress will be made toward correcting present deficiencies in weed control programs and in so doing the drain of weeds on our national economy will diminish.

# INDUSTRY'S CONTRIBUTION TO WEED CONTROL

Dale E. Wolf
District Sales Manager
Industrial and Biochemicals Department
E. I. du Pont de Nemours and Company

It is an honor to me and to the Du Pont Company to be invited to present the industry viewpoint at this meeting of the Southern Weed Conference. This conference brings together representatives of consumers, growers, extension workers, state experiment station workers, U. S. Department of Agriculture workers, and various representatives of different segments of the chemical industry. Each of the groups represented has shared in the contributions which have advanced the science of weed control so spectacularly in recent years.

Each group has a real responsibility for the future, to see that growth in this field is commensurate with the problems facing all of us today. It is not easy to draw any definite and exclusive areas of responsibility for each group--either in looking back over what has been accomplished, or in looking ahead to future growth in the science of weed control and its application to economic needs. One thing that I think everyone notices about men working in this field, regardless of their own personal assignment, is the spirit of enthusiastic teamwork that exists among them.

From my present position I look at the field from the viewpoint of the chemical industry, but I can only speak from my personal experience. Another spokesman might see the picture a different way.

I mentioned teamwork--and I think that is the key to the spectacular progress of chemical weed control in recent years. Basic chemical knowledge has advanced through the productive creative efforts of many scientists in the laboratories of universities, government, and industry. Farmers have seized the opportunities which these discoveries have given them, and have worked hard to learn how to use these chemicals, usually with the help and leadership of state and federal agencies.

A healthy and growing chemical industry has been able and willing to devote large expenditures to research and has proceeded with substantial investments, even when a chemical weed control development was a long way from success.

And around it all, the economic system and government climate have promised rewards to the inventor and innovator, allowing him a maximum degree of freedom to explore the new, with due regard for the risks involved, both to himself and to the users.

Now I expect discovery of new concepts and new compounds to continue to be a basic, although not exclusive, responsibility of industry in the future advancement of the science of weed control.

Industry, particularly the chemical industry, is recognizing more and more that its future is built on fundamental research. The latest annual report of our company shows 2,300 technically trained people engaged in research and development, at an annual cost of about $90,000,000. About one-sixth of this money and manpower was spent on fundamental research in organic, inorganic, and physical chemistry, physics, microbiology, biochemistry, and engineering.

Not many years ago, it would have been inconceivable that a commercial company would go deeply into fundamental research in the specialized field of plant growth. But we know that the chemistry of life processes in living cells represents one of the most promising fields of study for future discoveries in biochemical fields, including weed control. The behavior of chemicals in living systems depends on intricate chemical reactions in the enzymes and nucleic acids of individual cells. These reactions are sensitive to slight influences, and they occur in successions and combinations which are presently difficult or impossible to duplicate in the laboratory.

As a result, development of products for any kind of biochemical activity--in the field of weed control or elsewhere--depends too often upon an empirical approach which is inevitably slow and wasteful. Success is all too often the result of change, rather than skill. A better understanding of life processes will, we hope, bring us closer to prescribing molecular formulas to fit given biochemical needs.

Understanding biochemical activities in living cells would also help to overcome some of the major problems in establishing safe levels of exposure to chemicals. It may lead to simplifying or even to eliminating the present cumbersome procedures of bio-assays with laboratory animals.

A second important field of chemical exploration broadly concerns testing and analytical techniques. These are concerned not only with plant responses, residues, and toxicology, but with all fundamental biochemical research. We have to identify and measure various synthetic and natural compounds in controlled or uncontrolled biochemical reactions in order to know the chemical situation we are working in. We have to be able to differentiate infinitely small amounts of compounds from closely related or similar chemicals.

Present bio-assay methods can only demonstrate effects of some particular recognized magnitude. They cannot demonstrate the absence of any effect at all. Likewise, in chemical analyses, we can be accurate only to a point. Present analytical procedures cannot prove an absolute zero. It is not possible to prove the presence of a smaller amount of chemical than can be detected. If we are accurate down to one part per million, then anything less than that represents zero by our analysis.

