The Role of University Workers in the Problems of Pesticide Information

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The universities stand in an intermediate position between government and the public, including industry among the latter. Thus through the experiment stations there is official responsibility for recommendations for pest control which must not lead to trouble for the farmer because of heavy loss, from too costly programs or from excessive residues. On the other hand, the producers of new pesticides look to the universities for recognition and recommendation of their products. Thus it is essential that information on new regulations be received promptly and that the identity and proper uses of new materials be ascertained both from manufacturers and by original experiments. Such information is not in the textbooks but must be exchanged through journals, such as the *Journal of Economic Entomology*, in station circulars and bulletins, in governmental reports such as the announcements of registration and tolerances in the *Federal Register*, and in the information sheets of industry. It is no simple matter to even be aware of all the important sources of information. Many experiment stations maintain special collections of such publications and have technical librarians and experts in agricultural chemistry, pest control, etc., charged with advising other officials and researchers.

For university researchers and administrators the problem of keeping abreast of information on pesticides is really the same as for government and industry workers with this difference—that the plans of government regarding new regulations and the new and still unannounced discoveries of industry come to us only through confidential channels. Of course, published material is available and the only limitation is its vast bulk and the press of other duties. This doubtless accounts for a general tendency to specialize in certain areas, *e.g.*, an entomologist responsible for protection of fruit trees pays little or no heed to what is happening in the residue picture for vegetable, and *vice versa*. Or, a residue chemist will know all about analytical procedures but nothing about the pests for which his samples were treated.

This specialization is inevitable and probably is beneficial for the research workers of experiment stations but it is not good for students. I wish to emphasize for a moment the special difficulties involved in training the future productive workers in the subject of pesticides, for this is of necessity a function and duty largely the universities' own. A goodly number of institutions in the United States have programs for those students who wish to specialize in pesticides. These vary greatly in content but in general consist of one or more undergraduate courses plus research programs for graduate students leading to the M.S. and/or Ph.D. degrees. In its entirety the subject "Pesticides" covers an enormous range of topics, which may be grouped under:

(a) Chemistry, such as the properties of pesticides, their detection and quantitative analysis, especially in very minute amounts, and changes undergone after exposure to the atmosphere, sunlight, etc.

(b) Biochemistry, *i.e.*, the changes that pesticides undergo in living tissues of plants, insects, and animals.

(c) Pharmacology, the effects produced in living organisms.

(d) Entomology, the selection of the proper pesticide and formulation for each pest or group of pests.

(e) Engineering, the various methods of application, dispersal, and buildup on surfaces.

(f) Mathematics, interpretation of data, and estimation of confidence to be placed in results such as those from bioassay.

(g) Languages, in order to understand what is published in many other tongues and available in English only in brief abstracts.

To understand the particular problems involved in each of the above categories, a rather broad knowledge of the background sciences is needed. This is something of a lifetime job and impossible for a student. Undergraduate courses usually are built around a textbook, and several pesticide specialists have bravely attempted to write a text for class use. In our experience at Berkeley, none has been adequate, doubtless because among such a host of subjects, different teachers are bound to select different ones for presentation to beginners. There is great need for a textbook on pesticides but general agreement on what should be considered fundamental is necessary first. Probably there is no single answer, for the practical entomologist or plant pathologist needs to know considerable about the suitability of each pesticide for various uses, its toxicity toward plants and animals, and the tendency to persist on treated materials, and he usually is impatient with any more details concerning dispersed systems, membrane action, distribution between phases, capillary and surface action, all of which are involved in a deeper understanding of the behavior of sprays and dusts. And he will neither understand nor appreciate a discussion on the biochemical complexities of toxic action. On the other hand, an introduction to these and many other fundamental matters should be given as early as possible to those students who intend to specialize in insect toxicology, in order to give them a background and time for advanced work as graduate students.

For instruction at the graduate level, textbooks on various background subjects, *e.g.*, chromatography, population genetics, general biochemistry, are useful but for pesticides only the original literature is of much use. This is scattered in many journals and station, governmental,

and industry reports. It is futile to expect students to find what is important and hence a principal function of a university teacher is to help his students find what they need. A large reprint collection is useful here and I have encouraged my students to start their own at an early stage of their student days.

In brief summary, the problems of information on pesticides are especially difficult for university researchers, agricultural advisors, and teachers because, on the one hand they have the responsibility of recommending measures for pest control, but little or no voice in formulating regulations regarding residues that steadily are being imposed by governmental agencies. On the other hand, the growing mass of information on pesticides makes it well nigh impossible to give the proper instruction to students whose future activities will range from very practical use of pesticides to research on fundamental problems of toxic action.

Problems in Handling Pesticide Information

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The problems I shall discuss are those which may be categorized as

1. Current Awareness
2. Retrieval
3. Correlation
4. Standardization

Viewed in isolation, the size and growth of the pesticide literature are quite manageable as scientific literature goes. The number of pesticide books, such as those by Frear, Metcalf, etc., published yearly is remarkably small, and total number of significant books which have been written fill from three to four shelves in a library. About two dozen journals throughout the world account for over 90% of the significant pesticide articles being published. These articles number less than fifty per week, and most are concerned with the pesticidal activity of a specific or generic pesticide; the next most written about area is residue analysis. The world's output of pesticide patents is approximately thirty per week, of which, however, at least one-third are counterparts. The patent literature for the most part is concerned with the use of organic chemicals as pesticides.

The scientist engaged in pesticide research and development views the pesticide literature not in isolation but as a part of the total literature. This is the root of both the current awareness and retrieval problems of the pesticide scientist. Indeed, these problems will persist as long as mission-oriented scientists must use discipline-oriented information services for their information needs. Information services, such as Chemical Abstracts, Derwent, and Information for Industry, classify and index a document from the pesticide viewpoint only when the document discloses this objective. They index organic chemicals from the nomenclature viewpoint, not from the toxophoric group viewpoint as needed by the pesticide scientist. For these information services to do otherwise would be a disservice to a majority of their subscribers. This is not to say, however, that information services could not do a better job for their mission-oriented users. I suggest that the first step in this direction should be taken by the mission-oriented users. For the pesticide scientists, the Pesticide Subdivision of the Division of Agricultural and Food Chemistry is a natural vehicle for engaging the cooperation of information services to increase the effectiveness of these services for both awareness and retrieval. The ultimate, of course, is a Pesticide Information Service, comparable to that of the American Petroleum Institute's petroleum information service. Time is not available, however, to consider the pros and cons of this approach.

One of the greatest needs of pesticide scientists is a mechanism for the correlation of chemical moieties and functional groups with toxicological data. This is an area in which information and pesticide scientists may gainfully join forces. Solutions to this problem will contribute towards controlling the vast amount of apparently unrelated data resulting from pesticide research activity and contribute towards our understanding of the underlying principles governing the relationships between pesticides and pests.

Low reliability and lack of consistency of toxicological data in the literature have been a most frustrating problem, a problem which can be eliminated by a cooperative effort. Standardization of analytical methods is another area which is amenable to a cooperative effort. The most obvious solution to these problems is an ASTM for pesticides.