Losses Due to Agricultural Pests: Conference Summary of the Agricultural Board, Committee on Agricultural Pests, November 4-5, 1959. (1959)

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Need Better Data Pest Experts Say

Introduction

MANY requests have been made in recent years for the development of documentable data on losses caused by agricultural pests and wildlife and for activity in research to develop means of controlling soil-borne plant pathogens. These requests came to the Agricultural Board from members of the Agricultural Research Institute and from other groups. The Agricultural Research Institute recommended that a Committee on Agricultural Pests be formed. This was approved by the Agricultural Board and the Committee is now a unit of the Board and functions under its jurisdiction.

The Committee carries on its work through six subcommittees—one on the biological control of soil-borne plant pathogens and five that have to do with losses caused by agricultural pests and wildlife. They are: insects, nematodes, plant diseases, vertebrates, and weeds. After studying various approaches to these problems it was decided that the committee could function to best advantage by stimulating interest and activity in state, federal, and industry groups and to eventually transfer responsibility to committees in organizations in related fields of interest.

1958 Conference

A conference, supported by a grant from the Rockefeller Foundation, was held in October, 1958 to develop plans for implementing indicated programs. This was attended by members of the Committee on Agricultural Pests and of all of its subcommittees. A report of these developments and of later progress was made in May, 1959. This report indicated that the conference had successfully stimulated a vast array of interest in research and publication with correlative activities of scientific societies and individuals. It was also apparent that the initial stimulus needed follow-up to take advantage of the impetus developed. It was believed that additional effort would produce sufficient momentum so that the program would become self-perpetuating. To accomplish this end, it obviously was desirable to fully inform representatives of parallel and interested groups of the program and its objectives and to seek their help and advice in putting the projects into a form that would be acceptable to such organizations.

1959 Conference

With these objectives in mind a second work conference was held in Washington on November 4 and 5, 1959. This was also made possible by a grant from the Rockefeller Foundation. This was held at the National Academy of Sciences—National Research Council building in Washington, D. C. and was attended by 61 top scientists interested in agricultural pests, wildlife, and biological control of soil-borne plant pathogens. Included were committee and subcommittee members, representatives of parallel organizations, and special guests.

Purpose of Conference

Purpose of the 1959 conference was threefold: (1) to evaluate the status of the subcommittee programs in stimulating studies and publication of data on losses caused by pests, (2) to prepare parallel committees and other organizations to continue the program, and (3) to re-evaluate the methodology and principles for assessment of losses as applicable to domestic and international problems.

Program

Following a few introductory remarks W. C. Dutton, Chairman of the Committee on Agricultural Pests and also of the Conference, introduced the two keynote speakers. First of the speakers was Dr. T. C. Byerly, Deputy Administrator, Agricultural Research Service, U.S.D.A., whose subject was entitled, "Why Do We Need Loss Data?" Speaking for industry was Dr. R. D. Wellman, Manager, Agricultural Chemicals Division, Union Carbide Chemicals Company, who discussed the "Importance of Loss Data to Industry." These talks are included as part of this report.

At the close of Wellman's talk, the group was dismissed so that the six subcommittees could meet separately *(Continued on page 8)*

Why We Need Loss Data?

Dr. T. C. Byerly,

**Deputy Administrator, Agricultural Research Service,
U. S. Department of Agriculture**

I know of no other area more urgent at the present time than agricultural research to agriculture as a whole and the topic you are gathered to consider.

The farmer needs loss data in deciding what crops to grow, what yields and qualities to expect, and what pests he must recognize and learn to control. Agencies which respond to, or are affected by, the farmer's pest protection problems, and by others of their own, are equally concerned. The purchaser of farm products needs to know the areas and farms where pests have caused damage and the nature and extent of this damage. He must consider the damage to the product while in his possession resulting from pests of farm origin. Regulatory and extension agencies must estimate losses in order to discharge their reponsibilities.

Public and private research agencies need such data as a basis for effective use of their resources. Industry must have loss data to plan for the production and marketing of machinery and chemicals for pest control. Nor is it enough to have data on losses in the absence of control; data for losses in areas where control measures are applied must be obtained to measure the adequacy of control. Finally, we need methods and data for forecasting losses.

There are presently available many kinds of loss data, from many sources, none of them wholly adequate. One principal source is "Losses in Agriculture," issued by the U. S. Department of Agriculture in 1954. This document contains estimates of losses from plant and animal diseases and parasites, weeds, insects, rodent, flood, fire, hail, soil erosion, and other causes which are controllable through application of present information or may become so through further research. They represent expert opinion based on incomplete data.

Losses, evaluated at 1942-51 prices, averaged about 13 billion dollars worth of goods per year—nearly one-third of the potential production. About 120 million fewer acres of cropland would have produced the 1942-51 volume of farm products in the absence of these losses. However, the committee which prepared the report was careful to point out that the dollar value assigned to these losses is not to be interpreted as the financial loss incurred since no consideration was given to price reductions which might have resulted had these losses been prevented.