Another area where we need to progress is in reducing the cost and time required to establish the safety of chemicals to be used in food production. The time elapsed between the discovery of a biochemical compound and the start of its commercialization is from four to seven years. The cost of establishing safety is on the order of half a million dollars for a single product, and involves testing over a period of several years. These costs must inevitably appear in the price of the product. If any product fails after any part of this expenditure, then some other product must bear the cost.

Then too, to a considerable degree, every research project is competing with every other one. As we add to the cost of doing research and subtract from the potential earning capacity of the resultant development, we make this research effort less attractive relative to others.

Future discoveries in weed control depend on overcoming some of these fundamental problems in biochemical research. We expect they will be overcome. This progress will depend on continued dedication to basic research by government and university scientists. But it will also depend upon the willingness of industry to support the research which this progress requires, and then to take the capital risks involved in manufacturing and marketing the products that research has uncovered.

In spite of the many obstacles, however, we in the chemical industry are confident that the need for chemicals in food production will continue to demand industrial supported research. The stakes and opportunities are great, and the needs are pressing. We have been successful in increasing food supplies faster than population growth and we must continue to do so.

To make a long story short, industry is one means, in our society, of consolidating many fields of science and engineering, and directing capital resources and human talents to projects which a single scientist would never think of tackling alone. The result is that discoveries need not languish in test tubes or stop at the laboratory level if they give promise of meeting a human need.

So we consider discovery to be one broad field of industry's responsibility--but not industry's alone.

Second is development--development of practical applications of the discoveries of science. In weed control, this calls for an awareness of the important weed problems that face various segments of agriculture, and industry too. To be specific, there are many weed problems here in the South that are not yet solved. In industry, they include various species of unwanted vegetation under telephone lines and power lines, along railroad tracks, and around buildings. In crops, we seem to get one group of weeds under control, only to be faced with others.

In addition, there are certain specific weeds which are problems in limited areas--such as witchweed in North and South Carolina.

Once we know from research that "X" chemical will do an excellent job of controlling certain kinds of plants, we have the job of developing its use. In an industrial organization, this involves research liaison in the field, technically trained salesmen, and careful planning and direction at the management level. It also involves close coordination with the land-grant colleges and experiment stations, U. S. Department of Agriculture, pioneer-minded customers, and especially with toxicologists and regulatory agencies.

Here in the South, our company maintains two research laboratories specifically designed for testing chemicals in southern agriculture. In addition, a number of our personnel working both in research and sales are charged with the responsibility of finding out how the chemicals which have been discovered in the laboratory fit into the various weed problems of the South.

When you come to Florida with a new chemical for agriculture, your prospect--whether he's a research worker, extension agent, or farmer--wants to know what it will do in Florida. You can tell him how it worked in Delaware, or Pennsylvania, or California, and he's likely to say "Yes, that's fine, but in Florida, everything works differently." And it's not only true for Florida, but it's true for local agricultural areas everywhere you go.

So many different factors affect the working qualities of a new weed killer that it almost has to be tested under the conditions under which you intend to use it. Variations in soil type and rainfall throughout this great land of ours make it imperative that industry take the responsibility of seeing that its new weed control discoveries are tested under as many conditions as possible. This is fundamental to introducing a chemical in agriculture. It also affects the selfish interests of industry, because one aspect of developing a new chemical is to learn its limitations as well as its potentialities. This is one determining factor in decisions on marketing a new compound.

The industrial weed control development team has to determine the true value of its candidates before offering them to federal and state laboratories. Only the best of the hundreds of new test-tube candidates are worthy of the searching examination necessary to determine their safety and full efficacy.

It seems only right that the cost of developing a product should primarily be borne by industry. Before sending a product out for widespread evaluation by federal and state laboratories, an industrial concern must decide that the product intrinsically has enough merit, is safe enough, and is of sufficient economic value so that the company is willing to say that the product has a good chance of being made available commercially.

This decision must be reached honestly and thoughtfully on the basis of adequate information developed through the company's own resources--even though future evidence may contradict what is already known and force an end to commercialization of the compound. The information leading to this initial decision should be developed through the company's own resources. State and federal laboratories cannot be free testing agencies for hundreds of purely experimental, untried products and formulations.

However, once the basic facts about a new weed control chemical have been established, and it is clear that the new material promises to have one or more economically important fields of use, then it seems not only proper but essential for the product to be discussed with federal and state authorities and made available to them for such evaluation as may be appropriate to their own interests and responsibilities.

By this time the question should not be whether the product will be sold and will find uses, but rather exactly what those uses will be and how the candidate can best be applied to the benefit of agriculture and those other sectors of the economy which make use of weed control agents.

From an industry standpoint, I can only say that all of us appreciate sincerely the many man-hours, sweat, and toil that federal and state workers put into testing new materials to find out how they will fit into the agriculture of a given geographical area. Without this untiring help, it would be virtually impossible to get weed control chemicals onto the market, and get them used to the extent that they are being used today.

After perhaps three or four seasons of work by virtually every group represented in this room, it is time to draft the proposed label text for registration under the Federal Pesticide Act and the Miller Amendment, and to assemble the detailed report of "supporting data." Again it is the responsibility of industry to gather and correlate this data so that it has real meaning to the agencies responsible for reviewing and approving it.

After the label is registered with federal authorities and various states, we are in business only theoretically. Industry then has a real job, with the help of public educational agencies, such as the state and county extension services, to transfer this detailed scientific "know how" to the consumer, including some who may care little or nothing about technical matters and labels.

es.

Our first approach to this is to work with our distributor and dealer salesmen by a series of formal and informal meetings at which technical information and "know how" are discussed. With them we discuss the kinds of literature that would be most helpful, and train them, if necessary, in adapting farmers' equipment and practices to apply the product effectively. During this period too, many of the state and federal people are also holding meeting--depending upon the extent of innovation which the new product represents in local agriculture.

As many of you know, who have worked with new chemicals in southern agriculture, you rely heavily on careful instruction of the first users of a new product. For adoption of a new practice in agriculture spreads only as fast as the good word spreads among farmers who have used it. Careful attention to problems which develop in the first season of use will help to assure that any given segment of agriculture will ultimately derive the maximum benefit of a new scientific discovery.

Much of what I have said may be "old stuff" to many of you. But I have tried to review some of the fundamental principles which have proved to be the foundation for the advancement of the science of weed control to its present-day status, and to give you some idea of how industry is approaching the problems which lie before us now and in the future.

The record of chemical weed control in agriculture and in the industries which use it speaks for itself. Today farmers are using chemical weed control practices which did not seem possible when the science of weed control was in its infancy. Cotton has progressed from a high-labor crop to a low-labor crop as chemical weed control has been added to so much other technology in cotton production. Chemical weed killers are being used commercially where it once seemed impossible--as in spinach, and in selective weeding of grasses in the Pacific Northwest. Farmers are making spot treatments for noxious weeds in various crops, even though the crop itself may be susceptible. Chemicals are keeping irrigation and drainage ditches free of unwanted vegetation without damage to cropland. Equipment, methods of application, and timing have been adapted in ways that seem almost incredible. And each new discovery seems to enlarge the use of existing materials.

Furthermore, our success with weed control is broadening our practical knowledge of the whole field of regulation of plant growth--so that laboratory screening programs evaluate all responses of plants to candidate chemicals, rather than just the killing effect.

In industry, we feel that the science of weed control has a lot to gain from the incentive and initiative in our American economy which permit commercial companies to commit substantial resources in money, manpower, and equipment to this important field. It is a challenge and a responsibility which we accept gladly.

But most of all, we appreciate the opportunity for teamwork in weed control research, education, and practice. We in industry get a great deal of personal pleasure and inspiration out of our opportunities to work with you who are, in the finest sense of the words, "public servants." We look to those of you who live with weed control problems in local and regional areas to aid us in defining those problems which are important to you and would also be commercially important. The success of weed control conferences like this one over the years is indicative of the extent to which scientific, governmental, educational, and commercial communities are pursuing common objectives.

MINUTES OF THE BUSINESS MEETING
SOUTHERN WEED CONFERENCE

Soreno Hotel
St. Petersburg, Florida
January 19, 1961

The meeting was called to order by Dr. Darrow, President of the Southern Weed Conference at 1:15 P.M.

A motion was made and seconded that the minutes of the 1960 meeting be approved as printed and distributed. The motion was passed.