Since this is the principal source of loss data, I will comment here as to the statement of losses. Thirteen billion dollars that didn't happen. It is a stupendous amount of money. What did happen? This is one of our major problems we have to consider. I have seen these data; they are published. Their principal source is quoted without qualification. We ought at least to understand when we use a dollar figure what we are saying. With this major reservation, total losses from all insects to crops, livestock, forests, fabrics, households, and buildings were estimated at $3.6 billion and the cost of control measures $400 million.

A current document used as a correspondence aid by the U. S. Department of Agriculture Plant Pest Control Division (Pests or Pesticides, CA-8, June, 1959) estimates annual losses from:

Insects—12% of total agricultural output
—14 billion board feet of saw timber
Weeds—$4 billion
Plant diseases—$3 billion
Rats and rodents—$1 billion-$2 billion

These estimates are based on expert opinion and fragmentary data. They are subject to adjustment for effect of volume limitation through damage incurred on price with respect to weed, plant disease, and rodent loss estimates.

Our Crops Research Division assembles and issues information on plant disease occurrence in the "Plant Disease Reporter" and conducts a limited survey and forecasting service. The Rust Prevention Association issues seasonal information on occurrence and extent of cereal rusts. The Animal Disease Eradication Division assembles voluntary reports from cooperative State agencies and tabulates disease information contained in meat inspection reports. Entomology Research and Plant Pest Control Divisions cooperate in a limited survey and insect pest forecasting service. Statistical tables on production and trade in pesticides in the USDA statistical yearbook provide some indirect information on pest damage. There are many other sources of information direct and indirect, public and private.

These sources of information are sufficient to demonstrate the vast magnitude of the problem of control of agricultural pests but are inadequate to serve the total need of farmers, industry, regulatory extension and research agencies, and the general public, which ultimately pays the bill.

The public is generally unaware since losses are concealed in price, availability, and quality of product. Occasionally, public interest is aroused by obvious effects in the community of pests or of the control measures to prevent their spread. Sweet corn is an example. Pesticides have made possible production of perfect ears of corn.

How do we estimate a loss which is potential, as a limitation? Farmers in the Northern Intermountain area can't be sure of raising tomatoes profitably for processing because of white fly-transmitted curly top. How much does it cost a community when it can't obtain a cannery because it can't guarantee a supply of tomatoes? This happened potentially in the Columbia Basin. A man had a dryland ranch. He brought in irrigation water, developed the ranch, and called in a planning organization to see what he could do with it. They decided there was water, a growing community, and so developed a town of 10,000-15,000 people. To have a town that size you have to have an industry. They went east and found a processor who was interested in moving. They saw the potential. Among this group of crops were tomatoes. They put out a number of small plots to test the quality, appearance, and yield. They sent them to California for quality determination. Excellent. Then somebody reminded them it was an unusual year, and indicated that most years they couldn't have any tomatoes for processing. So there is a town that doesn't exist and an industry that isn't there.

What is the potential loss to the public if the gypsy moth is permitted to invade the hardwood forests of Pennsylvania, the Appalachian region, and eventually the Ozarks? We have an abundance of hardwood forests. We could replace them with softwood forests. Would it be a social good to have a hardwood forest destroyed by the gypsy moth and replaced by softwood. Most of you would be opposed to elimination of hardwood forests. How do you express such a loss?

How does the farmer calculate the loss caused by his family's annoyance by mosquitoes breeding in his stock pond? Some of the methods of controlling the mosquito might kill some fish. You have got to make a choice. Or how does he measure the loss by myriad fire ants in his crops and pastures?

We also need loss data for markets we do not now enjoy because our products are excluded. For example, our pork and poultry are not admitted to United Kingdom markets because we cannot assure their freedom from the viruses of hog cholera and Newcastle disease. Our soybeans are questioned because it is alleged they sometimes contain bindweed seed which is said to cause acute intestinal discomfort when eaten by humans. And weed losses certainly would include those suffered by poultrymen who lost broilers presumably from toxic seeds of cover crop legumes included in mechanically harvested local corn.

Our effective plant and animal quarantine services prevent losses to our crops and livestock from many exotic pests and diseases. Most plant materials can be admitted with adequate treatment and quarantine procedures, but access to the world's livestock breeding stocks is prevented by our need to protect our domestic stock from foot-and-mouth disease, rinderpest, African swine fever, and other exotic diseases. There is no realized loss of product but substantial loss of potential breeding improvement.

It is difficult to generalize our need for loss data since each need has its own peculiar requirements. Estimates of probable annual cost of Medfly damage made by University of Florida and citrus industry experts amounted to $20 million if it had become established. But this didn't happen. As a basis for the necessary immediate decision, the estimate was adequate.

Much more difficult is the case of Hoja Blanca, which has recently invaded our rice fields. The disease is spread by the insect *Sogata orizicola*. Both disease and vector have been found in the river parishes in Louisiana. It is probable that the disease will spread to all the Gulf Coast and Delta commercial rice areas. With the present rice varieties it could cause a 25 to 50 per cent crop loss, or about $150 million. But rice breeders have on hand 6,000 bushels of seed of resistant varieties which by 1961 can be increased to provide seed for the entire acreage. Will growers and the market accept the resistant varieties? What is the estimated potential loss?

Let us consider a major problem—cotton—treated in the Delta with a variety of pesticides 4 to 10 times during the season. "Losses in Agriculture" estimates the cost of insecticides to farmers as $75 million plus cost of application, and the product loss at $335 million. Overwintering counts of hibernating weevils are an aid to forecasting losses the following season. As the season advances, field surveys of infestation serve to guide time of treatment and choice of pesticide. Rate of fertilization and rainfall or irrigation complicate estimates of probable loss and effectiveness of treatment.

Down at New Orleans 3 or 4 weeks ago they took us to see some fine cotton fields. The small difficulty of treating during wet weather hadn't got an insecticide on the fields. Per acre yield was lower than expected. Let us make a generalization. Let us move out to the High Plains of Texas and grow something else. What else? Are they going to leave farming?

Let us make a generalization in summary of these specific examples and the need of farmers, regulatory, and other agencies for loss information. As in the case of the Medfly, potential loss availability of an effective insecticide-attractant and a probably favorable cost-benefit ratio, and eradication program was clearly indicated and carried out. Since Angelica seed oil used in traps to locate and delineate outlying infestations requiring treatment was in short supply, research was accelerated and successfully produced an adequate synthetic. In the case of Hoja Blanca, observed Latin-American losses alerted research workers who identified and commenced increase of resistant stocks before appearance of the disease in commercial rice fields of the United States. In the case of cotton, broad experience with cost, insect resistance, and extent of problem has kept farmers, industry, extension, and research agencies at top speed just to keep the pest within bounds.

Without loss information, we'd all be working in the dark. Need for loss information before the pest appears to guide public and private research agencies is of the utmost importance. We maintain directly and cooperatively research on plant diseases, insects, and livestock diseases in several foreign countries. We will augment such research through support in countries where PL-480 funds are available for that purpose. We are making final negotiations of 17 or 18 contracts in European countries. We hope we will be able to find a way. We hope we will be able to keep some of these things away before they happen.

Of day-by-day importance is the need for information on the effectiveness of new insecticides under field conditions which may replace those to which substantial

resistance has developed, or in the increasing number of cases in which use of effective insecticides results in a residue problem. I'm not going to say anything more about the residue problem. Public research agencies must continue to cooperate with industry and regulatory agencies in the evaluation of new insecticides. Public research agencies must emphasize biological control methods in appropriate areas and must pay special attention to pests of minor crops which cause serious losses to affected farmers, but which do not cause aggregate losses sufficient to justify probable research and development costs necessary for industry to develop effective pesticides. Both public research agencies and industry must have loss data so that they can project and estimate the risk taken. Neither of us has enough money to do everything.

The problem of expressing losses in terms of dollars, acres, or product amounts is a difficult one. It is recognized that increase in volume of product generally results in decrease in price. Loss is so great that if the elasticity of price with respect to the volume of agricultural products were known, we would have got a yield of 1 per cent, and a price of 99 per cent. We wouldn't quite keep up the gross return with increase in volume.

We must emphasize the importance of loss data in planning so that farmers may predict yields, total costs, and quality of product. After all, the first purpose of science is to develop methods of reliable prediction. I am reluctant to criticize use of dollar loss estimates since they are so readily understood by the public but they should always be accompanied by explicit statements qualifying them or they should be modified by the elasticity characteristic of the particular commodity by a qualified economist. This is a pious statement. We are going to use dollar estimates—but at least we ought to understand what they mean, then use them deliberately.

In summary, farmers, public agencies, and industry need data for losses from agricultural pests, both realized and potential, to guide control, eradication, manufacture, research, and development. These estimates should include factors of human health, comfort, and satisfaction as well as economic loss.

Importance of Loss Data To Industry

Dr. R. H. Wellman
Union Carbide Chemicals Company

I would like to compare the market data available to our industry today with the data which is available to automotive industry. It is an industry for which a wealth of statistics are available. The automotive people know about the average, the range, and the distribution of incomes broken down by city and by county. They know whether income is expanding or contracting. They know the age and the make of the cars that are now on the road. They know the number of new households that are being formed. They know the miles and conditions of roads built and being built in this country. They know the number of two-car garages. They know how far people commute in various areas. They know the availability of public transportation. They know all kinds of other statistics that govern their predictions, and guide the planning and conduct of their business, but they still can't predict in one year exactly how many cars will sell. They end up many years with some cars that have to be sold before new models come out.

In the pesticide business, however, we frequently end the year with an inventory of 30, 40, or 50 per cent of specific products we started out to sell. This is

because accurate market data is not as available to us as it is to the automotive industry, and most other industries. In addition, the forces of Mother Nature—which cause unpredictable developments in weather conditions and insect infestations—are tremendous factors in determining the volume of any one pesticide sales season. I suppose the kind of thing we are trying to do when we make our annual market forecast could be likened a little bit to finding a black fly on a black cow in a field of charred stubble at midnight on a moonless night.