President Darrow requested that Dr. Frans present the Treasurer's Report.

Southern Weed Conference
Financial Statement
Conference Year 1960

| | | | |
|---|---|---|---|
| ASSETS: | | | |
| Carry Over | | $3,327.37 | |
| Receipts of 1960 Meeting | | | |
| Banquet | $ 452.00 | | |
| Registration Desk | 1,039.00 | | |
| Scholarship Fund | 119.00 | | |
| Total | | 1,610.00 | |
| Sale of Proceedings After Meeting | | 639.00 | |
| Sustaining Members | | 1,210.00 | |
| Scholarship Fund | | 186.00 | |
| | Total | | $6,972.37 |
| EXPENDITURES: | | | |
| 1960 Meeting | | | |
| Banquet | 435.49 | | |
| Registration | 127.42 | | |
| Total | | 562.91 | |
| Production of 1960 Proceedings | | 1,245.54 | |
| Secretarial Supplies and Services | | 348.55 | |
| Badges for 1961 | | 21.00 | |
| Executive Delegates Expenses | | 320.75 | |
| Bank Charge | | 1.00 | |
| Programs for 1961 | | 166.10 | |
| Preparation of 1961 Research Report | | 714.45 | |
| Public Relations | | 25.41 | |
| | Total | $3,405.71 | |
| Total in Bank | | 3,566.66 | |
| | Total | | $6,972.37 |

| | |
|---|---|
| Section I | Weed Control in Agronomic Crops including Turf and Pastures |
| Section II | Weed Control in Horticultural Crops |
| Section III | The Control of Weeds and Woody Plants in Forests and Rangelands |
| Section IV | The Control of Weeds in Utility, Railroad, and Highway Right-of-Ways, and in Industrial Sites |
| Section V | Aquatic Weeds and Special Weed Problems |
| Section VI | Ecological, Physiological and Edaphic Aspects of Weed Control |
| Section VII | Extension, Teaching, Regulatory, and Public Health Aspects of Weed Control |
| Section VIII | Developments From Industry |

Each sectional chairman was primarily responsible for developing the program in his section. The consensus was that the above approach would strengthen the Southern Weed Conference by emphasizing development of the program on the sectional level. The committee further recommends that a continuation of this or a similar approach be considered

In the eight sections this year, over 90 papers were scheduled, more than for any previous conference.

A total of 2500 copies of the program were printed. In December, 1900 copies were mailed out to all individuals on the Secretary's mailing list, to all sustaining members, and to others who had requested printed programs. Approximately 600 copies were sent to the hotel for registration purposes.

Respectfully submitted,
Ellis W. Hauser, Chairman
J. F. Freeman
Henry Andrews
John Kirch

It was moved, seconded, and passed that the report be accepted. Dr. Shaw moved that the Program Committee Chairman be commended for developing a very fine program for this conference. The motion was amended to include an expression of sympathy to Dr. Hauser for the illness of his wife with the hope that she would recover soon. This amended motion was seconded and passed.

## ARTICLE V - COMMITTEES

Standing committees shall be:

1. Program
2. Research
3. Nominating
4. Legislative
5. Public Relations
6. Terminology
7. Auditing
8. Resolutions
9. Sustaining Membership

Any voting member of the conference shall be eligible to appointment on committees.

## ARTICLE VI - AMENDMENTS

Section 1. Any five or more voting members of the Southern Weed Conference may initiate a proposed amendment to this Constitution. The amendment shall be submitted to the voting membership with recommendations either at the next meeting or by mail ballot.

Section 2. The Executive Board may propose amendments to this Constitution at any time either by mail ballot or at the regular meeting as outlined in Section 3 below.

Section 3. The Executive Board shall submit any proposed amendments to the membership at least 30 days before they are voted on. Adoption of a proposed amendment shall require a majority vote of those voting members present at a regular meeting, or if by mail ballot, a majority of all ballots returned within 30 days after date of the original mailing.

## BY - LAWS

### I - DUES

Registration dues at each regular meeting for the various membership classes are:

| | |
|---|---|
| Voting | $5.00 |
| Contributing, sustaining | 25.00 |
| Contributing, associate | 10.00 |

### II - Duties of Officers and Executive Board