We are all trying to get food to the consumer at a reasonable price. The farmer's aim is to try to produce more and more efficiently. That is our business too. Neither of us is efficient if we don't do this the best possible way we can. Loss data is important to the farmer, and it's important to us. It takes 7 to 10 years to bring a pesticide from its inception to its maturity. We have an insecticide coming along called SEVIN. It is 7 years since we started on it. In this industry we have to start gambling 7 to 10 years before we are going to get our money back. The stakes for a new pesticide have been variously estimated at 1.5 to 3 million dollars. Producing a new pesticide is similar to playing poker. The more you know about the game and what cards make a winning hand the better off you are. Therefore, from the very inception of an agricultural chemical, loss data is extremely important. It tells us what areas to do research in and how much we can afford to spend doing it.

The next step where loss data is important to us is when approaching management. In any company there is always competition for dollars. Maybe somebody else has a project that sounds as good as yours. There is never enough money to satisfy everyone's wants. So the more concrete facts you have to convince your management your project is sound, the more chance you have of getting financial support. When you consider building a plant that is going to cost several millions of dollars, your management wants and needs to know why they are doing it.

An area particularly important to an industrial research worker, I believe, is that of the appearances of new pests and losses that follow. And a good current system of loss data would do as much as anything in stimulating industrial workers in trying to find a proper pesticide for the new pest.

Knowing how much a pesticide is worth to the grower is another area in which industry needs loss data badly. We aren't going to be able to sell a pesticide that costs more than the grower is able to pay. One of the ways we can conduct our industry most efficiently is to kill those materials that aren't going to make the grade.

If I may divert just a little I would like to point out that the pesticide industry, through the handling and pricing of DDT, did itself a disservice. We were opening a new era of organic pesticides with an effective new compound and it was priced far below what it was worth to the farmer. It may not be obvious why this was a disaster. I think if you will inspect it a little, you will see why. Many companies have gone out of this business because the return was too low. Further there has not been financial incentive to do the expensive research to bring out the new products to benefit the farmer in the future.

For contrast, let us turn to the pharmaceutical industry which has brought out a succession of new compounds. The industry is growing rapidly and research is continuing to expand. They are offering a service to consumers and they know what their service is worth.

The return on all chemical industry was about 15 per cent as late as 1956. The return on the agricultural chemical industry that year was estimated at six per cent. It cannot be an active growing industry with that kind of pricing.

There is another area in which loss data—and good loss data—is very important. Our industry is facing a time in which it may develop a very bad name. There have been many groups who have said we are doing tremendous damage to wildlife. There are very few facts available to support this. We know we do a lot of

good for wildlife. But, we need to know how much good we do—both for forests and wildlife. We need to know how much good we do for crops. If we get these facts, then I think we can assure the public that we are doing good. But to argue pro or con without facts—this is a useless argument and will cause our industry harm. We are told insects cause seven times as much damage to forests as forest fires do. This is a nice generalization. If it is true, then we in industry should start working to find measures to control these forest insects. We need to know where to start.

From a business standpoint, if we had precise information about losses by geographical area this would be a tremendous help in scheduling where we should put our technical and sales representatives in the field, where and to what extent we should warehouse our materials, and where we should advertise locally. The knowledge of loss by farm, and how many farms are affected, would do a great deal in intelligent formulation of a distribution program.

We need to know the year-to-year variations in crop losses. This would help us greatly in inventory control; in realizing the risk we are taking with a product. If in the apple scab market year-to-year variations of sales fall into the 50 per cent range, then our risk is less in this market than some of the others. In the Delta, for example, the range of variation of cotton insecticide sales may be 200 per cent.

We are not trying to minimize the data that already exists about insects. We rely heavily on the publications available today. Sometimes, however, I think it is unfortunate that we have to put more weight on this information than it has been designed to support. In many cases, the people who prepared it specifically point out shortcomings of their methods of data collection, and the estimates on which they have based their findings. I don't think they would take offense if I say that some of the loss data which has been made available could be compared to the reading on that clock in the back of the room. It is running and I think it says it is morning, but I would hate to try to catch a train by that clock. It seems to be off by at least an hour.

We need more complete information on pests and losses that goes far beyond anything we now have. We need loss data on a current basis, year by year, for each pest—by area—even by county. We need to know when that loss has occurred, or is likely to occur. Having this information would be the most important single factor in clearly helping our industry.

(Continued from page 2)

and discuss in detail individual problems as they applied to their field of work. Chairmen of the six subcommittees are:

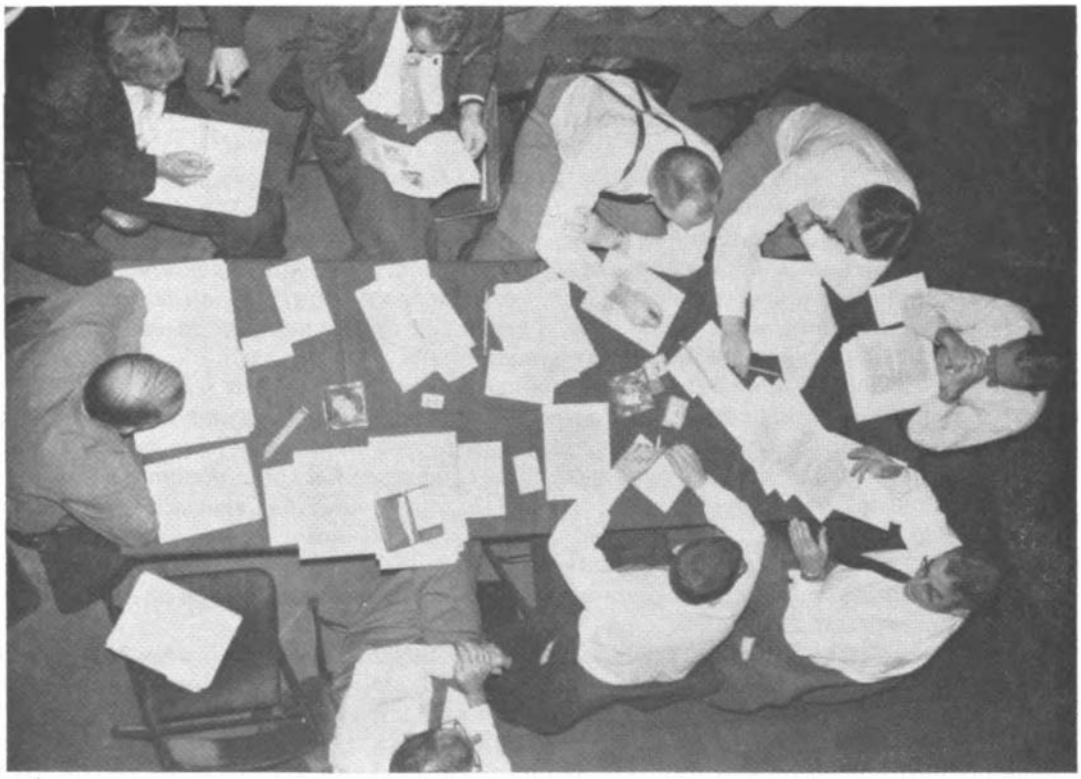
Biological Control of Soil-Borne Plant Pathogens
W. C. Snyder
Insects
H. M. Harris
Nematodes
A. L. Taylor
Plant Diseases
J. R. Shay
Vertebrates
W. W. Dykstra
Weeds
Oliver C. Lee

Separate meetings of the subcommittees were held during the first afternoon and again during the second morning. A summary of their findings are included in the *Summary of Parent Committee Meeting.*

Summary of Parent Committee Meeting

A meeting of the parent committee on Agricultural Pests was held on the afternoon of November 5. The parent committee is composed primarily of the chairman of each of the six subcommittees.

At the first conference in 1958 it was suggested that a Treatise on Methodology be published, thereby bringing together, under one cover, present data on the entire category of pesticides. Because some areas



In order to accomplish in two days all the work that had to be done, the 61 guests at the Conference on Agricultural Pests were divided into their respective subcommittees. Except for occasional breaks the six subcommittees worked continuously bringing to a close more than seven years of hard effort.

have rather detailed reports already available and other areas practically nothing, it was decided to forego a treatise for the time being. Instead, each of the subcommittees agreed to prepare a guide to research needs which would point out areas needing more research. These guides would also serve to stimulate study of methods and collection of loss data and explain ways of using these data once obtained.

Biological Control Symposium

A symposium dealing with the principles and research needs in the area of soil pathogens, root hosts, and other mechanisms affecting biological control was proposed by the Subcommittee on Biological Control of Soil-Borne Plant Pathogens. This symposium is being planned for 1961 and the proceedings will be published so that they can be used as a basic reference point for research needs.

Since the November 4-5 Conference, the National Academy of Sciences—National Research Council has authorized the Agricultural Board to acquire up to $70,000 for supporting such a symposium and publishing the proceedings.

Resolutions on Losses and Aerial Survey

It is recognized that informing administrators of the nature and importance of the losses studies is essential in order that facilities and funds can be made available to research workers. Such a resolution was prepared and referred by the Committee on Agricultural Pests to the Agricultural Board. The Committee also acted on a suggestion that the study of aerial surveys should be encouraged and approved a resolution to the Board on this subject. These resolutions have been approved by the Executive Committee of the Agricultural Board and by the Division of Biology and Agriculture of the Academy—Research Council. They will be sent by the Board to administrators in state, federal, and other interested organizations. Context of these resolutions follows.

A Resolution to Develop a Program of Research On Losses Caused by Agricultural Pests

INSECTS, nematodes, plant diseases, weeds, and wildlife compete with man for the fruits of America's farms, forests, and ranges. The damage caused by these competitors and the cost of preventing or reducing losses are important in the economy of agriculture and the country as a whole. Information now available on such losses is based largely on estimates. These estimates, while useful, are recognized as being inaccurate in many cases and there is no reliable data on many pests.

The Agricultural Board's Committee on Agricultural Pests has made progress in stimulating interest in research to develop documentable data but because of inadequate financial support research workers have been unable to make significant progress. The Committee finds that documentable data are available in only a few instances and that research on methodology and a concerted effort by responsible agencies and groups to accumulate documentable data of sufficient uniformity to permit proper summarization are essential prerequisites to an eventual compilation of the desired statistics.

The Committee on Agricultural Pests, therefore, recommends that the need for research and accumulation of reliable data on losses caused by agricultural pests and wildlife be brought to the attention of administrators in appropriate U. S. Governmental Departments, Land-Grant Colleges, industry, and other interested agencies. It is urged that due consideration be given to such research and that funds be made available to support it in developing departmental, state, regional, and inter-regional research programs.

A Resolution to Develop Further Work on Aerial Survey Research

THE Committee on Agricultural Pests recommends that the Agricultural Board take appropriate action to encourage research on the use of aerial photographic surveys during the growing season of agricultural crops to determine incidence and severity of damage caused by diseases, insects, weeds, nemas, and wildlife. An earlier project sponsored jointly by the National Academy of Sciences—National Research Council and the Office of Naval Research has demonstrated the utility of this method in detecting incidence and severity of cereal rusts (Colwell, R. N. 1956. Determining the prevalence of certain cereal crop diseases by means of aerial photography. Hilgardia 26:223-286). We believe the method offers great value for obtaining qualitative and quantitative data on the incidence and severity of damage to crops by nearly all pests, but three to five years of intensive research effort will be required before the method can be widely applied and the degree of usefulness determined.

The Committee on Agricultural Pests believes that photographic data can be widely useful for purposes other than determining the incidence and severity of damage by pests.

The Committee considered approaches to the problem of developing research on the use of aerial photographic surveys. The advice and suggestions of Dr. Colwell, University of California, were sought. Copy of a letter from him is presented here.

Dr. J. R. Shay, Head
Department of Botany and Plant Pathology
Purdue University
Lafayette, Indiana

Dear Dr. Shay:

This is in reply to your letter of November 25 in which you invite my comment on the recommendation that the Agricultural Board encourage research on the use of aerial photographic surveys to determine "incidence and severity of disease, insect, weed, and wildlife damage" to agricultural crops. I would like to make the following comments:

(1) There is a steady increase in the evidence that aerial photography is a useful tool for determining the incidence and severity of pest attacks on agricultural crops. As recently as last week I visited an orange grove which is being infested by the fungus Phytophthora (sp), and which at my request had been photographed from the air with special film-filter combinations to detect evidence of the disease, tree by tree. As predicted, evidence of the disease was virtually indiscernible on conventional panchromatic and color photographs, but could be readily seen on infrared photographs taken through a deep red filter; a few months ago I was involved in similar tests on cotton in the San Joaquin valley and Armallaria mellea on various stone fruit orchards. There is limited evidence that artichokes and other vegetable crops lend themselves to similar analysis from aerial photography. In some instances, evidence of the pest attack is more apparent or can be seen earlier on photography blown to the proper specifications than on the ground, where direct observation of the crop itself can be made. More commonly, however, the best results are to be found by combining field work with photo interpretation, rather than by setting the two methods in competition with each other.

(2) There is a need for the rather spasmodic and duplicative research now being done in this field to be integrated into a cooperative effort in which each investigator can build upon the findings of others, rather than setting out to prove everything himself.

(3) The National Academy of Sciences—National Research Council constitutes an ideal organization within which to accomplish this integration. I base this state-

ment not merely on surmise, but on actual experience during a period of nearly four years when I was conducting the NAS—NRC sponsored project on detecting cereal crop diseases from aerial photographs. I received cooperation from many agencies then that would have been most reluctant to cooperate with any private individual, or even with the University or the Federal Government. As a result, that entire study was perfomed at a cost of less than $3,000, whereas an Air Force officer charged with letting contracts for similar research said that had a contract for this work gone through his office the cost would have been in the neighborhood of $400,000. There seems to be something impressive and even phonetically appealing in the term "National Academy of Sciences—National Research Council" that instills a spirit of cooperation among even those who have little knowledge as to just what NAS-NRC is.

(4) The Committee on Agricultural Pests seems to me to be the most logical group within NAS-NRC, as presently constituted, to assume leadership in this undertaking. This does not mean that all crop damage that might be detected by photo interpretation is attributable to "pests." In its present state of development aerial photography seems to be excellent for distinguishing between vigorous and non-vigorous agricultural crops, but rather uninformative in itself as to the exact cause for loss of vigor, whether due to disease, insects, mineral deficiencies, mineral toxicities, too much water, too little water, frost damage, sun-scald, brows damage, weed infestation, or what not. As I visualize the matter, the main research yet to be done in this field is that designed to arrive at means of telling more specifically what the cause is for loss of vigor on a particular crop in a particular field. This in turn may necessitate the devising of means for identifying various types of crops, even in the healthy state, on aerial photographs.

You may recall that when I did my work on the photo interpretation of cereal crop disease for NAS-NRC, I did so as chairman of a Subcommittee on Crop Geography and Vegetation Analysis of the Committee on Plant and Crop Ecology. Somewhere in this batch of words should be the title which defines the area of investigation which I believe constitutes a logical unit. If I were to pick an appropriate phrase it would probably be: "Photo Interpretation as an Aid in Crop Analysis." But even research integrated under this title might logically be integrated by the NAS-NRC Committee on Agricultural Pests, in my opinion.

(5) In reply to your invitation or "suggestions on the possible organization of such a research unit," this probably is a matter that merits more careful thought than I have been able to give it thus far. My initial reaction is that you need three types of people

within such a unit: (a) pest experts, such as are embodied in your Committee on Agricultural Pests as it is presently constituted; (b) photographic-photo interpretation experts, who know photographic films, filters, cameras, processing and printing techniques, methods for image enhancement, and methods for extracting information from photographs; and (c) cooperation-getters, i.e., men like Cyril J. Staud, in charge of research for Eastman Kodak, who can pledge cooperation of Eastman and of other agencies who stand to profit from successful development of new uses for their product; or Leon Eliel, past president of Fairchild Aerial Surveys; or Virgil Kauffman, president of Aero Service Corporation; or Dr. H. A. Rodenhiser, whom you mentioned in your letter, and who has demonstrated his ability to get the cooperation of federal and university agricultural experiment stations, where tests might most economically and efficiently be conducted; or Dr. Louis Quom, or Orr Reynolds of the Office of Naval Research who can secure the cooperation of military agencies. In this regard you should know that there is an Interservice Committee of Photo Interpretation Research, Keys and Techniques within the Armed Forces, through whom maximum cooperation of the armed forces might be achieved. When I was the Navy member of that committee, its approval of photo interpretation research projects of military interest did much to assure such cooperation. Perhaps a member of that committee should also be a member of the research unit to which you refer.

One final point: The American Society of Photogrammetry is sponsoring the preparation of a "Manual of Photo Interpretation" which will be published next March or April. This book is nearly 1,000 pages long, and has more than 700 black-and-white photos and 16 pages of color aerial photographs. During the five years that this Manual has been in preparation, I have been the so-called "Editor-in-Chief," and have secured contributions from more than 100 experts on photo interpretation. One of the most important chapters in this Manual is entitled, "Photographic Interpretation in Agriculture" and in it there is a rather lengthy discussion of the present status of aerial photography as an aid in determining damage to crops and predicting crop yields.

Sincerely,

/S/ Robert N. Colwell

Robert N. Colwell
Professor of Forestry
University of California

ATTENDANCE

Committee on Agricultural Pests

Dutton, W. C.	Chairman of Committee Retired Assistant Director, Agricultural Chemical Research, The Dow Chemical Co., Midland, Michigan (Mail address: 523 Bailey Street, East Lansing, Michigan)
Dykstra, Walter W.	Staff Research Assistant Fish and Wildlife Service Department of the Interior Washington 25, D. C.
Haller, H. L.	Assistant to the Administrator Agricultural Research Service, U.S.D.A. Washington 25, D. C.
Harris, H. M.	Head, Department of Zoology and Entomology Iowa State University Ames, Iowa
Lee, Oliver C.	Professor, Department of Botany and Plant Pathology Purdue University Lafayette, Indiana
Shay, J. R.	Head, Department of Botany and Plant Pathology Purdue University Lafayette, Indiana
Snyder, William C.	Professor and Assistant Head, Department of Plant Pathology University of California Berkeley, California
Taylor, A. L.	Principal Nematologist in Charge Nematology Section Agricultural Research Service U.S.D.A. Beltsville, Maryland

Speakers and Guests

Byerly, T. C.	Deputy Administrator Agricultural Research Service U.S.D.A. Washington 25, D. C.
Wellman, R. D.	Manager, Agricultural Chemicals Division Union Carbide Chemicals Company New York, New York
Hitchner, Lea	Executive Secretary, National Agricultural Chemicals Association Washington, D. C.
Dreessen, Jack	Herbicide Specialist, National Agricultural Chemicals Association Washington, D. C.

Campbell, F. L.	Executive Secretary, Division of Biology and Agriculture National Academy of Sciences-National Research Council Washington 25, D. C.

Subcommittee on Biological Control of Soil-Borne Plant Pathogens

Snyder, William C.	Chairman of Subcommittee Professor and Assistant Head, Department of Plant Pathology University of California Berkeley, California President, American Phytopathological Society
Baker, Kenneth F.	Professor, Department of Plant Pathology University of California Los Angeles, California
Clark, F. E.	Microbiologist, Soil and Water Conservation Research Division U.S.D.A. Fort Collins, Colorado
Miller, L. I.	Plant Pathologist, Virginia Polytechnic Institute Tidewater Research Station Holland, Virginia
Presley, John T.	Plant Pathologist Head, Cotton Disease Section U.S.D.A. Beltsville, Maryland

Guests

Koch, L. W.	Director, Research Station Canada Department of Agriculture Harrow, Ontario, Canada
Katznelson, H.	Director, Microbiology Research Institute Canada Department of Agriculture Central Experimental Farm Ottawa, Canada
Stotzky, Guenther	Microbiologist, Central Research Laboratories United Fruit Company Norwood, Massachusetts
Menzies, J. D.	Microbiologist, Irrigation Experiment Station U.S.D.A. Prosser, Washington Chairman, W-38 Western Regional Project
Baker, R. R.	Associate Professor of Plant Pathology Colorado State University Fort Collins, Colorado

Subcommittee on Insects

Harris, H. M.	Chairman of Subcommittee Head, Department of Zoology and Entomology Iowa State University Ames, Iowa President elect, Entomological Society of America
Decker, George C.	Chief Entomologist, Illinois Natural History Survey Past President, Entomological Society of America
Newsom, Dale	Professor and Head, Department of Entomology Louisiana State University Baton Rouge, Louisiana Governing Board, Entomological Society of America
McCauley, W. E.	Manager, Production and Sales Development Department Shell Chemical Corporation New York 20, New York
Pepper, Bailey B.	Professor and Head, Department of Entomology Rutgers University Chairman, Insect Losses Committee, Eastern Branch ESA

Guests

Apple, James W.	Professor of Entomology University of Wisconsin Madison, Wisconsin Chairman, North Central Branch, ESA
Eden, W. G.	Professor, Alabama Polytechnic Institute Auburn, Alabama Committee on Insect Losses, Southeastern Branch ESA
Hastings, Ellsworth	Professor of Entomology Montana State College Bozeman, Montana Representing Pacific Branch, ESA
Jones, M. P.	Extension Entomologist, Office of Experiment Station U.S.D.A. Washington 25, D. C. President, Entomological Society of America
Oman, Paul W.	Chief, Insect Identification and Parasite Introduction Branch Entomological Research Division U.S.D.A. Washington 25, D. C. Immediate Past President, Entomological Society of America
Parencia, C. R.	Entomologist, Field Crop Insects and Bee Culture Research Division U.S.D.A. Chairman, Committee on Insect Losses, Southwestern Branch, ESA

Subcommittee on Nematodes

Taylor, A. L.	Chairman of Subcommittee Head, Nematology Section U.S.D.A. Beltsville, Maryland
Christie, J. R.	Nematologist, Department of Entomology University of Florida Gainesville, Florida
Raski, D. J.	Chairman, Department of Plant Nematology University of California Davis, California

Members not present

Sasser, J. N.	Associate Professor, Department of Plant Pathology North Carolina State College Raleigh, North Carolina
Mai, W. F.	Professor of Plant Pathology Cornell University Ithaca, New York

Subcommittee on Plant Diseases

Shay, J. R.	Chairman of Subcommittee Head, Department of Botany and Plant Pathology Purdue University Lafayette, Indiana
Kelman, A. W.	Professor, Department of Plant Pathology North Carolina State College Raleigh, North Carolina
Miller, P. R.	Mycology and Plant Disease Reporting Section U.S.D.A. Beltsville, Maryland
Pound, G. S.	Head, Department of Plant Pathology University of Wisconsin Madison, Wisconsin Immediate Past President, American Phytopathological Society
Utter, L. G.	Diamond Alkali Company P. O. Box 348 Painesville, Ohio
Zentmyer, G. A.	Professor, Department of Plant Pathology University of California Riverside, California Secretary, American Phytopathological Society

American Phytopathological Society Committee Members

Carter, J. C.	Head, Plant Pathology Section Illinois Natural History Survey Urbana, Illinois

LeClerg, E. L.	Chief, Biometrical Services U.S.D.A. Beltsville, Maryland
Smith, A. L.	Professor, Department of Agronomy Alabama Agricultural Experiment Station Auburn, Alabama
Stout, G. L.	Head, Bureau of Plant Pathology California Department of Agriculture Sacramento, California
Taylor, A. L.	Head, Nematology Section U.S.D.A. Beltsville, Maryland
Miller, P. R.	Past President
Shay, J. R.	Councilor-at-Large

Subcommittee on Vertebrates

Dykstra, W. W.	Chairman of Subcommittee Research Staff Assistant United States Fish and Wildlife Service Department of the Interior Washington 25, D. C.
Howard, Walter E.	Specialist, Vertebrate Ecology University of California Davis, California
Lindzey, J. S.	Chief, Section of Upland Ecology and Management Patuxent Wildlife Research Center Laurel, Maryland
Merrill, H. A.	Assistant Chief, Branch of Predator and Rodent Control United States Fish and Wildlife Service Department of the Interior Washington 25, D. C.
Swift, L. W.	Chief, Division of Wildlife Management United States Forest Service U.S.D.A. Washington 25, D. C.

Advisor

Dambach, Charles A.	Director, Natural Resources Institute Ohio State University Columbus 10, Ohio

Representatives from proposed parallel committees

Kolbe, E. L.	Forester, Western Pine Association Yeon Building Portland 4, Oregon
Keith, James	Rocky Mountain Forest and Range Equipment Station P. O. Box 1349 Grand Junction, Colorado